ISSN: 1300-915X

# IOJPE

## INTERNATIONAL ONLINE JOURNAL OF PRIMARY EDUCATION

International Online Journal Of Primary Education

Volume 10 Issue 1

# International Online Journal of Primary Education

**ISSN: 1300-915X**

**JUNE 2021**

**Volume 10 – Issue 1**

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**Message from the Editor,**

I am very pleased to inform you that we have published the first issue in 2021. As an editor of International Online Journal of Primary Education (IOJPE), this issue is the success of our authors, very valuable reviewers who undertook the rigorous peer review of the manuscripts, and those of the editorial board who devoted their valuable time through the review process. In this respect, I would like to thank to all reviewers, researchers and the editorial board members. The articles should be original, unpublished, and not in consideration for publication elsewhere at the time of submission to International Online Journal of Primary Education (IOJPE). For any suggestions and comments on IOJPE, please do not hesitate to send me e-mail. The countries of the authors contributed to this issue (in alphabetical order): Australia, Ghana, Kenya, Nigeria, Sweden, Turkey, United States, and United Kingdom.

Prof. Dr. Sinan OLKUN

**Editor in Chief**

**ISSN:** 1300-915X

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ISSN: 1300-915X

IOJPE

ISSN: 1300 – 915X
www.iojpe.org

*International Online Journal of Primary Education* *2021, volume 10, issue 1*

# A LONGITUDINAL STUDY: EMERGENT BILINGUALS' HERITAGE LANGUAGE USE AND LEARNING OVER TIME

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**Received:** March 02, 2021 **Accepted:** April 15, 2021 **Published:** June 30, 2021

**Suggested Citation:**
Lee, C. (2021). A longitudinal study: Emergent bilinguals' heritage language use and learning over time. *International Online Journal of Primary Education (IOJPE), 10*(1), 1-18.



**Abstract**

This article discusses a comparison of the two focal primary school third-grade Korean bilingual students' language use with their previous language use when they were first-graders by examining their heritage language (HL) use at a Korean language school. For children of immigrant families in the U.S., there has been a pervasive hypothesis that their heritage language (HL) might be jeopardized due to their minimum exposure to it and its reduced status in the U.S., which can easily lead them to experience HL shift or loss (Montrul, 2018; Valdés, 2014). However, the present study shows that the focal third graders who were attending all-English schools during the week did not appear to lose their HL. Instead, the comparison of findings indicated that they had developed a certain degree of oral proficiency in their HL, including vocabulary knowledge, thanks to the parents' involvement and practices towards their children's HL learning as well as other socio-cultural influences on the students' HL language use and development over the years.

**Keywords:** Heritage language, Korean students, immigrant family, bilingualism, biliteracy.

## INTRODUCTION

Since the Immigration Act of 1965, the number of immigrants to the United States has proliferated. Throughout the 1980s, approximately 18 million immigrants resided in the U.S., and the number has continued to increase (U.S. Census Bureau, 2018). Today, among approximately 44 million immigrants in the U.S., the second-generation U.S.-born children of immigrants represent 38 million, consisting of almost 15 percent of the population. The influx of immigrant children in the U.S. brings scholars' and researchers' attention to heritage language (HL) maintenance and development. However, research to date has paid more attention to immigrant children's English development than their HL learning (August & Shanahan, 2010; Goldenberg, 2011). For example, a number of researchers investigated how immigrant children developed their English language proficiency and literacy skills (e.g., Golberg, Paradis, & Crago, 2008; Rodriguez-Mojica, 2017; Yang, Fox, & Jacewicz, 2015).

Yet, comparatively, little attention has been given to immigrant children's language and literacy development in their HL (Goldenberg, 2011; Seals & Peyton, 2017; Szilagyi & Szecsi, 2020). Furthermore, the majority of HL studies have focused on adolescent or adult HL learners by emphasizing the HL shift or loss phenomenon (Elabbas, Montrul, & Polinsky, 2013; Scontras, Fuchs, & Polinsky, 2015; Valdés, 2014). Limited studies are devoted to the issue of HL maintenance and development in early childhood; thus, we know less about second-generation immigrant children's HL learning trajectory. As Montrul (2018) suggested, investigating bilingual children's longitudinal language use and development can explain what is happening to their HL learning and bilingualism during their school years.

Since HLs are regarded as minority and under-representative languages in the host country (U.S.), they are less recognized, unacknowledged, or even unappreciated by the society of origin (Polinsky & Kagan, 2007). Thus, HL maintenance is often endangered and threatened as the use of the dominant

language (English) is favored in mainstream society (Valdés, 2014). Several researchers reported that when emergent bilingual children attended U.S. classrooms taught only in English, they often lost or did not continue developing their HL (Montrul, 2018; Ro & Cheatham, 2009; Shin, 2005; Polinsky, 2011, 2018). Researchers in HL studies reported that HL shift or loss had largely occurred not only with Latinx students (Beaudrie, Ducar, & Potowski, 2014; Gandara & Hopkins, 2010; Potowski, 2016) but also with Korean children in the U.S. (Lee & Wright, 2014; Shin & Lee, 2013).

In terms of Korean immigrant families in the U.S., Korean immigrant parents often decline bilingual education services (Lee & Jeong, 2013; Shin, 2005) because many of them believe that their children's Korean literacy skills have little direct relevance to their U.S. school performance, while the mastery of English directly impacts their children's success in school (Shin, 2014). The parents' desire for their children to have educational success and prestigious careers in the future leads them to immerse their children in English-only instruction (Kim & Pyun, 2014; McCabe, 2016). Although Korean parents may not support their children's enrollment in bilingual education, they often hold positive attitudes toward their children's HL development and consider the role of HL schools to be critical for their children's HL learning (Lee & Jeong, 2013; Shin, 2005). Hence, many Korean parents financially support Korean HL schools and send their child(ren) to the Korean HL, which their children attend on weekends (Lee & Wright, 2014; Shin & Lee, 2013).

Despite the support by parents and community for Korean children's HL learning, previous studies reported that among Asian ethnic groups in the U.S., Korean children were less likely to maintain their HL at home than other Asian ethnic groups (Kondo-Brown, 2011; López, 1996). Murphy (2014) correspondingly reported that Korean children's HL loss is a natural process among Korean immigrants in the U.S. because of the exposure to the English language in American schools and the mainstream culture. Other studies further discovered that Korean immigrant children became more resistant to acquiring their HLs and are more likely to experience the challenge of preserving their HL as they get older because they were more likely to expose to the societal language (i.e., English) than their HL (Cho, 2015; Shin, 2014).

Given the HL attrition phenomenon among Korean children of immigrants in the U.S., the current study investigates two third-grade Korean emergent bilingual students' longitudinal language use. By comparing the focal students' current language use to their previous language use when they were younger, the study explores whether and to what extent the Korean bilingual learners experience any HL attrition, or they were able to develop their HL as they become older. To further identify the elements for the students' HL shift or maintenance, the study also examines the parents' practices and involvement in their children's HL learning and the role of socio-cultural influences on the students' bilingual language use over the years.

## Theoretical Framework

### Sociocultural perspective on language use and learning

Many literacy scholars' work reflects sociocultural perspectives (Gee, 2012; Halliday, 1985; Street, 2001). By emphasizing the social environment, Halliday (1985) claimed that language is not independent of the social world. According to him, language occurs within a cultural context; thus, culture is generated through language. Halliday viewed children's language development as a function of their participation in a social world because language could not be separated from the culture. Hence, Halliday considered language and communication to be social semiotics and multiple-meaning systems that involved varied modes of representation or multimodality, such as oral and written language, gestures, drawings, signs, and symbols. Researchers who studied Halliday's systemic functional linguistics reported that he was interested in the functions or purposes of humans' use of semiotic resources to interact with each other and create oral and written texts (Moro, Mortimer, & Tiberghien, 2019). Similarly, Gee's (2012) Discourses (with the capital "D") as an "identity kit" also illustrated how language is connected with social and cultural contexts. According to Gee's notion of

language, language instantiates culture because the speaker's language use varies according to social and cultural contexts.

Street (2001) pointed out that to understand literacy practices, researchers need "detailed, in-depth accounts of actual practice in different cultural settings" (p. 430). According to him, a sociocultural view of literacy emphasizes literacies that are situated in and created by participants. Street argued that literacy emerges from social and cultural practices because it involves "thinking about, doing, and reading in cultural contexts" (p. 11). Street (1984, p. 1) employed the phrase "literacy practices" by focusing on "the social practices and conceptions of reading and writing" to emphasize the social models of literacy in which participants negotiate and make meanings when they read and write in specific cultural contexts. Street (1984) distinguished between an autonomous model and an ideological model of literacy. The autonomous model of literacy is a traditional psychological approach, which views literacy as a mental or cognitive phenomenon; thus, reading and writing are treated as things people do inside their heads as technical skills. In opposition to the autonomous model of literacy, Street proposed an ideological model. The ideological model of literacy challenges the traditional model since it offers a more culturally sensitive view of literacy practices by insisting that people engage in literacy practices in society, not just inside their heads.

Since the present study is conducted in classroom settings, where the participants negotiate and make meanings during their literacy practices in certain cultural contexts, the study is consistent with Street's social view of literacies. Considering Street's argument that literacy should be studied in an integrated way by looking at social, cultural, and historical aspects beyond cognitive facets, I considered the cultural contexts and social practices when investigating the participating students' language use, performance, and development.

## Literature Review

### Understanding the phenomenon of HL attrition in the U.S.

According to Montrul (2010), HL loss occurs when an individual's primary language shifts to a new language or second language (L2) when the individual lives in an L2 environment as a result of immigration (Tse, 2001). Schmid (2010) pointed out that immigrant children are susceptible to losing their HLs if they have not fully mastered their HLs before being exposed to a new language. Most young immigrant children in the U.S. are identified as potential linguistic emigrants (Veltman, 1983) who could lose their HLs when surrounded by the English language rather than their HLs. Several researchers pointed out that when immigrant children want to be accepted into the mainstream culture (Murphy, 2014), they are more likely to engage in English practices, which consequently leads them to experience a language shift from HL to English and/or language loss in their HLs (Polinsky & Kagan, 2007; Valdés, 2014).

It is important to note that language shift and loss are related to power relations between languages. When people immigrate to a new country, the language used in the country is regarded as a dominant language, which has privilege and supremacy, and the immigrants' HLs are often regarded as minority or less privileged languages (Schmid, 2010; Veltman, 1983). For this reason, some immigrants want to assimilate into the majority culture by actively participating in the majority language group using the majority language only (Shin, 2005). Veltman (1983) explained this phenomenon as linguistic emigration. It applies to language minority groups who immigrate to a country where the majority language is considered a high prestige language since they are more likely to assimilate to the majority culture by losing their HLs and ceasing to participate in the communities of origin.

Veltman (1983) considered language minority children in the U.S. as potential linguistic emigrants who have the potential to lose their HLs. Many of them are not only massively expose to and frequently use the societal language (English in the U.S.) but also want to be accepted into the mainstream culture to avoid alienation (Murphy, 2014; Tse, 2001). These practices are likely to lead them to shift their dominant language from HL to English and eventually experience HL attrition or loss (Polinsky, 2011; Valdés, 2014). Researchers reported that language minority students in the U.S.

often undergo a language shift by mainly interacting with interlocutors of the majority language (English), which results in them failing to gain native-like proficiency in their HLs (Carreira & Kagan, 2017; Seals & Peyton, 2017).

**Immigrant parents' practices and involvement in their children's HL development**

Since HL education is given less attention and support than the societal language (English in the U.S.) outside the home, immigrant parents' role prominently plays a pivotal role in their children's HL learning and development in the home context. A number of researchers reported that immigrant parents' practices and involvement were the most significant factor in sustaining their children's HL and that parents' support was a critical element in the children's HL development (Guardado, 2010; Liang, 2018; Lü & Koda, 2011; McCabe, 2016). For example, in their quantitative literacy assessment studies with 37 first- and second-grade Chinese-English bilingual children, Lü and Koda (2011) showed that Chinese immigrant parents' HL use and literacy support at home influenced their children's language and literacy skills in Chinese (i.e., oral vocabulary knowledge, phonological awareness, and decoding skill). Similarly, in his case study involving Hispanic families in Canada, Guardado (2010) revealed the importance of parental involvement in their children's HL development by showing that the children who advanced their HL had received positive support of learning HL from their parents. The studies discovered that the parents' home literacy practices facilitated their children's HL development in the long term.

Multiple studies showed how "family language policy (FLP)" that forces the use of HL exclusively at home (Spolsky, 2012) played an instrumental role in children's HL learning and development in immigrant households (e.g., Fogle & King, 2013; Guardado & Becker, 2015; Yazan & Ali, 2018). For example, in a study with an Arabic-speaking Muslim family, Yazan and Ali (2018) showed that the parents' language ideologies and policy regarding their daughter's maintenance of Arabic in the U.S. influenced the emergence and enactment of the daughter's Arabic HL development. The major findings in the FLP studies indicate that the exclusive and consistent use of HLs by immigrant families encouraged the children to not only practice their HLs but also construct their cultural identity since heritage language-only rules at home are "tied to the families' and individuals' sense of belonging" (Hua & Wei, 2016: 65).

A considerable number of studies explored HL maintenance or loss among immigrant families from different ethnic origins. The previous studies suggested that family context, including parents' attitudes, perceptions, and home practices, played an instrumental role in their children's HL maintenance and fundamentally influenced their children's HL outcomes (Liang, 2018). The findings indicate that immigrant parents should provide adequate support for their children to develop their HL in the home setting to raise them as bilingual. The following research questions guided the inquiry:

- ✓ How did the two focal third-grade emergent bilingual students' oral language use differ from their earlier use as first graders?
- ✓ What was the role of parents' practices and sociocultural influences on the two emergent bilingual students' longitudinal language use?

## METHOD

I employed qualitative discourse analysis (Gee, 2012) methodology to document, analyze, and interpret what the selected Korean American students used languages within specific events (Bloome, Carter, Christian, Otto, & Shuart-Faris, 2004) by analyzing their ways of thinking, interacting, and speaking in the HL classroom. The study aims to examine two focal HL learners' bilingual language use over the years by comparing their current language performance to when they were in first grade. Thus, I employed a constant comparative analysis method (Strauss & Corbin, 1998) to identify patterns and functions of consistencies and differences in the focal students' language use and performance.

**Research Context**

This study primarily took place in a Korean HL school in a university town in the Midwest where 200,000 people reside. Approximately, 63% of the town population identified as non-Latinx white, 13% as Asian, and 15% as foreign-born. There were no Korean-English bilingual education programs in the local school districts. Korean parents who wanted to develop their children's HL in the town funded the Korean HL school. Thus, the school was private and designed for Korean students in the town to help their HL learning by providing formal instruction in Korean at each grade level. Most of the enrolled students were second-generation Korean Americans who were born in the U.S. after their parents had immigrated to the U.S. The school provided classes for Korean students in preschool-grade 5. The classes at all grade levels met three hours per week on Saturdays, from 10:20 a.m. to 1:20 p.m. The data collection for this article occurred during the spring semester in first-grade class in 2014 and third-grade class in 2016 at the Korean HL school.

**Participants**

This paper focused on two focal third graders who attended the third-grade HL class at the Korean HL school. The two students (Toni and Suji – pseudonyms are used) were purposely selected as the focal participants for this article since they were former participants as first graders in the pilot study conducted in the first-grade classroom in the same Korean HL school in Spring 2014. Both Toni and Suji were born in the U.S. and attended all-English schools during the school week and the Korean HL school on Saturdays. They had attended the Korean HL school since kindergarten. The students reported that they used English during the school week and Korean with their parents at home. Both Toni and Julie spent one month each year visiting relatives in Korea with their families.

The parents of the students participated in this study. They were first-generation Korean immigrants who came to the U.S. during their twenties. The two mothers of students agreed to participate in interviews with me and to keep journals about their children's language use at home. The third-grade teacher (Mrs. Joen) participated in the study. Mrs. Joen was a female native Korean speaker. She came to the U.S. three years before the data collection of this study with her husband. It was her second year as a third-grade teacher at the HL school. I was the first-grade teacher in the same Korean HL school during the data collection of the pilot study when Toni and Julie enrolled as first graders in 2014, and it was my fourth year of teaching as a first-grade teacher. I referred to myself Ms. Lee in this paper when I analyzed the findings.

**Data Collection Sources and Procedures**

**Instruction and language use in the first- and third-grade classrooms**

Instruction in both the first- and third-grade classrooms was divided into three parts. For the first 50 minutes, the teachers (Mrs. Joen and me) in each grade focused on teaching speaking and listening comprehension of the Korean language using a government-designated Korean textbook, entitled *Kuk-uh* [the Korean language]. Then, the students in each class participated in Korean book reading and in-class writing for 50 minutes each. During the reading sessions each week, both teachers brought a Korean picture book (e.g., folktale, fables). The teachers did a picture walk by showing and discussing book illustrations before reading a book, had the class take turns reading the book aloud, and then held a book discussion as a whole group. The primary language of instruction was Korean in both first- and third-grade classrooms. Although the teachers mainly spoke Korean in their classrooms, the students in both grades were allowed to use English when they raised questions or communicated with their peers.

**Audio-recording of students' talk**

The audio recordings of Toni and Julies' spoken language use when they were in the first-grade classroom had previously been collected for the pilot study. I had audio-recorded the students' talk when they participated in class discussions based on the books that the class had read together. Similarly, the audio-recordings of Toni's and Julies' current oral language use in Mrs. Joen's class occurred during Korean book reading time for 30-40 minutes each week for 14 weeks, resulting in

about 500 minutes of audio-recording from each classroom. Then, I purposefully selected Toni's and Julie's oral language use when they provided their responses and engaged in the book discussions.

**Student interviews**

The interviews with the two students took place twice after school at the beginning and end of the Spring semester. For the first interview, I asked approximately ten interview questions about their language use at home (with parents, siblings, peers, etc.), language preferences in different contexts (e.g., at home, school, other public places), and different language domains (e.g., reading, speaking, writing). For the second interview, both Toni and Julie received interview questions based on his/her language use from the audio recordings in a retrospective way. In other words, I used a preliminary analysis of their classroom language use data to discuss their language use and choice at that time of speaking. During the interviews, the students were allowed to provide their responses either in English or Korean based on their preference.

**Mothers' interviews and journals**

The mothers of Toni and Julie participated in a semi-structured and open-ended interview with me. The interview with each mother was conducted after I completed analyzing the students' first- and third-grade language use data. For the interviews with the mothers, I brought the analysis of their children's first-grade oral language use. I then shared with them their children's third-grade language use data to show any shift in their language use over the years and to discuss their HL learning trajectory. By sharing the longitudinal data during the interviews, I was able to further learn about the mothers' perspectives and philosophies on their children's Korean language and literacy learning while living in the U.S. The mothers kept their journals on two to three different days per week to record their child's language use at home when s/he participated in activities with his/her family members. I gave the mothers several examples of events/activities that could capture the child's Korean language use (e.g., when their child talked with their grandparents in Korea via Skype, when they watched Korean TV programs or movies with their child, or when their child invited their Korean friends to their house). I collected the mothers' journals at the end of the semester and had 30 journal entries from each mother.

**Data Analysis**

The transcripts of audio recordings were the main resources for this qualitative study to examine the students' oral language use over the years. The transcripts of the mothers' interviews and their journals were analyzed to corroborate the students' language use findings and to further learn about the parents' practices and attitudes toward their children's HL learning.

To seek the answer for Research Question 1 – the comparison of the two focal third-graders' oral language use to their earlier use as first graders – the transcripts of their oral discourses during book discussions both from first- and third-grade class were analyzed. The students' oral language use was examined based on whether they used Korean, English, or "translanguaging," which describes bilingual learners' strategy to utilize their *integrated* and *entire* language repertoires (García, 2009). Then, their language data when they were in my first-grade class was analyzed and compared to their current language use as third graders to document the pattern of their HL use over time. Comparing their language use in the past to their current language use as a longitudinal study helped me explore any observed different language use patterns over time.

For Research Question 2 – the parents' practices and sociocultural influences on the students' longitudinal language use – the mothers' interviews and their journals were analyzed to identify any regular practices that the parents performed at home with their children. The interview results provided additional information about the families' home language use and relevant language and literacy practices that could influence their children's longitudinal language use.

ISSN: 1300 – 915X
www.iojpe.org
2021, volume 10, issue 1

## RESULTS

### Comparison of Focal Students' Oral Language Use between First and Third Grade

Table 1 compares Toni and Julie's language use during classroom interactions when they were first and third graders. The table displays how often Toni and Julie used Korean, English, and translanguaging when they spoke in both grades.

**Table 1.** Comparison of Toni and Julie's oral language use between first and third grade

| | | Only Korean | Only English | Word-level translanguaging [a] (English words in Korean speech) | Word-level translanguaging [b] (Korean words in English speech) | Frequency of TL at sentence-level [c] (Korean to English and vice versa) |
|---|---|---|---|---|---|---|
| **1st grade (Spring 2014)** | Toni | 36 (12%) | 122 (41%) | 138 (46%) | 4 (1%) | 91 times |
| | Julie | 41 (13%) | 98 (32%) | 163 (53%) | 6 (2%) | 87 times |
| **3rd grade (Spring 2016)** | Toni | 182 (51%) | 32 (9%) | 138 (38%) | 8 (2%) | 30 times |
| | Julie | 196 (49%) | 38 (8%) | 170 (41%) | 9 (2%) | 26 times |

*Note.* [a] Intra-sentential switching within a single utterance when the students inserted English words as they spoke in Korean.
[b] Intra-sentential switching within a single utterance when the students inserted Korean words as they spoke in English.
[c] Inter-sentential switching between the utterances (Korean to English and vice versa).

### Increased use of Korean when speaking in third grade

As shown in Table 1, when Toni and Julie were in first grade, they both spoke more in English than in Korean (41% in English vs. 12% in Korean for Toni; 32% in English vs. 13% in Korean for Julie). Conversely, their third-grade language use revealed that they spoke more in Korean than in English (51% in Korean vs. 9% in English for Toni; 49% in Korean vs. 8% in English for Julie). Both Toni and Julie still engaged in word-level translanguaging when they were in third grade, but the frequency of inserting English words when they spoke in Korean decreased (from 46% to 38% for Toni; from 53% to 41% for Julie). The frequency of their sentence-level switching (from Korean to English and vice-versa) was also less observed in their third-grade classroom (from 91 to 30 times for Toni; from 87 to 26 times for Julie). In other words, there was increased use of Korean and a decrease in their use of English when they were in third grade compared to when they were in first grade.

### Development of vocabulary knowledge in Korean

The focal students' increased vocabulary knowledge in Korean appeared to play a role in their increased use of Korean as third graders. Comparing Toni's language use in Figure 1 (in first grade) and Figure 2 (in third grade) shows evidence of his vocabulary gain in Korean. As shown in Figure 1, Toni (first grader) translanguaged into English for the words "favorite part" (turn 2) when he responded to my question about the book that the class read. When Toni was asked how to say the words in Korean, he stated that he knew how to say "like" but did not know the word "favorite" in Korean. In other words, Toni (as a first grader) translanguaged into English for unknown words to complete his response, which performed as a communicative purpose. (English translations are provided within the brackets. Translanguaged words are underlined in the English translation.)

1. Ms. Lee: 너네 은혜 반 친구들이 이름이 담긴 병 만든 거 기억해?
   [Do you all remember the part when the classmates created the name jar for Unhei?]
2. Toni: 네, 그거 내 favorite part 에요.
   [Yes, that was my favorite part.]

**Figure 1.** Toni's (first grade) translanguaging for unknown Korean words

Analysis of Toni's third-grade language use in Figure 2 demonstrated that he had acquired the word ("favorite") in Korean. Toni's response to Julie's question included the Korean word (the bold and italicized Korean word; turn 2) for "favorite" (turn 2). Yet, Toni later incorporated the word "favorite" in English in his Korean utterance (turn 4). It seemed that Toni spoke the word in English instinctively (turn 4) as he responded to Julie's praise (turn 3). In the interview, Toni explained that he sometimes used English because speaking in English is natural behavior as a bilingual. He stated that "I used English because sometimes I naturally spoke in English without knowing or realizing because I speak both Korean and English when talking to other bilinguals." Toni's third-grade language use example indicates that he had developed his Korean vocabulary knowledge but drew from his dual lexicon (bilingual vocabulary) to communicate with his bilingual audience. Toni's third-grade language use example displays not only his Korean vocabulary gain but also his flexible use of dual lexicon through translanguaging as a bilingual speaker's communicative strategy.

1. Julie: 누가 이거 할래?
   [Who wants to do this game?]
2. Toni: 나 할래. 이거 내가 ***제일 좋아하는*** 게임이야.
   [I will do it. That is my favorite game.]
3. Julie: 엄청 잘한다
   [You are so good at this.]
4. Toni: 내가 말했지? 내 favorite 이라고!
   [I told you that it was my favorite!]

**Figure 2.** Toni's (third grade) demonstration of Korean vocabulary gain and flexible use of dual lexicon

Figure 3 shows a similar pattern when comparing Julie's language use between the first and third grades. In Figure 3, Julie translanguaged into English for the words "shy" and "nervous" (turn 2) when responding to my question (turn 1). When she was asked how to say the words in Korean, she described the characteristics of being shy and nervous by using the English words ("face red" and "heartbeat" for the word "shy" and "worry" for the word "nervous"). However, she stated that she did not know the corresponding words in Korean (turn 4). Julie's response in turn 4 indicates that she could explain the definitions of the unknown Korean words using English. In other words, Julie employed the vocabulary knowledge from English for the unknown Korean words to complete her response.

1. Ms. Lee: 처음 미국학교 갔을 때 어땠어?
   [How did you feel when you went to the school for the first time?]
2. Julie: 저 학교 처음 갔을 때 많이 shy 하고 nervous 했어요.
   [When I went to the school for the first time, I was very shy and nervous.]
3. Ms. Lee: shy 랑 nervous 한 거 어떻게 한국말로 할 수 있지?
   [How can you describe being shy and nervous in Korean?]
4. Julie: shy 는 face red 하는 거고, nervous 는 heart beat 돼요
   왜냐면 worry 많이 해서. Korean 으로는 잘 몰라요.
   [Being shy is when someone's face becomes red, and if you feel nervous, your heart is beating because you worry a lot. I do not know them in Korean.]

**Figure 3.** Julie's (first grade) translanguaging to sustain communication

Contrariwise, Julie's third-grade language use in Figure 4 demonstrated that she had acquired the Korean words that she had not known in first grade. Julie's answer to Mrs. Joen's question included the Korean words for "shy" and "nervous" (the bold and italicized Korean words; turn 2). However, although Julie demonstrated her vocabulary gain in Korean, she still incorporated the English word "nervous" in her Korean discourse (turn 4). Close analysis revealed that she uttered the word in Korean first and then translanguaged to repeat the word in English. In the interview, Julie explained that she repeated the word in English to emphasize its meaning in her response. Julie stated, "I said the word "nervous" again in English because I wanted to emphasize how much Erevan (the character in the book) was nervous." Her translanguaging in this example was to emphasize her intended meaning by repeating the word in English. Julie's translanguaging is similar to the concept of bilingual re-voicing. Similar to what Toni did in the earlier excerpt, Julie as a bilingual speaker was able to move across the languages flexibly by selecting her dual lexicon from her bilingual resources.

1. Julie: 에르반이 ***부끄러워***서 귀가 빨개졌어요. ***떨리고*** 겁이 났어요 실수할까봐
   [Erevan's ears became red because he was shy. And he felt nervous and anxious.]
2. Julie: 왜냐면 수학문제 푸는데 실수할까봐 *떨렸어요* nervous 했어요.
   [Erevan was nervous nervous (repeated the word); he was afraid of making mistakes when he solved the mathematics problem.]

**Figure 4.** Julie's (third grade) employment of translanguaging to emphasize

**Parents' Practices and Socio-cultural Influences on the Focal Students' HL Development**

**Home language policy in the family**

When Toni and Julie were first graders, they stated that they were more likely to use English than Korean at home, even when interacting with their parents. Although their parents asked them questions in Korean, Toni and Julie mostly replied in English. In other words, when Toni and Julie were first graders, their primary language at home was English, according to their first-grade interview results.

Nevertheless, it was interesting to find that their language use at home in third grade had shifted. Toni, as a third grader, stated that he was required to speak in Korean at home upon his father's request, explaining:

> I have to speak in Korean with my parents. My dad gets mad when I reply in English during our conversation. He really wants me to use Korean all the time at home. When my dad is not at home, I can use English for my mom. But when there is my dad, I always have to use Korean.

Toni's mother provided a more concrete answer to explain why her husband became strict about Toni's language use. The mother indicated that they (her and her husband) were generous about Toni's English use at home when he was in first grade. However, when they observed that Toni exclusively used English with them, the father began to force Toni to use Korean when speaking to them:

> When Toni was in the first grade, we did not push him to use Korean at home because we believed that it was a transition time for him from using more Korean to more English. But, after a certain period, we witnessed that Toni used English predominantly even with us at home. Thus, my husband strictly told Toni that he had to speak in Korean whenever he says something to us.

Similarly, Julie stated that it was acceptable for her to use English at home when she was a first grader, but by the time she became a third grader, her parents made a Korean-speaking only rule at home. She shared:

> Korean is the language that my family has to use at home. It was okay to use English when I was younger, and I used English all the time. But nowadays my parents keep asking me to speak Korean only at home. We have a Korean-speaking only rule at home.

Julie's mother shared that Julie used to be outgoing and talkative when she interacted with others in Korean, which had led her to learn Korean quickly. Yet, once Julie entered kindergarten, she had difficulty interacting with peers in her American school because of her limited English proficiency. Therefore, her parents considered learning English to be an essential issue for Julie at that time. Her mother explained:

> When we saw that Julie often felt depressed, we thought that teaching English should be the first step for Julie so that she would feel confident in her American school. That is why there had been a time when we provided educational resources more in English than in Korean. For instance, we provided English songs, videos, and books at home.

As Julie became proficient enough in English, the parents observed that she tended to speak only in English and rarely used Korean. The mother explained that this was the reason why they initiated a Korean-only rule at home, stating, "We were concerned about Julie not using Korean, so we decided to make a Korean-language-only rule at home."

**Parents' instructional focus on reading in Koran**

Both the mothers' interview results and journal reports showed that they spent Korean book reading time with their children on a regular basis at home. The mothers indicated that they were concerned about their children's literacy development in Korean because of the limited opportunities and resources for HL literacy learning. Thus, both Toni and Julie's parents had engaged in their children's literacy learning regularly by providing instruction for Korean reading at home.

Julie's mother pointed out that she felt Julie was a slow reader when she read Korean books, compared to when she read English books in first grade. Once the mother noticed that Julie was a slower reader in Korean than in English, she had held a Korean book reading time with Julie every day until now. She asked Julie to read a Korean picture book aloud every night, and the mother helped her with difficult Korean words or phrases, along with their pronunciations and meanings. According to the mother, although Julie sometimes asked her mother for help when she found unknown Korean words, she became an independent reader when reading Korean books by the time she became a third grader.

In Toni's case, his mother stated that Toni was an avid reader in the fantasy fiction genre. According to the mother, Toni began to read the Harry Potter series in English in second grade. When Toni's grandparents from Korea visited his home during the summer break between second and third grade, they brought the Harry Potter series written in Korean. Toni began to read the Korean version of the books independently in third grade. Toni often told his mother that there were many unknown Korean words, which she usually explained by providing synonyms or example sentences. The mother believed that this practice (his independent reading with her assistance) had helped Toni improve his oral and reading fluency in Korean and develop his Korean vocabulary.

Both mothers acknowledged that they had focused on their children's Korean reading comprehension beyond their decoding skills in Korean. Toni's mother stated that although Toni read Korean books relatively fast, he sometimes did not understand the books he read. The mother reported that she usually checked Toni's reading comprehension by asking Toni to retell the stories when he finished reading Korean books, explaining:

> Whenever Toni told me he was done reading Korean books, I asked him to retell the story of the books, but he often did not remember the plot or story of the book in detail; thus, I usually provided a few guiding questions about the character or scene so that he could tell me about the story.

Similarly, Julie's mother mentioned that she often asked Julie to retell the story of Korean books that she had finished reading. According to the mother, Julie sometimes provided the retelling of Korean storybooks using English, but her English retelling indicated that she comprehended the stories accurately. The mother shared that she usually asked Julie to retell the story in Korean again, which might have helped Julie improve her oral speech in Korean by making up her own sentences using Korean. She explained:

> Julie sometimes told me her retelling story in English although she read the book in Korean. But I was able to see that she understood the story from the book. After she told the story in English, I encouraged her to retell the story in Korean again.

**The influence of relatives**

The focal mothers' journals showed that their relatives also had influenced their children's Korean language learning. In Toni's case, his grandparents from Korea visited Toni's home in the U.S. and stayed with them for a month during the data collection. Because Toni's grandparents did not speak any English, Toni had to use Korean, which eventually resulted in Toni practicing more Korean. One of the mother's journal reports indicated that Toni had learned how to play a Korean traditional game "Yutnori" from his grandparents. The mother believed that learning a traditional game from the grandparents had not only provided a good opportunity for Toni to learn about the Korean culture from the traditional game but also helped him improve his listening and speaking in Korean because Korean is the only language that Toni could use with his grandparents. The mother observed that Toni always paid close attention to his grandparents to understand what they said, explaining:

> When we explained something to Toni in Korean, but he did not get it, he often asked us to repeat it in English because he knew that we could speak in English. However, during the conversation with his grandparents, Toni tried to understand their Korean without asking them to restate what they said because he knew that his grandparents spoke Korean only. Thus, we believe that the grandparents' visits had played a significant role in Toni's Korean language use and learning.

Toni's mother further stated that having a regular conversation with his grandparents during phone calls or via Skype had helped Toni acquire Korean words and expressions. She stated:

> When Toni heard Korean words or expressions that he did not know from his grandparents over the phone or via Skype, he often asked me the equivalent words in English or the meaning of those unfamiliar expressions. I believe that the regular practice of communicating with his grandparents helped Toni acquire many Korean words and expressions that are not commonly used in the U.S. context.

Similarly, the journal entries by Julie's mother also showed the influence of Korean relatives on Julie's language use and learning. During the data collection of the study, Julie's aunt, who lived in Korea and barely understood English, visited Julie's house. Julie's mother observed that Julie spoke Korean exclusively when she talked to her aunt. The mother once recorded Julie's language use when the family played the board game "monopoly." Julie was familiar with instructions of the game in English but tried to explain to her aunt how to play it using Korean only as she knew that her aunt would not understand if the rules were explained in English. Julie's mother believed that the presence of Julie's aunt provided a good opportunity for Julie to be immersed in Korean as she tried to use Korean all the time with her aunt, who only spoke Korean:

> I noticed that when Julie explained the instructions to her aunt, her speech was a little bit clumsy and awkward since she explained everything in Korean. I know that she could have explained more fluently if she used English, but I saw that she stayed in Korean because Julie knew that her aunt would not understand if she used English. Also, since her aunt knew Julie's imperfect Korean language proficiency as a Korean American child, her aunt did not

> concern or criticize Julie's somewhat limited Korean expressions or awkward pronunciations. I think this led Julie to freely use her Korean without hesitation or reluctance.

The mothers' interviews and journal reports showed that both Toni and Julie's language use with their relatives promoted their Korean language use and learning. Toni's and Julie's language use examples illustrate that they flexibly chose their languages according to their interlocutors' language use and proficiencies.

**The influence of media**

Korean media also seemed to play a pivotal role in Toni and Julie's Korean language learning. The journal entries kept by Toni's mother reported that Toni watched one of his favorite Korean television programs, "Running Man," on every Sunday evening with his father. In this program, there were many Korean entertainers, and they were engaged in diverse activities that included funny episodes. According to the mother's journal, Toni knew the entertainers' names, the nicknames they used in the program, and their hilarious characteristics. However, because many of the conversations among the entertainers were not always straightforward (e.g., using exaggerated expressions to make jokes, adding humorous language with jargon), it was difficult for Toni to understand the conversation completely. His mother observed that Toni sometimes asked his father about words or expressions that the characters used in certain situations. Although Toni did not know the meanings of every word, the mother believed that he mostly appeared to grasp the intended messages in certain situations because he knew the overall context and circumstances. Toni's mother stated:

> Although Toni could not get all the dialogues among the entertainers, he seemed to understand what was going on in certain situations. I think Toni's incomplete Korean communicative skills did not hinder him from understanding or enjoying watching the program; rather, the exposure to the Korean program accelerated Toni's Korean communicative skills.

The journal entries by Julie's mother also showed how Korean media positively influenced Julie's Korean learning. According to the mother's journal, Julie watched a Korean program in which many famous Korean singers appeared in a competition to select a top singer. The mother often recorded when Julie repeated the Korean songs as she listened to them. During the mother's interview, it was revealed that Julie knew many Korean singers and memorized their songs by listening to them repeatedly. The mother shared that Julie occasionally asked her mother to print out the lyrics of her favorite Korean songs so that she could sing them by looking at the lyrics. This eventually led her to memorize the lyrics although sometimes she did not know all the meanings of the phrases. The mother believed that listening to Korean songs and reading the Korean lyrics had assisted Julie to gain Korean vocabulary and to improve her Korean pronunciation:

> I have seen Julie singing Korean songs many times at home. I think singing Korean songs helped Julie learn Korean easily since it provided Julie a good opportunity to learn about Korean vocabulary in context and acquire more native-like pronunciation.

**Developed courtesy manners appropriate for their heritage culture**

During the data collection of this study, Toni's and Julie's nonverbal performances along with their verbal communication were observed, which demonstrated their understanding of Korean courtesy and manners. The comparison of their spoken and behavioral performances between first and third grades showed that they had developed how to use polite speech patterns in Korean (i.e., honorifics) and learned the required body gesture when greeting (i.e., bowing) to older Korean people.

**Appropriate use of Korean honorifics**

A comparison of Toni and Julie's oral language use between first and third grade showed that their use of honorifics (a polite form of speaking) has been firmly established. It is important to note that using honorifics is a required practice in the Korean language, which is a formal and humble form of speaking in Korean. This indicates that hierarchical social status of speakers plays an essential role in

social interaction as it conveys esteem, courtesy, or respect when addressing or referring to a person (Brown, 2011). Although young Korean children seldom use it with their parents in the home setting to express intimacy and affection, most Korean parents teach their children how to properly conjugate Korean honorifics when communicating with others in the polite form.

When Toni and Julie were in first-grade, Julie was the student who did not use honorifics when communicating with me (her first-grade teacher). On the other hand, analysis of the students' oral language use in third grade showed that Julie used honorifics appropriately whenever she responded to Mrs. Joen. In addition, Julie also appropriately used honorifics during the interviews with me during the data collection of this study as well as when she met other Korean teachers in the school building. According to Julie's mother, her parents had not asked her to use honorifics when speaking to them. However, when Julie was in second grade, there was an occasion when her mother saw Julie not using honorifics when she met a Korean adult neighbor. Since then, the mother had tried to teach Julie how to use honorifics to other Korean adults in a proper manner.

For Toni's case, although he was more likely to use Korean honorifics to address me in his first-grade class, he did not always use them properly. There are different levels of Korean honorifics depending on the level of politeness. For instance, to make honorifics, Korean speakers not only have to add a suffix to the end of verbs but also switch the verbs to suppletive forms to connote being humble. In first grade, Toni often correctly added suffixes to the end of verbs but rarely used the polite form of verbs. However, his third-grade speech displayed that he had learned how to use appropriate honorifics during the conversation with Mrs. Joen and me. According to Toni's mother, when he became a second grader, his father constantly asked him to use honorifics to address his parents. The mother also said that Toni had a lot of opportunities to practice Korean honorifics when his family visited Korea every summer. Thanks to the parents' lesson on the humble and polite form of using honorifics, both Toni and Julie appeared to use Korean honorifics appropriately throughout their third-grade language use data.

**Bowing when greeting**

When Koreans greet older people, they use not only honorifics (Brown, 2011) but also a specified body gesture (i.e., bowing). Bowing is the act of lowering the torso and head as a social gesture towards older people (Brown & Winter, 2018). Since I was not the teacher for Toni and Julie when they were third graders, the students did not regularly see me in the classroom. However, I met them occasionally in the hallway in the school building during the semester of data collection. Whenever the students greeted me, they bowed to me while using honorifics (the formal form of "hi" in Korean). Their actions indicated that they had learned how to bow when greeting an adult.

During the interview with Toni's mother, the mother revealed that she and her husband had taught Toni how to greet his grandparents politely by bowing. The mother stated that since Toni regularly saw his grandparents, he often practiced bowing when greeting them, which led him to use the body gesture when he met other Korean adults. In Julie's case, her mother shared that when Julie visited Korea once a year, she and her husband showed Julie how others bowed when they greeted adults and taught her the proper way to greet older people. After that, the mother observed that Julie began to bow when she greeted older Korean people.

## DISCUSSION and CONCLUSION

This article presented two focal third-grade Korean bilingual students' language use over time by examining different patterns between their first- and third-grade spoken language use. For the Korean students in the U.S., like Toni and Julie, there has been a pervasive hypothesis that their Korean might be jeopardized due to their minimum exposure to Korean and its reduced status in the U.S. as well as their rapid increase in English usage (Carreira & Kagan, 2017; Murphy, 2014; Polinsky, 2018). Indeed, previous literature revealed that when emergent bilinguals attended all-English schools taught only in English, the students tended to experience HL shift or loss because they did not have much

exposure and opportunity to develop their HL (Montrul, 2018; Shin, 2014). However, the present study showed that the focal third graders who were attending all-English schools during the week did not lose their HL since they continued to use their HL at home and improved Korean proficiency by interacting with other Korean speakers at the Korean HL school.

The comparison of findings indicated an increase in Korean and a decrease in English in the students' oral language use over the two years. It was further revealed that the patterns and functions of their translanguaging when speaking in the two grades were different. As first graders, Toni and Julie frequently employed oral translanguaging into English because they did not know the corresponding words in Korean. That is, their translanguaging in first grade was often found when they borrowed their language repertoires from English for the unknown or unsure Korean words, which consequently helped them complete their talk.

In third grade, however, it displays that the students had learned about most of the Korean words that they had not known in first grade. In other words, Toni's and Julie's translanguaging in third grade occurred not because they did not know the correspondences in Korean but because they were flexibly employing their bilingual resources from both languages. Their translanguaging in third grade implies that they were sociolinguistic competent in both languages. In other words, although Toni and Julie engaged in translanguaging as a bilingual's natural practice in both first and third grades, their translanguaging practices in third grade appeared to be more strategic and purposeful (e.g., to highlight) than in first grade. In the same sense, analysis of their language use in third grade displayed that they decisively and intuitively translanguaged (e.g., bilingual re-voicing; Gort & Sembiante, 2015), which suggests that their translanguaging practices in third grade met a metalinguistic function.

The parents' Korean-language-only rule at home appears to play a pivotal role in the students' longitudinal language use between first and third grades. It was discovered that the parents focused on their children's literacy learning in Korean at home by providing Korean book reading time, which assisted their children to improve their Korean communicative skills. Frequent communication with their Korean relatives helped Toni and Julie practice Korean as much as possible by considering their interlocutors' different language preferences/proficiencies. In addition, exposure to Korean media (television programs and songs) also seemed to influence their increased Korean language use over the years. Overall, the findings showed that the focal third graders did not experience HL shift or loss; rather, they were able to improve their communicative skills gradually and becoming competent Korean speakers both sociolinguistically and socioculturally as they have developed Korean courtesy manners in their heritage culture, such as appropriate use of formal Korean (i.e., honorifics) and required body gestures (e.g., bowing). Accordingly, their third-grade Korean language use further demonstrates their understanding and knowledge of cultural values and manners beyond their sociolinguistic competence in their HL.

**Implications and directions for future research**

When researchers pay close attention to bilingual children's complex and rich linguistic experiences and resources at home as well as immigrant families' efforts to support their children's HL development, they can advocate and empower bilingual families' and their children's linguistic and cultural resources as valuable assets (Cummins & Persad, 2014; Shin & Viruru, 2021). By focusing on how bilingual children participate in the home- and community-based discourses, researchers can contribute to constructing the practices and pedagogies to expand emergent bilingual children's language and literacy repertoires for their HL development. These directions for future research will help us understand how to support HL bilingual children's overall language learning and development.

Given the socio-political contexts surrounding HL and bilingual education (Leija & Fránquiz, 2021; Melo-Pfeifer, 2015), teachers of bilingual learners of HL need to realize that pedagogies based on language separation could easily marginalize students' HLs. As shown in this study, although the language of instruction was primarily in Korean both in the first and third-grade classrooms, the

students utilized their entire language resources through translanguaging when needed to engage in class discussions. This finding suggests that HL teachers should allow bilingual learners of HL to engage in translanguaging practices by utilizing their entire language repertoires flexibly when they verbally communicate. By doing so, teachers of HL learners can motivate their students to actively learn and participate in the classroom, and the classroom can become a vibrant bilingual space where the students and teachers can display dynamic bilingualism while developing their HLs.

Immigrant parents whose children are emergent bilinguals of HL learners should acknowledge that they play a vital role in their children's HL maintenance and development (Lee, 2021; Liang, 2018; Yazan & Ali, 2018). This study showed that parental involvement and practices at home helped their children's HL use and learning over the years. Hence, parents of emergent bilingual children should encourage the use of HL at home and provide diverse opportunities for their children to make use of it. As shown from the findings, immigrant parents should understand that communicating with other family relatives can provide an opportunity for their children to learn and practice their HL. Parents can also promote their children's literacy skills in HL by providing various reading materials and spending reading time with their children together. In addition, as the study exhibited the positive impact of media in HL learning, parents can provide songs, television programs, or video resources in HL so that their children are more likely to be motivated in developing HL from their positive learning experiences.

**The limitations of the research**

This study had a number of limitations. First of all, although it was a longitudinal study, the focal student sample size (n=2) was still small. Secondly, since I was the teacher in the first-grade classroom but was not the teacher for the third-grade students, it was difficult to capture data on their inner speech from the audio-recordings of their class interactions. Thus, there was a limited number of third-graders' translanguaging findings that served as their sociolinguistic and metalinguistic functions in their oral language use. Although I asked Mrs. Joen (the third-grade teacher) to audio-record the student talk in the third-grade classroom, I (as a researcher) was not present in the research setting; thus, I might not be familiar with the classroom context in detail, and I might not have understood some of the data accurately. For instance, I was able to hear the students' voices but could not see their non-verbal language (e.g., body gestures, facial expressions), which might have led to a more precise analysis. Thirdly, I hold positions as an insider (the classroom teacher) and an outsider (the researcher in this study). My dual role and positionality in this study might impact the study's credibility. For example, the mothers might have considered me as their child's teacher rather than a researcher during the interviews; thus, their answers might have been overly influenced by my own stance and viewpoint (i.e., valuing HL learning and supporting bilingualism rather than favoring of English-only education and monolingualism).

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IOJPE
ISSN: 1300 – 915X
www.iojpe.org
International Online Journal of Primary Education 2021, volume 10, issue 1

# SPECIALISED CONTENT KNOWLEDGE: THE CONVENTION FOR NAMING ARRAYS AND DESCRIBING EQUAL GROUPS' PROBLEMS

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**Received:** March 10, 2021 **Accepted:** April 17, 2021 **Published:** June 30, 2021

**Suggested Citation:**
Hurst, C., & Hurrell, D. (2021). Specialised content knowledge: The convention for naming arrays and describing equal groups' problems. *International Online Journal of Primary Education (IOJPE), 10*(1), 19-31.



**Abstract**

Specialised Content Knowledge (SCK) is defined by Ball, Hoover-Thames, and Phelps (2008) as mathematical knowledge essential for effective teaching. It is knowledge of mathematics that is beyond knowledge which would be required outside of teaching; for instance, the capacity to determine what misconception(s) may lie behind an error in calculation. Such knowledge should be core business of teachers of mathematics, and any perceived shortfall in SCK viewed as problematic. The research reported on here is part of a large study about multiplicative thinking involving approximately two thousand children between nine and twelve years of age and their teachers. Data were generated from semi-structured interviews and a written diagnostic assessment quiz. As part of that large project, forty-four Australian and New Zealand primary and middle school teachers were asked to respond to student work related to multiplicative thinking, particularly to concepts of numbers of equal groups and commutativity. Participants' responses reflected confusion about a pivotal piece of SCK, the convention for naming arrays. As well, questionable assumptions about the children's work samples were made. Given that there is not unanimous agreement amongst mathematics educators about naming conventions, these observations may not be surprising. Due to the sample size, broad generalisations cannot be made, but the results suggest that many teachers may have limited SCK with regards to the important mathematical area of Multiplicative Thinking (MT).

**Keywords:** Conventions, arrays, multiplicative, teacher content knowledge.

## INTRODUCTION

### Background

Since the publication of Shulman's seminal work on Pedagogical Content Knowledge (PCK) in the 1980s, much has been written about PCK, as well as the variations of it. The attempt by Shulman to codify the elements which can be identified in effective teachers, has provided a platform from which the idea of Mathematical Knowledge for Teaching (MKT) (Ball, Hoover-Thames & Phelps, 2008) has evolved. This paper posits the question "To what extent can a sample of primary and middle school teachers articulate the Specialised Content Knowledge needed for teaching aspects of multiplicative thinking, in particular, with regard to equal groups' problems?" Further, it will make a case for the development of teachers' Multiplicative Thinking (MT), an essential 'big idea' (Siemon, Beswick, Brady, Clark, Faragher, & Warren, 2015) of mathematics which spans the domains of Common Content Knowledge (CCK) and Specialised Content Knowledge (SCK). It will assert that many of the teachers involved in this study did not display sufficient levels of SCK, and therefore Subject Matter Knowledge (SMK) regarding MT, that are necessary to effectively teach this vital concept. Further it will investigate a pedagogical tool, the multiplicative array, for the teaching and learning of MT, a tool which can be used to promote a conceptual understanding of this important mathematics.

## Literature review

### Pedagogical Content Knowledge (PCK) and Mathematical Knowledge for Teaching (MKT)

Shulman (1986) argued the presence of Pedagogical Content Knowledge (PCK), a form of knowledge which could be described as the nexus between the content and pedagogy, and a third essential domain, context (Figure 1). PCK can be described as a practical knowledge of teaching and learning, through a contextualised lens of knowledge of a particular classroom setting (Shulman, 1986).


**Figure 1.** Shulman's (1986) domains of pedagogical content knowledge

Since the 1980s, Shulman's ideas and schema regarding PCK has been widely accepted and has been adapted by a number of authors. In elaborating on Shulman's construct of PCK, several teams of researchers (e.g. Hill, Ball & Schilling, 2008; Ball, Hoover-Thames & Phelps, 2008; Delaney, Ball, Hill, Schilling & Zopf, 2008) have used a construct (Figure 2) which aligns their stated domains of content knowledge for teaching onto two of Shulman's (1986) categories for PCK, Subject Matter Knowledge (SMK) and Pedagogical Content Knowledge. This construct by Hill et al. (2008) to illustrate Mathematical Knowledge for Teaching (MKT) was described by Depaepe, Verschaffel and Kelchtermans in 2013, as being mathematics education's most influential reconceptualisation of teachers' Pedagogical Content Knowledge.

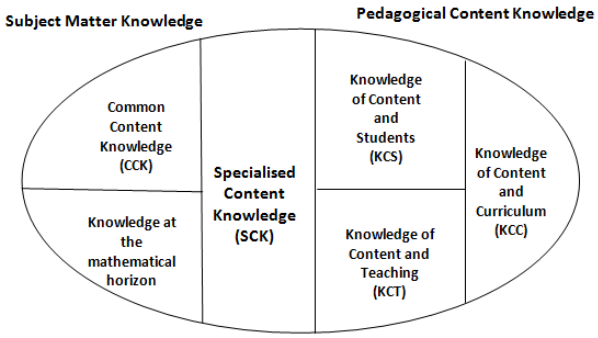


**Figure 2**. Mathematical knowledge for teaching (Hill, Ball, & Schilling, 2008, p. 377)

Hill, Ball and Schilling (2008) assert that Pedagogical Content Knowledge can be broken into three domains: Knowledge of Content and Students (KCS); Knowledge of Content and Teaching (KCT); and Knowledge of Content and Curriculum (KCC). Subject Matter Knowledge (SMK) also contains three domains: Common Content Knowledge (CCK); Specialised Content Knowledge (SCK); and Knowledge at the mathematical horizon. This paper will primarily concern itself with only two of the domains CCK and SCK, while acknowledging that all domains are interrelated.

Common Content Knowledge (CCK) is mathematical knowledge and skill used in settings not necessarily unique to teaching (for example the ability to: calculate an answer correctly or recognise incorrect answers). Effective teaching requires more than CCK, it also requires Specialised Content Knowledge (SCK) which is the basis of quality instruction, instruction which is focussed and where

decisions regarding both content and pedagogy are made (Delaney et al., 2008). SCK is the understanding of the mathematical knowledge and skills which are particular to teaching (for example the ability to respond to students' "why" questions or recognise what is involved by using a particular representation).

SCK of pedagogical concerns (for example, in recognising what is involved in using a particular representation or linking representations to underlying ideas and to other representations) is necessary to develop conceptual and/or procedural knowledge (Rittle-Johnson & Schneider, 2015). Bruner (1966) asserted that concepts are progressively developed, first in the 'enactive' stage through engagement with concrete experiences, then the 'iconic' stage, when pictorial and other graphic representations are used, and finally, the symbolic stage. Bruner's work underpins the contemporary practice of CRA (Concrete-Representational-Abstract), a graduated sequence of instruction proven to be an effective strategy for teaching mathematics concepts and skills (Agrawal & Morin, 2016; Goonen & Pittman-Shetler, 2012). An example of CRA is presented in Figure 3.

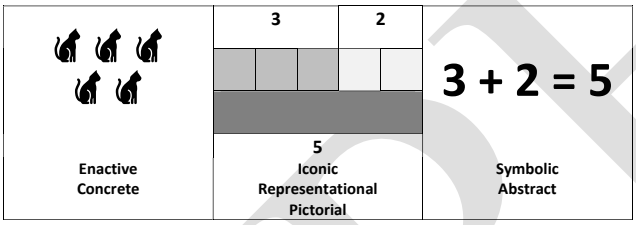


**Figure 3.** Example of CRA Model

CRA purports that it is developmentally advantageous for students to be afforded opportunities to move from the concrete, to the representational, and then to the abstract (Goonen & Pittman-Shetler, 2012), in order to be facilitated in gaining a deeper and lasting understandings of mathematical concepts (Mutodi & Ngirande, 2014). Research indicates that for learning benefits to occur, concrete material is appropriate to the topic (Askew, 2018; Swan & Marshall, 2010), in order to stimulate students' thinking. Merely providing students with materials to manipulate, will not provide the benefits of thoughtful selection and employment – that must be associated with particular SCK that is linked to the use of manipulatives. (Askew, 2018; Swan & Marshall, 2010).

More recently, various researchers and mathematics educators have indicated the need for teachers to hold a strong and connected knowledge of mathematical structure. Siemon, Warren, Beswick, Faragher, Miller, Horne, Jazby, Breed, Clark, and Brady (2021) noted its importance if teachers were to make learning meaningful for children. Similarly, Waller and Marzocchi (2020), Parker (2019), and McKenna (2019) all provided examples of how string teacher content knowledge could enhance teaching and learning of mathematics at a conceptual level. Also, Clements and Sarama (2019) clearly allude to the importance of strong teacher knowledge in understanding children's developmental learning paths.

**Multiplicative Thinking (MT)**

Multiplicative thinking is fundamental to the development of important mathematical concepts and understandings such as algebraic reasoning (Brown & Quinn, 2006), place value, proportional reasoning, rates and ratios, measurement, and statistical sampling (Mulligan & Watson, 1998; Siemon, Izard, Breed & Virgona, 2006). According to Siemon, Breed, Dole, Izard, and Virgona (2006), students who are not proficient with multiplicative thinking lack the foundational skills and knowledge to participate effectively in further school mathematics, or to avail themselves of some post-compulsory school opportunities. Further, Siegler, Duncan , Davis-Kean, Duckworth, Claessens, Enge, Susperreguy, & Chen (2012) advocate that knowledge of division and of fractions (another part of mathematics very much reliant on multiplicative thinking) are unique predictors of later mathematical achievement.

Multiplicative thinking is significantly more complex than addition so is consequently not easy to teach or to learn (Barmby, Harries, Higgins & Suggate, 2009). Although most students will enter school with an informal knowledge that underpins counting and initial additive thinking (Sophian & Madrid, 2003) re-conceptualisation of understanding about number is necessary to understand multiplicative relationships (Wright, 2011). Multiplicative thinking is markedly different from additive thinking (Jacob & Willis, 2001) and needs to be understood as being much more than the capacity to remember and use multiplication facts. What is needed is a developing ability to apply these facts to the many and varied situations which are built on multiplication. Jacob and Willis (2003) outlined five broad phases for the development of multiplicative thinking: One-to-One Counting; Additive Composition; Many-to-One Counting; Multiplicative Relations; and Operating on the Operator. It is at the third phase, the development of many-to-one counting when students can simultaneously hold two numbers in their head; the number of groups and the total in each group.

Traditionally the approach has been to use links with repeated addition to facilitate students' multiplicative thinking (Confrey & Smith, 1995), an approach which may not be helpful in addressing the variety of situations to which multiplication needs to be applied (Wright, 2011). Behr, Harel, Post and Lesh (1994) posit that students often have the inappropriate additive model presented to them by teachers, who themselves use an additive model. It may be useful for teachers to be given the opportunity to 'see' multiplication as standard and non-standard multiplicative partitioning and to create situations where they are mindful of the way in which questions and tasks are phrased and are aware of the power of particular representations. A multiplicative array is a powerful representation which may allow this to occur and teachers require a strong level of SCK to facilitate that.

**Multiplicative Arrays as a powerful mediating artefact for MT**

Research (Barmby et al., 2009; Young-Loveridge & Mills, 2009) suggests that the array is a potent way in which to represent multiplication. Multiplicative arrays have the potential to allow students to visualise commutativity, associativity and distributivity, (Nunes & Bryant, 1996; Young-Loveridge, 2005) and that if employed alongside other representations, can serve to "allow students to develop a deeper and more flexible understanding of multiplication/division" (Young-Loveridge, 2005, p. 38-39). Indeed, they enable students to understand commutativity through rotating the array, and, by seeing that although the multiplicand and multiplier can be exchanged without effecting the product, the two situations (e.g., $4 \times 3$ and $3 \times 4$) are different. Further, multiplicative arrays exemplify the dualistic character of multiplication (Barmby et al., 2009), and have value in as a representation, that they also connect to the mathematical ideas of area and volume and Cartesian products (Wright, 2011).

The representation of multiplicative thinking using the array is not a trivial decision, and one which allows students to develop from being solely additive thinkers (Askew, 2018; Downton, 2008). While representations such as ten-frames are adept at helping children to develop additive reasoning, arrays have been the preferred representation in the development of multiplicative thinking (Siemon et al., 2015; Vale, & Davies, 2007; Young-Loveridge, 2005). According to Askew, (2018) additive problems and additive thinking (AT) are essentially problems involving three numbers, where all three numbers relate to the same referent. For example, there are five sheep in a pen, three more sheep are placed in the pen, so there are now eight sheep in the pen. Multiplicative Thinking (MT) problems have numbers that do not all share the same referents; there are 4 pens, there are three sheep in each pen, there is a total of 12 sheep. The four tells of how many iterations, or the number of pens, and the three tells of how many sheep in each pen. This mental manipulation of the multiplier and the multiplicand can be facilitated through the use of arrays which allows students the opportunity to both visualise and manipulate the concrete representation, before moving to pictorial and then an abstract representation (Askew, 2018; Lesh, Cramer, Doerr, Post, & Zawojewski, 2003; Sriraman, 2006). A further advantage of the array is that it allows for collinearity (Jacob & Mulligan, 2014), the capacity to focus students' attention on the three quantities, the coordination of; the number of rows, the number in each row (both factors), and the whole amount (the multiple), simultaneously (Jacob &

Mulligan, 2014; Siemon et al., 2015). Importantly the multiplicative array also has agency in allowing the opportunity to see multiplication as a structure rather than a procedure (Askew, 2018). Again, teachers need to hold a strong level of SCK for this to occur.

**Conventions for naming arrays and equal groups**

There is an accepted convention for naming arrays and for describing numbers of equal groups, and this is an essential component of teachers' SCK. In a multiplication fact, the first number indicates the number of groups and the second number indicates the number in each group. In an array, the first number indicates the number of rows and the second number indicates the number in each row (Jacob & Mulligan, 2014). Hurst and Hurrell (2018, p. 25) noted that it must be understood that "four groups of seven (4 × 7) is conceptually different to seven groups of four (7 × 4) but that the order of factors can be changed and the product will remain the same". Hurst (2018) also pointed out the importance of a conceptual understanding of ideas like the commutative property and how it underpins the later use of mathematical algorithms and procedures. Indeed, Hurst (2017, p. 3) stated that, "being able to understand and articulate that four groups of seven is quite a different multiplicative situation to seven groups of four, demonstrates more powerful knowledge".

To ascertain the extent to which this convention is accepted, a content analysis of 24 reputable sources was conducted. Sources included research articles, conference papers, teacher education textbooks, and publisher websites. Twenty of those sources, a selection of which is provided here, (e.g., Benson, Wall, & Malm, 2013; Stott, 2016; Tipps, Johnson, & Kennedy, 2011; Van de Walle, Karp, & Bay-Williams, 2013; Way, 2011) clearly adhered to the convention. For example, Tipps et al. (2011, p. 236) stated that, "The first factor is called the multiplication operator or multiplier because it acts on the second factor, the multiplicand, which names the number of objects in each set". In four other sources, there was some confusion and/or contradiction about the convention (Barmby, Harries, & Higgins, 2010; Cotton, 2016; Haylock, 2010; Reys et al., 2020). As an example of this contradiction, Cotton (2016) discussed how 4 × 3 could be shown and promptly showed an array with three rows of four. Later, he showed a three by eight array of postage stamps and correctly described it as a 3 × 8 array. While over 80% of the analysed sources adhere to the convention, it would be preferable if they all did in order that teachers in all jurisdictions received the same message that the convention is important.

The problem here is that not all of the sources used the convention for naming arrays. In the context of the overall research described earlier, a sub-problem emerges – To what extent do teachers adhere to the convention when naming and describing arrays?

## METHOD

### Theoretical Framework

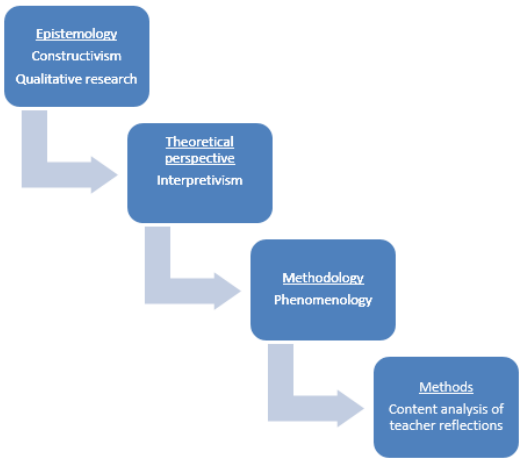


**Figure 4.** Theoretical framework

**Research Design**

The study utilised a qualitative method of investigation that follows a constructivist research paradigm and an interpretivist theoretical perspective, as outlined in Figure 4, which seeks to understand the primary importance of the meaning people attach to the world around them (Creswell, 2007). The qualitative methodology used content analysis of reflection sheets compiled by teacher participants.

**Participants and Data Collection**

Data were collected from 44 primary and middle school teachers from both Australian and New Zealand schools, and this was done through working with small focus groups. The participants were supplied with authentic work samples which had been collected through work with primary school aged students and were asked to make some determinations about those samples.

Participant teachers were presented with printed student work samples and asked to individually respond to two questions for each scenario:

a. What does each work sample tell you about the student's understanding of the mathematics involved?
b. What teaching strategies would you employ to help each student?

The first question to which teachers were asked to respond, and which is the focus of this paper, is shown in Figure 5.

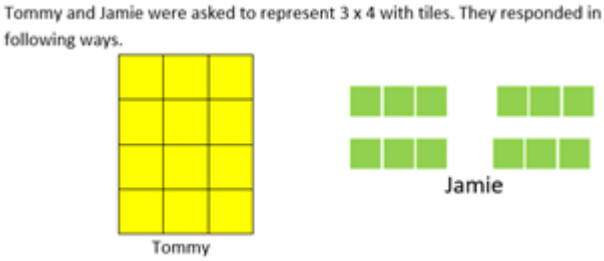


**Figure 5.** Question 1 from scenarios given to teachers

Fundamentally, the researchers were interested to determine which aspects of the identified SCK were evident in the participants' responses. Thus, there were two ways in which participants could demonstrate SCK – appropriately identifying the students' responses in terms of SCK, and identifying an appropriate intervention in terms of SCK.

After multiple readings of the scripts, the responses were categorised by one of the interviewers according to the aspects of SCK in the framework presented below. The responses were considered to be either:

- A valid or appropriate response indicating the presence of the specific SCK
- A vague or inappropriate response indicating partial presence of SCK, or lack of it

These categorisations were then given to the second interviewer and challenged until a final set of categories was established through consensus. This process required both researchers to agree on the intent of the written materials, both in what was written and what that writing was trying to convey. The process, although quite time consuming, proved to be instructive and challenging but remained systematic and thorough.

**Framework for Data Analysis**

The framework for this study is based on the premise of Specialised Content Knowledge (SCK) and the following five phases of development of multiplicative thinking proposed by Jacob & Willis (2003).

1. One-to-one counting – can count by one, but do not trust the count and do not count on

2. Additive composition – trust the count, do not count groups, and can count on.

3. Many-to-one counters – can hold two numbers (the number of groups and the number in each group) in their head and double count. They need to use arrays to move on. They do not understand the inverse relationship of the multiplicative situation, nor the commutative property. They understand the multiplicand but not the role of the multiplier.

4. Multiplicative relations – they know about the role of the multiplicand and multiplier and can coordinate the structure of grouping for both multiplication and division. They know which number tells them the number of groups and which one tells them the number in each group. They know whether to find five times the quantity or one fifth of the total. They are starting to use commutativity, inverse relationship, and part-whole understanding.

5. Operate on the operator – can work on variables in algebraic situations, operate on operators, and can flexibly use factors to make calculation of a multiplication sentence easier.

The first two phases related to counting and additive composition and were not considered relevant for this study and analysis. Also, the final phase relates to operating on variables and flexibly using factors, which are not appropriate for the specific mathematics involved in this sample. Essentially, Phases 3 and 4 focus on the transition from additive to multiplicative thinking on which the sample described above is based (see Figure 5).

Jacob and Willis stated that, "…unless teachers can actually recognise the difference between additive and multiplicative thinking, they would be unlikely to be able to help children develop the latter" (2003, p. 461). Clearly, they are alluding to the need for teachers to hold the necessary SCK in order for them to be able to assist their students to move beyond repeated addition. They need to recognise and use the array structure rather than continue to rely on the separate groups. Hence, the importance of teachers recognising the difference between the 'array response' and the 'group response' comes into focus and the need for teachers to hold strong SCK is emphasised. Jacob and Willis (2001) suggest that the power of the array lies in the fact that children can recognise the three aspects of the multiplicative situation – multiplier, multiplicand, and product – and that multiplicative thinking is about coordinating those three aspects in multiplication and division problems. Using two of the five phases outlined by Jacob and Willis (2001), the following framework was developed for the purpose of considering the data collected from the sample of teachers. The framework contains two aspects – first, the developmental phase of children, and second, the specialised content knowledge required of teachers to help children progress through each particular phase.

**Table 1.** Framework for data analysis

| **Children's developmental phase** | **Specialised content knowledge required by the teacher** |
|---|---|
| Many-to-one counters – can hold two numbers (number of groups and number in each group) in their head and double count. | ▪ 3 x 4 means 'three groups of four' because the convention is that the first factor indicates the 'number of groups' and the second factor indicates the 'number in each group'.<br>▪ The representation as separate groups likely indicates additive thinking and/or the use of repeated addition, and a lower level of thinking than is demonstrated by the use of the array. |
| Multiplicative relations – they know about the role of the multiplicand and multiplier and can coordinate the structure of grouping for both multiplication and division. They know which number tells them the number of groups and which one tells them the number in each group. | ▪ The use of the array shows the two factors and the product as one entity.<br>▪ An array is read as the 'number of rows' multiplied by the 'number in each row'. Hence, a 3 x 4 array is read as '3 rows of 4'.<br>▪ The use of the array more likely indicates a level of multiplicative thinking.<br>▪ Rotating the array can be used to demonstrate the commutative property. |

**Developing Categories for Responses**

The process of developing categories for participant responses took some time. Initially, it was thought important to identify what constituted a 'full response' to the questions about Tommy and Jamie and to see which participants were able to provide such a response. A 'full response' about Jamie's sample was considered to include the following points:

- Jamie should be asked to explain his thinking.
- Jamie needs to explain what 3 × 4 and 4 × 3 mean.
- Jamie needs to understand that 3 × 4 and 4 × 3 are different.
- Jamie needs to be exposed to arrays and the convention for naming them.
- Jamie needs to demonstrate an understanding of the convention for writing multiplication facts.
- Jamie needs assistance to understand the commutative property.

It soon became apparent that no participant gave such a complete response. It was then decided to classify responses as 'appropriate' or 'inappropriate', 'vague', or 'unclear/incoherent'. As the analysis continued, it was evident that participants frequently made assumptions about the work samples in terms of what they thought the samples showed about the knowledge of the two students. Even when challenged in conversation about whether their observations were assumptions or 'truths', few seemed to be able to concede that making the assumption could be erroneous. Through extensive interviews with children the researchers were abundantly aware that when such assumptions were made, they were almost always incorrect. For example, when students were questioned about the orientation of the array it was evident that it had been drawn with no understanding of the multiplicative situation or commutative property. Hence, responses where such assumptions could not be totally justified, were deemed to be inappropriate. Ultimately, it was decided that it would be better to focus on the percentage of appropriate responses based on the framework criteria (Table 1) and to include examples of inappropriate responses in the discussion.

## RESULTS

The following results are presented in terms of the two phases of the framework – Table 1 shows results for identification of SCK about many to one counters and Table 2 shows results for identification of SCK about multiplicative relations. To provide some clarity about how the responses were categorised, sample responses which are typically appropriate, or inappropriate, are provided after Tables 2 and 3. Teacher respondents are identified with pseudonyms – R1to R44.

**Table 2.** Data summary relating to 'many to one counters'

| **Many-to-one counters** | |
|---|---|
| (1) 3 x 4 means 'three groups of four' because the convention is that the first factor indicates the 'number of groups' and the second factor indicates the 'number in each group'. | |
| Part (a)<br>Appropriate Identification<br>40.9% | Part (b)<br>Appropriate Intervention<br>22.7% |
| (2) The representation as separate groups likely indicates additive thinking and/or the use of repeated addition, and a lower level of thinking than is demonstrated by the use of the array. | |
| Part (a)<br>Appropriate Identification<br>11.4% | Part (b)<br>Appropriate Intervention<br>2.3% |

Typical appropriate responses about the SCK in Table 2 Criterion (1) included that 'Jamie has shown 4 x 3 and not 3 x 4 which he was asked to do' (R1) or that 'Jamie has made three, four times' (R2). Another participant responded with 'Tommy is linking to arrays but doesn't understand correct placement. He should have three rows and four in each' (R3). Inappropriate responses included that

'They have both created three groups of four' (R4) as well as making unjustified assumptions such as 'Tommy has shown the relationship between 3 × 4 and 4 × 3' (R5). Other inappropriate responses for Criterion (1) included 'They both understand grouping' (R6), or 'They both have an understanding of what 3 x 4 means' (R4). With regard to a possible intervention for Criterion (1), appropriate responses included 'I would get blocks and do hands on. [They need] visual representation of each one whilst writing the number sentences' (R7). Another response was 'Jamie needs careful reading of the question to adjust the groups of tiles. The first number is the number of groups and the second number is the number in each group' (R8). As well, another said that 'I would want to interview Tommy to find out why he arranged it that way' (R1). Finally, another said that 'Jamie needs to see 3 × 4 with tiles and 4 × 3 with tiles to see if he can see the difference' (R9). For Criterion (2), typical appropriate responses included that 'Jamie had laid the times out in a repeated addition format' (R10) or that 'Jamie is still thinking additively and possibly skip counting' (R11). Good suggested interventions included that Jamie needed to be introduced to arrays (R12) and that Tommy would benefit from using strips of three and four to show groups and overlaying them to form the arrays (R13).

**Table 3.** Results identifying aspects of multiplicative relations

| **Multiplicative relations** | |
|---|---|
| (1) The use of the array shows the two factors and the product as one entity. | |
| Part (a) | Part (b) |
| Appropriate Identification | Appropriate Intervention |
| 0% | 0% |
| (2) An array is read as the 'number of rows' multiplied by the 'number in each row'. Hence, a 3 x 4 array is read as '3 rows of 4'. | |
| Part (a) | Part (b) |
| Appropriate Identification | Appropriate Intervention |
| 6.8% | 9.1% |
| (3) The use of the array more likely indicates a level of multiplicative thinking. | |
| Part (a) | Part (b) |
| Appropriate Identification | Appropriate Intervention |
| 6.8% | 2.3% |
| (4) Rotating the array can be used to demonstrate the commutative property. | |
| Part (a) | Part (b) |
| Appropriate Identification | Appropriate Intervention |
| 2.3% | 9.1% |

There were few responses related to Table 3 Criterion (1) apart from 'Tommy has shown the total or product as one entity' (R14) (appropriate) and 'Tommy represents the answer, not the question' (R15) (inappropriate). For Table 3 Criterion (2), appropriate responses included 'Tommy has shown as an array but unsure if it shows 4 x 3 or 3 x 4' (R9) and 'Tommy is linking to arrays but doesn't understand correct placement' (R3). Inappropriate responses included that 'Tommy has laid out the tiles in a 3 x 4 pattern' (R10). With regard to a possible intervention, an appropriate response was 'Ask children to share what they have made. Discuss how many groups they have created. Discuss what 3 x 4 means' (R16), and 'Ask Tommy – 'You have the right amount but how many groups are there in 3 x 4?' (R15) For Table 3 Criterion 3, an appropriate response was that 'Tommy is thinking in a multiplicative way and has used an array' (R18), while an appropriate response for an intervention would be 'Ask Jamie if he can show it as an array' (R15).

Table 3 Criterion 4 produced by far the highest number of inappropriate responses. Only one appropriate response was recorded – 'It would be easy to assume that Tommy perhaps sees the relationship to 4 x 3 in his array, however, my experience of making this assumption in the past has shown that this is often not a connection necessarily made' (R16). Inappropriate responses generally assumed that the commutative property was understood because Tommy had not shown the array as a 3 x 4 but in showing it as a 4 x 3, it indicated that he understood commutativity. For example, 'Tommy shows perhaps greater awareness of commutative property of multiplication' (R17). However, there were a number of appropriate suggestions for interventions including, 'Is this (3 x 4)

the same as 4 x 3 (i.e., 3 groups of 4 and 4 groups of 3)?' (R19), and, 'See if Tommy understands commutativity and is able to show as [rotated array drawn]' (R5).

Inappropriate responses for Table 3 included that 'Tommy has only put the total in and he needs separation to show groups' (R20) and 'Further investigation may be needed to see if they can be represented in other ways. If not, further teaching may be needed' (R21). The latter comment is not related to any of the specific SCK criteria and is therefore considered vague or inappropriate.

It is worth considering the range of individual results across the sample of 44 participant teachers as there was a great variation in the responses from person to person. The framework shown in Tables 1, 2, and 3 indicates six aspects of SCK that teachers could identify and about which they could respond. With regard to identifying the SCK contained in each criterion (i.e., the question asking 'What does each work sample tell you about the student's understanding of the mathematics involved?'), many participants gave appropriate responses alongside inappropriate, vague or unclear/incoherent responses. However, a large proportion (43.1%) provided no appropriate responses and 45.5% provided only one appropriate response to the six criteria. No participant recorded a majority of appropriate responses and 11.4% provided two appropriate responses. A total of 30 appropriate identifications/responses were given across the whole sample.

With regard to using the SCK for each criterion to suggest an appropriate intervention (i.e., the question asking 'What teaching strategies would you employ to help each student?'), there was a total of 20 appropriate interventions across the whole sample. Ten (10) of these related to the first of the 'many-to-one counters' criteria shown in Table 2, and there were four (4) appropriate interventions suggested for each of Criteria 2 and 4 about 'multiplicative relations' in Table 3. In all, 65.9% of participants were unable to suggest an appropriate intervention for any criteria, and 25.0% suggested one (1) appropriate intervention. A further 6.8% suggested two (2) appropriate interventions while 2.3% (one participant suggested three (3) appropriate interventions.

## DISCUSSION and CONCLUSION

Numerous educators have continued to write about the importance of deep teacher knowledge of mathematical structure. In discussing pedagogical content knowledge, Siemon, Warren, Beswick, Faragher, Miller, Horne, Jazby, Breed, Clark, and Brady (2021), noted the importance of teachers having a strong understanding of structure in order for them to identify the best way/s of explaining a concept so that their students find it meaningful. Clements and Sarama (2019, p. 44) alluded to the importance of teacher knowledge, especially of mathematical connections, in discussing teacher awareness of appropriate learning trajectories, stating that, "As teachers come to understand children's probable developmental paths and become adept at anticipating children's strategies and misconceptions, their teaching practices may become more grounded and solidified". McKenna (2019) discussed children learning about factors through exploring, rather than simply being 'taught'. Clearly, if such an approach is to be successful, teachers need a deep and broad understanding of the structure about factors and multiples, a vital aspect of multiplicative thinking.

This is echoed by Waller & Marzocchi (2020) who assert that if children are to develop as deep and flexible thinkers, then the mathematical content knowledge held by their teachers needs to be strong and connected. Parker (2019) makes a similar point when discussing how children need to learn multiplication facts with conceptual understanding. For that to occur, teachers need a strong knowledge of multiplication and division. Hurst, Hurrell, & Huntley (2021) discussed children's fragmented understanding of factors and multiples. Their observations suggest that such fragmented knowledge is possibly due to the way in which factors are taught which is likely to have its origins in incomplete or unconnected teacher content knowledge.

The study clearly has limitations and it would not be appropriate, given the sample size (n = 44), to attempt to generalise widely from the results of this study. Nonetheless, it appears that there needs to be further research into teachers' SCK about aspects of multiplicative thinking. Even when given that

the sample is small, some worrying indicators have emerged. First, the high proportion of participants who were unable to identify the specific mathematics nor suggest an appropriate intervention is of concern. Second, a number of participants made inappropriate assumptions about what the samples demonstrated. This was particularly evident in responses to the 'multiplicative relations' criterion about the commutative property where participants said that Tommy's sample indicated that he understood the property. It is just as likely that he does not understand commutativity nor the convention for writing number facts, as in 'many-to-one counters' criterion 1. Third, the high number of inappropriate responses that reflect a confused understanding of the mathematics needs further investigation. Finally, there seems to be no 'down-side' to adopting a consistent convention for naming arrays and describing equal group problems. In fact, research such as this would suggest that consistency is advisable and desirable.

Even considering the limitations in terms of the sample size and the relatively narrow focus of the study, there are some implications that are evident. First, the results suggest that further research should be undertaken with a larger sample and a broader content focus about multiplicative thinking. Second, with regard to teacher professional learning and pre-service teacher education, the results suggest that closer attention may need to be paid to Specialised Content Knowledge (SCK), specifically the fine points of mathematical structure about multiplicative thinking. In particular, the convention of describing number facts in terms of numbers of groups and the number in each group is important and forms the basis for understanding commutativity rather than considering it in a procedural way in terms of 'swaps and switches' (Anthony & Walshaw, 2002). Teachers need to better understand the structure if they are going to be in a position to assist their students to do so.

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IOJPE

ISSN: 1300 – 915X
www.iojpe.org

*International Online Journal of Primary Education* *2021, volume 10, issue 1*

# AN EXPLORATION OF PRIMARY SCHOOL TEACHERS' MATHS ANXIETY USING INTERPRETATIVE PHENOMENOLOGICAL ANALYSIS

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**Received:** March 31, 2021 **Accepted:** May 14, 2021 **Published:** June 30, 2021

**Suggested Citation:**
Dove, J., Montague, J., & Hunt, T. E. (2021). An exploration of primary school teachers' maths anxiety using interpretative phenomenological analysis. *International Online Journal of Primary Education (IOJPE), 10*(1), 32-49.



**Abstract**

Primary school teachers are important in children's learning of mathematics, and maths anxiety development has been partly attributed to children's classroom experiences (Das & Das, 2013). Maths anxiety was explored in UK primary school teachers, with a view to understanding its development and impact. Data from four semi-structured individual interviews were analysed using Interpretative Phenomenological Analysis (IPA), which facilitates a deeper knowledge of individuals' personal experience. Three key themes emerged: "experiencing the psychological consequences of maths anxiety", "social influences" and "the consequences of experiencing maths anxiety as a teaching professional". The findings contribute to our understanding of the influence of maths anxiety on teachers and teaching practices.

**Keywords:** Maths anxiety, qualitative research, primary school teachers, experience of teaching.

## INTRODUCTION

Maths anxiety is a negative emotional response to situations involving mathematics (henceforth maths); it is not simply a proxy for poor maths ability but rather the fear that arises in individuals undertaking a mathematical task, which impedes performance (Beilock, Gunderson, Ramirez, & Levine, 2010). Indeed, there is much evidence that maths anxiety is negatively related to maths performance (Hembree, 1990; Namkung, Peng, & Lin, 2019; Zhang, Zhao, & Kong, 2019; Barroso, Ganley, McGraw, Geer, Hart, & Daucourt, 2021). It is associated with avoidance of effort-based decision making (Choe, Jenifer, Rozek, Berman, & Beilock, 2019) and maths related education or career paths (Hembree, 1990; Ahmed, 2018). It can also have serious implications within the workplace such as inaccurate calculations of drug dosages by medical staff (Ahmed, Minnaert, Kuyper, & van der Werf, 2012) or impaired financial planning (Beilock & Willingham, 2014). People with maths anxiety may experience negative feelings when asked to divide up a restaurant bill or answer a mathematical problem in front of others. Fear of being judged or looking incompetent in front of others are the consequences of failure and can lead to unpleasant physiological reactions such as feelings of tension, nervousness or nausea (Dowker, Sarkar, & Looi, 2016).

It is difficult to determine the causes of maths anxiety. One argument is that some people have a genetic predisposition to develop maths anxiety. This has been seen in maths anxiety studies involving

twins. For example, Wang, Hart, Kovas, Lukowski, Soden, Thompson, Plomin, McLoughlin, Bartlett, Lyons, and Petrill (2014) studied 514 twelve-year-old twin pairs who were given a test to assess their maths anxiety levels, a general test of anxiety, a maths problem solving test and a reading comprehension test. A multivariate analysis revealed 40% of the variance in maths anxiety of the twin pairs was accounted for by behavioural genetic factors and the remaining variance explained by non-shared child-specific environmental factors. This suggests that maths anxiety may result from a combination of negative experiences with maths and predisposing genetic risk factors associated with maths cognition and general anxiety (Wang et al., 2014). Other work has suggested that brain activity is associated with maths anxiety, e.g. neuroimaging studies indicate individuals with high maths anxiety show reduced response in the posterior parietal and dorsolateral pre-frontal cortex brain regions (which are involved in mathematical cognition) and increased responses in the right amygdala – the brain region involved in affective fearfulness and threat detection (Young, Wu, & Menon, 2012).

Psychological theories have emphasised the role of cognitive processes, e.g. that working memory of individuals with high maths anxiety is impaired by intrusive, worrisome thoughts (Ashcraft & Krause, 2007). In particular, it is thought that high maths anxious individuals use up limited attentional resources of the central executive component of working memory, rather than allocating their attentional resources to the task at hand (Suárez-Pellicioni, Núñez-Peña, & Colomé, 2016). This debilitating effects model, however, has been discussed against a deficit model whereby an early deficit in mathematical understanding and knowledge is thought to lead to the later development of maths anxiety (Ma & Xu, 2004). As Carey, Hill, Devine and Szucs (2016) note, it is likely that a reciprocal model is more likely. It also seems that maths anxiety is strongly related to the way a person rates themselves in relation to maths (Dowker, Sarkar, & Looi, 2016).

It is likely that negative or positive reactions and experiences associated with maths will influence an individual's self-concept. Self-concept is a global composite view of oneself: how an individual perceives their skills and abilities they possess (Bong & Skaalvik, 2003). Self-efficacy, on the other hand, is concerned with what individuals believe they can do with the skills and abilities they possess (Bong & Skaalvik, 2003) and constitutes an individual's innate belief in their ability to succeed at a task or in a situation (Bandura, 1982). Emotional and psychological states contribute to an individual's self-efficacy towards their maths capabilities. Self-efficacy is influenced by an individual's past experience and their perceived ability to master, or not, a particular task. It is also influenced by seeing others who they determine to be similar to themselves either succeed or fail. Social encouragement from others also influences self-efficacy; however, positive encouragement is more difficult to impart and therefore to influence positive self-efficacy compared with the ease it takes to undermine an individual. Reducing the stress response and an individual's negative tendencies that they associate with a task or situation will also modify self-efficacy (Bandura, 1994): how an individual perceives themselves and their abilities influences their thoughts and behaviours towards a task or situation. A high self-concept in maths for example may lead an individual to have a positive outlook on maths and based on their feelings towards it and their past positive experiences may lead them to consider that they have good maths abilities. For these individuals any maths difficulties may be seen as challenges, thus prompting a positive approach towards solving problems. On the other hand, a low maths self-concept can lead to a focus on negative maths experiences and a low perception of one's maths ability, giving a negative overall view of maths and possibly prompting anxiety around it.

One of the most clearly investigated factors on maths anxiety is the relationship between gender and maths. Although research indicates that males and females provided equal education in maths show little or no difference in mathematical performance, females do tend to rate themselves lower in maths ability and to express more anxiety (Dowker, Sarkar, & Looi, 2016). This increased anxiety expression in females is posited to come from several sources such as exposure to gender stereotypes and the influence of and social transmission of anxiety by female teachers who are maths anxious (Beilock et al., 2010). Stereotypically the common assumption in the maths domain is that males are better at maths than females. When a relevant negative stereotype is made salient in a

performance situation an individual may perform more negatively than perhaps their ability would suggest, resulting in stereotype threat (Maloney, Schaeffer & Beilock, 2013); this can impact both maths anxious males who feel they are required to uphold the positive image of male maths superiority, and females who feel they confirm the negative stereotype.

Some researchers have suggested anxiety as resulting from a combination of factors: if a child has cognitive issues with numerical and spatial competencies and lacks confidence, they may have a greater predisposition to pick up the negative cues from their maths anxious teacher, leading to the development of maths anxiety (Maloney & Beilock, 2012). Additionally, negative classroom experiences are considered by some researchers as key factors in the development of maths anxiety. This includes maths being taught in a rigid, non-participatory or rote fashion without full explanation of the concepts and procedures behind the methods (Das & Das, 2013) or an overreliance on using tests to assess maths learning as well as teacher attitudes (Hamza & Helal, 2013). Schofield (1981) found that teacher attitudes were linked to students' performance and attitudes towards maths. Teachers who were classified with low or middle levels of achievement and attitude in their own maths ability maintained the lowest student performance scores with students holding the least favourable attitudes towards maths. This was compared to teachers with high maths achievement and a positive maths attitude whose teaching produced high achieving students even though the students had initially had an unfavourable attitude towards maths. Jackson and Leffingwell (1999) also researched teachers' own attitudes towards maths as a subject and how their attitude towards teaching affected student performance. They found that many had negative early school years experiences, describing negative teacher behaviours, including hostility if they asked for help or highlighting student errors in front of the class, causing embarrassment and humiliation. Overall, their study suggested that just 7% of their sample reported having had only positive experiences with maths during their school years.

It is important to understand, therefore, how for some teachers a negative maths attitude might evolve. Teachers who are anxious about their own maths ability may unwittingly impart these negative beliefs to some of their students and therefore contribute to the development of the cycle of maths anxiety. A negative attitude towards maths may also lead teachers to reduce their effort, affecting their instructional behaviour, which in turn influences student attitudes. Relich, Way and Martin (1994) suggested that a positive teacher attitude towards maths is beneficial as it helps develop positive student attitudes; this then increases the likelihood of students investing more time and energy in improving their own competence.

A teacher's professional identity is a combination of their past experiences around maths, social influences such as maths gender stereotypes as well as their knowledge, maths self-efficacy and maths self-concept (Bennison & Goos, 2013). Research has shown that even teachers with high levels of maths anxiety hold high efficacious beliefs about their ability to teach maths and express confidence in their ability to be effective maths teachers (Swars, Daane, & Giesen, 2006). This may be due to the availability of professional learning and improved pedagogical maths content support for teachers that helps bolster their confidence in their ability to teach maths effectively.

Much of the research into maths anxiety seems to rely on questionnaires, beginning with the Mathematics Anxiety Rating Scale (Richardson & Suinn, 1972), and its subsequent versions (Plake & Parker, 1982; Alexander & Martray, 1989; Suinn & Winston, 2003). More recent scales have been developed or modified to measure maths anxiety in populations outside of the U.S.A. (e.g. Hunt, Clark-Carter, & Sheffield, 2011; Nunez-Pena, Suarez-Pellicioni, Guilera, & Mercade-Carranza, 2013). Questionnaires provide useful data about maths anxiety; however, such a measurement technique may not capture the full range of individuals' attitudes, feelings and experiences of maths.

To date, relatively few studies have adopted a qualitative methodology to investigate maths anxiety. Those that have, have tended to focus on pre-service teachers. Trujillo and Hadfield

(1999), via a series of interviews, identified commonalities between pre-service teachers in relation to their negative emotions relating to maths, including early school and home experiences and how they planned to overcome their maths anxiety. More recently, Uusimaki and Nason (2004) conducted mixed-methods research to investigate pre-service teachers' negative beliefs and anxiety around maths. Applying thematic analysis (Braun & Clarke, 2006) to interview data, they generated three 'school experiences' themes: '*origins of negative beliefs and anxiety about mathematics', 'situations causing most maths anxiety'* and '*types of maths causing maths anxiety'*. They demonstrated that most of the pre-service teachers' maths anxiety could be attributed to their own primary school experiences in learning maths, such as within test situations, having to give verbal explanations, dealing with poor teacher attitudes and difficult mathematical content. In their quantitative element, Uusimaki and Nason (2004) ascertained the number of participants per theme and converted the totals to percentage scores. These findings suggested that 72% of their participants attributed their negative school maths experiences to their teachers, rather than to specific mathematical content or social factors such as family or peers. These findings have been supported more recently within work from Bekdemir (2010), who found pre-service teachers' maths anxiety to be related to their own remembered negative classroom experiences, in particular the perceived hostility and inadequacy of their teachers.

It seems, then, that teachers' own early negative experiences in learning maths might contribute to the development of anxiety towards maths in others. However, research has suggested that even if teachers experience maths anxiety and have a low aptitude for maths themselves, this does not preclude them from continuing their career as a teacher and successfully teaching maths nor does it negatively impact their confidence in their ability to teach maths (Beilock et al., 2010: Bennison & Goos, 2013). A qualitative approach, aimed at giving a deeper understanding of what it is like to experience maths anxiety, can be used to develop more applicable interventions and training as well as to help raise awareness of the impact of experiencing its potentially debilitating effects. Maths teachers in secondary education elect to specialise in maths and therefore, we suggest, may not exhibit as much maths anxiety as teachers in the primary education sector who are obliged to teach mathematics as part of the curriculum. To facilitate a more in-depth understanding, the present research utilizes the qualitative approach of Interpretative Phenomenological Analysis to explore primary school teachers' experiences and understanding of their own maths anxiety.

## METHOD

### Analytic Approach

Teachers' personal accounts, gained via semi-structured interviews, are analysed using Interpretative Phenomenological Analysis (IPA, Smith, Flowers, & Larkin, 2009). IPA has been developed through integrating ideas from philosophers such as Husserl, Heidegger, Merleau-Ponty, and Sartre (Smith, Flowers, & Larkin, 2009). Drawing on philosophical areas of phenomenology, hermeneutics and ideography, IPA goes beyond pure description of events exploring how individuals make sense of their experiences, such as maths anxiety, and what meanings they attach to them. For example, IPA can give a deeper understanding of the feelings, behavior and consequences of how a participant felt about being singled out when they were a child to answer a maths problem in front of a class.

IPA is fundamentally ideographic – researchers are committed to a detailed analysis of the phenomenon under investigation, analysing each individual's lived experience before moving to a cross-case analysis illuminating convergence and divergence between individuals (Tuffour, 2017). Teachers are the experts on their own maths anxiety experiences offering an 'insider's' perspective through accounts of their childhood maths encounters and the impact of those encounters on their professional lives as primary school teachers.

The data generated are embedded in the specific contextual and socio-cultural background that participants and researcher share (Reid, Flowers, & Larkin, 2005) and the analytic process of IPA

is a subjective and reflective process of interpretation by the researcher of the participants' experiences (Smith, Flowers, & Larkin, 2009). The researcher actively works with these data, balancing shared commonalities across each account and highlighting participants' experiences (Reid et al., 2005). It has been argued that IPA might become more descriptive than interpretative (Truffour, 2017) therefore it is important to acknowledge the double hermeneutic of the researcher interpreting the participants' interpretations of their experiences.

With its focus on lived experience IPA was deemed appropriate for an exploration of the experience of maths anxiety. This is a topic that individuals express their feelings towards – it is socially acceptable to 'admit' to not liking/not being good at maths (Kindermann & Skinner, 2009) – therefore participants are likely to share rich and detailed information about its impact on their lives. As discussed previously much of the research in this area has used quantitative approaches such as surveys and questionnaires whereas insights into the experience of anxiety about encounters with maths are limited. Taking this novel approach our overall aim was to explore the maths anxiety experiences of primary school teachers, offering a specific focus on increasing understanding of the psychological impact of maths anxiety on primary school teachers and their perception of its impact upon them.

**Research Design**

Data were generated using semi-structured interviews and then analysed using Interpretative Phenomenological Analysis (IPA). Rather than predicting what might prevent maths anxiety, IPA enables insight into how primary school teachers make sense of their own maths anxiety experiences thus informing recommendations for future developments of support in the area (Cooper, Fleischer, & Cotton, 2012).

**Recruitment Strategy**

Participants were recruited from a state-run mixed primary school (ages 7-11) based in a large town in the U.K. Permission was granted to advertise in the staff room for participants who believed they suffered with maths anxiety; thus the participant group all self-reported their maths anxiety. All participants consented to the study and were fully debriefed. Anonymity was guaranteed through the *use of pseudonyms in all transcripts and reporting. Ethical clearance was granted by the university research ethics board following guidelines from the British Psychological Society (BPS)* Code of Human Research Ethics (2010).

**Participants**

As guided within the methodological framework of IPA a small, purposive sample of primary school teachers (Table 1, four participants) was selected for inclusion. Their homogeneity (sharing similarities such as occupation and working environment) ensured that detailed accounts generated during the interview yielded sufficient relevant and idiographic information (Cooper, Fleischer, & Cotton, 2012). No age range or gender was specified.

**Table 1**. Participant details

| Participant pseudonym | Tania | Maria | John | Kate |
|---|---|---|---|---|
| Participant age (years) | 29 | 28 | 38 | 21 |
| Number of years teaching | 10 | 7 | 2 | <1 |
| Ages of children they teach | 7-8 | 8-9 | 7-8 | 6-7 |

**Being taught maths at school and additional maths education**

Tania remembers learning multiplication tables by rote, being selected to answer a maths problem in front of the class and being sat at a desk with the teacher in the front of the class as well as a lot of writing in exercise books rather than practical maths work. She took extra tuition in high school to obtain a maths qualification in order to get to university and study a post-

graduate certificate in education (PGCE). John remembers standing in front of a chalkboard at school working out an equation in front of the class. He also remembers desks in a row and copying from the blackboard and writing in exercise books. John hired a tutor and re-took his maths qualification twice before he could study for his PGCE. Maria remembers working through text books, learning multiplication tables sitting at desks and learning in a rote fashion. Maria had no further maths education after gaining the required grade on her first attempt in order to attend university. Kate remembers teachers standing at the front of the class with her then writing answers in an exercise book. She also remembers being asked to answer maths problems in front of class and its damage to her confidence. At the time of interview Kate was having extra maths tuition as part of her newly qualified teacher (NQT) training in order to help her complete the maths requirement of the training.

**Data generation and materials**

Individual face-to-face semi- structured interviews were conducted using a schedule asking 12 open-ended questions plus prompts (see Appendix). Questions were designed to address a number of considerations. They built rapport with participants, enabling them to contemplate the topic under discussion and elaborate on aspects that held importance for them in relation to the overall focus of the research question. As the research question's aim is to uncover participants' experiences of maths anxiety the questions were open ended and framed to encourage participants to reflect on their childhood maths experiences, their adult and professional experiences and the type of maths support they may have received. The questions also enabled the interviewer to maintain control of the interview without leading the participant in particular directions (Willig, 2013). Each interview was held in a private room on school premises lasting 35 to 45 minutes and recorded using a Dictaphone. The material gathered from participants was transcribed verbatim.

**Analytic procedure**

Following the recommendations by Smith and colleagues (2003; 2009), IPA processes were applied to each transcript on a case-by-case basis. This was then followed by comparison across all the case transcripts.

**Stage one**

The interviews were read repeatedly to facilitate close interaction with the data followed by initial noting of exploratory comments. The exploratory comments consisted of descriptive, linguistic and interpretative comments. Descriptive comments involved identifying explanations and descriptions of events, emotional comments or key experiences described by the participants. Linguistic comments focused on the specific use of language that participants used to describe events and feelings. Linguistic features such as the use of metaphors, repetition, pauses, sighs or laughter were also noted. The third stage was interpretative and involved making conceptual comments about what the researcher believed was the participant's overarching understanding of what they were saying (Smith, Flowers, & Larkin, 2009). Table 2 outlines examples of the types of comments with the analysis found in the transcripts.

**Table 2.** Exploratory comments

| Type of Comment | Analysis of comments | Original Transcript |
|---|---|---|
| Descriptive | Remembers the panic which heightened awareness of how children may feel when asked on the spot questions | "I just remember the panic part so it definitely makes me more aware of my kids" |
| Linguistic | Use of 'freak' expresses strength of reaction, use of 'definitely' reinforces action | "I would definitely have a bit of a freak out because I would have to go over things before I taught them" |

| | | |
|---|---|---|
| Conceptual | Feels the advantage of having maths anxiety makes her a more effective teacher of maths | "I do think it has an advantage being aware I wasn't good at maths…..I almost find it easier to teach maths because I feel I have a very simple way of doing it" |

**Stage 2**

Initial themes that emerged from the exploratory analysis were identified by taking note of the transcript and the exploratory comments (Smith, Flowers, & Larkin, 2009). Themes were produced using a concise statement or phrase that captured and reflected the participant's original words that alluded to their cognitive states, thoughts and feelings as well as the researcher's interpretations (Table 3).

**Table 3**. Developing emergent themes

| **Exploratory Comments** | **Transcript** | **Emergent themes** |
|---|---|---|
| Remembers the panic which heightened awareness of how children may feel when asked on the spot questions | ''I just remember the panic part so it definitely makes me more aware of my kids'' | Heightened awareness |
| Feels the advantage of having maths anxiety makes her a more effective teacher of maths | "I do think it has an advantage being aware I wasn't good at math because when I explain maths to kids now, I almost find it easier to teach maths because I feel I have a very simple way of looking at it" | Empathy |
| Recognises panic in children | "If now if I have a kid that panics I can see and know they are going to panic" | Recognition of fear in others |

**Stage 3**

Superordinate themes were then developed by identifying connections between the emergent themes. Emerging themes were entered onto a list, printed and cut into separate pieces. The themes were moved around on a piece of card (670mm x940mm) into clusters that represented parallel or similar understandings and given a superordinate theme title that reflected the essence of the cluster (Box 1).

Heightened awareness

Empathy

Recognition of fear in others

**Box 1.** Developing a superordinate theme

**Stage 4**

Once stages 1- 3 had been carried out on all transcripts, the final stage looked for patterns across all the cases to produce a master table of themes for the group. This involved laying out the individual themes for each participant typed in a different colour to ensure an even consideration of each participant. Each theme was cut into single items, placed on the card to facilitate identification of connections between the themes. As clusters of themes for the group were emerging the passages from each transcript were reread to ensure a close reflection of the data leading to the creation of new superordinate themes and sub themes along with extracts from the data to illustrate them. The superordinate themes were developed based on their perceived importance of the participant's maths anxiety experiences. On completion, the final master table of

themes for the group emerged (Table 4). The quotes that it was felt most effectively reflected participants' thoughts and feelings about their maths anxiety were then analysed and are presented in the analysis section of this article.

## FINDINGS

The three master themes and their subthemes (Table 4) that emerged from the analysis are presented with quotes from the participants and the researcher's interpretation of the analysis.

**Table 4**. Master themes for the group and their related sub-themes

| Superordinate Themes | Subordinate themes |
|---|---|
| Experiencing the psychological consequences of maths anxiety | Effects on learning and maths performance<br>Effect on self-efficacy |
| Social influences | Parents and Teachers<br>Peer relationships |
| The consequences of experiencing maths anxiety as a teaching professional | Recognition and understanding maths anxiety in pupils<br>Benefits of experiencing maths anxiety |

Each superordinate theme and its related subordinate themes are presented and discussed individually.

### Experiencing the psychological consequences of maths anxiety

Throughout their accounts, participants' experiences of maths were discussed as making them feel anxious and affecting their learning, maths performance and mathematical self-beliefs.

### Effects on learning and maths performance

Participants reflected how their childhood classroom experiences contributed to their feelings of anxiety and how they made sense of the development of their maths anxiety.

> 'I hated maths, I really hated maths and being put on the spot I absolutely hated it (sigh, pause) You know when you are sat there and the teacher is going 'what is 5 x 7?' even if I knew it, I didn't know it when they asked me (pause) I remember just being so 'please don't ask me please don't ask me'. I just hated having to do something really quickly in front of people.' (Tania).

Tania's emphatic response, in which her strength of feeling was emphasised, reflected her tension, apprehension and worry at being singled out to answer a maths question in front of others. She focused on the apprehension of being selected to provide an answer rather than being able to think about the answer to the problem itself. Her constant fear of being singled out and being unable to answer questions appeared to reinforce her negative thoughts and feelings towards maths, thus setting up a situation of anxiety even around fairly straightforward numerical problems.

Maria recalled how her anxiety arose from the feelings of confusion she felt when attempting to learn new mathematical concepts but was unable to grasp the theories:

> I do remember really hating it (pause) because it was just hard and fractions in particular. I didn't get it, they were just numbers and lines. People were giving me food and trying to talk to me about pizzas and cakes, way over my head and it stressed me out.

As with Tania, Maria emphasised her negative emotional response with reference to a specific issue – in her case 'fractions'. Even when people tried to illustrate them in everyday ways, such as with food, she became stressed as she struggled to understand these attempts at clarifying new concepts, thus linking to self-efficacy (Bandura, 1986).

**Effect on self-efficacy**

Self-efficacy is concerned with the extent to which an individual believes they are able to perform an activity (Bandura, 1986) and for these participants a shared negative self-belief in their maths ability was evident. For some, this judgment arose from a comparison of how good they believed they were at other subjects and the emotional attachment they attributed to them. Tania said:

> I got an A in English because I loved it so much I think I would have been much more disappointed if I'd got low scores in anything like that I'm just really bad with numbers like I said before I don't remember numbers, no we're not friends.

Tania's emphasis that maths was not an area she was comfortable with, alongside her perception of her poor ability, was based on the comparison she made on her past performances in English. Her positive self-efficacy towards English, which she 'loved' was contrasted with her negative self-efficacy towards maths, which she 'hated'. Her rejection and dismissal of anything positive being linked to numbers appeared to reinforce her negative self-belief and led to her conclusion she was 'really bad' at maths.

Other participants demonstrated similar feelings of negative self-efficacy towards their maths ability, a stress that was perceived to have wider implications in terms of career choices. Maria said:

> Before gaining newly qualified teaching status you have to do a maths multiple - choice. That was a bit stressful cause I'm like '(gasp) oh my gosh I don't know if I can even do it, how can I teach it?'.

Maria's inward expression of doubt over her performance ability became apparent in her discussion of training to become a teacher. Her worry about having to complete the maths test influenced her perception of her ability to teach it. Similarly, Kate was concerned about the effects of her perceived lack of ability:

> I just get worried that one day someone is going to ask me a question like subtract something and I'm going to be like 'umm ermm ' and just not be able to answer it which as a teacher you're expected to be like 'yep yep that's right'. Sometimes I feel like I'm not quick enough (pause) it's always been my weakest subject (pause) but I have actually not found that in the 7 weeks that I have been here.

Kate's internal conversation, suggesting the type of response she believed teachers are expected to give and what she believed would be her own response, again indicates negative self-efficacy towards maths ability. Her negative expectation suggested a belief that she was not good enough to teach maths even though that does not seem to have been found in practice.

Bandalos, Yates and Thorndike-Christ (1995) suggest that cues from past performance experiences can be factors that contribute to self-efficacy judgments. Some of the participants seemed to doubt their ability to teach maths based on previous negative experiences (McCulloch-Vinson, 2001). The lack of confidence is suggested by Klinger (2006) to be linked to negative mathematics self-efficacy beliefs that prevailed during school years. These are then carried on into adulthood and are supported by registering and recalling events that support this belief.

In addition to the psychological consequences of maths anxiety that were discussed in relation to their learning, maths performance and mathematical self- beliefs, participants also referred to the social influence of parents, teacher and peers.

**Social influences**

The second theme focuses on how the attitudes and behaviours of parents, teachers and peers affected participants' maths anxiety.

**Parents and teachers**

As a child, maths homework was a key activity for all the participants but, as Tania explained, this could become a problem:

> I can remember taking maths homework home and obviously because my dad's a teacher and my mums a teacher I remember them trying to help me do it and I remember I'd get so frustrated I'd say 'no you don't understand that's not how we're doing it' (pause) it probably was how we were doing it but because I didn't understand it I remember having right strops about it.

Although Tania's parents were supportive in their attempts to help her with her homework, their problem-solving approaches were described as clashing with her teacher's instructions. This difference in approach appeared to leave her experiencing frustration and confusion which, in her own words, led to an angry reaction. In linking her frustration and anger to her lack of understanding of her maths homework, its difficulty became more apparent. Categorising her parents in terms of their occupation adds emphasis to her self- perception as someone who does not understand. Not all participants felt the same level of frustration, however. Maria, in contrast, felt encouraged and motivated by her mother's involvement:

> My mum went and bought me books and I'd be like 'I don't get it' so yeah she'd buy me loads of stuff and be like 'this is how you do it'. It was good 'cause I liked working through books and getting stars and I liked the well done I liked that I remember my mum always saying 'ask someone if you don't know ask, ask what can you do, don't just sit there' I remember the stern talking to so I'm assuming that I asked.

Maria's memory of having the resources she needed and the pleasure she derived from being rewarded suggests she associated these positive events with her maths learning experience. The clear description of the memory of her mother demonstrating how to solve maths problems, and of the repetition and directive tone of her words of encouragement to Maria to actively ask questions suggests she was aware of the level of her mother's involvement and influence on her maths experience.

Participants also described clear memories of the pivotal part played by their teachers' attitudes and approaches in their maths anxiety experiences. Tania described how a teacher helped her reach a key goal in maths:

> In fact, it was when I started not to hate it so much because I had a lot of tuition from my maths teacher at the time and erm (pause) I guess in a way it affected me in a good way, in the beginning your scared of it, because I had to work really hard and I ended up getting a B and was so so chuffed (pause) because I was trying to just trying to get the C and I just worked hard.

Tania suggests that as her fear subsided, she began to feel less negative towards maths; although she still verbalised her negative feelings the teacher's support may have increased her motivation. Her hesitation as she speaks suggests her careful consideration of the effort required. Similarly, her recognition of the support she received suggests an understanding that the efforts of her teacher helped her reach her goal.

John experienced both positive and negative teacher attitudes and his contrasting accounts suggest this had an important influence on his approach to maths:

> My middle school maths teacher, I had the same teacher all the way through I loved the guy he was fantastic and I remember, I don't remember many teachers names but I remember his (pause) he would actually talk to us like a proper human and he was a very very interesting guy and I think that maybe that made him more human.

John's use of emotive language alongside repetition alluded to the impact of his positive

experience with this particular teacher. The teacher's open and encouraging approach appeared to engage John's interest and he began to feel comfortable in the maths learning environment. He contrasted this experience with a different maths teacher whose attitude had a negative impact:

> The teacher was very, erm (pause) she wasn't (pause) actually she wasn't very patient, she was very impatient (pause) you couldn't ask a question. I felt I couldn't ask a question without being shouted at.

John's hesitation in discussing how this teacher made him feel suggests his discomfort at remembering the teacher's impatient and aggressive approach that seemed to discourage student questions and created an intimidating environment. The negative cues John picked up from this teacher's behaviour may have highlighted maths in negative terms and possibly discouraged him from engaging in the learning experience for fear of being reprimanded.

Parental encouragement and expressing belief in a child's ability to learn may ensure they continue to try even when they find things difficult, something which is likely to lead to less maths anxious behaviour (Gunderson, Ramirez, Levine, & Beilock, 2012) and could increase mathematical resilience (Johnston-Wilder & Lee, 2010). Schofield (1981) concluded that teacher attitudes were directly linked to student attitude and performance in maths. In addition, as Das and Das (2013) suggested, teachers provided a guiding and leading role in the learning environment and were therefore highly influential in determining what happened in classrooms. Different experiences ensued from this complexity of interaction, though teachers who cultivated a positive learning environment encouraged children to learn and gain confidence. The opposite was true of negative teacher behaviour and attitudes, which discouraged children and created anxiety in them (Plaisance, 2009).

As well as the impact of their teachers the participants highlighted how their interactions with their peers also affected their maths anxiety.

**Peer relationships**

Peer relationships were important indicators to participants of how they compared themselves with their colleagues with regards to their concerns around maths.

> 'Once the Head gave us (a group of teachers) a SATS mental maths test cause she wanted us to see the pressure the kids were under. My first instinct was to see what the person next to me has written, you know like oh I'm right.' (Tania).

John describes his experience:

> When I was doing my PGSE I realised I wasn't alone in my class of 30 people. There were guys who were phenomenal they were real mathematicians and it's when you start talking to your peers you realise 'you are actually in the same boat you're not so confident with it' and I could probably get to the same answer as they guy who got there in 30 seconds it might take me 2 minutes but I will get there.

John's personal attachment to his class suggests his feeling of connection to his peer group. His expression of admiration of colleagues whom he considered to be mathematicians indicates an acceptance of a range of maths skills. The 'same boat' metaphor suggests John's feelings of connection with others who experienced anxiety and reduced his feeling of isolation. Identifying with peers seemed to help John acknowledge his strengths rather than focusing on feeling less adequate. Being able to share experiences appeared to make him feel more comfortable in expressing his maths anxiety.

How individuals believed they were perceived by their peers appeared to be of concern throughout the interviews. For example, Maria said:

> Sometimes when we are talking, when I'm with Tash and Gina, they are really

> mathematicians, when I talk to them it all goes a bit over my head and I wouldn't ask (pause) I'd just be like 'yeah aha' . It's all about your relationship, (pause) Tash I'm a bit closer to and I would be like' I didn't get it' whereas in front of Gina 'oh ok that's great' but have no idea.

Maria discussed how she modified her behaviour in front of her peers when discussing maths so that they did not perceive her to have less knowledge than them. This was particularly apparent in her description of her behaviour with different people and its link to how well she knew them. She seemed to gain some confidence from presenting an outwardly knowledgeable image when discussing maths, achieved by observing her colleagues' interactions and maintained her equal standing in that interaction by expressing agreement. In other cases, within the data, peer interaction was discussed as enhancing the ways in which participants viewed themselves. Kate said:

> Coming straight from Uni your shown strategies for maths like multiplication grids (pause) they didn't know about that and I showed them the box method I was like 'who's seen that?' a few people had but some were like' oh we've not seen that' so I was like 'yes one point to me'.

Kate outlined a maths discussion with peers where she introduced new mathematical tools that she had been introduced to while at university. This seemingly more knowledgeable status from someone who was lacking in experience seemed to give Kate a boost in confidence, enhancing her self-esteem. Her use of descriptive point scoring suggests that being able to demonstrate this greater knowledge made her feel as if she had an advantage over her peers, thus enhancing her self- image.

The awareness of the influence key people had on participants' maths anxiety was a common thread in their accounts. Research suggests that it is socially acceptable to express dislike for maths and to have anxiety around it without it affecting social perceptions of an individual's normal contribution to society or feeling socially compromised (Kindermann & Skinner, 2008), and this was certainly demonstrated by some participants. Others described comparisons with peers. Those who described more successful peers seemed to suffer from increased anxiety and stress, an effect seen in research where comparison to others may negatively affect self-esteem if an individual feels less able (Klinger, 2006). In other cases, however, successful comparisons can aid in self-evaluation (Wood, 1989), something demonstrated by participants in some circumstances. In addition to these comparisons, participants also discussed how experiencing maths anxiety was sometimes considered of benefit to them.

**The consequences of experiencing maths anxiety as a teaching professional**

In some of their discussions participants highlighted advantages of having a level of personal maths anxiety. In this theme we explore how experiencing maths anxiety was described as enabling participants to recognise similar feelings in their own pupils and how they believed it improved their maths teaching ability.

**Recognition and understanding maths anxiety in pupils**

Kate recognised behaviour in her pupils that she had exhibited as a child in maths lessons:

> There are the ones that don't put their hands up probably like I used to do, that's when you get picked on because you've not put your hand up and then you get it wrong which knocks your confidence.

Kate related particular classroom behaviour to her own experience, interpreting not raising hands to answer questions as maths anxious behaviour: she reasoned that the children's fear of being selected made them anxious. Her use of 'picked on' suggests she felt empathy towards pupils exhibiting this behaviour. Recognition of anxiety and understanding its consequences enabled participants to employ teaching strategies that encouraged children to be less maths anxious. As Tania explained:

> You can just tell straight away, I've got a little boy who just sits there and if there's a test or you are doing something or ask him something he doesn't know the answer, you can tell he is just going 'oh my God' and he just says numbers, random numbers and you think 'oh' and move onto someone else and then every time he does put his hand up I'll ask him because he knows and I'll give him a chance to say.

Tania's description of what she perceived the child may be thinking suggests she felt empathy for him within the classroom situation, which in turn enabled her to modify her own behaviour in order to reduce his anxiety levels. Awareness and recognition of maths anxious behaviour and understanding its impact on a child's learning meant participants were implementing positive teaching practices. Maria's example of positive teaching practice appeared also to be as a result of her awareness of her own maths anxiety experiences:

> Now as a teacher I say 'when I was your age I didn't get this either so it's alright if you don't get it'. So I generate that sort of culture in the classroom.

Maria's expression of understanding demonstrates her expectation that some pupils would not understand some areas of maths. Her reflection on her own childhood experience seems to indicate why she was motivated to cultivate an inclusive classroom environment where it was socially acceptable to not understand maths immediately.

It has been suggested that teachers who fail to implement positive practices may actually cause students to learn maths anxious behaviours (McCulloch-Vinson, 2001). Subtle messages may unintentionally be given to children that can validate their opinion of being poor at maths; this, in turn may lower motivation and performance expectation. The participants' heightened awareness of maths anxiety and empathy, which they all perceived as a benefit, can help build confidence and encourage pupils to work harder to overcome maths difficulties (Beilock & Willingham, 2014).

**Benefits of experiencing maths anxiety**

Experiencing maths anxiety and having difficulties with it appeared to enhance Tania's teaching ability:

> I do think it has an advantage being kind of aware that I wasn't good at maths or that I didn't really get maths because when I explain maths to kids now I almost find it easier to teach maths than I do English because I feel like I have a very simple way of looking at it.

Tania's observation that she found maths almost easier to teach than English suggests she understood the advantage of a simpler, more straightforward teaching approach, recognising the importance of being clear when delivering maths as a subject. Her own maths learning experience enhanced her awareness of the consequences of adopting a more flexible teaching approach towards. The participants also recognised, from their own experiences, that as teachers their attitudes were an important influence on children potentially developing maths anxiety. John highlighted:

> I'm much more patient with them and er ok you don't understand it this way let's think of it another way so there's two, three or four ways that we try and get or I try and get the message across and er (slight pause) hand on heart I can honestly say if someone doesn't understand something I won't shout, you're not going to shout at a child because they don't understand and I think that is my biggest learn from my experience of maths being at school. You know I think, I think its criminal to be impatient with a child with maths only from my point of view you know knowing how how I felt its em my job to then to try and think of different ways to make them understand.

John's use of affirmative language and his commitment to avoiding expressing irritation or impatience with children when they are learning suggests an awareness of his importance on the pupils' learning. His expression that this behaviour is "criminal' alludes to the strength of his belief

that intimidating behaviour is unacceptable and counterproductive.

Participants' approaches to teaching, based on their own experience, indicates the advantages that experiencing maths anxiety can bring to a maths teaching context. The role of the teacher in developing effective teaching methods breaks the cycle of maths anxiety that might otherwise continue (Beilock & Willingham, 2014). Being more attuned to recognising maths anxiety in their pupils, they felt they were better equipped to make adjustments to their teaching approach and instructional delivery.

## DISCUSSION and CONCLUSION

The aim of this study was to explore the personal accounts of maths anxiety of primary school teachers using IPA, with the specific objectives of increasing understanding of its psychological impact by personal interaction with teachers and listening to their maths anxiety stories, their own reflections, perceptions and interpretations of their experiences. The key findings emerging from this study lend support to previous maths anxiety research whilst also contributing new aspects for future investigation.

This study helped uncover possible psychological consequences of maths anxiety with the use of IPA by highlighting details of participants' specific childhood maths situations. These were organised into three key themes: 'experiencing the psychological consequences of maths anxiety', 'social influences' and 'the consequences of experiencing maths anxiety as a teaching professional. Situations such as feelings of worry over being singled out and being 'picked on' to answer questions in front of others in class and being judged caused participants high levels of anxiety. Also, their anxiety interfered with their learning, particularly those aspects of maths perceived to be more difficult, such as fractions. The detailed information about past experiences and comparisons with performances in other areas also appeared to influence their self-efficacy judgement about not only their maths ability but also ability to teach it.

The detailed accounts connected to participants' social relationships and the impact these had on their maths anxiety mirrored other research findings that found positive support and encouragement from parents and teachers resulted in maths progression and increased confidence (Gunderson et al., 2012). However, if the social cues and observed behaviour particularly from teachers was deemed to be critical, aggressive and unsupportive this highlighted maths negatively, discouraged learning and resulted in increased anxiety (Schofield, 1981). Peer relationships helped participants feel less isolated and influenced aspects of their behaviour by either modifying it to 'fit in' socially or resulted in enhanced levels of self – esteem; social comparisons with peers influenced how participants viewed themselves in relation to how they interpreted their maths anxiety and ability within a social context (Klinger, 2006; Wood, 1989).

Finally, this study uncovered some potential consequences of experiencing maths anxiety as a teaching professional and offers some new insights. Previous research suggests in order to prevent maths anxiety developing, teachers need to adopt a variety of strategies: flexible teaching and testing methods, creating positive environments to help encourage positive self- concepts, encourage original thinking rather than learning by rote as well as being aware of teacher behaviours and the influence they can have on pupils (Plaisance, 2009). These recommendations mostly are based on findings from questionnaires with fixed choice responses whereas findings from this IPA study add further contributions to the literature by giving specific information direct from the participants' own experiences. In addition, the findings showed that teachers who have experienced maths anxiety believe it may be helpful in their teaching, echoing Trujillo and Hadfield's (1999) finding that maths anxious teacher wanted to be more understanding and progressive in their teaching. In our study teachers believed that their ability to identify and respond appropriately to maths anxious pupils was advantageous as it enabled them to further understand how their maths anxious pupils feel, readily recognise maths anxious behaviour, develop new teaching strategies to help

their pupils cope with maths anxiety and be more aware of the consequences of their own behaviour. Indeed, such a positive view of experiencing maths anxiety is associated with the concept of mathematical resilience, e.g. perseverance despite setbacks in maths (Johnston-Wilder & Lee, 2010); the findings presented here suggest mathematical resilience may be relevant to teachers as well as pupils, which can be further explored in future research. Future research could also investigate if these positive maths anxiety consequences are supported by use of measures of teacher effectiveness. This would have a huge impact on how and why we study maths anxiety in preservice and in-service teaching populations.

**Limitations**

The research reported here is one of only a few studies of maths anxiety taking a qualitative approach and is the first to use IPA to investigate maths anxiety amongst primary school teachers. The analysis of the data gives specific detail and a deeper understanding of primary school teachers' personal maths anxiety. However, some limitations should be considered. Participant teaching experience ranged from seven weeks to 10 years; more experienced participants may be more likely to have developed strategies for observing maths anxious behavior, not only due to their own maths anxiety experiences but also due to overall teaching experience of recognising children in difficulty. Heterogeneity of time spent teaching raises issues concerning disentangling attitudes and approaches based on teaching experience from those related to experiences pertaining to maths anxiety. This is particularly important given that length of teaching experience has been shown to be inversely related to maths teaching anxiety (Gresham, 2018; Hunt & Sari, 2019). Although gender differences in maths anxiety were not explored in this study, previous research into maths anxiety suggests females exhibit higher levels of maths anxiety than males (Devine, Fawcett, Szucs, & Dowker, 2012) therefore suggesting it is worth exploring this further across primary school teachers. Finally, the present study is confined to the specific context of UK culture; it is important to bear in mind the context-specific challenges faced by teachers globally, particularly in developing nations (Hunt, Simms, Cahoon, & Muwonge, 2021).

**Conclusion**

The findings from this study hold useful implications for understanding the influence of maths anxiety on teachers and teaching practices. Participants in this study perceived their own maths as beneficial, feeling it has helped them be more effective teachers. Highlighting the positive aspects of a phenomenon like maths anxiety, such as effective recognition of anxiety in pupils and using flexible teaching strategies to accommodate anxious pupils whilst still delivering the curriculum effectively, may help encourage a more mainstream approach to dealing with maths anxiety in the UK education system. This study also highlights the fact that teachers themselves experience maths anxiety and complements recent work on maths teaching anxiety (Hunt & Sari, 2019). Such awareness and recognition of the influence of teacher maths anxiety on its development in children could contribute to teacher training in the delivery of maths, as well as improved personal support to alleviate maths anxiety in teachers. Future research into teacher maths anxiety and whether it impacts teacher effectiveness may also provide new information that could highlight the benefits of experiencing maths anxiety rather than it being seen in a wholly negative light; indeed, such experiences may be associated with greater mathematics resilience. IPA is useful for exploring the self- reflective processes through which individuals interpret and understand their experiences (Brocki & Wearden, 2006). Therefore, continued use of IPA analysis in future studies may help with understanding the developmental trajectory of maths anxiety and its negative and positive impact on maths education. Overall, increasing awareness of the existence of maths anxiety in teachers is important for informing further research, interventions and training for student teachers as well as improving support and training for maths anxious qualified teachers, which may in turn impact the development of maths anxiety in the next generation of children.

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IOJPE

ISSN: 1300 – 915X
www.iojpe.org

*International Online Journal of Primary Education* *2021, volume 10, issue 1*

# THE EFFECT OF PROBLEM-BASED LEARNING ON PRE-SERVICE PRIMARY SCHOOL TEACHERS' CONCEPTUAL UNDERSTANDING AND MISCONCEPTIONS

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**Received:** November 04, 2020 **Accepted:** March 20, 2021 **Published:** June 30, 2021

**Suggested Citation:**
Şenyiğit, Ç. (2021). The effect of problem-based learning on pre-service primary school teachers' conceptual understanding and misconceptions. *International Online Journal of Primary Education (IOJPE), 10*(1), 50-72.



**Abstract**

The aim of this research is to investigate the effect of problem-based learning on misconceptions and conceptual understanding regarding simple electric circuits. Participants are 54 pre-service primary school teachers enrolled on the *Basic Science in Elementary School* course at a state university. The research employs a nonequivalent control group model. The activity sheets containing problem-based scenarios prepared by the researcher were used in the experimental group. In the control group, the lecture-based learning supported by problem solving, question-answer, discussion activities and demonstration experiments was used. Data were gathered by three-tier Simple Electric Circuit Diagnostic Test consisting of 12 questions developed by Peşman (2005). The research revealed that problem-based learning is more effective in improving conceptual understanding and overcoming misconceptions than lecture-based learning.

**Keywords:** Problem-based learning, conceptual understanding, misconceptions, simple electric circuit, pre-service primary school teachers.

## INTRODUCTION

In modern education systems, it is aimed to train individuals who can acquire scientific knowledge and concepts, and integrate these into the solutions of problem situations. Learning environments are of great importance in raising individuals with these qualities. This requires learning environments that allow learners to construct and internalize scientific knowledge based on their own prior knowledge. Learners develop some knowledge and explanations about the natural world from formal or informal learning environments based on their experiences (Soeharto, Csapó, Sarimanah, Dewi, & Sabri, 2019). However, these pre-knowledge and concepts do not always correspond to accurate scientific explanations (Duit & Treagust, 2003). The literature shows that the learners have some non-scientific concepts and explanations in various subject fields of science, such as electric circuits (Engelhardt & Beichner, 2004; Küçüközer & Kocakülah, 2007; Peşman & Eryılmaz, 2010; Tahir, Nasri, & Halim, 2020), force and motion (Anggoro, Widodo, Suhandi, & Treagust, 2019; Fadaei & Mora, 2015; Narjaikaew, 2013; Nie, Xiao, Fritchman, Liu, Han, Xiong, & Bao, 2019), chemical bonding (Fadillah & Salirawati, 2018; Fahmi & Irhasyuarna, 2017), acids and bases (Mubarokah, Mulyani, & Indriyanti, 2018), photosynthesis (Haslam & Treagust, 1987; Kırılmazkaya & Kırbağ Zengin, 2016), heat and temperature (Alwan, 2011; Suliyanah, Putri, & Rohmawati, 2018). These non-scientific concepts and explanations pose great obstacles to the conceptual understanding, and it is important to reduce their effect to achieve the determined learning goals. However, scientifically reconstructing these concepts is not always an easy process. The required conceptual change is expressed as the process of repairing the misconceptions to allow a deeper conceptual understanding (Chi & Roscoe, 2002). When considered from this point of view, identifying and correcting the misconceptions is the basis for learners to construct scientific knowledge and concepts. The lecture method is ineffective for this task (Desstya, Prasetyo, Suyanta, Susila, & Irwanto, 2019), and it is necessary to apply appropriate teaching strategies (Widarti, Permanasari, & Mulyani, 2017). For this, learning environments and approaches that give opportunities conceptual change to the learners are needed. It can be said that

problem-based learning (PBL) will allow learners to understand if their concepts are correct, and to correct them if not. At the same time, it is thought that the PBL will help the learners to provide conceptual understanding by constructing the conceptual structure of the knowledge in the subject field within the scope of scientific methods. In the following sections, there is a discussion on why and how PBL has these effects.

**Theoretical Background**

A conceptual understanding becomes meaningful when conceptual knowledge is used in the process of discovering and explaining new situations, beyond knowing the facts and conceptual labels (Roth, 1990). For this reason, there is a need for educational approaches that allow the concepts to be structured beyond memorization and to be interpreted by transferring them to different situations. Considered in a theoretical context, it can be said that cognitive theories are among the leading theories that play a role in concept formation and conceptual understanding. Cognitive theories place great emphasis on learners processing information (Schunk, 2012). Cognitive psychologists who research the mental processes in the learning process argue that prior knowledge has a critical role in the learning process (Roth, 1990). In addition, constructivism, which emphasizes that knowledge is not independent of the human mind, cannot be transferred among individuals, must be structured by individuals based on their prior knowledge and experience (Hendry, Frommer, & Walker, 1999), is a leading approach in the process of concept formation and conceptual understanding. Constructivism emphasizes that the learning process should take place in meaningful contexts, and what has been learned will be meaningless unless put into practice (Marra, Jonassen, Palmer, & Luft, 2014). Piaget, who has one of the biggest influences on the rise of constructivism (Schunk, 2012), has defined a learning process in which individuals create meaning with the dynamic cognitive schemas they have created as a result of their experiences (Scott, Asoko, & Leach, 2007). These schemas are sets of information that define the concepts that exist in individuals' minds and the relationships among concepts (Roth, 1990). Individuals create various conceptual structures in their mental schemas based on experiences in their own lives. When the new concepts that individuals encounter are compatible with their existing schemas, they include them in their existing schemas; this is assimilation (Scott et al., 2007). However, a cognitive imbalance occurs when the concepts that individuals encounter are incompatible with their existing schemas (Abraham, 2005). In this case, individuals enter into the process of organizing their existing schema or creating a new schema; i.e. accommodation (Zhiqing, 2015). Cognitive development can only occur when there is a cognitive imbalance or cognitive conflict (Schunk, 2012). Learners need to change their current non-scientific concepts with correct concepts by experiencing cognitive conflict in order to form the correct conceptual understanding. In this context, PBL comes across.

PBL is basically based on the constructivist assumption (Loyens, Rikers & Schmidt, 2006; Marra et al., 2014). Promoting experiential active learning, PBL focuses on supporting the formation of knowledge (Torp & Sage, 2002). Conceptual understanding refers to the ability to integrate the theoretical knowledge existing in the mind of the individual into practice in different events and situations (Darmofal, Soderholm, & Brodeur, 2002). PBL uses real world problems to help learners identify concepts and information they want to know and integrate them into practice (Duch, Groh, & Allen, 2001). This shows that PBL can be effective in forming a conceptual understanding. In PBL, while students determine the concepts they need to know in order to solve the problem, they actually enter the conceptual change process required for conceptual understanding. Trying to create meaning between what we know and what we want to know about the problems in the PBL includes incompatibility, and trying to solve this incompatibility is the essence of knowledge construction (Marra et al., 2014). Learners conduct a pre-discussion in small groups about the problem situations in order to activate their own prior knowledge in PBL (Wood, 2003). These pre-discussions support to create new cognitive structures by enabling learners to encounter different views (Dolmans, Wolfhagen, Van Der Vleuten, & Wijnen, 2001). The opportunity for learners to question their own concepts when confronted with different views may cause renewal and change in the cognitive structures of the learners. This situation may foresee that different views may create cognitive conflict.

In this case, PBL aims to provide a cognitive conflict that will initiate the conceptual change process required for a correct and valid conceptual understanding (De Grave, Boshuizen, & Schmidt, 1996). Cognitive conflict is an important factor in the basis of the conceptual change required for correct conceptual understanding (Hadjiachilleos, Valanides, & Angeli, 2013; Lee, Kwon, Park, Kim, Kwon, & Park, 2003).

In addition, small group discussions support the formation of explanatory statements beyond activating learners' prior knowledge and concepts during the problem analysis process (Schmidt et al., 1989). Learners form a hypothesis for the solution of the problem situation based on these explanatory statements. At this stage, learners experience a discussion within the learning groups by giving reasons to validate or reject views to support own conceptual understanding. Throughout this discussion, learners try to convince each other about the validity of their arguments beyond developing arguments made up of claims, evidence, and reason (Aydeniz & Dogan, 2016). Discussion can make connections between isolated facts and concepts (Venville & Dawson, 2010). In this sense, these processes in PBL are an important tool in structuring correct conceptual understanding on the basis of valid scientific realities. Learners who identify learning subjects that include the concepts they do not know and need to learn, evaluate hypotheses in the light of their new knowledge after going through the self-direction learning process (Hmelo-Silver, 2004). These stages offer learners the opportunity to integrate their concepts into a new situation. Since learners discuss the relationships between concepts and principles, transmit their knowledge and concepts into problem situations, integrate different literature sources as a result of their self-direction learnings, it is assumed that the PBL encourages deep and comprehensive learning process (Dolmans, Loyens, Marcq, & Gijbels, 2016). In this learning process, learners have the opportunity to notice their current concepts and change their wrong concepts in order to reach the correct conceptual understanding. This situation reflects the conceptual change process. Problem situations that PBL uses as a focus and the process of finding solutions to them triggers the conceptual change process required to reach conceptual understanding. Within all this capacity, there is a strong structure in which the PBL supports conceptual understanding.

**Problem-Based Learning**

Constructivism theory, which aims to understand how individuals construct information in their mind, views meaning not as independent from the individual, but structured by the individual (Uden & Beaumont, 2006). In PBL, individuals build new knowledge based on their existing knowledge (Awang & Ramly, 2008). In this sense, it can be said that PBL is related to constructivism. PBL based on the educational principles and practices of the constructivist approach theoretically (Savery & Duffy, 1995), emerged in Case Western Reverse University in the United States in the 1950s and in Medical schools at McMaster University in Canada in the 1960s (Uden & Beaumont, 2006). Since then, PBL approach has been applied in many disciplines (Savery, 2006). There are many definitions in the literature. Savery (2006) defines PBL as a didactic approach that requires research, questioning, putting theoretical knowledge into practice, and using knowledge and skills to find solutions. Barrows and Tamblyn's (1980) PBL definition is learning that occurs through the process of understanding and problem-solving.

PBL is a teaching method that uses problems as a focus provider and encouraging (Boud & Feletti, 1997), and involves cognitive and interrogator processes in which problems are the starting point in learning, and actively facilitates the construction of knowledge (Reynolds & Hancock, 2010). PBL is experiential learning organized around researching and solving real-world problem situations (Torp & Sage, 2002). In traditional learning approaches that present information ready, the problems are given after necessary concepts and information, while in the PBL approach, the problem is the starting point of the learning process (Chin & Chia, 2006). The learning subject in PBL is integrated into real-world problem situations (Hmelo-Silver, 2004), and the presentation of problem situations at the beginning of the learning cycle allows creation of content for the learning process (Prince, 2004). These problem situations, presented by fusing them into learning scenarios in PBL, have been created in a complex structure regarding real life and the concepts and principles in the learning process (Dahlgren &

Öberg, 2001). These problem situations are classified by Jonassen and Kwon (2001) as *well-structured* and *ill-structured*. Well-structured problems are those in which elements related to the problem are presented, and whose real-life transferability is very low, the problems are not too complex, and require a limited number of principles and rules to find the possible solution (Jonassen, 1997). On the other hand, ill-structured problems have many features and multiple solution methods (Chin & Chia, 2006). Ill-structured problems require use of metacognitive skills and knowledge related to various fields, beyond what is known about the subject represented in the problem situation (Chen & Bradshaw, 2007). Ill-structured problems are frequently encountered in daily life, usually require the integration of information about more than one discipline, and include more than one option for the solution (Jonassen, 1997). PBL consists of ill-structured problems that usually deal with real life problems, require connection between concepts and facts, and have multiple and complex solution processes (Lohman & Finkelstein, 2000).

The learning content aimed to be acquired by students in PBL is organized as problem scenarios shaped within the problem framework, and presented as modules consisting of several sessions (Cantürk-Günhan, 2006). In PBL, learners need to determine the background information about the problem and further information needed, working in small collaborative groups on a problem scenario related to the real world (Hmelo-Silver, 2004). In this process, learners set out to define other required information after systematically organizing their own relevant knowledge regarding the solution of the problem situation which acts as a trigger for learning (Hendry et al., 1999). This promotes understanding of how to organize the conceptual framework, and brings insight into the kind of knowledge needed and ways to structure it (Duch et al., 2001). Later, a hypothesis for the solution is created and is evaluated in the light of new knowledge obtained by working on various scenarios (Hmelo-Silver, 2004). Then the hypotheses are tested. In the last stage, the results are made available and the process is evaluated (Wood, 2003).

**Misconceptions and Conceptual Change in the Conceptual Understanding Process**

Learners have many pre-concepts and knowledge before the teaching (Duit & Treagust, 2003). Although these pre-concepts and knowledge brought to science lessons are well structured in the learners' minds, they may inconsistent with scientific thought (Treagust, 1988). Such unscientific concepts can be variously expressed by terms such as *misconception* (Fisher, 1985; Helm, 1980), *alternative concepts* (Klammer, 1998; Schoon & Boone, 1998), *common sense belief* (Halloun & Hestenes, 1985), *children's science* (Gilbert, Osborne & Fensham, 1982) and *alternative framework* (Driver, 1981). In this research, however, the term *misconception* is used.

All individuals have misconceptions, as a result of misunderstandings personally created to make sense of the world (Gooding & Metz, 2011). Considering that science education is aimed at developing learners' conceptual understanding (Gavalcante, Newton & Newton, 1997; Smith, Blakeslee & Anderson, 1993), it is important to identify their misconceptions and replace these using a conceptual change process. The conceptual change model of Posner, Strike, Hewson and Gertzog (1982) can be considered as a conceptual change framework structure. According to this model, for change to occur, the new concept must meet the conditions of intelligibility, plausibility, and fruitfulness, bringing dissatisfaction with the currently-held concept (Posner et al., 1982). The first condition for conceptual change is intelligibility (Hewson & Thorley, 1989), referring to understanding what the new concept means (Hewson & Hewson, 1983) and how to construct it (Posner et al., 1982). Plausible condition implies the belief that the new concept can be integrated with the learner's existing concepts (Hewson & Hewson, 1983). Dissatisfaction refers to the situation experienced when the currently-held concept is insufficient to solve the problem (Posner et al., 1982), and fruitfulness represents the functionality of the new concept in solving problems (Hewson & Hewson, 1983).

Hewson and Hewson (1984) state that disagreement between the existing and new concepts causes difficulty in the learning process, and in order to prevent this, the existing concept should be reconstructed or replaced. Therefore, conceptual change is necessary and important for the learning

process to reach its goal. Learners who realize the inaccuracy of their own concepts and their inadequacy in problem-solving will be guided to the correct concepts through conceptual change. It can be said that realizing their misconceptions is an important step in this process. Traditional learning processes, involving passive listening does not actively engage the learners' minds or provide much opportunity for them to become aware of their misconceptions (Darmofal et al., 2002). Similarly, Fisher (1985) also states that traditional learning methods are insufficient to eliminate misconceptions. It can thus be understood that the structure of traditional learning does not direct learners to conceptual change. In this sense, it is important to adopt learning approaches that allow learners to realize their own misconceptions, and to see if their concepts are sufficient in understanding the content of learning and solving problem situations, i.e., PBL.

**Problem-Based Learning in Providing Conceptual Understanding and Eliminating Misconceptions**

PBL, which enables learners to access information content by engaging with real-life problem situations, provide learners to gain experience as active learners with a guide (Hmelo-Silver, 2004). In the PBL process, teachers have a facilitating role as well as a guide (Barrows, 1996). Students are at the center of the learning process. Learners involved with various disciplines have the opportunity for preliminary experience in solving real-life problems by transferring the knowledge acquired via self-directed learning to new problem situations (Stepien & Gallagher, 1993). When learners discover new methods for solving the problem, they are able to integrate their conceptual knowledge into the implementation in the solution phase (Roh, 2003). This allows students to test the accuracy and effectiveness of their current concepts. In PBL, students construct hypotheses based on their solution suggestions by using their preliminary concepts for the problems in the scenario. When testing their hypotheses with the information obtained in the later parts of the scenario, they begin to question existing concepts. They then come to doubt about the reliability of these concepts and gain awareness through experience about these concepts' functionality and validity. In this way, learners area able to assess their existing conceptual structures, and their misconceptions, beyond generalized discourses through personal experience. Such a process is an important step for conceptual change. It is important to identify misconceptions in order to reach the correct conceptual understandings. Posner et al. (1982) state that one of the conditions for the realization of conceptual change is that learners should first experience dissatisfaction, and realize that their current concepts are inadequate. PBL provides such a process, promoting conceptual change.

In terms of PBL structure, it involves learners working in small groups to obtain information, discuss and integrate information regarding problem situations (Goodman, 2010). In PBL, learners reflect on their knowledge, by listening to the ideas of others, while engaged in finding various possible solutions (Erickson, 1999). Therefore, each student involved in the PBL process becomes aware of their own pre-concepts during these discussions. This situation may cause students to encounter with different opinions, question their current concepts and realize their misconceptions, if any. PBL process thus appears as an opportunity to initiate the conceptual change process in order to reach a valid conceptual understanding. In this context, it can be said that PBL is an effective method for replacing incorrect concepts with scientifically correct ones. From this point of view, PBL can help learners in structuring their knowledge, as based on scientific explanations, as basic concepts are perceived in more complex and abstract ways in science.

The concrete foundations of the concept of electricity, one of the most fundamental concepts of science, are generally imparted via simple electric circuits at primary level. Learning the concepts related to simple electric circuit, which is the basis of the study of electricity, helps students to learn related subjects and concepts. Considering that the knowledge structuring starts from the early ages (Wild, Hilson & Hobson, 2013), basic education is a key stage in education. In this context, primary school teachers have great roles and responsibilities. For this reason, it is very important for educators to be able to clearly articulate the concepts in related subject field and to eliminate their misconceptions. Pre-service primary school teachers should therefore be trained in an environment

that promotes these qualities. In this research, it is assumed that PBL will overcome pre-service primary school teachers' misconceptions regarding simple electric circuits, and improve their conceptual understanding. There are many studies that investigate conceptual understandings and misconceptions at various levels of education, using different methods and models, regarding simple electric circuits and related concepts (Afra, Osta & Zoubeir, 2009; Aykutlu & Şen, 2012; Bostan Sarıoğlan & Abacı, 2017; Cohen, Eylon, & Ganiel, 1983; Demirezen & Yağbasan, 2013; Dupin & Johsua, 1987; Farrokhnia & Esmailpour, 2010; Fredette & Lochhead, 1980; Jaakkola, Nurmi, & Veermans, 2011; Kalaya, Nopparatjamjomras, Chitaree, & Nopparatjamjomras, 2019; Manunure, Delserieys, & Castéra, 2019; Millar & King, 1993; Picciarelli, Di Gennaro, Stella, & Conte, 1991; Setyani, Suparmi, Sarwanto, & Handhika, 2017; Shepardson & Moje, 1994; Shipstone, 1988; Suciatmoko, Suparmi, & Sukarmin, 2018; Suryadi, Kusairi, & Husna, 2020; Şenyiğit, 2020; Türkoğuz & Cin, 2013; Villarino, 2018; Widodo, Rosdiana, Fauziah, & Suryanti, 2018; Zacharia & de Jong, 2014). However, no study was found that specifically examines the effect of PBL on conceptual understanding and misconceptions of pre-service primary school teachers regarding simple electric circuits. This research aims to fill this gap in the literature by examining the effect of PBL on elimination of misconceptions about simple electric circuits and improving conceptual understanding. The main aim of this research is to investigate PBL's effects on conceptual understanding and misconceptions, with the following research questions:

**Research Questions**

- ✓ Does PBL improve pre-service primary school teachers' conceptual understanding of simple electric circuits at a significant level?
- ✓ Does PBL decrease pre-service primary school teachers' misconceptions about simple electric circuits at a significant level?

## METHOD

**Research Model**

The pre-test and post-test nonequivalent control group model design was used in the research. This design, one of the most common experimental designs includes an experiment and a control group; the subjects are not randomly assigned, but efforts were made to ensure the similarity of the groups (Campbell & Stanley, 1963). In the nonequivalent control group model, both the experimental and control groups are subjected to a measurement before and after the implementation (West, Biesanz, & Pitts, 2000).

**Research Design and Implementation**

This research includes an experimental and a control group; PBL was used in the experimental group, and lecture-based learning supported by problem solving, question-answer, discussion activities and demonstration experiments in the control group. A pre-test was applied to both groups to determine their conceptual understanding and misconceptions regarding simple electric circuits, and after the implementation, the same test was applied as a posttest, in order to determine any changes in these.

**Materials**

Experiment materials required for participants in experimental group to design experimental setups and the activity sheets containing scenarios regarding PBL and are among the main materials used in the research.

**Problem-based Scenarios**

In the experimental group, in which PBL was applied, the lessons involved activity sheets containing problem-based scenarios prepared by the researcher. While preparing the scenarios, firstly the literature on simple electric circuits was scanned to identify the common misconceptions. The next step was to identify targeted learning outcomes for teaching within the framework of the concepts of closed circuit, open circuit, short circuit, internal resistance, equivalent resistance, ohm law, lamp brightness (electrical power) on subject of simple electric circuits. Then, researcher prepared scenarios

for achieving these learning outcomes. The scenarios contain ill-structured problems that involve more than one solution, and reflect real life. Later, two science education experts who worked in the subject of PBL were consulted, and the scenarios were adjusted accordingly. Necessary corrections were made after expert opinions. One correction was the revision and restructuring of scenarios so that they provided more than one solution option. Another important correction was the revision of language and narration, to reflect more realistic daily life situations, with a more detailed narrative. After the corrections made, the final version of the activity sheets was obtained. In the activity sheets containing problem scenarios, empty boxes were provided under each question for participants to write their answers.

**Experiment Materials**

In the research, the researcher provided the experimental group with materials for the experimental setup, including batteries, lamps, lamp holders, conductive wires, switches, ammeters, voltmeters. Care was taken to ensure that the sufficient materials were available to allow the implementation to be carried out flexibly. These materials were checked before the implementation and those that were not intact were removed.

**Experimental Process**

The implementations in the experimental and control groups were carried out over 4 weeks by the researcher during the face-to-face training process. Before the experimental procedure, the experimental group participants were divided into groups of 4-5, in a way that ensured heterogeneity within groups and homogeneity between groups. Participants in the experimental group were informed about the PBL process and its principles before the implementation with a sample scenario before they received activity sheets containing scenarios regarding complex problem situations. The concepts regarding target learning outcomes in the experimental process were presented to the participants within a problem scenario. Care was taken to present the relevant concepts in a specific order in problem situations; for example, the concept of closed circuit was presented before the concept of open circuit and short circuit. Scenarios in the research were handled in sessions. The experimental process was carried out over a total of 4 weeks, 3 lesson hours (135 minute) per week. Three course hours were allocated for each scenario in the experimental process. This research was carried out in 12 sessions, in total including 4 scenario consisting of 3 sessions. These were conducted on the basis of the session steps for the scenarios, consisting of 3 sessions each, as explained by Musal, Akalın, Kılıç, Esen, and Alıcı (2002). Accordingly, after reading the scenarios in the first session, the participants examined the problem situation presented, and summarize the information. Then, the participants determined the problem situation based on their prior knowledge. Later, the participants formed a hypothesis by brainstorming the problem situation. Subsequently, the participants determined what they need to know in order to test their hypotheses. Then, the learning goals were determined and the feedback process was carried out. In the second session, the participants summarized and shared the data they obtained as a result of their individual studies in the previous session. At these stages, the participants were able to benefit from various internet databases and printed resources in the learning environment. Later, in the previous session, the questions about what the participants needed to know were answered. Then, after reading the next part of the scenario, they narrowed down the hypotheses using the newly obtained information. Later, new learning topics were determined and the feedback process was carried out. In the third session, after reading the next part of the scenario, the participants summarized and shared the data they obtained as a result of their individual work in the previous session, and then they reviewed hypothesis in the light of all the data. Then, the participants were asked to design an experiment in which they could test their hypotheses. Finally, it was ensured that the result obtained for the solution was determined by associating the hypotheses with the result of the experiment. The next aim was for the group leaders to present the obtained results to the class in a report and to exchange ideas on the results. Then the feedback process was carried out by summarizing the learning topics.

In the control group with the lecture-based learning, problems on subjects in the activity sheets were handled with traditional question-answer, and problem solving activities. During the course of a lesson, the teacher presented the necessary information and concepts at the beginning of the lesson. Then, the teacher solved problems on simple electrical circuits related to the learned subjects and concepts through mathematical operations on the board. These mathematical operations include basic calculation (addition, subtraction, multiplication and division) and equations on the subject used to solve problems on simple electrical circuits. Later, similar problems were solved individually by the participants. Thus, an improvement was made in the control group by trying to limit the participants' being passive in the learning process. At the same time, lesson-based learning in the control group was supported by demonstration experiments. The aim was to limit the possible biased research results in favor of the experimental group in which experimental implementations were made. After each teaching input, a demonstration experiment was carried out. Control group' participants answered questions about the variables manipulated and their possible effects, especially during demonstration experiments, and they discussed their predictions, ensuring the active involvement. This situation is another improvement made in the control group. Attention was paid to the simultaneous processing of related topics and concepts in both groups.

**Study Group**

Participants of the research consist of 54 pre-service primary school teachers enrolled in the *Basic Science in Elementary School* course in the 2019 spring semester at the state university. The participants were easily accessible, therefore convenience sampling was used; sampling that is continued until the required sampling size is reached (Cohen, Manion, & Morrison, 2018; Gravetter & Forzano, 2018). All participants were pre-service primary school teachers studying in the first grade. Participants were divided into two groups, so as to ensure homogeneity between groups and heterogeneity within groups, according to their grade point averages of the previous term. The two groups were assigned as the experimental and control groups, with 27 in each. 16 of the participants in the experimental group were female and 11 were male, and in the control group, 17 female and 10 male. The average age of the participants was 18.9.

**Data Collection Tool**

*Simple Electric Circuit Diagnostic Test (SECDT)* developed by Peşman (2005) was used as a data collection tool in the research.

**Simple Electric Circuit Diagnostic Test (SECDT)**

The SECDT, developed by Peşman (2005) was used to determine the misconceptions and conceptual understanding of pre-service primary school teachers in this research. This test is a three-tier test consisting of 12 questions. The first stage is in a traditional multiple-choice test structure (Peşman, 2005). The second stage consists of options that indicate the possible rationale for the answer given in the first stage (Caleon & Subramaniam, 2010). In the third stage, the focus is on the respondent's certainty of the answers given in the first two stages (Peşman, 2005). This test represents a sufficient tool to measure the learning outcomes of the participants. The maximum score that can be taken from the test is 12, and the minimum score is 0. Many analyzes were performed in the test development phase by Peşman (2005) regarding the SECDT used for this research. As result of these, relationship between Score-2 and the confidence score was found significantly positive ($r = .51$, $p < .01$), which is evidence for the construct validity; in addition, Cronbach's Alpha reliability coefficient was determine as .69 (Peşman, 2005). Later, point biserial correlation coefficient, false negative, and false positive values were examined, and acceptable values were determined for content validity (Peşman, 2005).

SECDT is a test developed for a high school level target audience. Participants of the current study group of this research last took courses related to the research topic in the high school. In addition, SECDT's validity and reliability analyzes were conducted in order to determine the applicability for pre-service primary school teachers of the test in this research. For this, SECDT was applied to 232 pre-service primary school teachers outside the study group of this research. The answers based on the *score-3*, which are considered as correct information, were taken into consideration in performing item

and reliability analyzes. The arithmetic mean value for the SECDT was 5.73, the standard deviation value was 3.32, and the coefficient of skewness was .362, the coefficient of kurtosis -.697. The difficulty indices of the items in the test were between .35 and .47; the discrimination indices varied between .52 and .78, and the point biserial correlation coefficient values were determined to be .20 and above for each item. In this case, point biserial correlation coefficient values (Crocker & Algina, 1986), item difficulty (Crocker & Algina, 1986), and item discrimination (Ebel & Frisbie, 1986) index values are acceptable. As a result of the reliability analysis of the SECDT performed on 232 participants, the Cronbach's Alpha reliability coefficient was calculated as .81. Hestenes and Halloun (1995) state that the false positive and false negative rates should be below 10% in order to ensure the structure and content validity of the test. In this research, SECDT's *second type misconception score (false positive)* and *third type misconception score (false negative)* were used to determine the false positive and false negative rates, respectively. For this research, the false positive rate was 7.65% and the false negative rate was 3.27%. In this case, the false negative and false positive rates were below 10%, evidence that the SECDT provided content and structure validity for this research. Cataloglu (2002) states that the positive correlation between score-2 type and confidence score is evidence of the test's construct validity. The relationship between score-2 and confidence score type for this research was positive and significant ($r = .45$, $p < .00$). This result is another indicator of the SECDT's construct validity. These results reveal that the SECDT is a valid and reliable test for pre-service primary school teachers. In addition, there are different studies in which SECDT is used on pre-service teachers as a data collection tool (Altun, 2009; Arı, Peşman, & Baykara, 2017).

**Data Scoring**

The data related to the research were obtained from the SECDT applied to both groups before and after the experimental process. Şen and Yılmaz's (2017) scoring system is thought to be the most up-to-date and comprehensive scoring system for the three-tier tests in the literature, and was used in scoring of the data obtained. According to this scoring system, nine different types of scores can be obtained. This wide-ranging scoring system prevents from evaluating every wrong answer as a misconception, and highlights that that they may also be caused by the lack of information (Şen & Yılmaz, 2017). Using such a detailed scoring system in the research is important factor in the accurate identification of misconceptions.

Şen and Yılmaz (2017) propose three types of scores representing misconceptions: *misconception, false positive* and *false negative*. These score types were evaluated under the name of *first, second* and *third type misconception score* for this research. Dealing with misconceptions under three sub-headings leads to more detailed results regarding misconceptions. In this research, the score type coded to determine conceptual understanding was evaluated under the name of *conceptual understanding score*. In this case, the results obtained were the conceptual understanding score for conceptual understanding, and three different types misconception scores. Although nine different types of scores can be obtained from Şen and Yılmaz's (2017) system, the focus was on the conceptual understanding scores, and the misconception scores, since the conceptual understanding and misconceptions of the participants were examined in this research. Score-4 and Score-5 are used to determine lack of information and lack of confidence/lucky guess, respectively (Şen & Yılmaz, 2017). Since the aim of the research is to determine conceptual understanding and misconceptions, these score types (Score-4 and Score-5) were not used. Detailed information about score types, and how to code them for the data analysis process is provided below.

*Score-1:* This type of score calculated by examining the answers given only in the first stage is obtained by scoring of the condition that the participants gave correct answer in the first stage, as 1, and the incorrect answer as 0 (Şen & Yılmaz, 2017).

*Score-2:* This type of score calculated by examining the answers given in both the first and the second stages is obtained by scoring of the condition that the participants gave correct answers in the first and second stages, as 1, and all other situations as 0 (Şen & Yılmaz, 2017).

*Score-3 (Conceptual understanding score):* This scoring type represents the scientifically correct answers given by the participants. This type of score is obtained by scoring of the condition that the participants gave correct answers in the first and second stages and were sure of their answers, as 1, and all other situations as 0 (Şen & Yılmaz, 2017). This type of score, coded as Score-3 by Şen and Yılmaz (2017) was explained as the *conceptual understanding score* in this research.

*Score-6 (First type misconception score (misconception)):* This type of score is obtained by scoring of the condition that the participants gave incorrect answers in the first and second stages, and were sure of their answers, as 1, and all other situations as 0 (Şen & Yılmaz, 2017). This type of score, coded as Score-6 by Şen and Yılmaz (2017) was explained as the *first type misconception score* in this research.

*Score-7 (Second type misconception score (misconception, false positive)):* This type of score is obtained by scoring of the condition that the participants gave correct answers in the first stage, incorrect answers in the second stage, and were sure of their answers, as 1, and all other situations are scored as 0 (Şen & Yılmaz, 2017). This scoring is a misconception type, it indicates that the respondents give the correct answer with a wrong justification, and are sure of their answers (Şen & Yılmaz, 2017). This type of score, coded as Score-7 by Şen and Yılmaz (2017) was explained as the *second type misconception score* in this research.

*Score-8 (Third type misconception score (misconception, false negative)):* This type of score is obtained by scoring of the condition that the participants gave incorrect answers in the first stage, correct answers in the second stage, and were sure of their answers, as 1, and all other situations are scored as 0 (Şen & Yılmaz, 2017). This scoring is a misconception type, it indicates that the respondents give the wrong answer with a correct justification and are sure of their answers (Şen & Yılmaz, 2017). This type of score, coded as Score-8 by Şen and Yılmaz (2017) was explained as the *third type misconception score* in this research.

*Score-9 (Confidence score):* In this score type, only the answers to the third stage are taken into account (Şen & Yılmaz, 2017). The answers given are coded as 1 if "I am sure" and 0 if "I am not sure". This type of score, coded as Score-9 by Şen and Yılmaz (2017) was explained as the *confidence score* in this research.

**Data Analysis**

SPSS Statistics 23 program was used for data analysis. In data analysis, the level of significance was evaluated as .05. Analysis was conducted using arithmetic mean, standard deviation, percentage value, independent samples t-test, paired samples t-test, One-way MANOVA, and One-way repeated measures MANOVA. The purpose of using the independent samples t-test is to determine the significance of the difference between the arithmetic means of data values obtained from two independent or unrelated groups (Morgan, Leech, Gloeckner & Barrett, 2011). Independent samples t-test was used to compare the mean score of the groups regarding conceptual understanding before and after the implementation. Before the test, the assumptions were checked. The independent samples t-test assumption is that the data are suitable for normal distribution and the variances are equal (Cronk, 2020). Tabachnick and Fidell (2019), and Ntoumanis (2001) state that the normality assumption can be evaluated with the coefficients of skewness and kurtosis. George and Mallery (2020) state that the coefficients of skewness and kurtosis between ± 2.0 are acceptable. The results of the analysis showed that the experimental group pretest (Skewness= .374; Kurtosis= .769), the control group pretest (Skewness= -.400; Kurtosis= -.20), the experimental group posttest (Skewness= .100; Kurtosis= -1.226), and the control group posttest (Skewness= -.805; Kurtosis= .417) data for the conceptual understanding were suitable for normal distribution. Levene's test results for equality of variances regarding the pretest mean scores ($p= .585$, $p>.05$) and the posttest mean scores ($p= .70$, $p>.05$) of the experimental and control groups revealed no significant difference between the variances of the groups. The paired samples t-test is performed to determine the significance of the difference between the arithmetic mean values of the data obtained as a result of successive measurements over the same data source (George & Mallery, 2020). Paired samples t-test was conducted to determine whether the

conceptual understanding of the groups improved significantly compared to the pre-implementation. The paired samples-t test assumes that the data shows a normal distribution and are measured with the same scale (Cronk, 2020). Before the test, the normality condition was checked by calculating the values of skewness and kurtosis coefficient. Accordingly, the skewness and kurtosis coefficient values were obtained from the averages of the experimental group's the posttest pretest difference score and the control group's posttest pretest difference score. The results of the analysis showed that the experimental group's posttest pretest difference score (Skewness= .389; Kurtosis= -1.089), control group's posttest pretest difference score (Skewness= .012; Kurtosis= .059) data were suitable for normal distribution. These results revealed that the necessary conditions for independent samples t-test and paired samples t-test were met.

One-way MANOVA was used to determine the significance of the difference between misconceptions pretest and posttest mean scores of the two groups. Before the test, normality condition was checked by the coefficients of skewness and kurtosis and multivariate normality condition was checked by calculating Mahalanobis distance values. The analysis results showed that the pre-test and post-test mean scores of the experimental group were suitable for normal distribution regarding the first (Skewness $_{(pretest;\ posttest)}$ = .504; 1.007, Kurtosis $_{(pretest;\ posttest)}$ = .230; .670), second (Skewness $_{(pretest;\ posttest)}$ = 1.634; .237, Kurtosis $_{(pretest;\ posttest)}$ =1.396; -1.106), and third (Skewness $_{(pretest;\ posttest)}$ = 1.691; 1.099, Kurtosis $_{(pretest;\ posttest)}$ = 1.683; 1.594) type misconception. In addition, the analysis revealed that the pre-test and post-test mean scores of the control group were suitable for normal distribution regarding the first (Skewness $_{(pretest;\ posttest)}$ = .671; .262, Kurtosis $_{(pretest;\ posttest)}$ = .075; -.668), second (Skewness $_{(pretest;\ posttest)}$ = 1.567; .422, Kurtosis $_{(pretest;\ posttest)}$ =1.651; -.650), and third (Skewness $_{(pretest;\ posttest)}$ = 1.452; 1.416, Kurtosis $_{(pretest;\ posttest)}$ = 1.379; .649) type misconception. Mahalanobis distance values revealed that there is no multivariate outlier that breaks multivariate normality. Analysis results showed that the data were distributed normally in both cases. Box's M test showed that there is no significant difference between the covariance matrices (Box's M= 6.092, F= .952, p= .457, p>.05). Levene's test showed that error variances for scores of the first type misconception (p= .277, p>.05), the second type misconception (p= .216, p>.05), and the third type misconception (p= .168, p>.05) can be considered equal. One-way repeated measures MANOVA was conducted to determine the significance of the difference between experimental group' the posttest pretest mean scores and control group' the posttest pretest mean scores for each type of misconception. The assumptions required for the validity of the results obtained from the One-way repeated measures MANOVA analysis were examined. Before the test, normality condition was checked by the coefficients of skewness and kurtosis. The analysis results showed that the post-test pre-test difference scores of the experimental and control groups were suitable for normal distribution regarding the first (Skewness $_{(experimental;\ control)}$ = .662; -.236, Kurtosis $_{(experimental;\ control)}$ = .355; .248), second (Skewness $_{(experimental;\ control)}$ = -1.264; -.664, Kurtosis $_{(experimental;\ control)}$ = 1.661; .510), and third (Skewness $_{(experimental;\ control)}$ = -.997; -1.108, Kurtosis $_{(experimental;\ control)}$ = .852; 1.298) type misconception. Mauchly's test of Sphericity results showed that there was no significant difference between the variances of the difference scores (p=.065, p> .05). These results revealed that the necessary conditions for One-way MANOVA and One-way repeated measures MANOVA were met.

## RESULTS

*Conceptual understanding score* was used to determine the effect of the method applied on the participants' conceptual understanding of basic electric circuits. *First type misconception score (misconception), second type misconception score (false positive)* and *third type misconception score (false negative)* were used to determine the applied method's effect on the change of misconceptions. High conceptual understanding mean scores as a result of the scores obtained from the data collection tool are considered as a benefit for participant groups, and the high mean score for misconception types, a drawback.

This section includes, in parallel with the research questions, the results of the analysis of the effect of the method applied on misconceptions and conceptual understanding.

**Results Regarding the Change in the Conceptual Understanding**

The aim of the first research question is to determine whether there was significant improvement in the conceptual understanding in the experimental and control groups after the implementation. As a result of the analysis of SECDT's conceptual understanding scores, the pretest mean scores of the experimental and control groups were determined as 2.30 and 2.74 respectively. To determine whether this difference was significant, the groups' the pretest mean scores were compared with independent samples t-test (Table 1).

**Table 1.** Independent samples t-test results regarding conceptual understanding

| Group | Pretest | | | | | | Posttest | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | M | SD | df | t | p | n | M | SD | df | t | p |
| Experimental | 27 | 2.30 | 1.07 | 52 | 1.463 | .150 | 27 | 7.26 | 2.18 | 52 | 7.814 | .000* |
| Control | 27 | 2.74 | 1.16 | | | | 27 | 3.33 | 1.44 | | | |

*p<.05, M: Mean, SD: Standard Deviation

In the Table 1, the research showed no significant difference between the SECDT's pretest mean scores of the experimental and control groups ($t_{(52)}$=1.463, p>.05). In order to determine the significance of the difference between the SECDT's posttest mean scores of the experimental and control groups in Table 1, independent samples t-test was conducted. Table 1 shows a significant difference between the SECDT's posttest mean scores of the experimental and control groups ($t_{(52)}$=7.814, p<.05).

Then, in order to determine whether there was significant improvement in participants' conceptual understanding in the experimental and control groups after the implementation compared to before the implementation, paired samples t-test was conducted related to conceptual understanding mean scores (Table 2).

**Table 2.** Paired samples t-test results regarding conceptual understanding

| Group | Experimental | | | | | | Control | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | M | SD | df | t | p | n | M | SD | df | t | p |
| Pretest | 27 | 2.30 | 1.07 | 26 | 11.579 | .000* | 27 | 2.74 | 1.16 | 26 | 1.728 | .096 |
| Posttest | 27 | 7.26 | 2.18 | | | | 27 | 3.33 | 1.44 | | | |

*p< .05, M: Mean, SD: Standard Deviation

In the Table 2, the research showed a significant difference between SECDT's pretest and posttest mean scores of the experimental group ($t_{(26)}$=11.579, p<.05). In addition, Table 2 indicates no significant difference between SECDT's pretest and posttest mean scores of the control group ($t_{(26)}$=1.728; p>.05). Table 3 shows the conceptual understanding percentages in the experimental and control groups.

**Table 3.** Percentages of conceptual understanding regarding experimental and control groups

| Group | Conceptual understanding (%) |
|---|---|
| Experimental pretest | 19.12 |
| Experimental posttest | 60.49 |
| Control pretest | 22.82 |
| Control posttest | 27.76 |

Table 3 reveals that the experimental group's conceptual understanding was 32.73% higher than the control group's after the implementation compared to before the implementation.

**Results Regarding the Change in the Misconceptions**

The aim of the second research question was to determine whether there was a significant decrease in misconceptions in the experimental and control groups after the implementation. In order to determine

the significance of the difference between the pretest and posttest mean scores of the two groups regarding SECDT's misconception score types in Table 4, One-way MANOVA analysis was conducted (Table 4).

**Table 4.** One-way MANOVA test results regarding misconception score types

| Misconception score types | Group | Pretest | | | | | Posttest | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | n | M | SD | F | p | n | M | SD | F | p |
| First type misconception | Experimental group | 27 | 3.30 | 1.49 | 1.076 | .304 | 27 | 1.63 | 1.39 | 7.929 | .007* |
| | Control group | 27 | 2.89 | 1.40 | | | 27 | 2.82 | 1.69 | | |
| Second type misconception | Experimental group | 27 | .48 | .89 | .024 | .877 | 27 | .44 | .51 | 2.579 | .114 |
| | Control group | 27 | .52 | .85 | | | 27 | .70 | .67 | | |
| Third type misconception | Experimental group | 27 | .48 | .85 | .103 | .750 | 27 | .15 | .36 | .477 | .493 |
| | Control group | 27 | .56 | .85 | | | 27 | .22 | .42 | | |

*p< .05, M: Mean, SD: Standard Deviation

Table 4 reveals no significant difference between groups' pretest mean scores regarding the first type misconception (F=1.076, p>.05), the second type misconception (F=.024, p>.05), and the third type misconception (F=.103, p>.05). Wilks' Lambda analysis results showed a significant difference between the experimental and control group regarding SECDT's posttest misconception mean scores ($F_{(3\text{-}50)}$=3.624, p=.019, p<.05, Wilks' Λ=.821, partial $\eta^2$=.179). Table 4 indicates significant difference between groups' posttest mean scores regarding the first type misconception (F=7.929, p<.05), but no significant difference between the posttest mean scores regarding the second (F=2.579, p>.05) and the third type misconception (F =.477, p>.05).

One-way repeated measures MANOVA analysis was conducted to determine whether there was significant decrease in misconceptions in the experimental and control group after the implementation compared to before the implementation (Table 5).

**Table 5.** One-way repeated measures MANOVA results regarding misconception score types

| Misconception score types | Test | Experimental group | | | | | | Control group | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | n | M | SD | F | p | $\eta^2$ | n | M | SD | F | p | $\eta^2$ |
| First type misconception | Pretest | 27 | 3.30 | 1.49 | 15.476 | .001* | .373 | 27 | 2.89 | 1.40 | .047 | .830 | .002 |
| | Posttest | 27 | 1.63 | 1.39 | | | | 27 | 2.82 | 1.69 | | | |
| Second type misconception | Pretest | 27 | .48 | .89 | .031 | .861 | .001 | 27 | .52 | .85 | .632 | .434 | .024 |
| | Posttest | 27 | .44 | .51 | | | | 27 | .70 | .67 | | | |
| Third type misconception | Pretest | 27 | .48 | .85 | 3.000 | .095 | .103 | 27 | .56 | .85 | 3.900 | .059 | .130 |
| | Posttest | 27 | .15 | .36 | | | | 27 | .22 | .42 | | | |

*p< .05, M: Mean, SD: Standard Deviation

Table 5 shows significant difference between experimental group' posttest and pretest mean scores regarding the first type misconception (F=15.476, p<.05), but no significant difference between the posttest and pretest mean scores for the second type misconception (F=.031, p>.05) and the third type misconception (F=3.000, p>.05). Table 5 indicates no significant difference between control group' posttest and pretest mean scores regarding the first type misconception (F=.047, p>.05), the second type misconception (F=.632, p>.05), and the third type misconception (F=3.900, p>.05). Table 6 shows the misconception percentages of the participants in the experimental and control groups.

**Table 6.** Percentages of misconception regarding experimental and control groups

| Group | First type misconception (%) | Second type misconception (%) | Third type misconception (%) |
|---|---|---|---|
| Experimental pretest | 27.45 | 4.32 | 4.01 |
| Experimental posttest | 13.57 | 3.7 | 1.23 |
| Control pretest | 24.05 | 4.32 | 4.63 |
| Control posttest | 21.89 | 5.86 | 1.85 |

Table 6 reveals that the first type (8.32%), the second type (2.16%), and the third type (.62%) misconception percentage was lower in the experimental group compared to the control group after the implementation.

## DISCUSSION and CONCLUSION

This research focused on comparing the effect of PBL and lecture-based learning in improving conceptual understanding of simple electric circuits, and eliminating misconceptions. The results support the assumption that PBL stated at the beginning of the research will be more effective in improving conceptual understanding and in decreasing misconceptions when compared to the lecture-based learning. diSessa (2014) states that for some difficult subjects, conventional teaching methods are often unsuccessful. The teaching of concepts, such as closed circuit, open circuit, short circuit, internal resistance, equivalent resistance, ohm law, electrical power in the subject field of simple electrical circuits is generally limited to the mathematical operations for problem solving in lecture-based learning. Explanations for these concepts in lecture-based learning, however, are likely to remain abstract in the minds of learners. The abstract structure of the subjects and concepts, in particular, may make it difficult for learners to structure these concepts correctly, and gain conceptual understanding. Gavalcante et al. (1997) states that the conceptual understanding cannot simply be transferred to the learners; they should construct it themselves. For this reason, learners should be given the opportunity to construct these concepts in real-life learning situations, rather than listening to verbal explanations, for correct interpretation. Thus, learners may be more likely to realize the inaccuracy of their own abstract explanations, and embrace scientific explanations that will provide correct conceptual understanding. Bilgin, Şenocak, and Sözbilir (2009) state that PBL is among the various learning approaches developed by researchers to improve conceptual learning skills, as an alternative to moving away from memorization. PBL includes problem situations that are used to increase knowledge and understanding (Awang & Ramly, 2008). Iglesias (2002) states that PBL, which is characterized by posing real-life problems, enables learners to acquire basic concepts for certain content fields. In this research, in the experimental group, concepts in the subject field of simple electric circuits were studied through scenarios involving real-life problem situations. In this way, learners have the opportunity to transform their abstract explanations and misconceptions into correct scientific explanations through concrete implementation. Research results support these explanations. The maximum score that can be obtained from the SECDT for conceptual understanding is 12. However, before the implementation, this score was found to be 2.30 in the experimental group and 2.74 in the control group. This highlights the low conceptual understanding, of the pre-service primary school teachers in the participant group before the implementation. These scores for conceptual understanding were found to be 7.26 in the experimental group and 3.33 in the control group at the end of the implementation. In the light of the findings obtained, the research showed that PBL is significantly more effective in improving conceptual understanding regarding simple electric circuit compared to lecture-based learning. PBL made a 32.73% greater contribution in improving conceptual understanding compared to lecture-based learning. In the literature, existing studies support this result, and show that PBL has positive effects on conceptual understanding and concept learning. Sahin (2010) concluded that PBL has a more positive effect on university students' conceptual understanding of Newtonian Mechanics compared to traditional instruction. Günter, Akkuzu, and Alpat (2017) determined that PBL has more positive effects on the understanding of *green chemistry* and *sustainability* compared to traditional expository learning. Wardani, Nurhayati, and Hardiyanti (2017) found that PBL model more positive effect the conceptual understanding of students compared to the lecture-based learning. Eren and Akınoğlu (2012) determined that PBL has a significantly greater positive effect on concept teaching compared to the lecture-based learning. Nangku and Rohaeti (2019) found that PBL model positively affected students' conceptual understanding. Ahied and Ekapti (2020) concluded that learning using PBL can improve students' conceptual understanding of pressure concept. In addition, there are studies regarding the positive effects of PBL supported by various methods and techniques on conceptual understanding. Pratiwi, Cari, Aminah, and Affandy

(2019) determined that PBL applying argumentation skills improves learners' conceptual understanding regarding relationship between buoyant and sinking volume. Zahro, Jumadi, Wilujeng, and Kuswanto (2019) determined that web-assisted PBL model resulted in a higher conceptual understanding compared to the traditional learning model. Rohmah, Pramono, and Yusuf (2020) stated that PBL supported by mobile learning media can improve primary students' conceptual understanding, and Ula, Supardi, and Sulhadi (2018) concluded that the implementation of PBL with mind mapping improves understanding of concepts.

In this research, the participants with misconceptions in general were more likely to give wrong answer with the wrong reason, rather than reaching the wrong answer with the correct reason, or the correct answer with the wrong reason. Thus, of the three sub-score of misconception examined, the mean scores for the first type misconception are higher than for the others. The research showed that PBL provided a decrease in all misconception types at the end of the implementation, but this decrease was significant only for the first type. Consistent with this result, the research revealed that PBL provided a 13.88% decrease for the first type misconception at the end of the implementation compared to before the implementation. The fact that the research was limited to 4 weeks can be shown as the reason why the decrease in other misconception types was not significant. The results revealed that the lecture-based learning after the implementation provided a non-significant decrease in the first and third types of misconception, and a non-significant increase in the second type. Based on this result, in the control group, after the implementation, there was an increase in the numbers giving the correct answer based on the wrong reason, and being sure of the answers. Percentage changes in misconception score types are consistent with this result. The research showed that lecture-based learning increased the second type misconception (false positive) by 1.54% at the end of the implementation. This increase in the second type misconception, as opposed to a decrease or no change, was an unexpected result. However, this increase was not significant. The lack of a significant increase may be a reason for optimism about the effect of this result. The cause may be that participants are likely to reach correct answers in their predictions results, even without the correct justification. Hestenes and Halloun (1995) states that it is difficult to reduce the rate of false positives, and that even random choices are effective in increasing the rate of false positives. This explanation supports the result obtained.

The research revealed that PBL was effective 13.88% and lecture-based learning was 2.16% effective in decreasing the first type misconception after the implementation. It was previously stated that some improvements were made in the control group in order to limit the results of the biased research in favor of the experimental group in which the experimental implementations were made. Accordingly, in order to ensure the activeness of the participants in the control group, question-answer and problem solving activities were carried out. In addition, during the demonstration experiments used in the control group, a discussion environment was provided on the predictions of the control group participants. However, unlike lecture-based learning, PBL provides an opportunity for learners to think about the solution of a problem situation, to form a hypothesis and test it. In PBL, learners make pre-discussions based on their pre-knowledge to determine the problem and its solution. These discussions cause learners to encounter different ideas and question their own concepts. In addition, the process of creating and testing hypotheses provides an opportunity for learners involved in the learning process with their pre-concepts to question their existing concepts and realize that they are wrong. Thus, learners enter a process that will replace their misconceptions with scientific explanations. The inability of lecture-based learning to have a significant effect on overcoming misconceptions in this research can be attributed to these reasons. Widarti et al. (2017) states that lecture-based learning will be insufficient in overcoming misconceptions related to conceptual change. PBL was significantly effective in overcoming misconceptions, but did not completely eliminate misconceptions. This is probably because the participants had a lot of misconceptions before the implementation. Perhaps the success of PBL could be seen more clearly if it had been studied with a group of participants who had less misconceptions before the implementation. But still the research revealed that PBL is more effective at overcoming misconceptions of all types than lecture-based

learning. The research showed that PBL is more effective by 8.32% at decreasing misconception compared to lecture-based learning. This shows the success of PBL in overcoming misconceptions. These results confirmed the assumption that PBL presented in the research is effective in decreasing misconceptions. In the literature, there are studies that support the effectiveness of PBL in decreasing misconceptions. Akınoğlu and Tandoğan (2007) determined that the PBL model not only positively affected the conceptual development, but also kept misconceptions at a low level. Tarhan and Acar (2007) found that PBL compensates for misconception in students, and Bayram (2010) found that PBL is more successful in eliminating misconceptions compared to traditional learning methods. The PBL method applied in this research was more effective in decreasing the participants' misconceptions about simple electric circuits compared to the lecture-based learning and had a more positive effect on enabling participants to make scientific explanations about simple electric circuits, and improve their conceptual understanding.

**Suggestions**

The research results reveal the positive effects of PBL in eliminating pre-service primary school teachers' misconceptions and supporting conceptual understanding, compared to lecture-based learning. This suggests that PBL should be employed more frequently in the education system. This research was carried out on simple electrical circuit issues and concepts, but future studies can be expanded to include other science subjects and concepts. Longer-term research will enable the effect of PBL on variables to be determined more clearly. The current research focused on the elimination of misconceptions within the scope of the general results obtained from the test, but the misconceptions surrounding each concept were not examined individually before and after the implementation. For this reason, it is not known which misconceptions were more resistant to elimination at the end of the implementation. Therefore, in subsequent studies, the results obtained may be supported with qualitative data in order to determine the change of pre-and post-implementation misconceptions for each concept.

**Limitations**

There are some limitations of the present research. The first limitation of this research was that the research period was limited to four weeks in order to minimize disrupt the education program. This limitation can be overcome by carrying out the research with a longer implementation period to reveal the change in conceptual understanding and misconceptions more clearly. In this research, concepts regarding basic electric circuits were limited to closed circuit, open circuit, short circuit, internal resistance, equivalent resistance, ohm law, lamp brightness (electrical power). In future studies, these concepts can be further expanded taking a holistic approach. The last limitation is that the research data was obtained using three-tier SECDT. In the third stage of the three-tier tests, the participants were asked to confirm whether they were sure of their answers in both stages (Şen & Yılmaz, 2017). Similar research can use a four-tier test to be developed on simple electrical circuits in the literature. Thus, this limitation of the three-tier tests can be eliminated by asking the participants about the certainty of their responses separately for both stages.

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IOJPE

ISSN: 1300 – 915X
www.iojpe.org

*International Online Journal of Primary Education* *2021, volume 10, issue 1*

# TEACHERS' EXPERIENCES WITH OVERCROWDED CLASSROOMS IN A BASIC SCHOOL IN GHANA

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**Received:** February 15, 2021 **Accepted:** April 11, 2021 **Published:** June 30, 2021

**Suggested Citation:**
Osai, J. A., Amponsah, K. D., Ampadu, E., & Commey-Mintah, P. (2021). Teachers' experiences with overcrowded classrooms in a basic school in Ghana. *International Online Journal of Primary Education (IOJPE), 10*(1), 73-88.



**Abstract**

This research sought to investigate teachers' experiences with overcrowded classrooms: the case of new Gbawe experimental 1 basic school in Ghana's Greater Accra region. The study explicitly followed a qualitative approach to research specifically a case study design. Unstructured questionnaires and Teacher observations were utilised in the process of generating the data. This investigation's general results indicate that educators' perceptions with overcrowded classrooms are 'stressful'. Similarly, teachers described some situations in an overcrowded classroom which they defined as stressful. Some of the descriptions given by educators include insufficient learning environments, safety and health concerns, limited contact between pupils and educators, disruptive behaviour, emotional and mental challenges for educators, increased workload and insufficient time in the classroom. In addition, the factors contributing to traumatic experiences include lack of administrative support, lack of policy enforcement, insufficient teacher preparation and professional development and lack of teaching material for learning. Educators, however, suggested that they still had recourse to improvisation to allow them to handle overcrowded classrooms. Working on teacher best practices in overcrowded classrooms was suggested to be helpful in helping teachers who find themselves in such circumstances.

**Keywords**: Class size, classroom discipline, classroom management techniques, overcrowded classroom, public basic school teachers' experiences.

## INTRODUCTION

Globally, all countries both developed and developing, including Ghana, experience a fundamental challenge in education and training institutions when it comes to providing all school-going children with a satisfactory basic education. This is as a result of the unprecedented increase in enrolment in schools worldwide (Hachem & Mayor, 2019). Despite the significant steps accomplished especially in access to basic education, momentous difficulties remain, particularly in developing countries. Some of the difficulties include the issue of improving quality and expanding learning accomplishment. Accordingly, Ahmed and Arends-Kuenning (2003) posited that essentially, education is a foundation for monetary development and advancement attributable to the colossal extension in the number of

applications for its products and services around the world. Subsequently, student enrolment is on the increase thereby driving the global community, governments, and administrators of the education system to deal with the huge enrolment numbers without trading off quality. "Education is the wise, hopeful and respectful cultivation of learning undertaken in the belief that all should have the chance to share in life" (Smith, 2020: p.1). This implies that education requires a conviction that everybody holds in life and a vision of what will make people happy and prosperous.

This is in accordance with the desire or disposition of others (fear of respect, knowledge, and prudence) and collaboration (relationship with others in establishing relations and learning environments) with others. In conclusion, it is the issue of customary practice or behaviour that leads to a committed and responsible action (Carr & Kemmis, 1986; Grundy, 1987). The classroom as a unit of the school executes its role as part of the learning process. Correspondingly, a classroom, a room where children, as well as adults, learn (Moreno, Cavazotte, & Dutra, 2020), is also a study area. Classrooms can take place in all kinds of educational establishments, from preschools to universities or elsewhere, such as in religious and humanitarian institutions, for example.

Overcrowding in classrooms is an international issue that hinders an efficient teaching and learning process (Hachem & Mayor, 2019). One of the most pressing issues facing educators in the United States today is overcrowding (Hachem & Mayor, 2019). The question is a combination of population growth, the lack of educators, and a reduction in grants or support that has increased class size (Hachem & Mayor, 2019). There are about 17,400 schools that are overcrowded in the USA (Hachem & Mayor, 2019). Class sizes would be set in an ideal world for 15-20 students. Sadly, many classrooms now surpass 30 students on a daily basis, and even in some cases, schools have more than 40 learners in one class. Likewise, the only EU nation with overcrowded primary classes is the United Kingdom. In Ireland, two out of three primary pupils are also in above-average classes of 25 or more, second only to the UK in Europe (Donnelly, 2019). There were also more than 30 pupils per class in China. Among primary school and lower secondary education, the number of students per class appears to increase. A 2015 provincial survey found that in Shandong, more than 40 percent of classes in primary and middle schools were over-sized. Ten per cent had a class size of more than 666 per cent (China Xinhua, 2016). The average class size is more than 100 at a middle school in Zhoukou District, in China's most populated Henan province (China Xinhua, 2016). In China, education officials describe classes of "normal" size as those with up to 45 learners. Classes with more than 55 pupils are called "large" and "super-large" are those with more than 65. But in 15 Chinese provinces, the average for junior high schools reaches 45, and in two provinces, it is more than 55 (China Leiyang, 2018).

The problem of overcrowded classrooms in most African countries is no different. Overcrowded classrooms have been reported in some countries in Africa. Nigeria, Kenya, South Africa have all admitted congestions that are overly above the UN acceptable ratio (Motshekga, 2012; Mutisya, 2020; Onwu & Stoffels, 2005). The learner teacher ratio (LTR) (Motshekga, 2012; UNESCO Institute of Statistics, 2008) for primary education is 40:1. Pupil teacher ratio (PTR) is, however, troubling in the majority of developed countries. It was calculated by UNESCO (2008) that more than 84% of the classrooms had more than 40 learners. However, Sub-Saharan Africa and Asia, form the majority of countries with PTR over 40:1. Although Ghana was at 27.25 pupil-teacher ratio in primary schools in 2018 (UNESCO Institute of Statistics, 2020), Ghana has many more schools that are associated with a large number of pupils at the same age. Nevertheless, there have been major regional variations in national pupil-classroom ratio (PCR). According to the Ministry for Education, Ghana (2018), the PCR of public elementary schools is 55:1 for kindergarten, 38:1 for primary school, and 35:1 for junior high school (JHS).

Therefore, overcrowded classrooms disrupt teaching effectively as most teachers experience teaching difficulties, discipline, physical, and appraisal problems (Iqbal &, Khan 2012). Regrettably, teachers in public schools are still facing severe problems with congested classrooms (Amarat, 2011). Consequently, Oliver (2006) argues that overcrowded classrooms lead to frustration when learners

withdraw, become frustrated, and exhibit negative attitudes. Consequently, overcrowded schools have negatively affected the self-confidence of teachers and their professional satisfaction, creating a situation in the classroom whereby educators encounter countless difficulties (Fin, 2003). Learners learn at different levels and, because of a learning barrier, some learners might need individual attention. In Ghana, the School Feeding Scheme, the provision of free school uniforms and workbooks, and the "FREE, Compulsory Universal Basic Education" (FCUBE), are some recent policies introduced in the education sector (Kweitsu, 2019). From 1996-2005, the FCUBE presented an action plan to close the gender gap in primary schools, to strengthen education and the living situation of teachers (Thompson & Casely-Hayford 2014). Ghana thus scored 1 for both elementary school and high school levels in 2013 on the UNESCO Gender Parity Index (GPI) (World Bank, 2013). These policies have led to an increase in the number of students in classrooms, given the lack of appropriate school facilities (Kweitsu, 2019).

Given the strides that Ghana has made in enhancing access for all to education, obstacles remain that prevent the acquisition of knowledge in quality learning by thousands of children (Kweitsu, 2019). Normally, since schools are overpopulated, the school environment is not ideal for learning. In consequence, the low standard of education is reflected in the academic performance of the students (Shah & InamuIlah, 2012). Due in part to numerous initiatives aimed at enrolling more students, some schools in the Accra Metropolis, including New Gbawe Experimental 1 Basic School, has been overcrowded during the course of time.

When the researcher examined and witnessed students studying, and teaching at New Gbawe Experimental 1 Basic School, the researcher confirmed the condition of overly crowded classrooms. The investigator noted that students sat in threes or fours on benches supposed to be occupied by two students, obstructing the movement of teachers and students alike, in the classroom, causing discomfort among students, and requiring exceptional tactics. Correspondingly, in the New Gbawe Experimental 1 Basic School, the average pupil-teacher ratio is 72. It is almost twice as much as the Ghana Education Service's standard pupil-teacher ratio of 38 (Ministry of Education, MOE, 2018).

According to Freiberg (2013), classroom management plays a significant role in student success in a chaotic and badly controlled classroom. The classes are usually crowded and students have little space to navigate. Accordingly, Marzano and Marzano (2003) described aspects of the management of classrooms, including the creation of a place for successful class management (Saifi, Hussain, Salamat, & Bakht, 2018). Marzano and Marzano noted that the management of the classroom will involve a teacher, who will ensure that the students will have a sense of what they need to do within a given time span. A second approach would be to reorganise the seats to allow all students to participate equally in their learning experience.

Behaviourism is used in many class management investigations, where the teachers manage the atmosphere in the classroom for the students to understudy them (Edwards & Watts, 2010; Freiberg, 2013; Saifi, Hussain, Salamat, & Bakht, 2018). Particularly, the use of desks, lamps, ventilation, and the proper use of blackboard, as techniques for the management of classrooms, is continuously defined by teachers. In huge classrooms, educators often use various approaches such as the establishment of positive relationships with students; the arrangement of their instruction to improve access to learning for students; and the promotion of students' participation in academic activities using social management techniques. The rest are promotion of learners' communal abilities and trying to control one's actions, feelings and thinking in the pursuit of long-term objectives; and usage of suitable interdisciplinary approaches to support learners experiencing reactions to the social stimulation difficulties.

Nevertheless, the organisation of large and smaller classrooms is differentiated (Asodike & Onyeike, 2016). Consequently, stratagems in smaller classrooms cannot easily be translated into those with large classes. For starters, the consideration of seating arrangements because of space is useless in a large classroom. Also, the standard of the teacher and his connection with students is a fundamental

element of all other class management aspects in large classrooms. Adeyemi (2008) opined that the average number of learners in a class is reported in class size or in the number of students taught by a teacher in a single classroom. Kedney (2013), however, found that class size is a method for evaluating the educational system's success as the bigger the class size the less efficient is the instruction. An alternative opinion is held by Stepaniuk (1997) that educators' organisation could define the triumph or the non-fulfilment in instruction and learning and not the quality utilisation of the classroom even though that may depend upon class space and size. It is significant in instruction and learning, not because of the size of the class, but rather how the teacher handles their classes in terms of the classroom's size and capacity (Stepaniuk, 1997). Educators and learners alike would have trouble moving about during learning, especially when there is a lack of space. Likewise, pupil-teacher ratios (PTRs) and class size are dissimilar or inconsistent as opined by some investigators (Harfitt, 2015; O'sullivan, 2006). Unlike PTR that is the overall student enrolment at one school divided by administrators, counsellors, professional teachers, and other people supporting the school and not just the number of teachers, class size is the average number of children for which the Teacher is responsible. This thesis, therefore, examines the experiences of educators at the New Gbawe Experimental 1 Basic School as a case study of overcrowded classrooms.

**Statement of the Problem**

Challenges with overcrowded classrooms have been reported all over the world. For instance, overcrowding is one of the most significant concerns facing schools and teachers in the United States today (Hachem & Mayor, 2019), the UK and Ireland (Donnelly, 2019), and China (China Xinhua, 2016: China Leiyang, 2018). Additionally, overcrowded classrooms are also found in some countries in Africa such as Nigeria, Kenya, South Africa (Motshekga, 2012; Mutisya, 2020; Onwu & Stoffels, 2005). Ghana is also experiencing unprecedented levels of overcrowding as a result of the FCUBE and school feeding programme (Kweitsu, 2019; Ministry for Education, Ghana, 2018). Teachers around the world, like Ghana, have trouble managing overcrowded classrooms (UNESCO Institute for Statistics, 2018). Although measures are put in place to reduce the overcrowding issue in schools, they are not enforced and cause teachers a variety of problems. Teachers are faced with overcrowded tasks, as they are responsible for instructing, learning and managing the classroom simultaneously. There are schools in Ghana with many more learners in one classroom despite the fact that the officially prescribed LTR for primary schools is 40:1 (Motshekga, 2012; UNESCO, Statistics Institute, 2008). Relatively, this accounts for an overcrowded classroom, and that of New Gbawe Experimental 1 Basic School with an LTR of 72 cannot be overemphasised.

LTR is directly related to the standard of schooling according to Lannoy and Hall (2010). Such challenges have an immense effect on teachers as teaching and learning quality in overcrowded setting decreases. Similarly, teachers find it very easy to get upset when they face challenges that hinder them from producing educational results. In addition, there is a variety in every classroom because the learners have specific needs and aspirations. Therefore, learners learn at various rates and due to learning challenges they may meet, some learners may need individual attention. As part of its pledge to Free and Compulsory Basic Education (Ghana Education Service, GES, 2014), Ghana's new education programme provides two years of Kindergarten (KG) which brings it ahead of the curve relative to other countries in sub-Saharan Africa. Ghana's education is "divided into three phases: basic education (nursery, elementary, lower secondary), secondary education (high school, technical and vocational education), and higher education (universities, polytechnics, and colleges)" (GES, 2014: p.2). Acknowledging the gains of the last two decades, Ghana has significantly higher efforts of the government through the Ministry of Education and the Ghana Education Service, GES (2014) to extend KG services equitably, particularly for its most marginalised and vulnerable children (UNESCO, 2018). The Ministry of Education and Ghana Education Service have been steadily working for universal access to basic education (UNESCO, 2018). The Inclusive Education Policy Framework delivers opportunities for the students to obtain a quality education. Ghana's Inclusive Education (IE) programme supersedes the concept of geographic location (UNESCO, 2020).

However, the strategy acknowledges the varying learning needs of the students. Teachers cannot enforce this in an overcrowded classroom.

There is no comprehensive literature regarding the disparity between the scholastic achievement of the learners and the number of learners enrolled. Although some genuinely think that large classes are detrimental to student accomplishment, (Cooper, Lindsay, & Nye, 2000), think alternatively. UNESCO (2020) has expressed the view that although the number of classrooms built in different parts of the country has not increased correspondingly, enrolment in all primary schools, especially public schools, has doubled. Yelkpieri, Namale, Esia-Dankoh, and Ofosu-Dwamena (2012) researched on overcrowded classrooms at University of Education, Winneba campus. Similarly, Akoto-Baako (2018) also reported overcrowding in senior high school (SHS) in Cape Coast Metropolis, Ghana. From the above it is realised that research on overcrowded classrooms have been performed in some parts of Ghana and at certain levels of education but not in the current study area. It is against this backdrop that the research is conducted to interrogate issues regarding overcrowding in Gbawe Experimental 1 Basic School. Again, it will analyse the procedures that teachers utilise to handle overcrowded classrooms, and recognise the obstacles that educators experience as they handle overcrowded classrooms.

## Theoretical Framework

### School Improvement programme theory

Van Velzen, Miles, Elholm, Hameyer, and Robin (1985) described school improvement as "a comprehensive, concerted initiative targeted at enhancing learning environment as well as other relevant internal circumstances in one or more schools, with the overarching goals of attaining more efficiently academic objectives." Consequently, Jansen (2001) observed that school improvements are important for a school and an emphasis on results. With respect to congested schools, it's a concern for many educators worldwide and the sooner the condition is addressed the faster. In fact, school development plans are important to mitigate the issue for teachers and they help to reduce the repetitive tension that teachers face in congested classrooms on a regular basis. As a consequence, Creemers (2008) argues that a climate convenient for enhanced efficacy is perceived as important for institutions trying to implement action since this would enable them to increase productivity. While all factors relating to education are taken into account in the school improvement context, the study may concentrate on how this idea and the others mentioned earlier may be connected to the perceptions of educators to establish an initiative such that they will provide meaningful instructional interactions in the classroom. Educators are seen as an integral lever of transformation, according to Creemers (2008), so progress is visible in their classrooms and everyday activities. Furthermore, Creemers (2008) discusses that proposals for school change should often concentrate on educators who might want to enhance facets of their instruction and help to develop teaching skills. Teachers will still need preparation and encouragement to empower them with the ability to cope with the occurring challenges relative to consequences of the overcrowded classroom.

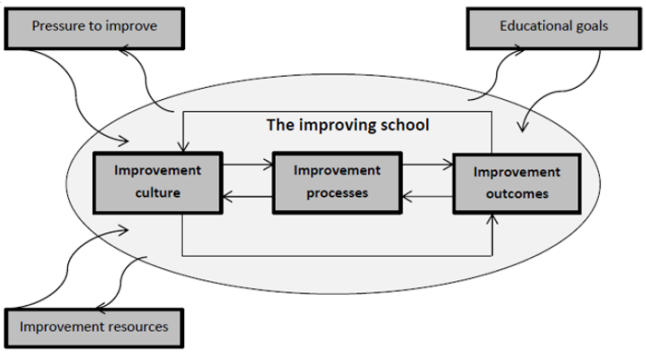


**Figure 1.** Efficient institutional amelioration related to congested classrooms (Creemers, 2008, p. 7).

Creemers (2008) further suggests that attempts to change would not just change the perceptions of teachers but also the teaching standard. In overcrowded classrooms, a study has demonstrated that often teachers feel stressed and are not prepared with the expertise to cope with overcrowded classrooms. There is a correlation between school reform and the perceptions of teachers as their perspectives will contribute to initiatives and encourage schools to reconsider methods and adopt initiatives to strengthen schools that help teachers in coping with overcrowded classrooms. Teachers often manage overcrowded classes and are struggling with them. 'Institution Reform' is the only way to make sense of how teachers treat overcrowded classes and work with them. This often causes less tension for teachers as schools are changed, as they will manage more in the classroom. Congested classes are not only a challenge but a means to build space for change and to reconsider strategies. This model indicates that productive progress contributes to better performance in achieving educational targets, according to Creemers (2008). It outlines the philosophy of school improvement and shows the theoretical basis for the essential structures of school improvement. If we strengthen the ability of teachers, it enhances learning and teaching and in essence, contributes to achieving the objectives of education. The model for the efficient institutional reduction of stress in overcrowded classrooms is shown in Figure 1.

The philosophy of school enhancement, which subsumes the constructivist theory, class management theory, conventional classroom management theory, and child-centred classroom model, supports this research. In this analysis, this theory will help to explain the data produced. The researcher considered the school improvement theoretical concept as central to the study because it indicates that instructional objectives are met through improvement and interaction.

**Review of Related Literature**

**Empirical Review**

The school atmosphere may have a beneficial effect on the wellbeing of the learning community or can be a huge obstacle to learning. The school atmosphere inside the schools will impact multiple places and individuals. A healthy school environment for example has been correlated with decreased mental and emotional concerns for pupils. It is also assumed that constructive organisational interactions and optional learning experiences will improve achievement behaviour for students in all educational settings. The strong student-teacher partnership provides students with a positive and welcoming school atmosphere to operate learning activities smoothly, resulting in successful academic results.

The school climate and educational attainment of standard six students were investigated by Arul and Vimala (2012). The input from 400 respondents in the study was used to assess the association between the school atmosphere and educational attainment. The outcome of this analysis showed that there is no substantial variation in gender and teaching methodology in the standard six learners' school setting. But there is a major variation in the standard six pupils' education setting in terms of the school's locality. There is a better school climate for urban learners than for rural pupils. In their everyday lives, urban learners have a traumatic or stressful world quite mostly because they live in a technological and fast-paced life. Thus, with their research, they found that the school atmosphere was not quite comfortable.

Chepkonga (2017) indicated that the consistency of school amenities tends to have an indirect impact on learning and instruction. This suggests that educational outcomes are dependent on, class size, instructional methods, Teacher competence and abilities, instructional and learning atmosphere, and subject matter, all affecting educational outcomes in both of these respects (Finn, Walton, & Elliott-White, 2000). As stated by Shamaki (2015), the content of the learning atmosphere is closely associated with the performance of the students in different subjects, so that literature surveyed from different developing countries in Africa, notably from Mozambique, Uganda, Zimbabwe, and Nigeria, revealed the connection between class size and learner success (Motshekga, 2012; Mutisya, 2020; Onwu & Stoffels, 2005).

According to Siperto (2017) in Mwanza, the overpopulated classrooms have been identified as increasing and sustaining problems that obstruct successful teaching and learning operation. According to Siperto, the proportion of learners she researched in the classes was too high for the small space of the classroom to be accessible. Siperto found that in all the schools studied, the teacher-student ratio ranged from 1:80-90. In such a scenario, educators were finding it impossible to implement successful teaching methodology. The investigator also noticed that educators were overwhelmed in such a way as not to be able to walk around a classroom.

Similarly, Mutisya (2020) published research in Kenya with the same experience as Siperto's in Mwanza. Free primary education in Kenya culminated in dangerously overpopulated classes in which the learner-centred method was quite challenging for the educators to introduce. Mutisya complained that although most of the classes were built to fit 45 students, the classrooms had between 80 and 90 students, beyond the number prescribed by the Ministry of Education. The consequence of this is that during classroom interaction, it continues to hinder teacher-student and student-student engagement, with detrimental effects on their academic success. Although Jason (2006) mentioned that large classrooms are major pitfalls, including stressed interpersonal relationships between learners and educators with a small variety of instructional techniques, teachers teaching a large class are uncomfortable.

In addition, he noted that amid a contradictory definition among investigators about class size and learners' success, small class size retains an advantage on the level of results. It was noted that large-scale instructional techniques have an influence on the efficacy of instructional practices. Similarly, she observed that in a typical classroom where the teacher-centred approach is used, marked by a high percentage of pupils with instructional practices, pupil innovation, and interest are therefore reduced.

**Research Questions**

This research aims to answer the following questions, in line with the objectives:

i. What experiences do teachers have with overcrowded classrooms?

ii. What challenges do teachers encounter as they manage classrooms that are overcrowded?

iii. What strategies do teachers use to manage overcrowded classrooms?

## METHOD

**Research Design**

The appropriate research design that was employed for this study is the case study. It is the framework that was created to seek answers to the research questions. The case study design subsequently supported the investigator to gain detailed information from educators concerning their experiences in congested classrooms (Burns & Grove, 2010) in New Gbawe Experimental 1 Basic School. As previously mentioned, this investigation took the form of a case study. The purpose of the case study is to understand the case in depth and in its natural environment, to understand its sophistication and meaning (Punch, 2009). In addition, Neale, Thapa, and Boyce (2006) postulated that a case study offers the story behind the result by documenting what happened to bring about a scenario. Neale et al. (2006) propose that case studies are necessary when there are special or interesting stories to be told. Case studies offer even more comprehensive information (Neale et al., 2006).This is also confirmed by Lee and Brennenstuhl (2010), who argue that an in-depth overview, discovery, or interpretation of a study is given by a case study.

In addition, the main principle of a case study is that it is necessary to discuss the 'how' and 'why' questions with the respondents (Lincoln, 2010). Consequently, the case study design supported the investigator to collect in-depth educator knowledge and how the public school faced congested classrooms. The data generation tools used enables the investigator to raise and explore questions about how and why. This was significant because it offered educators with a chance to offer in-depth information about their overpopulated classroom encounters. Additionally, Creswell

(2013) argued that a case study is related to offering a detailed overview of the circumstances involving persons, incidents and how their relationship with their setting is influenced in the research project. Cohen, Manion, and Morrison (2011) postulate in the same vein that case studies are very descriptive. The investigator selected a case study for this study to investigate a particular community of educators within a specific school to investigate their perceptions of overcrowded classrooms.

**Population**

The population for the study was centred on the teaching staff of New Gbawe Experimental 1 Basic School. It is located in the Weija Gbawe District of the Greater Accra Region. The school has 11 classrooms with staff strength of 14. New Gbawe Experimental 1 Basic School was preferred due to the surge in enrolment in every classroom in the school, which exceeds the pupil to teacher ratio of 35:1 as indicated by Ghana Education Service (MOE, 2018).

**Sample and Sampling Techniques**

Five participants were selected for the study based on the highest-class enrolment. The class teachers for the following classes, 2, 3, 4, 5, and 6, were used in this study. The study adopted both purposive sampling and convenience sampling for the investigation.

***Purposive Sampling***

Purposeful sampling means that respondents with certain features or characteristics are tested by the investigator (Koerber & McMichael, 2008). In this research, only those educators who work in a school with congested classrooms were chosen. Intentional sampling is synonymous with qualitative inquiry, Palys (2008) suggests. In order to obtain in-depth data on their encounters in these classrooms, educators who have overpopulated classrooms were selected. Creswell (2013) has suggested that the investigator must acknowledge the objectives of the study when choosing a sampling procedure.

Based on the objective of this study, the respondents were selected to participate in the research. Palys (2008) states that what exactly they want to achieve is the main question any investigator requires to ask themselves. The investigator decided to illustrate and identify the experiences educators have in a congested classroom in this report. The purposive sampling methodology was suitable as it matched the purpose of this study's investigative goals.

***Convenience Sampling***

The convenience sampling is described by Farrokhi and Mahmoudi-Hamidabad (2012) as comprising respondents who are easily accessible to contact. While this concept stresses easily accessible, certain convenience samples are more widely available than others, as per Koerber and McMichael (2008), but although a study is convenient, certain work would definitely be required in accessing respondents from that study. This sampling approach was used because respondents from the Municipality of the Investigator were chosen and were readily available and easy to collect information from.

**The Sample**

Three classrooms with the largest number of learners were used for observation although there were five respondents in this research. The following is included in the sample: educators with the largest number of students were selected for the research investigation; schoolrooms with the largest admission in the whole school were selected; and although three classes were observed, all five educators took part responding to the questions. The sample is presented in Table 1.

**Table 1.** Profile of educators who participated in the investigation

| Teachers' Name | Gender | Age | Class | Class Size | Highest Qualification | Teaching Experience | Years spent in the research school |
|---|---|---|---|---|---|---|---|
| Teacher A | Female | 44 | 2 | 68 | B.Ed. | 20 | 9 |
| Teacher B | Female | 34 | 3 | 62 | B.Ed. | 12 | 4 |
| Teacher C | Female | 38 | 4 | 80 | B.Ed. | 14 | 3 |
| Teacher D | Female | 47 | 5 | 74 | B.Ed. | 17 | 10 |
| Teacher E | Female | 36 | 6 | 68 | B.Ed. | 10 | 4 |

These educators in the New Gbawe Experimental 1 Basic School assisted the investigator with invaluable data about their perceptions of overpopulated classrooms at the public school.

**Methods of Data Generation**

In view of the qualitative aspect of this investigation, the investigator selected unstructured questionnaire and observation as data generation approaches. According to Adejimi, Oyediran and Ogunsanmi (2010), data generation is a very critical step in any investigative process, and investigation includes the identification of relevant data. According to Kothari (2004), all investigation involves the generation of suitable information. This information is invaluable since the outcomes of the research are decided by the knowledge that is produced. The investigator is responsible for choosing data collection methods that they believe can provide them with rich and suitable data to answer the research questions. The investigator selected unstructured questionnaire and observation as approaches of data generation for this qualitative study.

**Unstructured Questionnaire**

An unstructured questionnaire was utilised in this investigation as the main instrument for generating data. Fife Schwa (2001) noted that a questionnaire is the single most common research tool used owing to its simplicity and usability. Adejimi et al. (2010) argue that by adding more open-ended questions, it is possible to structure a questionnaire to add further value.

An unstructured questionnaire poses open-ended questions, according to Cohen et al. (2011). Wilkinson and Birmingham (2003) argue that open-ended questionnaires do not place any constraints and encourage the participant to answer any question. This form of a questionnaire was chosen because, without any limitations, the investigator wanted participants to openly share their encounters. It also gave participants enough time to think about their answers and complete their questionnaire and submit it on completion to the investigator. This questionnaire was structured with several questions as this would allow one to extract rich insightful details about the perspectives of educators in overpopulated classrooms with various how and why. It is also very easy to utilise investigation tool and encourages you to ask as many questions as you can. Personal views, opinions, feelings, and experiences were created by the questionnaire.

**Observations**

According to Crossman (2019), and Simpson and Tuson (2005), observation takes note of behaviours, actions, situations, artefacts, and habits of people. Cohen et al. (2011) noted that it allows the researcher the opportunity to collect 'live' information from naturally occurring social contexts. The method of observation was chosen as one of the data collection methods because it allowed the researcher to observe educators teaching in overcrowded classrooms. Simpson and Tuson suggest that what should be looked at and is grouped into categories is defined by an observation plan. There was the highest degree of enrolment in the school in the classrooms chosen to observe. The study assumed that it was important to observe and integrate these classrooms so that the researchers could also have first-hand knowledge of what is happening.

The researcher was a non-participatory observer and tried to remain as inconspicuous as possible. A colleague helped with the recording of the observation in order to compare notes. As what was happening in a natural environment was registered, this allowed the researcher to gather rich information. Cohen et al. (2011) argue that observations are powerful methods to gain insight into conditions. This data collection technique was ideal because it allowed the researcher to examine first-hand what was going on in overcrowded classrooms.

**Data Analysis**

The analysis of the data was carried out using a thematic analysis approach. The thematic analysis is a tool for defining, analysing, and reporting trends (themes) within the data, according to Braun and Clarke (2006). A theme captures something meaningful about the research questions' information and expresses some degree of patterned response or context inside the data (Braun & Clarke, 2006). Braun and Clarke (2006: p.79) also note that there are "six thematic analytical phases that include:

- Data familiarisation: This includes transcribing the content, reading, and re-reading the data and noting initial ideas. The researcher transcribed the content by reading and re-reading the data and taking note of the initial concepts.
- Generating initial codes: This refers to the quest for interesting patterns or features in the data collected. The investigator looked for interesting patterns in the data collected.
- Checking for themes: the compilation of codes into potential themes and the compilation of all relevant details for each potential theme. The researcher checked by creating codes into potential themes and compiling all the significant details for each potential theme.
- Reviewing themes: Check if the themes work on the coded extracts and the whole data collected. In reviewing the themes, the researcher compared the coded extracts with the themes by considering all the data collected.
- Defining and naming the themes: For each theme, simple meanings and names. The researcher provided simple and names for each theme to refine the data.
- Producing the report: making the investigation a scholarly document by writing up." Finally, the investigator wrote up the report based on the information generated through the thematic process.

The material was read carefully and extensively for this study and then transcribed and analysed. The investigator searched for trends in the data as the data was coded and put them into various categories. The investigator then grouped similar categories and placed them under three specified themes. In order to ensure a rich explanation of the data, the thematic analysis was selected as it offers a rich thematic explanation of the entire data collection so that the reader gets a sense of the prevalent and significant theme (Braun & Clarke, 2006).

## RESULTS

**RQ1: Educators encounter "stress" in congested classrooms**

Research question one investigated the experiences teachers have with overcrowded classrooms. The findings from this research suggest that teachers' encounters with congested classrooms are overwhelming. Teachers themselves have described such situations in an overcrowded classroom which are stressful (Mutisya, 2020; Muthusamy, 2015; Shah, & Inamullah, 2012; Yelkpieri, Namale, Esia-Dankoh, & Ofosu-Dwamena, 2012). Such conditions were insufficient classroom space, safety and health issues, limited contact between learners and teachers, destructive conduct, mental and psychological challenges encountered by educators, elevated responsibilities, and limited time (Asadullah, 2005; Muthusamy, 2015; Shah, & Inamullah, 2012). Some of the opinions expressed by the teachers are as follows:

> *"One classroom has too many kids. The classroom is inadequate for student numbers in the classroom. It minimises movement." "There's little room for students to sit down, 4 learners are required to share, instead of 2 per seat." "Sixty-four students in a summer class are a nightmare. Fans don't work. Learners are nervous, very restless, and not centred." "Because the classrooms lack space, they become extremely hot and uncomfortable to become impatient learners." "I do most of the talk, essentially. Sometimes the learners do not answer questions. It's hard to pay attention individually." "To involve the learners in the lesson is hard. It's loud, and you can't pay attention individually." "Personally, I have issues with the discipline. The learners are particularly too noisy when there's a feature that kids get into a frenzy." "Learners suffer a lot over trivial issues such as fighting one another for losing their possessions as their belongings have no location to be kept. And I do settle inconsequential issues that can trigger severe disciplinary concerns. That takes time away from teaching." "I can't deal with it at all. I am constantly nervous. I am still depressed and I sob." "I am really angry, and the despondent learners are behaving poorly, and they don't matter. I am also*

*depressed because my Headteacher does not support me." "Since it is difficult to mark at school, I take marking at home. This removes me since personal time. My daughter laments I ignore her. Often I disregard her need to get my job done and that creates trouble." "I find myself solving minor discipline problems and that takes time off teaching. I always take the marking at home as there is not enough time to mark the work of the learners."*

From the sampled opinions of the teachers, it is realised that in the school, teachers do not have adequate room so the tables and chairs are cramped and the students become very irritated (Asadullah, 2005). There is no wandering around the classroom for students as the mobility is very minimal. Health and safety problems have been reported as a result of room limitations. Interacting with learners is very difficult for the Teacher since these circumstances limit contact. As a consequence of the limited student-Teacher involvement that led them to indulge in destructive actions, pupils felt inferior. Educators also feel very nervous and stressed in a congested classroom, causing them to develop social and emotional difficulties (Mutisya, 2020; Shah, & Inamullah, 2012). Similarly, because of the increasing number of students in the school, the teachers' workload tends to be quite high. Educators' responses suggested that they did most of their school work, such as teaching and teaching-learning materials (TLMs) preparation and marking at home. They stated that such patterns have an effect on their personal and family lives, depriving their families of quality time. The educators argued that the process of teaching and learning is often disrupted constantly while they waste time settling disputes instead of teaching. From the above, the enumerated situations encountered by educators indicate that the interactions of teachers in congested classrooms are 'stressful' and can impair their classroom effectiveness.

**RQ2: Various and nuanced factors leading to stressful interactions for educators**

Research question two interrogated issues regarding the challenges teachers encounter as they manage classrooms that are overcrowded. Sampled comments made by the teachers are as follows:

*"Sometimes I'm not inspired and I don't know how to manage those problems and no-one wants to help. And I just find out what to do on my own." "The number of learners exceeds that prescribed by the Ghana education service." "The number of learners at the school is more than 50 learners in a single classroom." "The lessons cannot be thrilling because the classrooms are so overcrowded and the facilities are not enough that you completely lose hope." "We share what we have with the learners. There are inadequate resources and insufficient funds to provide services because school fees are a major issue." "Practical sessions are too complex to carry out. There are inadequate resources for making lessons interesting and exciting. I don't have enough teaching-learning materials. It's hard but I'm improvising."*

Teacher comments and our observation suggest that stressful experiences with congested classes, such as those identified in the New Gbawe Experimental 1 Basic School, are frequent and complicated. Career development and shortage of resources, policy compliance (Muthusamy, 2015), teacher readiness, and lack of institutional help are some of the reasons that are creating challenging circumstances for educators (Onwu & Stoffels, 2005). The direction or assistance offered by the school management, in particular, the head teacher is insufficient. The results have suggested that New Gbawe Experimental 1 Basic School is not following the policies as required by law. Secondly, any classroom enrolment exceeds what the policy states. The learner-teacher ratio is 35:1 according to the Ministry for Education, Ghana (2018). However, enrolment in the New Gbawe Experimental 1 Basic School is higher than the learner-teacher ratio of 35:1, suggesting at this stage the policy is not being implemented. Unfortunately, teachers may not have the expertise to contend with overcrowded classrooms, and their capacity to cope with this has been compromised (Mweru, 2010). At New Gbawe Experimental 1 Basic School shortage of funding was a big problem and this influenced teaching and learning. Teachers suggested that, due to lack of resources, the lessons cannot be informative and exciting. Both of the above factors are contributing to traumatic teachers' experiences.

**RQ3: Perspectives of educators handling congested classrooms**

In research question three, we investigated the strategies teachers use to manage overcrowded classrooms. Sampled comments made by the teachers are as follows:

> *"There are social exercises conducted outside to reduce movement and noise. I take one step at a time to ensure all prescribed work is complete. I like to scream a lot. I reward them with candy, occasionally. Nobody talks except for putting their hand up." "Group work is an efficient way for learners to provide guidance and test work. Consolidating and testing work in groups is easier for me." "I am basically struggling with problems to keep things from worsening. I try to hold the students engaged constructively from the beginning of the lesson till the end so that they do not get impatient, and mess with other learners. I plan lessons that make it interesting." "I lay down simple guidelines for handling classrooms. I don't neglect lesser discipline problems as they save me time to solve a small issue, then bigger ones. I do the training without interrupting the lesson. I offer rules and bonuses for good behaviour." "I'm using corporal punishment and I'm giving students tons of notes to copy and write and they're occupied but they're always crying and yelling and behaving like your invisible." "I am trying to keep an optimistic and relaxed outlook and I am trying to find answers to problems. I know the learners are victims. They have no alternative in terms of what school will they go to."*

We found that though educators' encounters with congested classrooms are daunting, the problem is often addressed by them (Yelkpieri, Namale, Esia-Dankoh, & Ofosu-Dwamena, 2012). Educators normally rally their resources to enable them to control overcrowded classrooms (Muthusamy, 2015). Correspondingly, in order to actively involve learners in their lessons and enhance learner achievement, educators designed cooperative learning activities. Similarly, the teachers used incentives to encourage positive learner behaviour. Additionally, educators suggested specific rules and guidelines should be set. Although some teachers were reported to use innovative methods to handle overcrowded classes, there were others who used offensive tactics such as insulting, yelling, and corporal punishment (Muthusamy, 2015). Findings from this study revealed that despite the challenges in overcrowded classrooms encountered by educators in New Gbawe Experimental 1 Basic School, they are still keen on working hard within the constraints of inadequate resources and the huge student numbers, suggesting that they have the best interest of the learners.

## DISCUSSION and CONCLUSION

### Discussion

The results of the study have shown that there are a multitude of difficulties for educators to face in congested classrooms. The results also suggest that the 'no effort' and often challenging methods used by educators have shown the Teacher's role in managing congested classrooms and transforming their schools and classrooms as agents of change (Donnelly, 2019; Fatima, Mushatq, & Fatima, 2019; Hachem & Mayor, 2019; Khanare, 2009; Marais, 2016; Muthusamy, 2015). The value of the school reform system driving this research highlights facets of how even the smallest interventions can be nurtured in the psycho-social well-being of children (Donald & Lolwana, 2006; Donnelly, 2019; Hachem & Mayor, 2019; Marais, 2016; Muthusamy, 2015). Thus, the researcher suggested in the results as to why the teachers are getting the experiences they do. The teachers still do this given the pressures of running overcrowded classrooms. Some teachers had shared optimism and positivity anyway. This research focused on the theoretical structure for school improvement and is perfect, because teachers are already familiar with and dealing with congested classrooms as they have a sense of school improvement and coping strategies. Thus, according to Creemers (2008), educators are seen as an important tool for progress, as transformation is evident in their classrooms and day-to-day activities, but effective school initiatives are still needed to bring about change. The emphasis was on educator interactions with congested classrooms, and why they have the experience they have, and what management techniques they use to deal with congested classroom challenges.

**Conclusions**

Teachers' overcrowded classroom experiences are "stressful." There are causative factors leading to traumatic situations for teachers but they often handle the overcrowded situation with tactfulness. As improvement is the main factor to bring about intervention, it is expedient that the problem is actionised in order to mitigate it. This will enhance the experience of teaching and learning for both teachers and learners. In order to cope with overcrowded classrooms in traditional schools, there are a number of approaches that schools may use to increase teacher ability and school performance as revealed in this research. From this study, we observed that teachers used different approaches to enable them overcome overcrowding in their classrooms. Some of the approaches mentioned include the following. Some teachers use group work in a flexible way to ensure that different ability groups are taken care of while helping to overcome overcrowding as well. Others used improvisation to improvise materials to stimulate and maintain the confidence and excitement of students (Marais, 2016; Muthusamy, 2015; West & Meler, 2020). One aspect that the researchers were not enthiused about was the use of corporal punishment. It is also not advisable for some teachers to keep the lesson too long in an overcrowded classroom. Keeping the lesson short is very helpful so that teachers can devote as much time as possible to working with a variety of groups. Keeping learners busy right fom the start of a lesson is very crucial in successful overcrowded clasrroom management. As a result, it's important that the teacher keeps the entire class occupied as much as possible. Thua, at the beginning of each period, get the students to work straight away (Kriegel, n.d.; West & Meler, 2020 ).

**Recommendations**

It is believed that when the required action is taken, schools experiencing overcrowding across the country can be improved. The research can be broadened to a number of schools from other backgrounds such as semi-urban and rural areas to get a clearer picture of the nature of congested classrooms. It is suggested that research involving other respondents like pupils using a variety of pedagogic approaches would be fascinating such as art-based approaches to make the learners' voices heard in their classrooms over-crowded. It is recommended that the Ghana education service takes a critical look of these behaviour that is exhited by some teachers in overcrowded classrooms.

**Limitations of the Research**

This study was conducted in an overcrowded urban school where all the teachers observed and interviewed were females. It would have been helpful if some of the teachers were males so that their divergent views could have been compared. Also overcrowded classrooms in semi-urban and rural areas could have also been considered to compare how teachers and learners will fare in these locations. It is suggested that further research be undertaken by including the aforementioned variables.

**Acknowledgment**

We wish to acknowledge the teachers used in this study for making themselves available and also allowing us to observe their classroom practice.

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IOJPE

ISSN: 1300 – 915X
www.iojpe.org

*International Online Journal of Primary Education* *2021, volume 10, issue 1*

# THE CONCEPT OF ANGLE IN TURKISH AND SINGAPOREAN PRIMARY SCHOOL MATHEMATICS TEXTBOOKS: DYNAMIC OR STATIC?

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**Received:** November 06, 2020 **Accepted:** February 08, 2021 **Published:** June 30, 2021

**Suggested Citation:**
Bütüner, S. Ö. (2021). The concept of angle in Turkish and Singaporean primary school mathematics textbooks: Dynamic or static?. *International Online Journal of Primary Education (IOJPE), 10*(1), 89-105.



**Abstract**

The present study compared Turkish and Singaporean textbooks with respect to their instructional contents on a difficult topic for most students: the concept of angle. The study used the 3rd and 4th grade mathematics textbooks taught in Turkish and Singaporean schools. The analysis showed that Turkish textbooks defined the angle as a static concept, and Singaporean textbooks defined it as both a static and dynamic concept. The definitions of the concept of angle included in the textbooks reflect on the representation of the angle, instructional tools and problems. Turkish students learn angle from textbooks only as a static concept, so they may have difficulties and misconceptions about the subject and related concepts. The findings showed that the contents of Singaporean textbooks offer students more opportunities than Turkish textbooks in learning about the angle as a static and dynamic concept.

**Keywords:** Singapore, Turkey, mathematics, textbook, the concept of angle.

## INTRODUCTION

Many countries participate in international comparative exams such as TIMSS, PISA and PIRLS in order to better see their own development in science, mathematics and reading skills. One of these international exams, TIMSS is held every four years to compare the science and mathematics achievement levels of elementary 4th and 8th graders. In the exam, participant countries' mathematics standards achievement scores are calculated (numbers and operations, geometry, algebra and data-probability) in order to reach an overall achievement score. In TIMSS 2015, Singapore was the top country with 617 points, and Turkey remained below the international mean with 463 points in the geometry domain (Mullis, Martin, Foy, & Hooper, 2016). The differences between Turkish and Singaporean students' geometry performances may be attributed to many factors. One reason could be differences in the content of the textbooks.

Rezat (2006) makes an attempt to develop a framework on the use of textbooks by both teachers and students. Using the tetrahedron model shown in Figure 1, Rezat (2009) represented the relationships among textbooks, students, teachers, and mathematical knowledge.

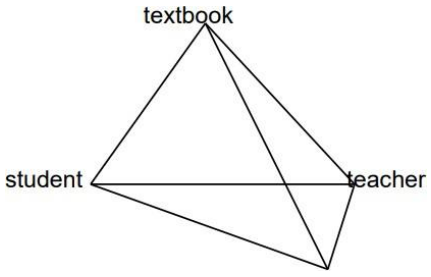


**Figure 1**. Rezat's tetrahedron model

Figure 1 indicates the importance of textbooks in the teaching process. Textbooks can be considered an important resource for both students and teachers (Fan & Zhu, 2000; Son & Hu, 2016). Textbooks shape what teachers will teach in the classroom and how (Alajmi, 2012; Hirsch, Lappan, Reys & Reys, 2005; Li, 2000). As different textbooks provide students with different learning opportunities, textbook comparison studies may help explain the differences in student success (Zhu & Fan, 2006). It is therefore not surprising that textbook comparison studies have become popular in recent years. These studies particularly use textbooks from high scoring countries in international exams such as the TIMSS or PISA namely China, South Korea, Japan, Taiwan, Singapore, and Finland. Most of these studies have analyzed textbooks with respect to their contents or problem types (Hong & Choi, 2014). There is a limited number of studies comparing Turkish and Singapore textbooks. These studies are summarized in Table 1.

**Table 1**. Studies comparing Turkish and Singapore textbooks and the content of the studies

| Author | Year | Countries | Content |
|---|---|---|---|
| Erbaş et al. | 2012 | Turkey, Singapore, USA | Design characteristics |
| Sağlam and Alacacı | 2012 | Turkey, Singapore | Content, organization, and presentation style (Quadratics) |
| Özer and Sezer | 2014 | Turkey, Singapore, USA | Problem type |
| Bütüner | 2019 | Turkey, Singapore | Problem Analysis (division in fractions) |
| Toprak and Özmantar | 2020 | Turkey, Singapore | Worked-examples and questions posed (potential cognitive demand, reasoning and proof) |
| Bütüner | 2020 | Turkey, Singapore | Instructional content (division in fractions) |

Differently from these previous studies, the present study compares Turkish and Singaporean textbooks with respect to their instructional contents on a difficult topic for most students: the concept of angle. There is a limited number of comparative studies on angle in the literature. Park (2015) compared the teaching contents for angle and measure of an angle in Korean and Japanese mathematics textbooks. The results show that it is necessary to reconsider the way of the definition of angle. Kim (2018a) investigated the definitions of angles in the past Korean Elementary Mathematics Textbooks. The results show that textbooks treat angles solely as a static concept. In another study, Choi, Kim, and Kwon (2019) examine angle-related contents and learning process and then look at the perspectives and the size aspects of angle in detail. Singapore, U.K., Australia, and U.S. were selected as comparable countries in this study. The results show that the dynamic definition of the angle is described later and less in the Korean curriculum when compared to other countries.

While considering that textbooks are primary sources used by teachers, possessing well-designed textbooks including correct and complete definitions, examples, representation modes, teaching tools and problems is one of the effective factors for students to have a correct conceptual image (Bingölbali, 2016, p. 140). The present study examines the definition of the concept of angle in Turkish and Singaporean textbooks, its representation (dynamic vs static), the tools used in the teaching of the angle and their purposes, and the aspect of the angle emphasized in problems (dynamic vs static). The findings of this study were used to make recommendations to curriculum designers in Turkish and Singaporean Education Ministries so as to guide them in amending the deficiencies in textbooks. The recommendations for improving textbooks will guide curriculum developers in overcoming the deficiencies of textbooks. Different textbooks can offer different learning opportunities to students and help explain the differences between students' success levels (Reys, Reys, & Chavez, 2004; Zhu & Fan, 2006). Therefore, the results of this study may give an idea about the performances of Turkish and Singaporean students, who will take international exams in future years, on the concept of angle. The research questions are as following:

• How is the concept of angle defined?
• How is the angle represented?
• What learning tools are used when teaching the concept of angle?
• What are the purposes of using these instructional tools in the process of teaching?
• What aspect of the angle is emphasized in problems related to the concept of angle?

**The Concept of Angle: Its Significance, Definitions and Representations**

The angle is an important concept in geometry as it is one of the most basic and fundamental geometry concepts. The concept of angle is always there regardless of the concept being studied (For instance, when two lines intersect or when we examine a polygon or a polyhedral) (Argün, Arıkan, Bulut, & Halıcıoğlu, 2014). Angles are also used in various other areas such as engineering, architecture, land measurement, geology and physics. In high school mathematics, students need knowledge of angles to solve various mathematical problems. Indeed, the problems that students encounter regarding the concept of angle also lead to other problems in future topics (trigonometric functions, etc.) (Moore, 2013).

Henderson and Taimina (2005) list the following conceptions of angle: angle as a geometric shape, union of two rays with a common end point (static); angle as movement; angle as rotation (dynamic); angle as measure; and, amount of turning (also dynamic). Older students may be able to conceptualize angles in turns, ray pairs, or regions, but may not be able to relate them. Younger students may be able to conceptualize certain angle situations in terms of ray pairs or regions, but may not conceptualize turns in terms of angles at all (Mitchelmore & White, 1998, p.5). Kim (2018b) investigated angle concepts and introduction methods of angles in textbooks. Her findings show that textbooks treat angles solely as a static concept. Kim (2018b) stated that treating angles solely as a static concept in textbooks leads to certain difficulties for students in understanding the concept. Bütüner and Filiz (2017) investigated high achievers' erroneous answers and misconceptions on the angle concept. According to the results, many students assumed that the size of an angle depends on the radius of the arc marking the angle and the area of the sector. 32% of students in this study were unable to recognize a 180° angle.

Presenting the angle as a static concept may lead to certain difficulties for students in understanding the concept. For instance, they may come to think that the arm length of the angle increases with its degree, and may therefore find it hard to grasp angles greater than 360°, and some students can not recognize 0° and 180° angles (Hansen, 2017; Keiser, 2004). Clausen-May (2005) stated that the angle is usually emphasized not as a measurement (dynamic) but only as a figure (static). In the static representation, the concept of kinesthetic angle (as motion) is lost, thus blurring the true meaning of the concept of angle. In order to avoid such problems, students should learn the angle both as a dynamic and static concept (Barmby, Bilsborough, Harries, & Higgins, 2009; Clausen-May, 2008; Clements, Wilson, & Sarama, 2004; Crompton, 2013; Mitchelmore & White, 2000). Clausen-May (2005) states that although it is not possible to show motion on paper, a directed arrow can be used as its representative. Three different representations of an angle are shown in Figure 2. Textbooks should therefore include content that enables students to learn the angle both as a dynamic and static concept.

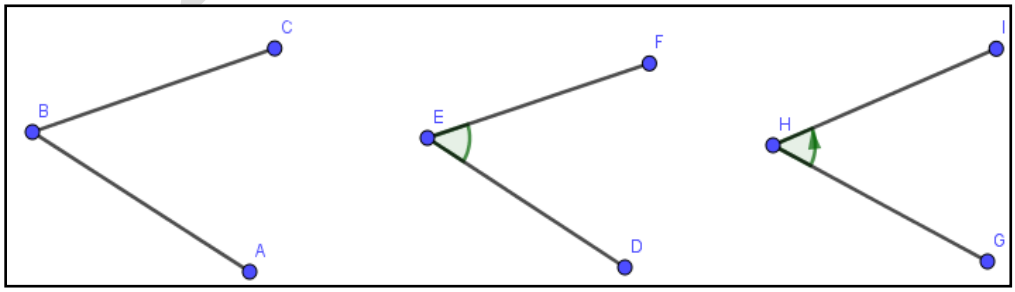


**Figure 2.** Three different representations of an angle (from left to right: static-static-dynamic)

**Tools Used in Teaching the Concept of Angle**

The instruction of the angle may involve dynamic mathematics software (Clements & Battista, 1990; 1994; Crompton, 2013; Kaur, 2020), various daily life tools (Clements & Burns, 2000; Fyhn, 2007; Mitchelmore, 1998; Mitchelmore & White, 2000), body movements (Fyhn, 2006; Smith, King, & Hoyte, 2014) and out-of-class learning experiences (Munier, Devichi, & Merle, 2008).

In studies conducted in the late 80s, the software Logo was used extensively in teaching the concept of angle (Clements & Battista, 1989; 1990; Clements, Battista, Sarama, & Swaminathan, 1996; Clements & Burns, 2000; Simmons & Cope, 1990). The results of previous studies have shown that Logo-aided learning environments may be effective in students' understanding of the dynamic definition of the angle and their skills for predicting the measurement of a given angle. Also, Logo-aided learning environments prevent the emergence of misconceptions. The literature also includes studies reporting the positive effects of dynamic geometry software such as Sketchpad (Crompton, 2013; Tieng & Eu, 2014) and Geogebra (Baya'a, Daher, & Mahagna, 2017; Boo & Leong, 2016) in teaching the concept of angle.

Many daily tools (wheels, doors, scissors, fans, signposts, hills, crossroads, tiles and walls) may be used when teaching this concept (Mitchelmore, 1998; Mitchelmore & White, 2000). The first four tools are suitable for teaching the dynamic definition of the angle, while the last five tools are suitable for teaching the static definition of the angle. Besides, tools such as doors or scissors give the opportunity to display limited turns, while tools such as wheels, fans, ventilators and wind chimes give the opportunity to demonstrate unlimited turns. While teaching the concept of angle, learning objects such as geometry strips or protractors may also be used in addition to daily life tools. In Figure 3, the red strip makes a counter-clockwise quarter turn. If a full turn is 360 degrees, 1 quarter turn equals to 90 degrees. As can be seen, geometry strips help establish a relationship between the concepts of angle and fraction (part-whole relationship) when teaching angle as a dynamic concept (Clausen-May, 2008, p. 6-7).

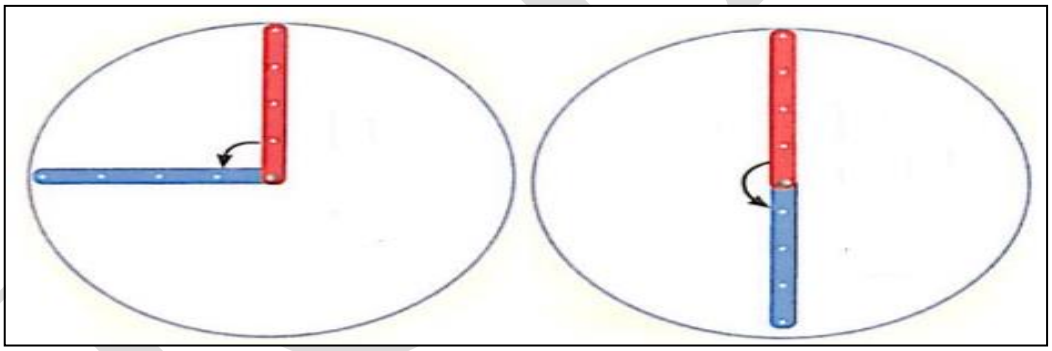

**Figure 3.** The use of geometry strips in angle instruction

## METHOD

**Textbooks Used in the Study**

In this study, selected Singaporean (Ming, 2016a, b) and Turkish mathematics (Genç, Güleç, Şahin, & Taşcı, 2019; Kayapınar, Şahin, Erdem, & Leylek, 2019) textbooks were compared. Textbooks from these two countries were selected because these countries represent different levels of performance on the TIMSS. While 4th-grade Singaporean students performed well, 4th-grade Turkish students performed below the TIMSS scale average. In Turkey, Primary Education involves the education and training of children in the age group of 6 to 10. Primary education is compulsory for all citizens. It is free in state schools and lasts four years (1st, 2nd, 3rd, and 4th grades). In Singapore, compulsory education includes six years of primary school (ages 6-12), four years of secondary school, and one to three years of post-secondary school. 3rd and 4th grade levels are primary school levels in both countries. The concept of angle is introduced in the 3rd grade in both countries, and continued in the

4th grade. The objectives regarding the teaching of the angle as a dynamic concept in Turkish and Singaporean primary mathematics curricula are given in Table 2.

**Table 2.** The Objectives regarding the teaching of the angle in Turkish and Singaporean primary mathematics (MONE, 2018, p. 41, 48; MES, 2012, p. 46-51).

| Country | Grade | Objectives |
|---|---|---|
| **SIN** | 3 | Students should have opportunities to:<br>**Illustrate an angle as an amount of turning using geostrips / riveted straws and use language such as "acute angle" and "obtuse angle" to describe angles.*<br>**find angles in the environment and use a "paper right angle" to identify right angles, angles greater than a right angle and angles smaller than a right angle. |
| **TUR** | 3 | **recognizes the angle and gives examples in the environment |
| **SIN** | 4 | Students should have opportunities to:<br>**Associate the amount of turning (rotation), clockwise or anti-clockwise, with an angle measured in degrees*<br>*1/4 turn is 90; 1/2 turn is 180*<br>**Estimate before measuring angles using a protractor<br>**Draw angles using a protractor<br>**Find the angles (in degrees) between two 8-point compass directions |
| **TUR** | 4 | ** Determines the rays that make up the angle and the corner, names the angle and shows it with a symbol<br>** Measures angles in non-standard units and explains the need for standard measuring units<br>** Measures angles with standard angle measuring tools and determines them as acute, obtuse and right angles.<br>*Can form an angle using standard measurement tools: *"Realizes with the help of an angle measurement tool (protractor, goniometer, etc.) that an angle is formed by rotating a ray around an endpoint"* |

*The objectives regarding the teaching of the angle as a dynamic concept in Turkish and Singaporean primary mathematics

The study used the 3rd and 4th grade mathematics textbooks taught in Turkish schools and published by the Turkish Education Ministry, and the Singaporean mathematics textbooks entitled Targeting Mathematics 3B-4A. "My Pals are here" and "Targeting Mathematics" are commonly used books at schools in Singapore. These two books are similar in terms of the teaching content of the angle concept. In Turkey, textbooks are decided by the Ministry of Education. The Turkish Ministry posts the textbooks used at schools on the webpage http://www.eba.gov.tr/ekitap. The Turkish textbooks examined in this study were obtained from this website. These textbooks were used on students in the same age groups that correspond to primary grades 3, and 4 and all books were in use in the 2019-2020 academic year in their respective countries. Two field specialists identified the grade levels where the textbooks introduced the concept of angle, and then noted the relevant page numbers. Following this, the analysis (coding) processes started.

**The Theoretical Framework for the Analyses**

In the study, vertical analyses were performed on the angles content in Turkish and Singaporean mathematics textbooks. As complementary to horizontal analysis, the vertical analysis offers in-depth understanding of mathematical content (Hong & Choi, 2014; Yang & Lin, 2015). For example, this analysis can reveal how the contents of a relevant mathematical concept are presented, what representation styles are used, what tools are used in concept instruction and their purposes. The scope of vertical analyses is given in Table 3.

**Table 3.** Scope of vertical analyses

| Vertical Analysis Indicators |
|---|
| • How has the concept of angle been defined?<br>• How is the angle represented?<br>• What learning tools are used when teaching the concept of angle?<br>• What are the purposes of using these instructional tools in the process of teaching?<br>• What aspect of the angle is emphasized in problems related to the concept of angle? |

**Data analysis**

In coding the angle as a static or dynamic concept, the opinions in the literature are taken as basis (Clausen-May, 2005; Henderson & Taimina, 2005; Mitchelmore & White, 2000; Wilson & Adams, 1992). The coding criteria for the angle as a dynamic and static concept is given in Table 4. The analyses were performed by two academics in the field of mathematics education. The coherence between the intercoders was calculated using the formula developed by Miles and Huberman (1994). The agreement for each category varied between 98% and 100%. They debated any differences and made the final decision based on the views of yet another researcher. The findings were supported with direct quotes from the textbooks.

**Table 4.** Coding criteria for the angle as a dynamic and static concept

| Indicators | Dynamic | Static |
|---|---|---|
| How has the concept of angle been defined? | angle as movement; angle as rotation; angle as measure; and, amount of turning (Henderson and Taimina, 2005) | angle as a geometric shape, union of two rays with a common end point (Henderson and Taimina, 2005) |
| How is the angle represented? | a directed arrow Clausen-May, 2005) | arrow with no direction; only as two rays-a corner; no arrow (Clausen-May, 2005) |
| What learning tools are used when teaching the concept of angle? | Wheels, doors, scissors, fans, geometry strips, riveted straws, clocks etc. (Mitchelmore & White, 2000). | Signposts, hills, crossroads, tiles, table and walls etc. (Mitchelmore & White, 2000). |
| What are the purposes of using these instructional tools in the process of teaching? | An emphasis on the dynamic aspect of the concept of angle (movement, amount of rotation) (Henderson and Taimina, 2005). | did not make any emphasis on the dynamic aspect of the concept of angle (movement, amount of rotation) (Henderson and Taimina, 2005) |
| What aspect of the angle is emphasized in problems related to the concept of angle? | Students are expected to solve, allowing them to realize that an angle *is formed by rotating a ray around an endpoint* and to associate the degree of the angle with the concept of fraction (part-whole) etc. (Wilson & Adams, 1992; Clausen-May, 2005, 2008). | Students are not expected to solve, allowing them to realize that an angle *is formed by rotating a ray around an endpoint* (Wilson & Adams, 1992; Clausen-May, 2005, 2008). |

## FINDINGS

Table 5 presents the findings concerning how the concept of angle is defined in Turkish and Singaporean textbooks, how it is represented, what instructional tools are taught to teach it, what purposes the instructional tools have, and what aspect (dynamic-static) is emphasized in problems concerning the concept of angle.

**Table 5.** Vertical analysis findings

| Indicators | TAR3B | TAR4A | TR3 | TR4 |
|---|---|---|---|---|
| How is the concept of angle defined? | Both Static and Dynamic | Both Static and Dynamic | Static | Static |
| How is the angle represented? | A directed arrow; arrow with no direction | A directed arrow; arrow with no direction | Arrow with no direction; only as two rays-a corner; no arrow | Arrow with no direction; only as two rays-a corner; no arrow |
| What instructional tools are used to teach the concept of angle? | Daily life tools, Learning objects (geometry strips, riveted straws), Body movements | Daily life tools, Learning objects (geometry strips, riveted straws and protractor), Body movements | Daily life tools | Daily life tools, Learning objects (protractor) |
| What purpose do the instructional tools have? | To teach the static and dynamic aspects of the angle | To teach the static and dynamic aspects of the angle | To teach the static aspect of the angle | To teach the static aspect of the angle |
| What aspect of the angle is emphasized in angle problems? | Both static and dynamic | Both static and dynamic | Static | Static |

**How is the concept of angle defined?**

The angle is defined in Turkish textbooks as "a plane formed by two rays with a shared endpoint (TR3, p. 229)" and "a plane formed by the closed edges of two intersecting rays (TR4, p. 207)". Singaporean textbooks state that "an angle is formed when two straight lines meet at a common point. The size of an angle depends on the amount of turning (TAR3B, p. 60-61, TAR4A, p.116)". The Singaporean book also emphasizes the dynamic aspect (quarter turn) when defining the right angle (Figure 4). As can be seen, Turkish textbooks define the angle as a static concept while Singaporean textbooks define it as both a static and a dynamic (amount of rotation) concept.

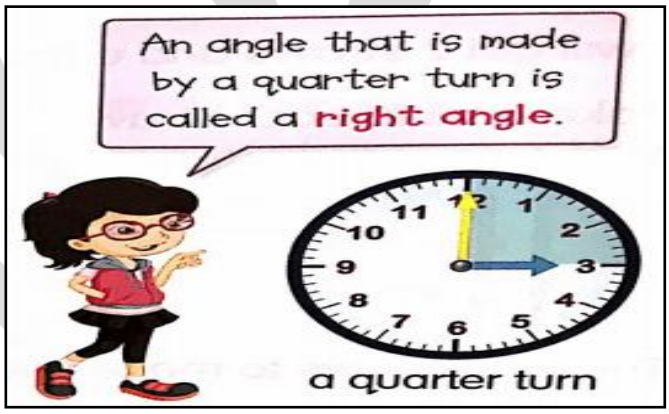


**Figure 4.** Definition of the right angle in the Singaporean book (TAR3B, p. 62)

**How is the angle represented?**

The definitions in the textbooks are reflected in angle representation. Singaporean textbooks represent the angle as an "arrow with direction" or an "arrow with no direction" (Figure 5). Turkish textbooks represent the angle as an "arrow with no direction" or "only two rays – a corner and no arrow" (Figure 6). Therefore, while the angle exists in Singaporean textbooks as both a dynamic and a static concept, it remains a static concept in Turkish books. In conclusion, it may be stated that the textbooks from both countries include representations in line with the definitions of the angle that they adopt.

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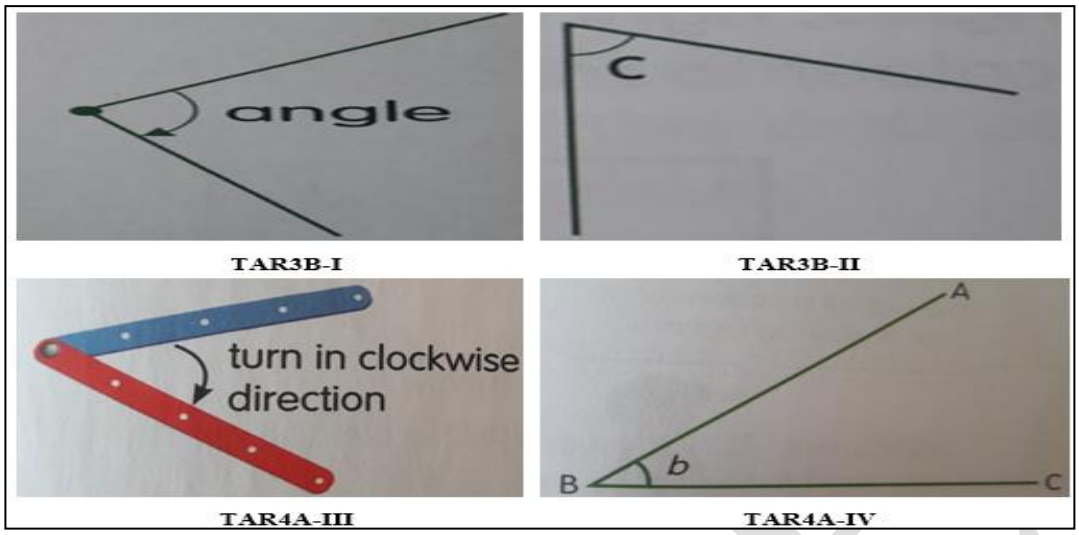


**Figure 5.** The dynamic ("arrow with direction," TAR3B-I, p.60, TAR4A-III, p. 123) and static ("arrow with no direction," TAR3B-II, p. 68, TAR4A-IV, p. 117) representations of the angle in the Singaporean textbook

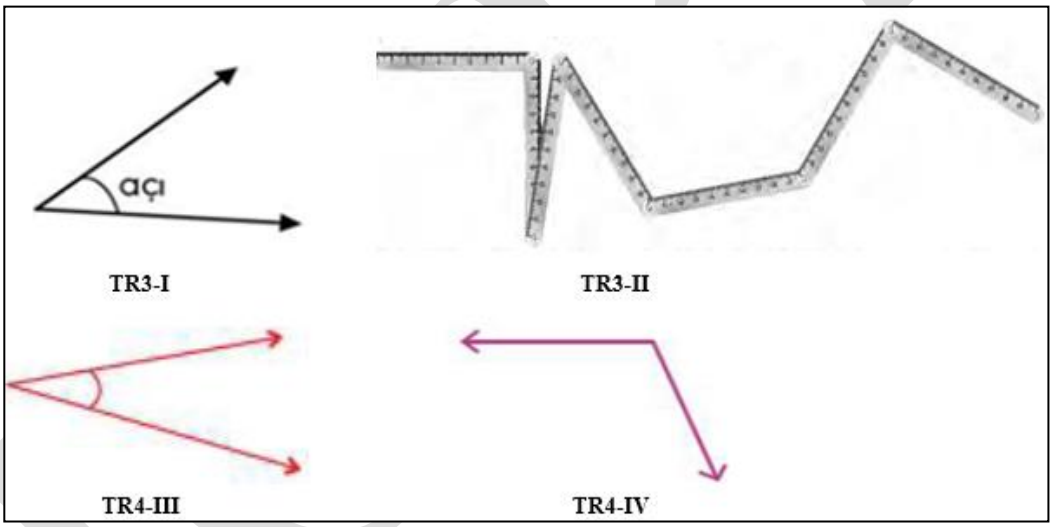


**Figure 6.** The static representation of the angle in the Turkish textbook ("arrow with no direction," TR3-I, p. 229, TR4-III, p. 209 or "two rays-a corner and no arrow," TR3-II, p. 230, TR-IV, p. 215).

**What instructional tools are used to teach the concept of angle and what purpose do the instructional tools have?**

The instructional tools used in Singaporean textbooks to teach the concept of angle include body movements, protractor, geometry strips, and daily life tools (fans, computer, traffic signs, scissors, stairs, clock, stapler, and compass). Singaporean textbooks teach the angle as both a static and dynamic concept by using these tools. As can be seen in Figure 7, as Singaporean textbooks introduce the concept of angle, they make use of body movements and riveted straws, thus emphasizing the dynamic aspect of the angle.

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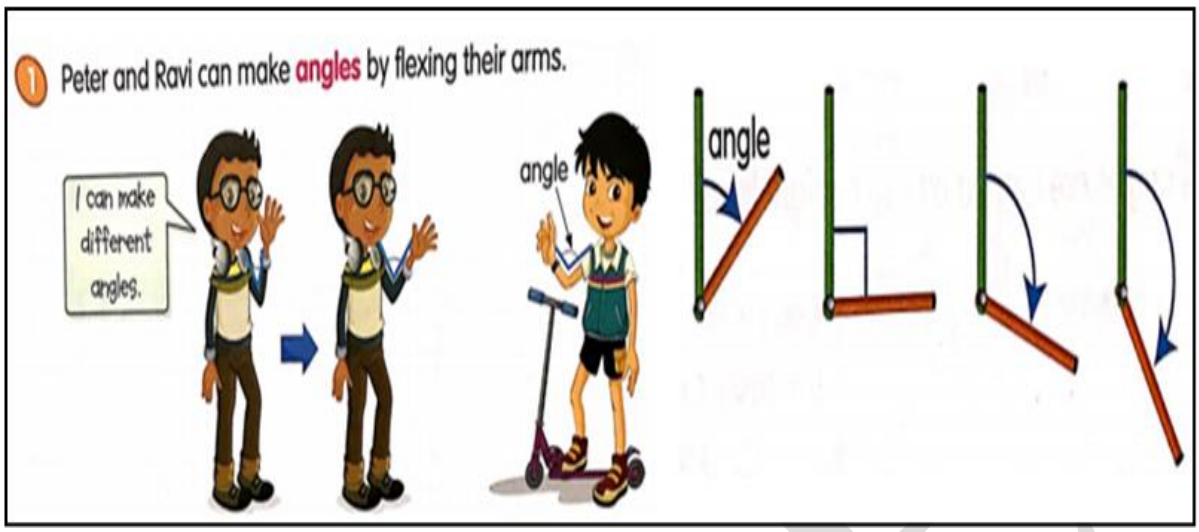


**Figure 7.** Teaching the angle as a dynamic concept in the Singaporean textbook via body movements and riveted straws (TAR3B, p. 60-61)

After emphasizing the dynamic aspect of the angle by using body movements, geometry strips and riveted straws, Singaporean textbooks pass on to the static aspect of angle by using daily life tools (fans, computer, traffic signs, scissors, stairs) (Figure 8). Visuals pertaining to these tools are given, asking students to find the angles in them. Even though a fan, notebook computer and scissors are suitable tools to teach the angle as a dynamic concept and they exist in Singaporean textbooks, they were there only as examples and did not make any emphasis on the dynamic aspect of the concept of angle (movement, amount of rotation). In other words, the angle was not treated as a dynamic concept alone (movement, amount of rotation).

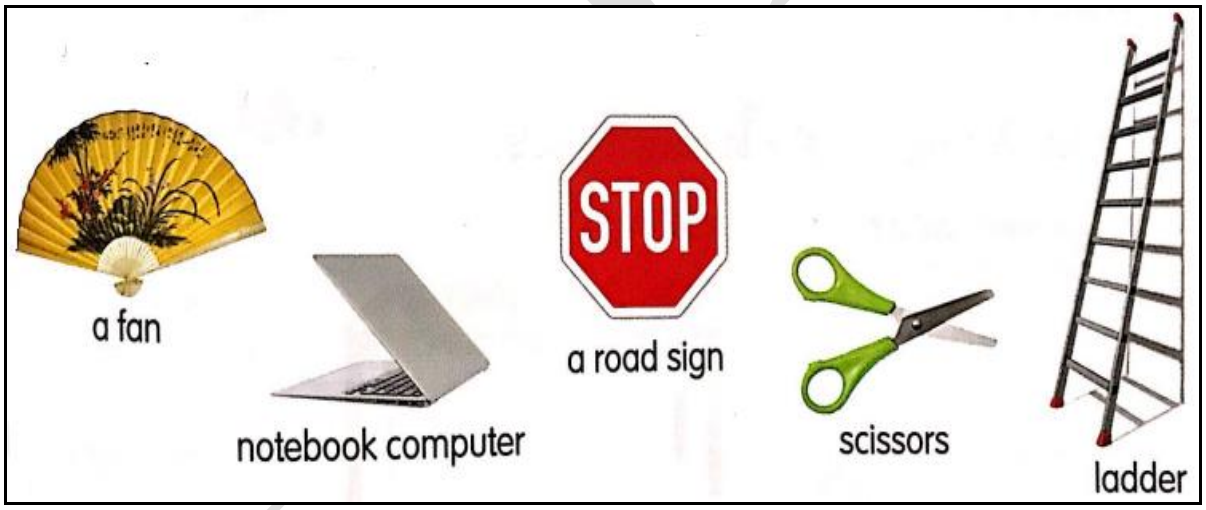


**Figure 8.** Tools used in the Singaporean textbook when teaching the angle as a static concept (TAR3B, p. 61).

The 4th grade Singaporean book also teaches the angle as a dynamic concept. As shown in Figure 9, the book uses geometry strips and makes a connection between the concepts of angle and fraction (part-whole relationship), thus emphasizing the dynamic aspect of the angle. It is easy to see in Figure 9 that 1 full turn corresponds to 360 degrees, while 1 quarter turn corresponds to 90 degrees, two quarter turns to 180 degrees, and three quarter turns to 270 degrees.

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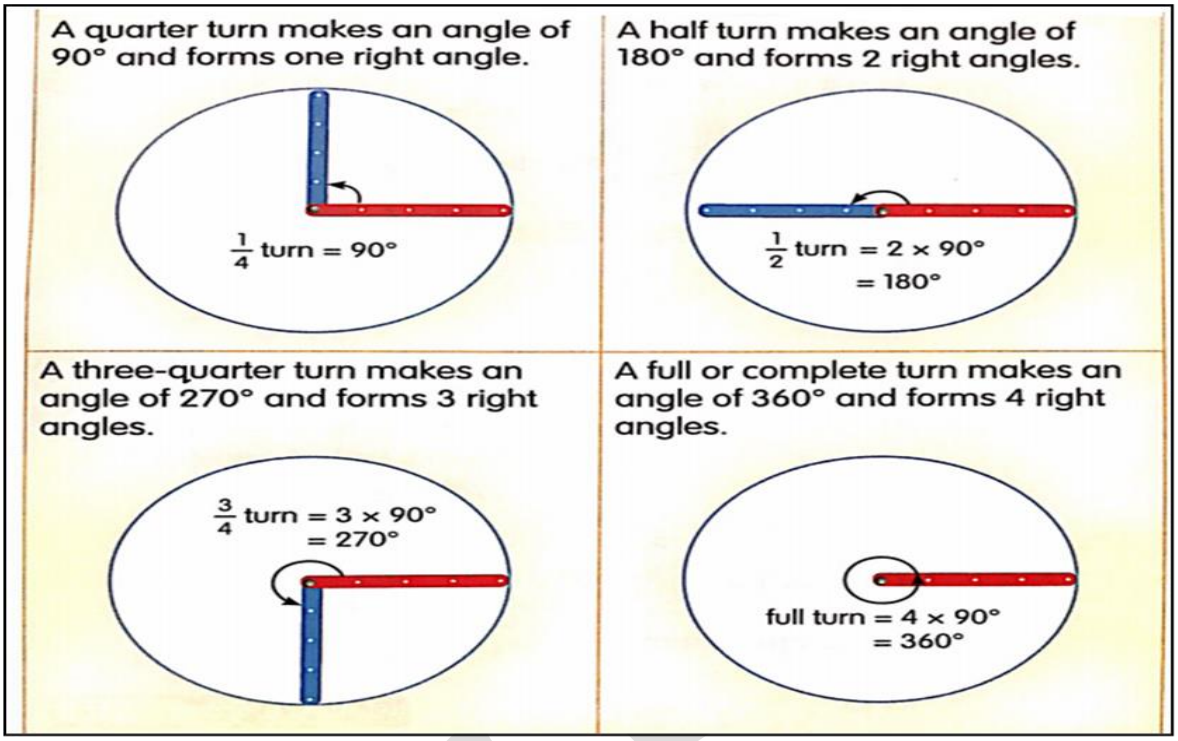


**Figure 9.** Teaching the angle in Singaporean books as a dynamic concept by using geometry strips (TAR4A, p. 123).

In Turkish textbooks, the teaching of the concept of angle made use of a protractor and certain daily life tools ("hanger, frame, chair" TR3, p. 229; "door, classroom desk, scissors, clock" TR4, p. 207) (Figure 10). Hanger, frame, chair and classroom desk are suitable tools to teach the angle as a static concept. Even though door, scissors and clocks are suitable tools to teach the angle as a dynamic concept and they exist in Turkish textbooks, they were there only as examples and did not make any emphasis on the dynamic aspect of the concept of angle (movement, amount of rotation). Thus, Turkish textbooks use these tools to teach the angle only as a static concept.

**Figure 10.** Tools used in the Turkish textbook to teach the concept of angle (TR3, p. 229; TR4, p. 207).

**What aspect of the angle is emphasized in angle problems?**

While the Turkish textbooks only include problems emphasizing the static aspect of the angle, Singaporean textbooks include problems including both the static and dynamic aspects. The number of problems with and without solutions in the two textbooks that treat the angle as a static and dynamic concept are given in Table 6.

**Table 6.** The Number of Problems in the Textbooks that Treat the Angle as a Static and Dynamic Concept

| Problem Type | Turkish Textbooks | | Singaporean Textbooks | |
|---|---|---|---|---|
| | TR3 | TR4 | TAR3B | TAR4A |
| Number of solved problems in the textbooks that treat the angle as a static concept | 0 | 1 | 1 | 6 |
| Number of unsolved problems in the textbooks that treat the angle as a static concept | 3 | 5 | 10 | 5 |
| Number of solved problems in the textbooks that treat the angle as a dynamic concept | 0 | 0 | 0 | 5 |
| Number of unsolved problems in the textbooks that treat the angle as a dynamic concept | 0 | 0 | 0 | 3 |

Turkish textbooks do not include any problems that treat the angle as a dynamic concept. In contrast, Singaporean textbooks include 5 problems with solutions and 3 questions that treat the angle as a dynamic concept. The first problem in Appendix 1 is a daily life problem that students are expected to solve, allowing them to realize that an angle is formed by rotating a ray around an endpoint and to associate the degree of the angle with the concept of fraction (part-whole) (TAR4A-I). The second problem expects students to classify given angles as straight, obtuse or acute (TAR4A-II). Therefore, the first problem emphasizes the dynamic aspect of the angle, while the second problem emphasizes its static aspect. Appendix 2 shows a problem from the Turkish textbooks emphasizing only the static aspect of the angle. Students are not expected to solve, allowing them to realize that an angle is formed by rotating a ray around an endpoint. This problem expects students to show the angles in the images and classify the given angles as a straight, obtuse, acute or right angle. Other problems from Turkish and Singaporean textbooks on the concept of angle are given in Appendix 3, 4, and 5.

## DISCUSSION and CONCLUSION

The present study investigated how Turkish and Singaporean primary mathematics textbooks define the concept of angle, how they represent angles, what tools are used with what purpose in teaching angles, and what aspect of the angle is emphasized in problems regarding the concept of angle. The concept of angle is introduced in both countries in the 3$^{rd}$ grade and continued in the 4$^{th}$ grade. The primary mathematics curricula of both countries include objectives concerning "teaching the angle as a dynamic concept.

The vertical analysis showed that Turkish textbooks defined the angle as a static concept, and Singaporean textbooks defined it as both a static and dynamic concept. The definitions of the concept of angle included in the textbooks reflect on the representation of the angle, the aims for using the selected instructional tools in angle instruction, and the problem structure in the textbooks. In Turkish textbooks, the angle is represented with "an arrow that does not show direction" or "two rays-a corner and no arrow." In Singaporean textbooks, it is represented with "an arrow that shows direction" or "an arrow that does not show direction." Therefore, in Singaporean books, the angle was treated both as a dynamic and static concept, while Turkish books only treated it as a static concept. According to Clausen-May (2005), the representation in Turkish books is a move away from the true meaning of the concept of angle. She continues that even when it seems impossible to indicate the movement on a piece of paper, a directed arrow may be used for representation. Turkish textbooks teach the concept of angle only by using a protractor and various daily tools (scissors, clocks, chairs, frames, hangers, doors). These textbooks do not emphasize the dynamic aspect of the concept of angle (motion, amount of rotation); they are merely included in the textbook as examples. Singaporean textbooks, on the other hand, use body movement, protractor, geometry strips, and daily materials (fans, computers,

traffic signs, scissors, stairs, clocks, staplers, and compass) as tools in teaching the concept of angle. In the 3rd grade Singaporean book, as an introduction was made to the concept of angle, it was treated as a dynamic concept by using body movements and riveted straws. In the 4th grade Singaporean textbook, geometry strips were used to make a connection between the concepts of angle and fraction (part-whole relationship) and to emphasize the dynamic aspect of the angle. The literature states that teaching the angle as a dynamic concept can help make use of learning objects (such as geometry strips). Considering that a full turn in a circle equals to 360 degrees, the students may be asked to think what a quarter turn or two quarter turns would equal to in degrees. In this way, students can have the opportunity to learn the angle as a dynamic concept by mobilizing their existing knowledge and using the part-whole meaning of fraction (Clausen-May, 2005, 2008; Wilson & Adams, 1992). There is no emphasis or activity on the use of dynamic geometry software in the textbooks of either country. The literature also includes studies reporting the positive effects of dynamic geometry software (Clements et al., 1996; Clements & Burns, 2000; Crompton, 2013; Boo & Leong, 2016). In GeoGebra software, students may be asked to rotate a ray around its endpoint by using a 'slider' and 'rotate around point.' Therefore, students may gain an awareness of the dynamic definition of the angle concept (Bütüner & Filiz, 2017).

The angle was treated as a static concept in all problems in Turkish textbooks. In contrast, the 4th grade Singaporean book included eight problems that treat the angle as a dynamic concept. Therefore, it was concluded that in both Turkish and Singaporean textbooks, there was harmony between the instructional contents of the concept of angle and the angle problems in the textbooks. The results show that Turkish textbooks need to be enriched with contents regarding teaching the angle as a dynamic concept. Angle problems that treat the angle as both a dynamic and a static concept should be added to the Turkish textbooks in a balanced way. When the angle is treated solely as a static concept, students may end up thinking that an angle may increase when its arm length increases (Clausen-May, 2008) and fail to recognize angles of 0 degrees or those larger than 360 degrees as they do not see an openness (Barmby et al, 2009, p. 147). Therefore, many studies have attempted to teach the angle as a dynamic concept (Clements & Battista, 1989; 1990, Clements et al., 1996; Clements & Burns, 2000; Mitchelmore, 1998; Mitchelmore & White, 2000; Simmons & Cope, 1990).

Other results from the findings include that, in contrast to the case in Singapore, there is a mismatch in the contents of Turkish textbooks and the objectives of the primary mathematics curriculum, and that the contents of Singaporean textbooks offer students more learning opportunities than Turkish textbooks regarding the concept of angle. These results also suggest that as the concept of angle is introduced in Turkish and Singaporean textbooks, students should be given learning opportunities to assist them in constructing the dynamic definition of the concept, rather than directly giving them a static or dynamic definition.

**Limitations and Implications for Future Research**

According to the findings, Singaporean students can learn from textbooks that angle is both a static and a dynamic concept. Therefore, they may not have difficulties or misconceptions about angle and related concepts (such as trigonometry) in their following years. Turkish students, on the other hand, learn angle from textbooks only as a static concept, so they may have difficulties and misconceptions about angle [e.g., students may think that the arm length of an angle affect its degree, (Clausen- May 2005); they may think that the degree of an angle is related to the area surrounded by the arms of the angle (Keiser, 2004); they may misread an angle on the protractor, (Hansen, 2017) and may have further problems on related concepts (such as trigonometry)]. The findings have shown that Singaporean students may display a better performance than Turkish students in problems based on the concept of angle. Therefore, the results of this study give an idea about the performances (in problems involving angles, polygons, trigonometry, slope etc.) of Turkish and Singaporean students, who will take international exams in future years.

The generalization of these results calls for caution as the findings come from two mathematics textbooks from either one of the two countries (Yang, 2018; Wijaya, Van den Heuvel-Panhuizen, &

Doorman, 2015). A well or poorly designed textbook may find life in the hands of a well-equipped teacher. Such a teacher may spot the deficiencies in textbooks and enrich classes with contents that enable students to better grasp mathematical concepts. Future researchers may study whether Turkish and Singaporean teachers use textbooks when teaching the concept of angle, how they utilize these books, how they teach the concept of angle, and what type of problems they use in their classes regarding the concept of angle.

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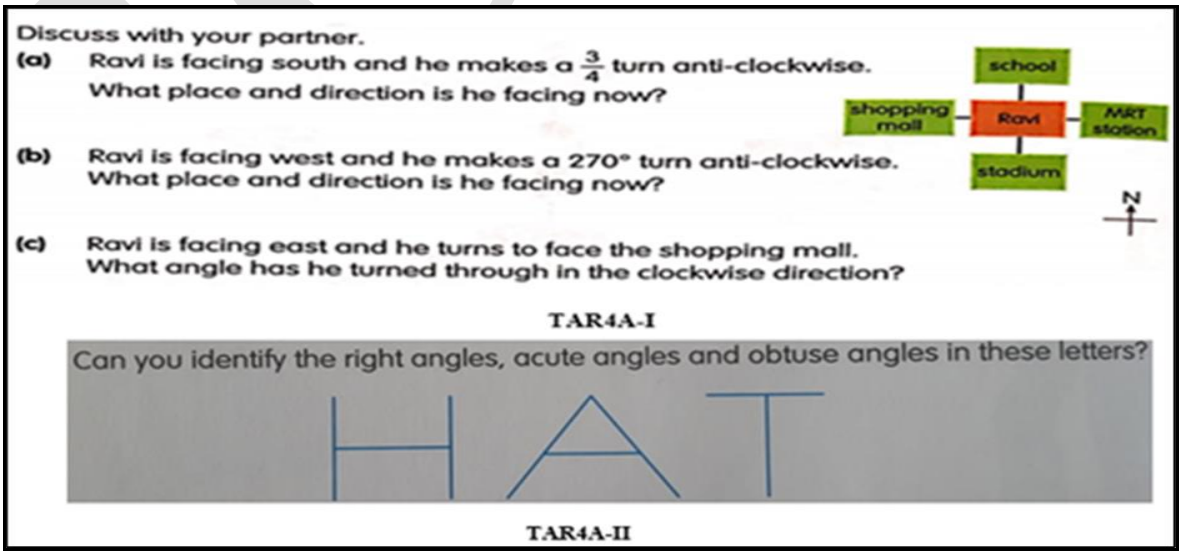
**Appendix 1.** Problems from the Singaporean textbook in line with both the dynamic (TAR4A-I, p.128) and static aspects of the angle (TAR4A-II, p. 116).



IOJPE
ISSN: 1300 – 915X
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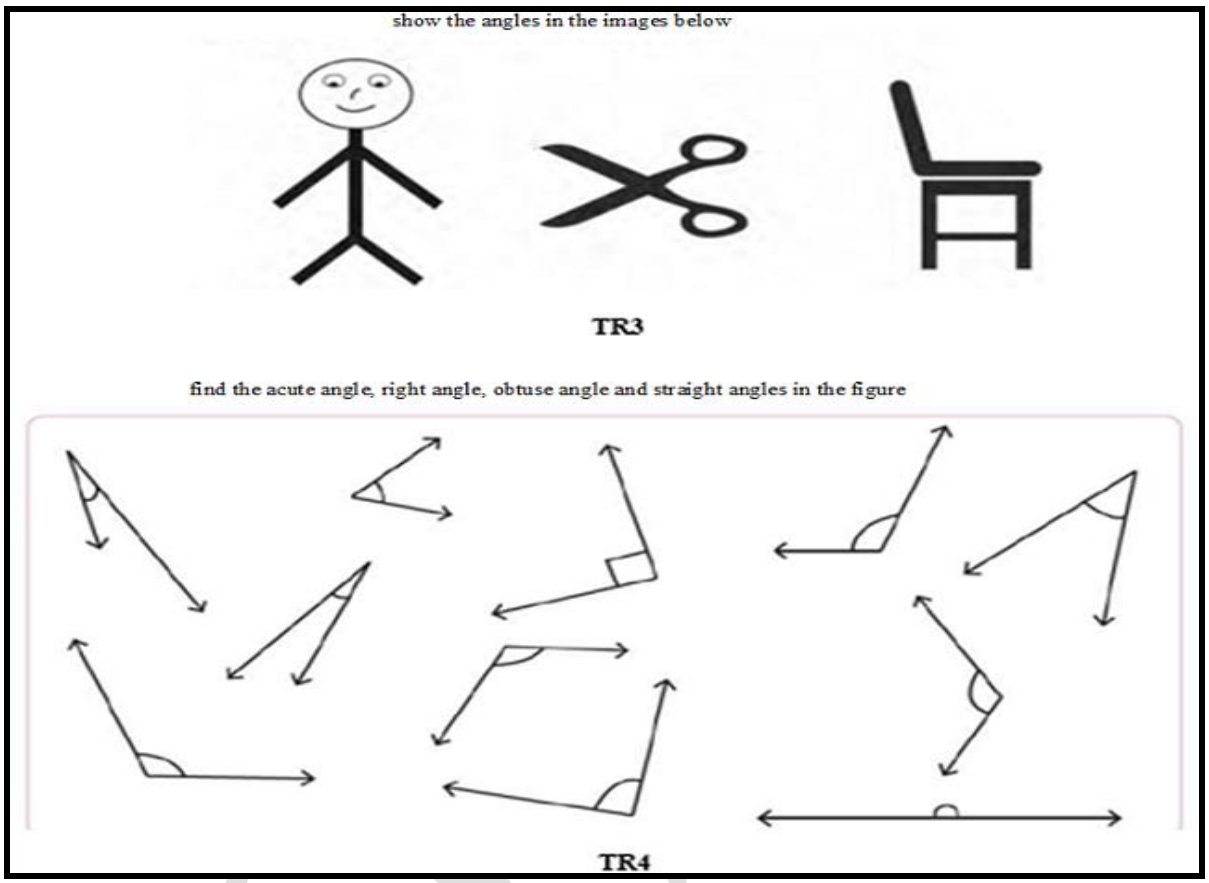
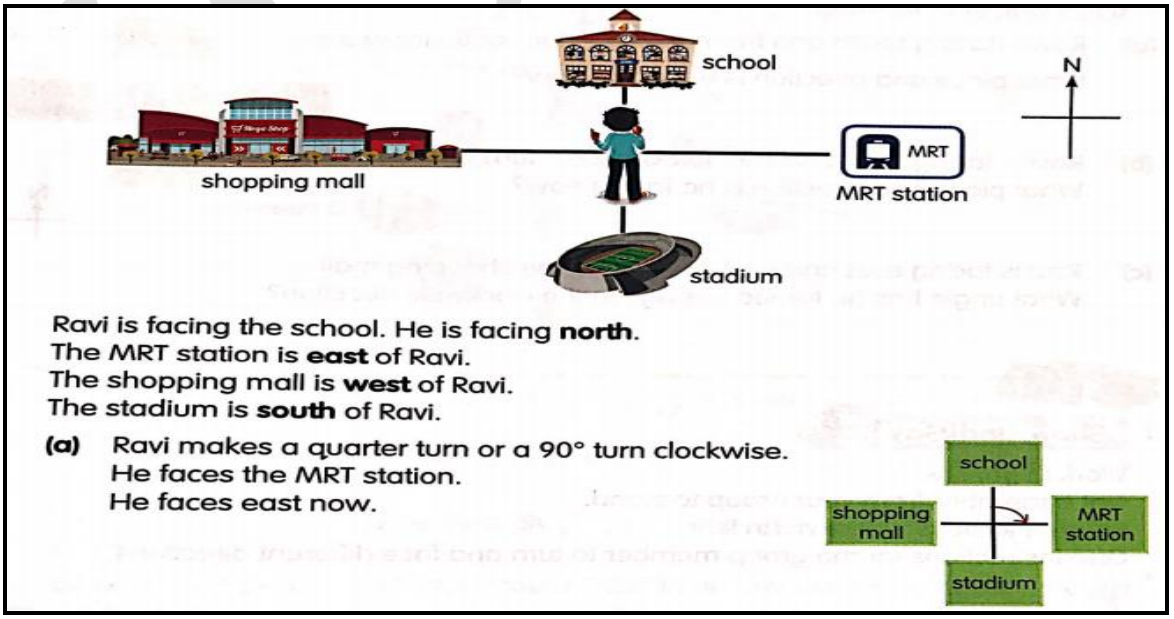
International Online Journal of Primary Education 2021, volume 10, issue 1

**Appendix 2.** Problem from the Turkish book in line with the static aspect of the angle (show the angles in the images below, TR3, p.233, find the acute angle, right angle, obtuse angle and straight angles in the figure) (TR4, p. 212)




**Appendix 3.** A problem with solution in Singaporean textbook (angle as a dynamic concept) (TAR 4A, p. 127)



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ISSN: 1300 – 915X
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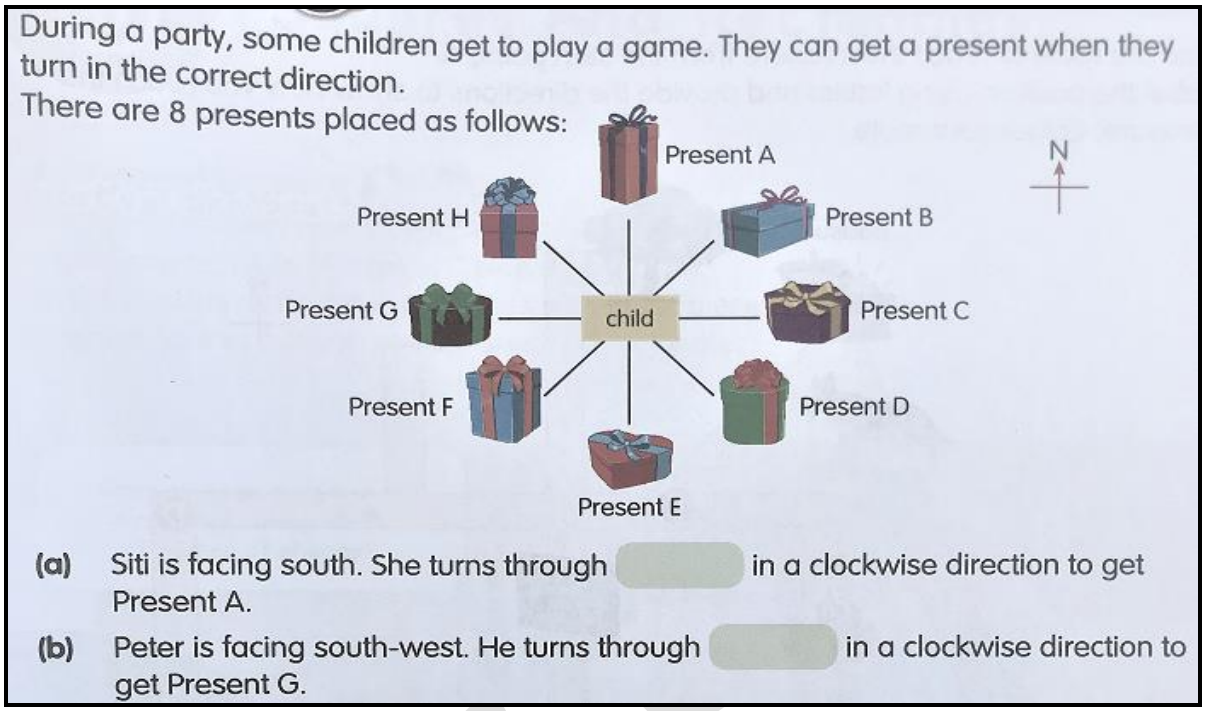
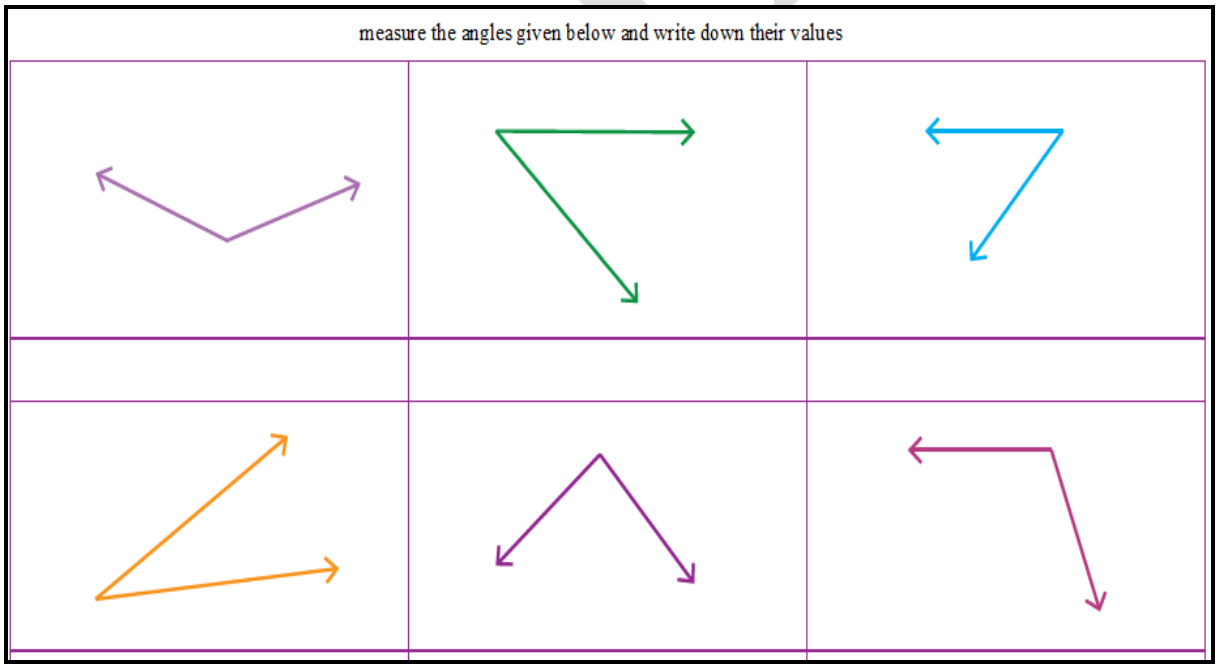
International Online Journal of Primary Education 2021, volume 10, issue 1

**Appendix 4.** A problem without solution (angle as a dynamic concept) (TAR 4A, p. 129).




**Appendix 5.** A problem without solution (measure the angles given below and write down their values) (angle as a static concept) (TR 4, p. 215)



IOJPE

ISSN: 1300 – 915X
www.iojpe.org

*International Online Journal of Primary Education* *2021, volume 10, issue 1*

# SCIENCING ACTIVITIES AND SCIENTIFIC SKILLS OF CHILDREN AT PRE-PRIMARY LEVEL IN NIGERIA

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**Received:** March 22, 2021 **Accepted:** May 15, 2021 **Published:** June 30, 2021

**Suggested Citation:**
Akintemi, E. O., & Oduolowu, E. A. (2021). Sciencing activities and scientific skills of children at pre-primary level in Nigeria. *International Online Journal of Primary Education (IOJPE), 10*(1), 106-118.



**Abstract**

Science is taught at the pre-primary level to foster scientific skills, essential for learning science at other levels of education. There is evidence that children are deficient in the scientific skills of observation, classification, communication, measurement, prediction and inference. This problem has been attributed to teachers' non-use of sciencing activities for children. This study was, therefore, carried out to determine the effects of sciencing activities (formal and informal) on pre-primary school children's scientific skills in Ibadan, Nigeria. The pretest-posttest control group quasi-experimental design was adopted. Three public primary schools were purposively selected from three Local Government Areas in Ibadan, Nigeria. An intact pre-primary class was used from each school, and randomly assigned to Formal Sciencing (17), Informal Sciencing (19) and Control (24) groups. Science Process Skills Rating Scale (r=.73) was used to measure the scientific skills of children before and after exposure to sciencing activities. Data was analysed using descriptive statistics, Analysis of covariance and Scheffe post-hoc test. There were significant main effects of treatment on children's scientific skills ($F_{(2, 57)}$=47.72; partial $\eta^2$=.65). Among the recommendations made was that sciencing activities should be adopted by pre-primary teachers to foster scientific skills of pre-primary school children.

**Keywords:** Sciencing activities, formal and informal sciencing activities, pre-primary science, scientific skills.

## INTRODUCTION

Pre-primary education is essential for children's holistic development and wellbeing. In the Nigerian education setting, it is the one year education given to five year old children before they begin primary school (Federal Republic of Nigeria [FRN], 2013). Haque, Nasrin, Yesmin, and Biswas (2013) identifies the essence of this level of education as ensuring a smooth transition to the primary level of education and laying the foundation for lifelong learning. This period is considered the right time to expose children to meaningful science learning that will build the scientific skills needed at other levels of education. It is in recognition of this that the Nigerian Government has made one of the objectives of pre-primary education to be to foster scientific skills through the exploration of various objects in the environment (FRN, 2013).

Hernawarti et al. (2018) described scientific skills as thinking skills that teachers and children use while engaged in science related activities. Durham (2017) also described these skills as the process of doing science which for young children involves observation, communication, classification, measurement, prediction and inference. It has been established that scientific skills of children can only be developed

when they are actively engaged in exploration and manipulation of objects in their environment (Suryanti, Ibrahim, & Lede, 2018; Andiema, 2016).

Oduolowu and Akintemi (2017a) observed that pre-primary school children in Ibadan, Nigeria learn science in abstraction without any form of active learning and experimentation, exploration and investigation. Pre-primary school children will not acquire scientific skills by just sitting down and listening to their teachers rather they acquire such skills through hands-on activities, inquiry, direct experience, experimentation, discovery and investigation is in line with children's nature as active learners.

This is why Yennizar, Eriyam, Susanti, and Kausari (2020) stressed that science teaching at the pre-primary level should not emphasise teaching children facts but should involve them in observation and manipulation of objects. The danger in teaching science in abstraction to pre-primary school children is that they are not adequately prepared for science at the primary level and other levels of education and teachers only concentrate on scientific facts thereby neglecting the development of the scientific skills in these children. Consequently, children who are not given the opportunity to be actively involved during science lessons will not develop these skills and will not be able to use the more complex integrated science process skills later in life.

However, the way children in Ibadan, Nigeria are learning is bereft of experiential/hands-on learning activities for children during science lessons as they do not explore, observe and experiment with materials (living and non-living) in their environment. Invariably, their lack of exposure to hands-on science activities has negatively affected the development of their scientific skills as they were observed by Oduolowu and Akintemi (2017b) to be deficient in the basic science process skills of observing, communicating, classifying, measuring, predicting and inferring. In other words, they have deficiencies in the skills of observing, classifying, communicating, measuring, predicting and inferring. For Nigeria to produce the next generation of scientists needed to make scientific advancements and to be globally recognised scientifically, pre-primary teachers need to go beyond the use of conventional teaching methods to those that will produce quality science education.

There is thus a dire need to use hands-on activities for pre-primary science which is not only developmentally appropriate, but can also be very effective in developing the process skills of young children. Sciencing activities allow children to observe, explore their environment, experiment with materials and discuss the results of their experiments with others as recommended in the one-year curriculum for pre-basic science activities (NERDC, 2013). Seefeldt and Galper (2007; 2017) defined sciencing as hands-on, brains-on endeavor for young children. Neuman (1972) defined sciencing as science related activities for young children and categorised the activities into three; formal sciencing, informal sciencing and incidental sciencing.

Lind (1999) observed that these activities differ in terms of who controls the choice of activity, the teacher or the child and stressed that for formal sciencing activities, the teacher chooses the activities for the child and gives some directions to the child's actions, for informal sciencing activities the child chooses the activity and action but the teacher intervenes at some point and for the incidental sciencing the child controls choice and actions. Formal and informal sciencing activities were of interest to this study because by nature both can be planned by the researchers in line with the Nigerian pre-primary curriculum that was used for this study. Neuman (1972) described formal sciencing activity as a type of sciencing whereby the teacher plans the lessons, prepares materials and guides children to explore with the materials and make discoveries.

Researchers have found that formal sciencing activities improve children's process skills. For instance, studies by Aydin (2020) and Raymond (2015) indicated that formal sciencing activities enhance the

process skills of children. Despite the benefits of formal sciencing activities to children especially in the acquisition of scientific skills, Oduolowu and Akintemi (2017a) observed that many pre-primary teachers do not make use of sciencing activities in their classrooms. Moreover, there seems to be dearth of studies on the impact of formal sciencing activities on pre-primary science learning outcomes in Nigeria.

Another type of sciencing activity which was of interest to the investigators is the informal sciencing. According to Mayesky (1990) informal sciencing is non-directional, free investigation by a child. It is a type of sciencing activity whereby the teacher sets up a science corner and allows children to independently explore with science materials at the science corner (Neuman, 1972). Creating a science corner in the classroom allows children to freely explore and experiment with things kept in the science corner which can foster scientific skills, independence, curiosity and creativity in children. Studies have established that informal sciencing activities improve scientific skills of children. For instance, Murphy, Smith, and Broderick (2019) and Legoria (2012) reported that informal sciencing improved the process skills of children. While Colgrove (2012) reported that informal sciencing activities did not improve the process skills of children.

Despite these benefits of informal sciencing activities for children, Oduolowu and Akintemi (2017b) observed that many pre-primary classrooms in Ibadan, Nigeria have no science corners for children to carry out informal sciencing activities. Where there were science corners, the materials were not adequate. What was available in most of the corners were old cartons, there were no living things such as small animals, fishes and plants. Thus, pre-primary children in Ibadan Metropolis may grow up not to appreciate and love nature because they are not exposed to nature in their classrooms. Appreciation and stewardship of the natural environment has been identified as one of the 10 pillars of a good childhood (Association for Childhood Education International, 2012). It also, appears that the impact of informal sciencing activities on pre-primary science learning outcomes have not been explored by researchers Ibadan, Nigeria.

Another major problem with pre-primary teachers' non-use of active learning strategies is that it is not individually appropriate as it does not consider individual differences in children. According to Browne and Gordon (2009) teachers' understanding and considerations for each child's strengths, weaknesses and interests will help them to plan and provide learning activities that are adaptable and responsive to individual differences within a group of children. There are, therefore, certain individual differences in children that can affect the way they learn science. Martin (2001) identified them as; learning modalities, locus of control, learning style, gender bias, multiple intelligence and cultural/ethnic differences. Shrooti (2011) stressed that learning can only be effective when learners' individual differences are considered. In other words, science learning at the pre-primary level can only be effective when teachers take cognizance of individual differences of children in their classroom. However; gender and ethnic affiliation were of great interest to the investigators because they have been found by researchers to influence learning outcomes in language during the early years.

Ethnic affiliation determines what children already know about science (pre-existing knowledge) and how they respond to science or do science (Universal Basic Education, 2010; Martin, 2001). Some of children's weaknesses or misconceptions about science come from their socio-cultural beliefs. According to Chidiebere (2008) socio-cultural beliefs are already formed in the African child before they begin formal schooling and that there are so many socio-cultural beliefs in Nigeria that make it difficult for children to learn science because they are contrary to what science is all about. For example, thunder, lightning, rainbow, rain, sun, stars, moon, rivers, land, trees in the forest are all believed to have supernatural powers (Chidiebere, 2008). These beliefs can affect children's understanding of scientific concepts. Similarly, Luykx, Lee, Mahotiere, Lester, and Deaktor (2007) pointed out that children's linguistic characteristics may be inconsistent with the way in which science is taught in schools. Similarly,

the linguistic characteristics of pre-primary school children in Nigeria may also interfere with their ability to learn science if the medium of instruction used is different from that of their ethnic affiliation especially when they do not understand the language. This interference will make it difficult for children to be involved in science activities as they will find it difficult to listen to instructions, express themselves or talk about their science experiences if the language that is used in the classroom is different from their home language.

Scholars have documented the influence of ethnic affiliation on scientific skills of children. For instance, Githinji (2011) observed that ethnic affiliation of children influences the science process skills of children. On the other hand, Duda, Susilo, and Newcombe (2019) observed that cultural background does not influence the science process skills of learners. As much as ethnic affiliation is important to the learning of science, it appears that nothing has been done on how ethnic affiliation influences science learning outcomes (science knowledge and process skills) at the pre-primary level in Nigeria. There is thus a need to examine whether the ethnic affiliation of children at the pre-primary level will influence learning outcomes in science (science knowledge and process skills) while they are carrying out sciencing activities.

For many years, gender has continued to play a significant role in science education globally. There still exists a wide gap between the females and males in terms of participation in science. According to the Soete, Schneegans, Eröcal, Angathevar, and Rasiah (2015) women constitute minority of the world's science researchers and in the Sub-Saharan region only 30.0% of the science researchers are women while the remaining 70.0% are men. The reason for this disparity could have stemmed from the gender stereotyping of the image of a scientist very early in life. Newton and Newton (2012) observed that children both boys and girls across many cultures view a scientist as a man in a laboratory coat. This stereotype if not addressed, could hinder female participation in science as girls would grow up feeling that they are not competent to learn science or science is meant for boys. Secondly, with the strategy used where there are no hands-on activities, girls may never be given the opportunity to try out things for themselves in order to discard this belief and gain confidence in their ability to do science.

Studies have being carried out to examine the influence of gender on science learning outcomes for young children. For instance, Simsar (2013) observed that gender influences children's performance in the science process skills. Similarly, Yuliskurniawati, Noviyanti, Mukti, Mahanal, and Zubaidah (2019) observed that gender influences the science process skills of learners at the senior secondary level. On the other hand, Ihejiamazu, Neji, and Isaac (2020) reported that the gender does not influence the science process skills of learners at the senior secondary level. These studies were not carried out in Nigerian pre-primary classrooms. Therefore, there is the need to examine how the gender of pre-primary school children will influence their science process skills while they are involved in sciencing activities.

**Purpose of the Study**

This study was carried out to determine the effect of sciencing activities (formal and informal) on the scientific skills of pre-primary school children in Ibadan and the moderating effects of ethnic affiliation and gender on the scientific skills of children.

**Hypotheses of the Study**

The following null hypotheses were tested in this study at .05 level of significance.

Ho1: There is no significant main effect of treatment on pre-primary school children's acquisition of scientific skills.

Ho2: There is no significant main effect of ethnic affiliation on pre-primary school children's; acquisition of scientific skills.

Ho3: There is no significant main effect of gender on pre-primary school children's; acquisition of scientific skills.

## METHOD

This study adopted a pretest-posttest, control group quasi experimental design (Cohen, Manion, & Morrison, 2007). Purposive sampling technique was used to select three public primary schools in Ibadan, Nigeria based on the criteria that; the public primary schools have 5 year old children in pre-primary classes, teachers' willingness to participate in the study and parents' willingness to allow their children to participate in the study. The sample comprised 60 pre-primary school children selected from the three public primary schools and intact classes were used. The three schools were randomly assigned to formal sciencing, informal sciencing, control groups and intact classes were used. Formal sciencing group comprised 17 children, informal sciencing group comprised 19 children and control group comprised 24 children.

### Research Instruments

#### Science Process Skills Rating Scale

Science Process Skills Rating Scale (r=.73) was used to measure the scientific skills of children before and after exposure to sciencing activities. It was designed by the researchers using the basic science process skills indicators by Padilla (1990). It was used to determine the performance of children in the process skills of observing, classifying, communicating, measuring, predicting and inferring using an Activity Guide for Hands-on Assessment of Science Process Skills and Science Process Skills Rubric. The rating scale is made up of two sections A and B. Section A contains the demographic data of the children. The items in this section are; gender and ethnic affiliation. Section B contains the indicators for each process skill and the level of performance for each skill. There are four levels of performance for this instrument (0=no performance, 1=moderate performance, 2=satisfactory performance, 3=excellent performance). To determine the reliability of the instrument; it was administered to pre-primary school children who did not participate in this study. Using test-retest method, the reliability coefficient of the Science Process Skills Checklist obtained was .73 using Pearson Product Moment Correlation.

#### Activity Guide for Hands-on Assessment of Science Process Skills (AGHASPS)

This instrument was designed by the researchers to guide the activities that were used to determine pre-primary school children's proficiency in the science process skills of observing, classifying, inferring, communicating, measuring and predicting before and after intervention. It is a hands-on assessment guide and the children were required do each of the activities specified for all the process skills to be assessed while the researchers or research assistant recorded their observation using the rating scale prepared for the hands-on assessment. There are specific process skills activities children must carry out to demonstrate their proficiency in each skill. It is made up of four columns; which are; serial number, materials to be used, activity and process skills to be assessed The hands-on assessment is the most suitable type of process skills assessment for pre-primary school children as multiple choice format of process skills assessment is not appropriate for young children. The content and face validity was established by experts in Early Childhood Education, Science Education and pre-primary school teachers who have taught this class for a minimum of five years. Necessary adjustments were made based on their recommendations.

#### Science Process Skills Rubric

This instrument was designed by the researchers to guide teachers' and research assistants' scoring of the Science Process Skills Rating Scale. It was used to determine specifically what children did to obtain the following marks indicated in the Science Process Skills Rating Scale; no performance (1mark), moderate

performance (2marks), satisfactory performance (3 marks) and excellent performance (4 marks) using the activity guide for hands–on assessment of science process skills. For instance to determine children's performance in the process skills of observation, children were expected to utilise all the senses. A child was scored no performance or 0 mark when he/she could not utilise any of the senses, moderate performance when he/she can utilise at least two senses, satisfactory performance when he/she could utilise three senses and excellent performance when he/she could utilise all five senses. This instrument is made up of five columns which are; process skills indicators, no performance (1mark), moderate performance (2 marks), satisfactory performance (3 marks) and excellent performance (4 marks). Copies of the instrument were given to experts in Early Childhood Education and Science Education. Also, pre-primary school teachers who have taught this class for a minimum of five years were given copies of the instrument. They determined its content and face validity and the clarity of its items.

**Procedure**

This study lasted for nine weeks. Five scientific activities were selected for the study in line with the Nigerian pre-primary school curriculum. These activities are; exploring with living things, exploring with non-living things, sense organs, exploration of seeds, planting of seeds and exploring with sinking and floating objects. During the first week, a letter of authorization was collected from the Local Government Education office and presented to Head teachers of participating schools for permission to use their schools, staff and pre-primary children for the study. For ethical reasons, consent letters were written and given to parents of the children that participated in the study to give their consent.

By the second week, pre-primary teachers assigned to both formal and informal sciencing groups and research assistants were trained on how to teach science using formal and informal sciencing activities and to administer the Science Process Skills Rating Scale (SPSRS). By the third week all pre-primary school children in the experimental and control groups were exposed to pre-test where the researcher and research assistants administered Science Process Skills Rating Scale (SPSRS) in order to determine the comparability of the three groups and this phase lasted for one week. The treatment phase lasted for five weeks, the experimental groups were exposed to treatments (formal sciencing and informal sciencing) while the control group were exposed to the conventional strategy.

For the formal sciencing group the activities were as follows:

Step 1 (Sciencing Stage): The teacher plans the sciencing activities, prepares materials to be used for sciencing activities, and uses questions to activate children's prior knowledge. Children answer teacher's questions and make predictions before the exploration. Children watch short video on the lesson to be taught and answer questions. Both teacher and children sing science songs relevant to the topic and recite poems relevant to the science topic.

Step 2 (Sciencing Stage): Teacher guides children's explorations and documentation of science experiences. Children make their own discoveries, and document their discoveries in their science journal by drawing.

Step 3 (Post-Sciencing Stage): Children and teacher reflect on the science experiences and apply the knowledge gained into real life situations.

For the informal sciencing group the activities were as follows:

Step 1 (Pre-Sciencing Stage): The teacher provides science materials which are structured in line with all the lesson/activities that were carried out during this study in the science corner for children to explore. The teacher also provides short videos, songs and rhymes relevant to the lessons/activities at the science corner.

Step 2 (Sciencing Stage): Children explore the materials in the science corner in whatever way they choose to, the teacher observes their exploration and gives them minimal support.

Step 3 (Post-Sciencing Stage): After exploration, the teacher finds out about children's discoveries by asking them questions and the teacher guides them to relate their experiences into real life situations.

For the control group the activities were as follows:

Step I: The teacher introduces the lesson to the children by asking questions.

Step II: The teacher teaches directly using chalk board.

Step III: Teacher asks children questions to see if they understand the lesson.

During the ninth week administration of post-test occurred across all groups.

**Data Analysis**

Analysis of Covariance (ANCOVA) was utilized to analyse the data collected. In order to determine the magnitude of the mean scores of each group, estimated marginal means aspect of ANCOVA was used. Also, to determine the sources of significant treatment effects observed on the ANCOVA, Scheffe Post-hoc analysis was used.

## RESULT

**$H_0$1:** There is no significant main effect of treatment on pre-primary school children's acquisition of science process skills.

**Table 1.** Summary of analysis of covariance on pre-primary school children science process skills

| Source | Type III Sum of Squares | Df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 1404.512[a] | 12 | 117.043 | 35.194 | .000 | .890 |
| Intercept | 234.785 | 1 | 234.785 | 70.598 | .000 | .576 |
| Prescoreskills | 142.769 | 1 | 142.769 | 42.930 | .000 | .452 |
| Treatment | 317.381 | 2 | 158.691 | 47.717 | .000 | .647 |
| Gender | .465 | 1 | .465 | .140 | .710 | .003 |
| Ethnic | 22.463 | 1 | 22.463 | 6.754 | .012 | .115 |
| treatment * gender | .298 | 2 | .149 | .045 | .956 | .002 |
| treatment * ethnic | 1,750 | 2 | .875 | .263 | .770 | .010 |
| gender * ethnic | ,127 | 1 | .127 | .038 | .846 | .001 |
| treatment * gender * ethnic | 12.108 | 2 | 6.054 | 1.820 | .172 | .065 |
| Error | 172.934 | 52 | 3.326 | | | |
| Total | 7190.000 | 65 | | | | |
| Corrected Total | 1577.446 | 64 | | | | |

a. R Squared = .890 (Adjusted R Squared = .865)

Table 1 shows that there is a significant main effect of treatment on children's science process skills ($F_{(2, 52)}$=47.72; p<.05; $\tilde{\eta}^2$=.65). Therefore, hypothesis 1 is rejected. To identify which of the three treatments have more effect on science process skills, Table 2 presents the estimated marginal means scores across the various groups.

**Table 2.** Estimated marginal means of the science process skills across the three groups

| Variables | | Mean | Std. Error |
|---|---|---|---|
| Intercept | | | |
| | Pre-score process skill | 5.28 | - |
| | Post-score process skill | 9.552 | .292 |
| Treatment | | | |
| | Exp. I (Formal) | 13.21 | .476 |
| | Exp. II (Informal) | 10.35 | .464 |
| | Control (Conventional) | 5.11 | .628 |

Table 2 indicates that the general performance of the children in science process skills at post-test level known as the post behaviour (Mean=9.55) is higher than their performance at the pre-test score (Mean=5.28) known as the entry behaviour. Again, the Table 2 shows that children exposed to formal sciencing (Experimental I) have the highest science process skills mean score (13.21), followed by those exposed to informal sciencing (Experimental II) (10.35) while those exposed to conventional strategy have the lowest science process skills mean score (5.11). The performance in science process skills across the groups are hereby presented in figure 1 as a bar chart.

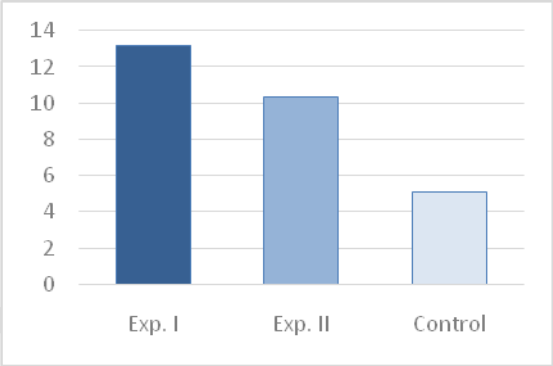


**Figure 1:** Performance of children in science process skills across the groups

**Table 3.** Scheffe' post hoc pairwise comparison on science process skills

| Groups | Exp. I | Exp. II | Control |
|---|---|---|---|
| Exp. I | | * | * |
| Exp. II | * | | * |
| Control | * | * | |

*Note, * implies that there is a significant difference*

Table 3 shows that the significant main effect that was revealed by Table 1 is as a result of the significant difference between:

i. Experimental I and Experimental II,
ii. Experimental I and control and
iii. Experimental II and control

This implies that formal sciencing enhances the children acquisition of science process skills significantly better than informal sciencing while informal sciencing is also significantly better than conventional strategy in enhancing the skills acquisition.

**$H_0$2:** There is no significant main effect of ethnic affiliation on pre-primary school children's science process skills.

Table 1 shows that there is a significant main effect of ethnic affiliation on children's science process skills ($F_{(1, 52)}$=6.75; p<.05; $\tilde{\eta}^2$=.12). Therefore, hypothesis 2 is rejected. In order to know which of the ethnic groups has the higher science process skills, estimated marginal means was performed and the summary is presented in Table 4.

**Table 4.** Estimated marginal means of children's process skills across ethnic groups

| Variables | Mean | Std. Error |
|---|---|---|
| Science process skills | | |
| Yoruba | 10.33 | .288 |
| Non-Yoruba | 8.70 | .518 |

Table 4 shows that Yoruba children had significantly higher science process skills mean score (10.33) than non-Yoruba children (8.70). This performance is graphically represented in a bar chart as shown in figure 2.

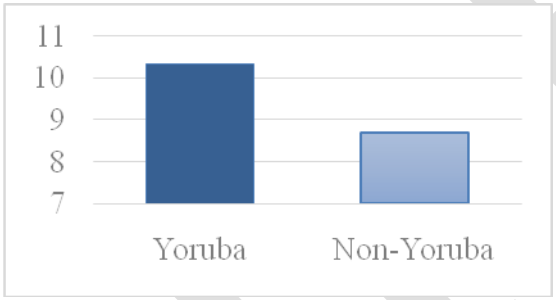


**Figure 2:** Children's science process skills across the ethnic affiliations

**$H_0$3:** There is no significant main effect of gender on pre-primary school children's science process skills.

Table 1 shows that there is no significant main effect of gender on children's science process skills ($F_{(1,52)}$=.14; p>.05; $\tilde{\eta}^2$=.00). Therefore, hypothesis 3 is not rejected.

## DISCUSSION and CONCLUSION

The findings of this study indicated a significant main effect of treatment on pre-primary school children's science process skills. Children exposed to formal sciencing activities had the highest mean score, followed by children exposed to informal sciencing activities while children taught with the conventional strategy had the least mean score. This means that both formal and informal sciencing activities are more effective in fostering the acquisition of the science process skills of pre-primary school children than the conventional strategy. The reason for this could be attributed to the fact that children exposed to formal and informal sciencing activities were actively engaged in hands-on activities where they interacted with both living and non-living materials provided for them while children who were taught with the conventional strategy were not actively engaged in hands-on activities but they were taught science in abstract. Children's active engagement during sciencing activities helped them to see and manipulate materials and subsequently enhance their science process skills. This supports the assertions of Suryanti, Ibrahim, and Lede (2018) and Andiema (2016) that the science process skills of children can only be developed when they are engaged in experiential or active learning experiences that involve exploration and manipulation of materials.

This therefore explains why formal and informal sciencing activities were more effective than the conventional strategy. The significant main effect of sciencing activities on pre-primary school children's

science process skills is in agreement with the findings of Raymond (2015) that sciencing activities improve the science process skills of children. Furthermore, the findings also showed that formal sciencing activities enhanced the science process skills of pre-primary children better than informal sciencing activities. This does not uphold the findings of Legoria (2012) that informal sciencing activities are more effective in fostering the science process skills of children than the formal sciencing activities. It was also established that children in the informal sciencing activities group performed better than children in the conventional strategy group. This is contrary to the findings of Colgrove (2012) that there was no significant difference between informal and conventional strategy in terms of the science process skills of pre-primary school children. The findings that formal sciencing activities mean score is higher than the conventional strategy mean scores corroborates the findings of Aydin (2020) that formal sciencing activities were more effective than the conventional strategy in the fostering of the science process skills of children.

The findings of the study also established a significant main effect of ethnic affiliation on pre-primary school children's science process skills. Yoruba children had significantly higher science process skills mean score than non-Yoruba Children. In other words, Yoruba children performed better than non-Yoruba children in science process skills. This finding could be as a result of the fact that the medium of instruction/communication used in this study was the Yoruba language as recommended in the National Policy on Education and majority of the children were Yoruba children. Therefore, non-Yoruba children found it difficult to communicate with and interact with peers and teachers while carrying out sciencing activities. The finding is in line with the assertions of Harlen (2014) that language particularly discussion and interaction with others plays an important role in the development of skills. This therefore explains why Yoruba children out performed non-Yoruba children in the science process skills. The significant effect of ethnic affiliation on pre-primary school children's science process skills is in congruence with the findings of Duda, Susilo, and Newcombe (2019) that ethnic affiliation of children influences their science process skills.

The findings of the study showed no significant main effect of gender on pre-primary school children's science process skills. This finding corroborates Yuliskurniawati et al. (2019) study outcomes which found no gender difference in the science process skills of children. However, this result is contrary to the study outcomes of Ihejiamazu, Neji, and Isaac (2020) and Simar (2013) which found gender difference in the science process skills of children. This could be because sciencing activities allowed both girls and boys be actively engaged in various activities therefore there were no disparities among both genders.

**Conclusion**

When pre-primary school children are exposed to formal sciencing activities where experiences/explorations are hands on, structured and are guided by the teacher, it fosters the scientific skills of children better than when they are exposed to informal sciencing activities that are not structured and are given little guidance by the teacher. It also fosters scientific knowledge and skills better than the conventional strategy. This is because formal sciencing activities are more directional, purposeful, intentional and interactive than informal sciencing activities and conventional strategy. The study has also established that ethnic affiliation can hinder pre-primary school children's science process skills especially when the medium of instruction is not their own language.

Based on the findings of this study the following recommendations are made:

- Pre-primary school teachers should adopt sciencing activities in fostering of scientific skills of pre-primary school children.
- All pre-service Early Childhood Education teachers at the Colleges of Education and the Universities should be exposed how to teach science at the pre-primary level using sciencing activities. This can

be done by incorporating and emphasising the use of sciencing activities when pre-service teachers in Colleges of Education are taught ECE 127 (Early Childhood Science) and when pre-service teachers in the Universities are taught the course science in the early years.

- Teachers should also make use of readily available materials in the immediate environment for sciencing activities to be carried out effectively in pre-primary classes.
- The rate at which children at the pre-primary level acquire science process skills when they are taught science in their own indigenous language also demands that children at that level should not be taught science in a language that they do not understand. However, in a situation whereby a teacher notices that some children in his/her class do not understand the language used as medium of instruction, he/she could make use of "Peer interpreters" that is a child or children in the class who understand both languages should be paired with another child who does not.
- Activity based science text books emphasizing sciencing activities and teachers' guides should be written and produced in at least the three major Nigerian languages for the pre-primary level of education.
- Workshops and seminars should be organized to train teachers how to teach science using sciencing activities.

The study is limited to pre-primary school children in Ibadan, Oyo state, Nigeria. The study determined the impact of sciencing activities on pre-primary science learning outcomes. In the course of the study some other constraints encountered were:

1. Transportation of both living and non-living instructional materials, audio visual materials and generator for the sciencing activities daily because there was no safe place to keep them was very tasking.
2. The outcome of the first planting experiment was not successful because the plants had to be locked in the classroom after school hours for fear of being damaged by touts and miscreants that take over the schools after school hours.
3. Technological issues with the generator and audio visual materials.
4. Teachers' carefree attitude towards the study posed some frustrations on the researchers and research assistants.
5. Children's lack of exposure to the science materials made them to damage the materials and be over excited.
6. Children in the informal sciencing group were more interested in watching the video than explore at the science corner.
7. Children from other classes also come to play at the science corner during break time and this caused distractions for the children in the informal sciencing group.
8. The living and non-living materials in the science corner distracted children from other class activities.

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IOJPE

ISSN: 1300 – 915X
www.iojpe.org

*International Online Journal of Primary Education* *2021, volume 10, issue 1*

# PLAYFULNESS OF PRE-SCHOOL CHILDREN IN TURKEY

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**Received:** July 15, 2020 **Accepted:** November 03, 2020 **Published:** June 30, 2021

**Suggested Citation:**
Bay, D. N. (2021). Playfulness of pre-school children in Turkey. *International Online Journal of Primary Education (IOJPE), 10*(1), 119-136.



**Abstract**

In this research, the playfulness of 4- and 5-years-old 181 children, 100 boys and 81 girls, attending a kindergarten in Turkey, was examined. The research was designed according to relational-correlational survey/research model, one of the quantitative research methods; the data were collected using Personal Information Form and Children's Playfulness Scale (CPS) developed by Barnett (1990) and adapted to Turkish by Keleş and Yurt (2017). The playfulness levels of the children were analyzed according to gender, age, number of children in the family, duration of pre-school education, mother's/father's age and education level, mother's working status, and father's profession. To identify the playfulness levels of pre-school children, descriptive statistics and difference statistics were calculated for both overall and each sub-dimension according to the demographic characteristics of the children. As a result of the study, the playfulness levels of the children were found to be high and physical spontaneity was observed to be the playfulness characteristic with the highest score. Significant differences were observed in playfulness of children according to age and duration of pre-school education; whereas no significant difference was observed according to gender, mother's/father's age and education level, mother's working status, and father's profession.

**Keywords:** Playfulness, play, early childhood education, child, Turkey.

## INTRODUCTION

Providing education in line with the interests and needs of children in pre-school education institutions and supporting the development of children at maximum level are considered very important in Turkey. With the increase of the importance of the pre-school education in the country, researches on children's plays have increased (e.g., Aksoy & Yaralı, 2017; Gündüz, Aktepe, Uzunoğlu, & Gündüz, 2017; Sapsağlam, 2018; Tuğrul, Boz, Uludağ, Aslan, Çelik, & Çapan, 2019). Game-based approach has been set as one of the basic principles of the Pre-school Education Program (2013), which has been put into practice by the Ministry of National Education. The researches involving the playing behaviors of pre-school children in Turkey, will contribute to increasing the quality of pre-school education.

Besides the individual differences of children, cultural and environmental differences cause their cognitive, language, social-emotional and motor development to develop at different rates (Shepard, Kagan, & Wurtz, 1998). Teachers should organize the educational setting by considering all these differentiating factors and provide opportunities for children to develop their potential using supportive methods (Cukierkorn, Karnes, & Manning, 2007). Organizing an educational setting suitable to play increases the participation of the children and allow them to achieve a better learning and development (Jones & Reynolds, 2011). In such a setting, children's imaginations, creativity and academic achievements develop (Kangas & Ruokamo, 2012). However, the increasing tendency towards acquiring learning and academic skills has created the necessity of intervention in establishing a playful and creative environment in pre-school education (Lobman, 2003). Children only perceive the activities they initiate as play, they see the activities that are structured and directed by the teacher as learning, not play, and therefore learning does not take place in such cases (Karrby, 1989). Instead of limiting or directing the activities, teachers should find ways to get clues from children's behavior and to expand, and improve their participation (Lobman, 2006). In this study, the

playfulness levels of 181 children attending pre-school education in Turkey were analyzed through independent variables, based on their teachers' observations. As far as is known, no research has been conducted for this cultural structure in this context.

**The Importance of Playfulness of Pre-school Children Study**

There are some reasons that are considered as important in planning the study on the playfulness of children. One of the most important reasons is the studies revealing that playfulness has an important effect on children's learning and development (Barnett, 1991a, 1991b, 2007; Cornelli Sanderson, 2010; Youell, 2008). Playfulness is an important part of the play (Youell, 2008). Play helps children overcome ordinary challenges they encounter in their lives and share their experiences with adults and peers. The factor that allows children to enjoy their play with their free will and reveal their creativity is having the spirit of playfulness (Singer, 2015). Play can be defined through observable features, however playfulness, which is defined as the child's disposition to play (Keleş & Yurt, 2017) involves children's intrinsic characteristics, depending on the feelings in the play process (Howard, Bellin, & Rees, 2002). These intrinsic features are; the internal motivation of the children independent of external factors, the ability to specify or manage the play, the freedom to use the imagination, and the ability to communicate and interpret in the play process (Pinchover, 2017). Considering the effect of these features on learning, it is important to think about children's perspective as players and to motivate learning through activities they perceive as plays (Howard, Bellin, & Rees, 2002).

The second important reason is the effect of understanding and improving children's playfulness on pedagogical goals (Jones & Reynolds, 2011). When the child plays a game within the activity, it is not clear whether he/she is playing voluntarily (Bateson & Martin, 2013; Howard, Bellin, & Rees, 2002). Teachers who begin to understand children's play and playfulness, can create more entertaining educational settings by planning activities that allow children to show their playfulness (Carter, 1993). Therefore, teachers should observe, understand and support children's playing behavior (Broadhead, Howard, & Wood, 2010), instead of spoiling their fun by using children's play according to the educational goals (Pramling Samuelsson & Carlsson, 2008). Because, the developmental potential of the play is maximized when children perceive the activity as a play and participate in it as a player. However, further information is needed to understand children's play perceptions and playfulness (Howard, Bellin, & Rees, 2002). Children start the play based on different motivations and tendencies. These motivations and tendencies defined as playfulness constitute the child's attitude during play. Children willingly decide with whom, how, when and how much to play in their games and enjoy playing by giving meaning to objects as imagined and desired, and adding their own humor, without being tied to the objective reality. All these playfulness attitudes differ between children (Román-Oyola, Figueroa-Feliciano, Torres-Martínez, Torres-Vélez, Encarnación-Pizarro, Fragoso-Pagán, & Torres-Colón, 2018). For this reason, the playfulness characteristics of children should be examined, and their changing playfulness behaviors should be understood by teachers.

In addition, discovering the effectiveness of various variables on children's playfulness also facilitates understanding children's playfulness characteristics. Some of the variables that have been found to be correlated with the playfulness of children in previous studies are; gender (e.g., Barnett, 1991b; Cornelli Sanderson, 2010; Saunders, Sayer, & Goodale, 1999; Tae-Hyung, Tae-Hyun, & Jae-Shin, 2014; Zachopoulou, Trevlas, & Tsikriki, 2004), age (e.g., Barnett, 1991b; Cornelli Sanderson, 2010; Lieberman, 1965; Rentzou, 2013; Saunders, Sayer, & Goodale, 1999), number of people in the family (e.g., Barnett, 1991b; Barnett & Kleiber, 1984; Rentzou, 2013) and parents' occupation and age (e.g., Barnett & Kleiber, 1984). In Turkey, there are limited number of studies on children's playfulness (e.g. Keles & Yurt, 2017; Macun & Güvendi, 2019) and these studies fail to adequately represent pre-school children's playfulness characteristics. This creates the need to determine children's playfulness levels and to investigate the variables according to which children's playfulness levels differ. In order to contribute to the existing literature, the playfulness characteristics of the children were examined according to various variables in a new cultural context, namely Turkey.

**Theoretical Framework**

Playfulness is the pure essence of the play (Cornelli Sanderson, 2010; Rentzou, 2013; Youell, 2008). Huizinga criticized focusing on the educational benefits of the play and argued that the essence of the play was lost with the functionalist play approach (Singer, 2013). According to Huizinga, the play cannot be played by force, it is played voluntarily depending on the person's will. At the same time, the play frees individuals by allowing them to create alternative worlds and identities far from their daily lives (Huizinga, 1955; Masters, 2008; Singer, 2013). Huizinga's play theory provides an important framework for defining the elements of the play and playfulness and analyzing the reflections of player interactions on societies and cultures (Masters, 2008). Contrary to the assumption that the play should serve other purposes outside the play, which is highlighted by the other play theories, Huizinga stated that the benefits of the play cannot be achieved without experiencing the fun, which is the essence of the play. Children play the game because they want it, not for its benefit (Singer, 2013). As a result, Huizinga's theory emphasizes the playfulness spirit of the game, which is a voluntary activity, which gives pleasure and freedom (Huizinga, 1955; Masters, 2008; Singer, 2013; Singer, 2015). Understanding the reflection of playfulness in children's own culture should be seen as a premise in achieving development and learning goals through play. Turkey does not have sufficient amount of research on children's playfulness (e.g. Keles and Yurt, 2017; Macun & Güvendi, 2019). In this context, it is thought that determining children's playfulness level within their own culture in Turkey and identifying the variables affecting this level will contribute to support their development and learning.

**Purpose of the Current Study**

Besides being a personal tendency (Lieberman, 1977), playfulness is a reflection of the culture (Huizinga, 1955; Trevarthen, 2011). Therefore, the results obtained from different cultures make contribution to the literature (Keleş & Yurt, 2017). The purpose of this research is analyzing the playfulness level of the children who attend pre-school educational institutions in Turkey according to different factors. In the current study, teachers were asked to fill the playfulness scale to identify the playfulness levels of the children in their classes.

In this study, the following primary question and two sub-questions were addressed:

What are the playfulness levels of pre-school children and the variables that affect these levels?

1. What are the playfulness levels of pre-school children?

2. Do the playfulness levels of pre-school children significantly differ according to their demographic characteristics (Gender, age, number of children in the family, duration of pre-school education, mother's/father's age and education level, mother's working status, and father's profession)?

## METHOD

This study, in which the playfulness of pre-school children and whether children's playing tendency shows a significant difference according to the demographic characteristics were investigated, was designed according to relational-correlational survey/research model, which is one of the quantitative research methods. Relational-correlational survey/research is a research approach aiming to describe a situation that existed in the past or that still exists as it is (Karasar, 2008).

In the research, the playfulness of pre-school children is included in the study as the dependent variable; whereas children's age, gender, number of children in the family, duration of pre-school education, mother's/father's age and education level, mother's working status, and father's profession were included as independent variables.

**Participants**

This study was carried out with 181 children attending a pre-school education institution in Eskişehir province, in 2019-2020 academic year. In the study, typical case sampling, one of purposeful sampling methods was used. Neuman (2014) states that typical case sampling method is used in

researches where a specific application is evaluated, or a typical situation is examined. Accordingly, based on the sampling feature (McNabb, 2015), the study was conducted with 181 pre-school children in a school at the center, which shows typical characteristics of Eskişehir.

The distribution of the children participating in the study according to their demographic characteristics were analyzed and the results are shown in Table 1.

**Table 1.** Frequency and percentages of pre-school children participating in the research according to demographic characteristics

| Variable | Category | f | % |
|---|---|---|---|
| Age | 4-years-old | 53 | 29.3 |
| | 5-years-old | 128 | 70.7 |
| Gender | Female | 81 | 44.8 |
| | Male | 100 | 55.8 |
| Number of children in the family | 1 child | 55 | 30.4 |
| | 2 children | 95 | 52.5 |
| | 3 children and more | 31 | 17.1 |
| Duration of pre-school education | 1 year | 112 | 61.9 |
| | 2 years and more | 69 | 38.1 |
| Mother's age | Less than 30 years old | 29 | 16.0 |
| | 30-39-years-old | 136 | 75.1 |
| | More than 40 years old | 16 | 8.8 |
| Father's age | Less than 30 years old | 14 | 7.7 |
| | 30-39-years-old | 136 | 75.1 |
| | More than 40 years old | 31 | 17.1 |
| Mother's Education | Secondary school or less | 50 | 27.6 |
| | High school | 89 | 49.2 |
| | University and more | 42 | 23.2 |
| Father's Education | Secondary school or less | 47 | 26.0 |
| | High school | 98 | 54.1 |
| | University and more | 36 | 19.9 |
| Mother's working status | Not working | 126 | 69.6 |
| | Working | 55 | 30.4 |
| Father's Profession | Unemployed | 3 | 1.7 |
| | Civil servant | 25 | 13.8 |
| | Worker | 85 | 47.0 |
| | Self-employed | 68 | 37.6 |

Regarding the information in Table 1, 29.3% (n=53) of the children participating in the study were 4-year-old and 70.7% (n=128) were 5-year-old. 44.8% (n=81) of the children were girls, and 55.2% (n=100) were boys. Of the children, 30.4% (n=55) were the only child of the family, there are two children in the family of 52.5% (n=95), and there are three or more children in the family of 17.1% (n=31). 61.9% (n=112) of the children attended pre-school education for a year and 38.1% (n=69) for two or more years. Regarding the age of pre-school children's mothers, 16.0% (n=29) were less than 30, 75.1% (n=136) were 30-39-years-old, and 8.8% (n=16) were more than 40 years old. Regarding the age of their fathers, 7.7% (n=14) were less than 30, 75.1% (n=136) were 30-39-year-old, and 17.1% (n=31) were more than 40. Regarding the education of the mothers, 27.6% (n=50) of them were graduated from secondary school and below, 49.2% (n=89) from high school, and 23.2% (n=42) were university graduate or more. The education of the fathers are as follows: 26.0% (n=47) were primary or secondary school graduate, 54.1% (n=89) were high school graduate, and 19.9% (n=36) were university graduate or more. The mothers of 69.6% (n=126) of the children were not working, whereas 30.4% (n=55) were working. Regarding the profession of the fathers, 1.7% (n=3) were observed to be unemployed; 13.8% (n=25) were civil servants, 47.0% (n=85) were workers, and 37.6% (n=68) were self-employed.

**Data Collection**
The data were collected from the children attending pre-school education institutions using Personal Information Form and Children's Playfulness Scale (CPS).

**Personal Information Form:** It has been developed by the researcher to collect information about children's age, gender, number of children in the family, duration of pre-school education, mother's/father's age and education level, mother's working status, and father's profession. Personal Information Form was filled out by the teachers of the children.

**Children's Playfulness Scale (CPS):** CPS, which has been developed by Barnett (1990) and adapted to Turkish by Keleş and Yurt (2017), was used to identify the playfulness level of the children attending pre-school education. The scale consists of 23 items grouped under five dimensions. The scale is answered by the teachers for each child. Items in the scale were rated in 5-point Likert scale, where 1 means "It doesn't fit to this child at all" and 5 means "It completely fit to this child". Two of the scale items contain negative expressions, whereas the other items are positive. The scale is used to identify the playfulness levels of 29-61.5-month-old children.

In the process of adapting CPS to Turkish, first, four people who are familiar with both languages undertook the translation process, then the translations were compared, and expert opinions were received from five academicians working in the field of pre-school education. In the first pilot study, the scale was filled for 79 children by their teachers and the expressions of the items were revised. A second pilot study was conducted to confirm the validity and reliability of the research, in which scale items whose translations were finalized were filled for 196 children by their teachers (Keleş & Yurt, 2017).

Then, first level and then second level confirmatory factor analysis were performed. As a result of the analysis, each item of the scale was found to significantly explain the sub-dimension to which it belongs. The standardized factor loads of the items included in the sub-dimensions were found to vary as follows: physical spontaneity .68 - .91; social spontaneity .48 - .89; cognitive spontaneity .55 - .89; manifest joy .68 - .90; and sense of humor .63 - .82. Model-data fit values calculated in the second level confirmatory factor analysis ($X2/df=2.84$, RMSEA=.097, CFI=.97, NFI=.96, NNFI=.97, GFI=.78, RFI=.95), show that the 5-dimensional 23-item structure was confirmed in the Turkish sample (Keleş & Yurt, 2017).

To determine the reliability of the answers given to the scale items, Cronbach alpha coefficients and McDonalds' ω coefficients were calculated. Cronbach's alpha coefficients were found to be ranged from .79 to .92 and McDonalds ω coefficient from .80 to .93, thus the reliability of the scale items related to their internal consistency was found to be high (Keleş & Yurt, 2017).

Within the scope of this research, CPS was answered by the teachers for 181 children. Cronbach alpha reliability coefficients were calculated to determine the reliability of the answers given to the scale items. As a result of this calculation, the reliability coefficients were found as follows: physical spontaneity .863; social spontaneity .830; cognitive spontaneity .695; manifest joy .805; and sense of humor .834. The reliability coefficient calculated for the overall scale was .942. These figures show that the reliability of the answers given to the scale items is high for the children participating in the research (Kalaycı, 2009).

**Data Analysis**
During data analysis, the data collected for 182 children were transferred to SPSS 23.0 program, and the analysis were performed. After confirming that there is no missing and incorrect data, the scores of the sub-dimensions and the whole scale were calculated. Afterwards, z statistics were used to analyze the extreme value of the scores (sub-dimensions and overall) and 1 observation showing extreme value was removed from the dataset. Skewness and kurtosis coefficients were calculated to check the distribution of the scores of the remaining 181 pre-school children. The results are shown in Table 2.

**Table 2.** Skewness and Kurtosis coefficients calculated for the answers given to the scale items.

| Scale | n | Skewness | SE | Kurtosis | SE |
|---|---|---|---|---|---|
| Physical spontaneity | 181 | -1.117 | .181 | .640 | .359 |
| Social spontaneity | 181 | -.735 | | -.118 | |
| Cognitive spontaneity | 181 | -.263 | | -.252 | |
| Manifest joy | 181 | -.590 | | -.503 | |
| Sense of humor | 181 | -.537 | | -.493 | |
| Overall playfulness score | 181 | -.541 | | -.400 | |

As can be seen in Table 2, skewness and kurtosis coefficients calculated for the distribution of the scores achieved from the sub-dimensions and from the whole scale were between (-1,+1), except for the first dimension. But the coefficient of physical spontaneity dimension was very close to -1. Büyüköztürk (2018) states that skewness and kurtosis coefficients between (-1,+1) indicate that the data does not show an excessive deviation from the normal distribution. Accordingly, CPS scores were found to show normal distribution.

After analyzing the dataset, descriptive statistics including minimum, maximum, average and standard deviation were calculated to determine the playfulness levels of pre-school children. Then, the difference statistics were calculated to identify whether the playfulness of children showed a significant difference according to their demographic characteristics. Before the calculations, each assumption was tested and either parametric tests (t-test, one-way variance analysis for independent measurements) or non-parametric tests (Kruskal Wallis) were performed. While interpreting the difference, p significance value was taken as .05. Cohen's d effect size coefficient was calculated in binary group comparisons to identify the effect size of the difference. The coefficient was interpreted as follows: .20-.49 low; .50-.79 medium; and over .80 high (Cohen, 1988).

## RESULTS

### Descriptive statistics

To determine the playfulness of pre-school children, descriptive statistics were calculated first, and the results are shown in Table 3.

**Table 3.** Descriptive statistics of pre-school children's playing tendencies

| Sub-dimensions | # of items | n | Minimum | Maximum | Mean | Std.Dev. |
|---|---|---|---|---|---|---|
| Physical spontaneity | 4 | 181 | 8.00 | 20.00 | 17.07 | 3.12 |
| Social spontaneity | 5 | 181 | 10.00 | 25.00 | 20.92 | 3.57 |
| Cognitive spontaneity | 4 | 181 | 6.00 | 20.00 | 14.91 | 3.00 |
| Manifest joy | 5 | 181 | 11.00 | 25.00 | 20.93 | 3.52 |
| Sense of humor | 5 | 181 | 8.00 | 25.00 | 19.76 | 4.29 |
| Overall playfulness score | 23 | 181 | 50.00 | 115.00 | 93.60 | 15.34 |

Table 3 shows that the scores that pre-school children got from the physical spontaneity dimension ranged between 8.00 and 20.00, and the mean score was calculated as 17.07 (± 3.12). Scores taken from the social spontaneity dimension ranged from 10.00 to 25.00, with an average of 20.92 (± 3.57). The scores of children from cognitive spontaneity were between 6.00 and 20.00 and the average was 14.91 (± 3.00). Manifest joy scores of pre-school children varied between 11.00 and 25.00, and the average was calculated as 20.93 (± 3.52). The scores that the children got from sense of humor ranged between 8.00 and 25.00, and the average was 19.76 (± 4.29). The last line of the table shows that the scores of pre-school children from 23-items playfulness tendency scale ranged between 50.00 and 115.00, and the average was calculated as 93.60 (± 15.34).

Since the number of items in CPS' subdimensions is different, the average scores achieved from each dimension and from the whole scale was scaled in 1-5 range for the ease of comparison. Accordingly, the average scores of the sub-dimensions were as follows: physical spontaneity 4.3; social spontaneity 4.2; cognitive spontaneity 3.7; manifest joy 4.2; sense of humor 4.0; whereas the average of overall playfulness score was calculated as 4.1.

While interpreting the scores, the "ranges/number of categories" proposed by Tekin (2002) was employed, then;

- The scores between 1.0-2.3 were specified as low;
- The scores between 2.3-3.7 were specified as medium;
- The scores between 3.7-5.0 were specified as high

In line with this information, the playfulness of pre-school children participating in the study was found to be high for all sub-dimensions and overall scale. The scores were ranked as physical spontaneity, social spontaneity, manifest joy, sense of humor and cognitive spontaneity.

**Difference statistics**

The differentiation of the playfulness of children participating in the study according to age was tested. The scores of the children according to age showed normal distribution, therefore t-test was used in the comparison of the related measurements, and the results are shown in Table 4.

**Table 4.** Independent T-test results for pre-school children's playfulness according to age

| Scale | Age | n | Mean | Std.Dev. | t | df | P | d' |
|---|---|---|---|---|---|---|---|---|
| Physical spontaneity | 4-years-old | 53 | 16.25 | 3.07 | 2.323 | 179 | .021* | .35 |
| | 5-years-old | 128 | 17.41 | 3.09 | | | | |
| Social spontaneity | 4-years-old | 53 | 19.09 | 3.44 | 4.690 | 179 | .000* | .70 |
| | 5-years-old | 128 | 21.68 | 3.35 | | | | |
| Cognitive spontaneity | 4-years-old | 53 | 14.09 | 2.65 | 2.387 | 179 | .018* | .36 |
| | 5-years-old | 128 | 15.25 | 3.08 | | | | |
| Manifest joy | 4-years-old | 53 | 20.28 | 3.20 | 1.606 | 179 | .110 | --- |
| | 5-years-old | 128 | 21.20 | 3.62 | | | | |
| Sense of humor | 4-years-old | 53 | 18.72 | 4.40 | 2.128 | 179 | .035* | .32 |
| | 5-years-old | 128 | 20.20 | 4.19 | | | | |
| Overall playfulness score | 4-years-old | 53 | 88.43 | 14.15 | 2.980 | 179 | .003* | .45 |
| | 5-years-old | 128 | 95.74 | 15.35 | | | | |

*p<.05

Regarding the information in Table 4, a significant difference was observed in physical spontaneity levels of pre-school children according to age ($t_{(179)}$=2.323; p<.05; d'=.35). Average scores showed that physical spontaneity level of 5-years-old children (17.41 ± 3.09) was significantly higher than 4-years-old children (16.25 ± 3.07). The calculated Cohen's d effect size shows that the effect of the difference is low. A significant difference was also observed in social spontaneity levels of pre-school children according to age ($t_{(179)}$=4.690; p<.05; d'=.70). Average scores showed that social spontaneity level of 5-years-old children (21.68 ± 3.35) was significantly higher than 4-years-old children (19.09 ± 3.44). The effect size implies that the effect of the difference is moderate ($t_{(179)}$=2.387; p<.05; d'=.36). Moreover, a significant difference was observed in cognitive spontaneity levels of pre-school children according to age ($t_{(179)}$=4.690; p<.05; d'=.70). Average scores showed that cognitive spontaneity level of 5-years-old children (15.25 ± 3.08) was significantly higher than 4-years-old children (14.09 ± 2.65). The effect size implies that the effect of the difference is low. The difference of manifest joy level of children was found to be insignificant according to age ($t_{(179)}$=1.606; p> 0.05). In other words, manifest joy level of 4 and 5-years-old children was similar. A significant difference was observed in the sense of humor of pre-school children according to age ($t_{(179)}$=2.128; p<.05; d'=.32). Average scores showed that sense of humor of 5-years-old children (20.20 ± 4.19) was significantly higher than 4-years-old children (18.72 ± 4.40). The effect size shows that the effect of the difference is low. Lastly in Table 4, the playfulness of pre-school children showed a significant difference according to age ($t_{(179)}$=2.980; p<.05; d'=.45). Regarding average scores, the playfulness of 5-year-old children (95.74 ± 15.35) was found to be significantly higher than 4-year-old's (88.43 ± 14.15). The effect size implies that the effect of the difference is moderate. In other words, 4-years-old children have a moderately higher tendency to play than 5-years-olds.

The scores of the children according to gender also showed normal distribution, thus t-test was used in the comparison of the related measurements, and the results are shown in Table 5.

**Table 5.** Independent T-test results for pre-school children's playfulness according to gender

| Scale | Gender | n | Mean | Std.Dev. | t | df | p | d |
|---|---|---|---|---|---|---|---|---|
| Physical spontaneity | Female | 81 | 17.06 | 3.06 | .039 | 179 | .969 | --- |
| | Male | 100 | 17.08 | 3.18 | | | | |
| Social spontaneity | Female | 81 | 21.14 | 3.25 | .723 | 179 | .471 | --- |
| | Male | 100 | 20.75 | 3.81 | | | | |
| Cognitive spontaneity | Female | 81 | 15.16 | 2.90 | 1.004 | 179 | .317 | --- |
| | Male | 100 | 14.71 | 3.08 | | | | |
| Manifest joy | Female | 81 | 21.40 | 3.30 | 1.593 | 179 | .113 | --- |
| | Male | 100 | 20.56 | 3.66 | | | | |
| Sense of humor | Female | 81 | 19.96 | 3.99 | .564 | 179 | .573 | --- |
| | Male | 100 | 19.60 | 4.54 | | | | |
| Overall playfulness score | Female | 81 | 94.72 | 14.22 | .879 | 179 | .381 | --- |
| | Male | 100 | 92.70 | 16.20 | | | | |

*p<.05

Regarding Table 5, pre-school children's physical spontaneity ($t_{(179)}$=.039; p>.05), social spontaneity ($t_{(179)}$=.723; p>.05), cognitive spontaneity ($t_{(179)}$=1.004; p>.05), manifest joy ($t_{(179)}$=1.593; p>.05), and sense of humor ($t_{(179)}$=.564; p>.05) scores did not show significant difference according to gender. Similarly, the difference on children's overall playfulness scores according to gender was not significant ($t_{(179)}$=.879; p>.05). In other words, the playfulness tendencies of girls and boys were found to be similar both in overall and in all sub-dimensions.

The playfulness of pre-school children according to the number of children in the family was first tested for normality, and then homogeneity of variances was tested by Levene test. After determining that the assumptions are met, one-way analysis of variance (ANOVA) was performed for comparison and the results are shown in Table 6.

**Table 6.** One way ANOVA analysis results for pre-school children's playfulness according the number of children in the family

| Scale | # of children | n | Mean | Std.Dev. | F | df | p | $n^2$ |
|---|---|---|---|---|---|---|---|---|
| Physical spontaneity | 1 child | 55 | 17.33 | 2.98 | | | | |
| | 2 children | 95 | 16.76 | 3.33 | 1.080 | 2 | .969 | --- |
| | 3+ children | 31 | 17.58 | 2.62 | | 180 | | |
| Social spontaneity | 1 child | 55 | 20.91 | 3.57 | | | | |
| | 2 children | 95 | 20.82 | 3.74 | .174 | 2 | .471 | --- |
| | 3+ children | 31 | 21.26 | 3.05 | | 180 | | |
| Cognitive spontaneity | 1 child | 55 | 14.85 | 2.56 | | | | |
| | 2 children | 95 | 14.87 | 3.23 | .098 | 2 | .317 | --- |
| | 3+ children | 31 | 15.13 | 3.08 | | 180 | | |
| Manifest joy | 1 child | 55 | 21.25 | 3.10 | | | | |
| | 2 children | 95 | 20.65 | 3.89 | .635 | 2 | .113 | --- |
| | 3+ children | 31 | 21.23 | 3.05 | | 180 | | |
| Sense of humor | 1 child | 55 | 20.15 | 3.93 | | | | |
| | 2 children | 95 | 19.46 | 4.52 | .494 | 2 | .573 | --- |
| | 3+ children | 31 | 20.00 | 4.27 | | 180 | | |
| Overall playfulness score | 1 child | 55 | 94.49 | 13.32 | | | | |
| | 2 children | 95 | 92.57 | 17.00 | .472 | 2 | .381 | --- |
| | 3+ children | 31 | 95.19 | 13.40 | | 180 | | |

*p<.05

According to Table 6, the differentiation of physical spontaneity ($F_{(2,180)}$=1.080; p>.05), social spontaneity ($F_{(2,180)}$=.174; p>.05), cognitive spontaneity ($F_{(2,180)}$=.098; p>.05), manifest joy ($F_{(2,180)}$=.635; p>.05), sense of humor ($F_{(2,180)}$=.494; p>.05) levels were found to be insignificant

according to the number of children in the family. Similarly, pre-school children's overall playfulness scores did not show a significant difference according to the number of children in the family ($F_{(2,180)}$=.472; p>.05). In other words, the playfulness of the children who are the only child of their family, and who has one, two or more siblings were similar both in overall and in all sub-dimensions.

The differentiation of the playfulness of pre-school children according to the duration of pre-school education was tested. The scores of the children according to the duration of pre-school education showed normal distribution, therefore t-test was used in the comparison of the related measurements, and the results are shown in Table 7.

**Table 7.** Independent T-test results for pre-school children's playfulness according to the duration of pre-school education

| Scale | Duration of pre-school education | n | Mean | Std.Dev. | t | df | p | d' |
|---|---|---|---|---|---|---|---|---|
| Physical spontaneity | 1 year | 112 | 16.61 | 3.03 | | | | |
| | 2 years and more | 69 | 17.83 | 3.14 | 2.595 | 179 | .010* | .39 |
| Social spontaneity | 1 year | 112 | 19.95 | 3.61 | | | | |
| | 2 years and more | 69 | 22.51 | 2.88 | 4.995 | 179 | .000* | .75 |
| Cognitive spontaneity | 1 year | 112 | 14.67 | 3.07 | | | | |
| | 2 years and more | 69 | 15.30 | 2.88 | 1.385 | 179 | .168 | --- |
| Manifest joy | 1 year | 112 | 20.27 | 3.50 | | | | |
| | 2 years and more | 69 | 22.01 | 3.30 | 3.330 | 179 | .001* | .50 |
| Sense of humor | 1 year | 112 | 19.04 | 4.10 | | | | |
| | 2 years and more | 69 | 20.93 | 4.37 | 2.925 | 179 | .004* | .44 |
| Overall playfulness score | 1 year | 112 | 90.54 | 15.05 | | | | |
| | 2 years and more | 69 | 98.58 | 14.57 | 3.534 | 179 | .001* | .53 |

*p<.05

Regarding the information in Table 4, a significant difference was observed in physical spontaneity levels of pre-school children according to the duration of pre-school education ($t_{(179)}$=2.595; p<.05; d'=.39). Average scores showed that physical spontaneity level of the children who were attending a pre-school education institution for two years and more (17.83 ± 3.14) was significantly higher than those who were attending for one year (16.61 ± 3.03). The calculated effect size shows that the effect of the difference is low. A significant difference was also observed in social spontaneity levels of pre-school children according to the duration of pre-school education ($t_{(179)}$=4.995; p<.05; d'=.75). Average scores showed that social spontaneity level of the children who were attending a pre-school education institution for two years and more (22.51 ± 2.88) was significantly higher than those who were attending for one year (19.95 ± 3.61). The effect size shows that the effect of the difference is moderate. The difference in cognitive spontaneity level of the children was found to be insignificant according to the duration of pre-school education ($t_{(179)}$=1.385; p>.05). In other words, the cognitive spontaneity levels of the children who have been attending a pre-school education institution for 1 year and 2 years or more were similar. Manifest joy levels of the children were found to significantly differentiate according to the duration of pre-school education ($t_{(179)}$=3.330; p<.05; d'=.50). Average scores showed that manifest joy level of the children who were attending a pre-school education institution for two years and more (22.01 ± 3.30) was significantly higher than those who were attending for one year (20.27 ± 3.50). The effect size shows that the effect of the difference is moderate. Sense of humor of the children was also found to significantly differentiate according to the duration of pre-school education ($t_{(179)}$=2.925; p<.05; d'=.44). Average scores showed that sense of humor level of the children who were attending a pre-school education institution for two years and more (20.93 ± 4.37) was significantly higher than those who were attending for one year (19.04 ± 4.10). The effect size shows that the effect of the difference is moderate. The table also shows that the overall playfulness scores of the children significantly differentiated according to the duration of pre-school education. ($t_{(179)}$=3.534; p<.05; d'=.53). Regarding average scores, the playfulness of the children who were attending a pre-school education institution for two years and more (98.58 ± 14.57)

was significantly higher than those who were attending for one year (90.54 ± 15.05). The calculated effect size shows that the effect of the difference is moderate. In other words, children who have attended pre-school education for 2 years or more have moderately more playfulness behaviors than children who have attended pre-school education for one year.

The differentiation of the playfulness of pre-school children according to their mother's age was tested. The scores of the children according to mother's age did not exhibit normal distribution, therefore Kruskal Wallis test was used in the comparison. The results are shown in Table 8.

**Table 8.** Kruskal Wallis test results for pre-school children's playfulness according to mother's age

| Scale | Mother's Age | n | Mean | Std.Dev. | Rank Mean | $X^2$ | df | p | $n^2$ |
|---|---|---|---|---|---|---|---|---|---|
| Physical spontaneity | Less than 30 years old | 29 | 17.24 | 3.16 | 96.95 | | | | |
| | 30-39-years-old | 136 | 16.99 | 3.12 | 88.53 | 1.331 | 2 | .514 | --- |
| | More than 40 years old | 16 | 17.50 | 3.14 | 101.19 | | | | |
| Social spontaneity | Less than 30 years old | 29 | 19.76 | 4.37 | 78.69 | | | | |
| | 30-39-years-old | 136 | 21.03 | 3.37 | 91.43 | 3.689 | 2 | .158 | --- |
| | More than 40 years old | 16 | 22.13 | 3.26 | 109.63 | | | | |
| Cognitive spontaneity | Less than 30 years old | 29 | 15.00 | 3.25 | 93.41 | | | | |
| | 30-39-years-old | 136 | 14.90 | 2.91 | 90.43 | .080 | 2 | .961 | --- |
| | More than 40 years old | 16 | 14.88 | 3.52 | 91.50 | | | | |
| Manifest joy | Less than 30 years old | 29 | 20.52 | 4.06 | 87.07 | | | | |
| | 30-39-years-old | 136 | 21.00 | 3.39 | 91.37 | .268 | 2 | .875 | --- |
| | More than 40 years old | 16 | 21.13 | 3.76 | 95.00 | | | | |
| Sense of humor | Less than 30 years old | 29 | 19.76 | 5.10 | 93.22 | | | | |
| | 30-39-years-old | 136 | 19.79 | 3.96 | 90.17 | .141 | 2 | .932 | --- |
| | More than 40 years old | 16 | 19.56 | 5.59 | 94.00 | | | | |
| Overall playfulness score | Less than 30 years old | 29 | 92.28 | 18.16 | 89.16 | | | | |
| | 30-39-years-old | 136 | 93.70 | 14.52 | 90.53 | .362 | 2 | .835 | --- |
| | More than 40 years old | 16 | 95.19 | 17.46 | 98.34 | | | | |

*p<.05

According to Table 8, the difference on physical spontaneity ($X^2_{(2)}$=1.331; p>.05), social spontaneity ($X^2_{(2)}$=3.689; p>.05), cognitive spontaneity ($X^2_{(2)}$=.080; p>.05), manifest joy ($X^2_{(2)}$=.268; p>.05), and sense of humor ($X^2_{(2)}$=.141; p>.05) levels of the children were observed to be insignificant according to the age of the mother. Similarly, pre-school children's overall playfulness scores did not show a significant difference according to the mother's age ($X^2_{(2)}$=.362; p>.05). In other words, the playfulness of the children whose mother are younger than 30-years-old, 30-39-years-old, or older than 40-years-old were similar both in overall and in all sub-dimensions.

The scores of the playfulness of the children participating in the research according to their father's age did not exhibit normal distribution, therefore Kruskal Wallis test was used in the comparison. The results are shown in Table 9a, and Table 9b.

**Table 9a.** Kruskal Wallis test results for pre-school children's playfulness according to father's age

| Scale | Father's Age | n | Mean | Std.Dev. | Rank Mean | $X^2$ | df | p | $n^2$ |
|---|---|---|---|---|---|---|---|---|---|
| Physical spontaneity | Less than 30 years old | 14 | 16.79 | 3.24 | 87.68 | | | | |
| | 30-39-years-old | 136 | 17.03 | 3.15 | 90.09 | .454 | 2 | .797 | --- |
| | More than 40 years old | 31 | 17.39 | 3.01 | 96.48 | | | | |
| Social spontaneity | Less than 30 years old | 14 | 20.00 | 4.19 | 80.18 | | | | |
| | 30-39-years-old | 136 | 20.86 | 3.52 | 89.68 | 2.002 | 2 | .368 | --- |
| | More than 40 years old | 31 | 21.61 | 3.49 | 101.68 | | | | |
| Cognitive spontaneity | Less than 30 years old | 14 | 15.57 | 3.61 | 101.64 | | | | |
| | 30-39-years-old | 136 | 14.75 | 2.85 | 88.65 | 1.209 | 2 | .546 | --- |
| | More than 40 years old | 31 | 15.32 | 3.36 | 96.50 | | | | |

**Table 9b.** Kruskal Wallis test results for pre-school children's playfulness according to father's age

| Scale | Father's Age | n | Mean | Std.Dev. | Rank Mean | $X^2$ | df | p | $n^2$ |
|---|---|---|---|---|---|---|---|---|---|
| | Less than 30 years old | 14 | 19.93 | 3.73 | 76.36 | | | | |
| Manifest joy | 30-39-years-old | 136 | 21.03 | 3.53 | 92.39 | 1.214 | 2 | .545 | --- |
| | More than 40 years old | 31 | 20.97 | 3.45 | 91.53 | | | | |
| Sense of humor | Less than 30 years old | 14 | 19.71 | 5.09 | 91.32 | | | | |
| | 30-39-years-old | 136 | 19.71 | 4.15 | 89.79 | .380 | 2 | .827 | --- |
| | More than 40 years old | 31 | 20.03 | 4.66 | 96.16 | | | | |
| Overall playfulness score | Less than 30 years old | 14 | 92.00 | 18.31 | 88.50 | | | | |
| | 30-39-years-old | 136 | 93.38 | 15.01 | 89.74 | .612 | 2 | .736 | --- |
| | More than 40 years old | 31 | 95.32 | 15.74 | 97.66 | | | | |

*p<.05

The playfulness of pre-school children according to the education level of the mother was tested for normality and homogeneity of variances (by Levene test). After determining that the assumptions are met, one-way analysis of variance (ANOVA) was performed for comparison and the results are shown in Table 10.

**Table 10.** ANOVA analysis results for pre-school children's playfulness according to mother's education

| Scale | Mother's Education Level | n | Mean | Std.Dev. | F | df | p | $n^2$ |
|---|---|---|---|---|---|---|---|---|
| Physical spontaneity | Less than high school | 50 | 17.00 | 3.12 | | | | |
| | High school | 89 | 17.15 | 3.04 | .049 | 2 | .952 | --- |
| | University and more | 42 | 17.00 | 3.34 | | 180 | | |
| Social spontaneity | Less than high school | 50 | 20.72 | 3.42 | | | | |
| | High school | 89 | 21.08 | 3.75 | .177 | 2 | .838 | --- |
| | University and more | 42 | 20.83 | 3.39 | | 180 | | |
| Cognitive spontaneity | Less than high school | 50 | 15.08 | 3.22 | | | | |
| | High school | 89 | 14.87 | 3.07 | .112 | 2 | .894 | --- |
| | University and more | 42 | 14.81 | 2.62 | | 180 | | |
| | Less than high school | 50 | 20.56 | 3.58 | | | | |
| Manifest joy | High school | 89 | 21.03 | 3.49 | .406 | 2 | .667 | --- |
| | University and more | 42 | 21.17 | 3.57 | | 180 | | |
| Sense of humor | Less than high school | 50 | 19.20 | 4.27 | | | | |
| | High school | 89 | 20.02 | 4.21 | .605 | 2 | .547 | --- |
| | University and more | 42 | 19.88 | 4.53 | | 180 | | |
| Overall playfulness score | Less than high school | 50 | 92.56 | 15.03 | | | | |
| | High school | 89 | 94.15 | 15.70 | .170 | 2 | .843 | --- |
| | University and more | 42 | 93.69 | 15.22 | | 180 | | |

*p<.05

According to Table 10, the difference on physical spontaneity ($F_{(2,180)}$=.049; p>.05), social spontaneity ($F_{(2,180)}$=.177; p>.05), cognitive spontaneity ($F_{(2,180)}$=.112; p>.05), manifest joy ($F_{(2,180)}$=.406; p>.05), and sense of humor ($F_{(2,180)}$=.605; p>.05) levels of the children were observed to be insignificant according to the education of the mother. Similarly, pre-school children's overall playfulness scores did not show a significant difference according to mother's education ($F_{(2,180)}$=.170; p>.05). In other words, the playfulness of the children whose mother are graduated from primary-secondary school, high school or university were similar both in overall and in all sub-dimensions.

The playfulness of pre-school children according to the education level of the father was found to show normal distribution and to have homogeneous variances (by Levene test). Therefore, one-way analysis of variance (ANOVA) was performed for comparison and the results are shown in Table 11.

**Table 11.** ANOVA analysis results for pre-school children's playfulness according to father's education

| Scale | Father's Education Level | n | Mean | Std.Dev. | F | df | p | $n^2$ |
|---|---|---|---|---|---|---|---|---|
| Physical spontaneity | Less than high school | 47 | 16.98 | 3.46 | | | | |
| | High school | 98 | 17.31 | 2.62 | .789 | 2 | .456 | --- |
| | University and more | 36 | 16.56 | 3.85 | | 180 | | |
| Social spontaneity | Less than high school | 47 | 20.60 | 3.81 | | | | |
| | High school | 98 | 21.14 | 3.46 | .424 | 2 | .655 | --- |
| | University and more | 36 | 20.75 | 3.57 | | 180 | | |
| Cognitive spontaneity | Less than high school | 47 | 15.21 | 3.36 | | | | |
| | High school | 98 | 14.94 | 2.97 | .674 | 2 | .511 | --- |
| | University and more | 36 | 14.44 | 2.60 | | 180 | | |
| | Less than high school | 47 | 20.53 | 3.70 | | | | |
| Manifest joy | High school | 98 | 21.15 | 3.28 | .501 | 2 | .607 | --- |
| | University and more | 36 | 20.86 | 3.95 | | 180 | | |
| Sense of humor | Less than high school | 47 | 19.38 | 4.27 | | | | |
| | High school | 98 | 19.76 | 4.21 | .440 | 2 | .645 | --- |
| | University and more | 36 | 20.28 | 4.61 | | 180 | | |
| Overall playfulness | Less than high school | 47 | 92.70 | 16.38 | | | | |
| score | High school | 98 | 94.30 | 14.44 | .218 | 2 | .804 | --- |
| | University and more | 36 | 92.89 | 16.64 | | 180 | | |

*p<.05

According to Table 11, the difference on physical spontaneity ($F_{(2,180)}$=.789; p>.05), social spontaneity ($F_{(2,180)}$=.424; p>.05), cognitive spontaneity ($F_{(2,180)}$=.674; p>.05), manifest joy ($F_{(2,180)}$=.501; p>.05), and sense of humor ($F_{(2,180)}$=.440; p>.05) levels of the children were observed to be insignificant according to the education of the father. Similarly, pre-school children's overall playfulness scores did not show a significant difference according to father's education ($F_{(2,180)}$=.218; p>.05). In other words, the playfulness of the children whose fathers are graduated from primary-secondary school, high school or university was similar both in overall and in all sub-dimensions.

Since the playfulness scores of pre-school children participating in the research according to their mother's working status showed normal distribution, t-test was used in the comparison of the related measurements, and the results are shown in Table 12.

**Table 12.** Independent t-test results for pre-school children's playfulness according to mother's working status

| Scale | Mother's working status | n | Mean | Std.Dev. | t | df | p | d' |
|---|---|---|---|---|---|---|---|---|
| Physical spontaneity | Not-working | 126 | 17.13 | 3.05 | | | | |
| | Working | 55 | 16.95 | 3.30 | .359 | 179 | .720 | --- |
| Social spontaneity | Not-working | 126 | 20.83 | 3.42 | | | | |
| | Working | 55 | 21.15 | 3.89 | .554 | 179 | .580 | --- |
| Cognitive spontaneity | Not-working | 126 | 14.70 | 3.01 | | | | |
| | Working | 55 | 15.40 | 2.95 | 1.450 | 179 | .149 | --- |
| Manifest joy | Not-working | 126 | 20.93 | 3.54 | | | | |
| | Working | 55 | 20.95 | 3.51 | .030 | 179 | .976 | --- |
| Sense of humor | Not-working | 126 | 19.54 | 4.28 | | | | |
| | Working | 55 | 20.27 | 4.32 | 1.057 | 179 | .292 | --- |
| Overall playfulness score | Not-working | 126 | 93.12 | 14.98 | | | | |
| | Working | 55 | 94.71 | 16.22 | .640 | 179 | .523 | --- |

*p<.05

The working areas of the mothers who participated in the study varied too much, thus the working status of mothers were evaluated in two categories as working and not-working. According to Table 12, the difference on physical spontaneity ($t_{(179)}$=.359; p>.05), social spontaneity ($t_{(179)}$=.559; p>.05), cognitive spontaneity ($t_{(179)}$=1.450; p>.05), manifest joy ($t_{(179)}$=.030; p>.05), and sense of humor

($t_{(179)}$=1.057; p>.05) levels of the children were observed to be insignificant according to the working status of the mother. Similarly, pre-school children's overall playfulness scores did not show a significant difference according to mother's working status ($t_{(179)}$=.640; p>.05). In other words, the playfulness of the children whose mother are working or not working were similar both in overall and in all sub-dimensions.

The playfulness of pre-school children according to the profession of their father was analyzed. Since the father of 1.7% (n=3) of the children who participated in the study were unemployed, the comparison was made for 177 children whose father were working. The playfulness score of the children according to the profession of the father was found to show normal distribution and to have homogeneous variances (by Levene test). Therefore, one-way analysis of variance (ANOVA) was performed for comparison and the results are shown in Table 13.

**Table 13.** Independent t-test results for pre-school children's playfulness according to father's profession

| Scale | Father's profession | n | Mean | Std.Dev. | F | df | p | $n^2$ |
|---|---|---|---|---|---|---|---|---|
| Physical spontaneity | Civil servant | 25 | 16.96 | 3.23 | | | | |
| | Worker | 85 | 16.91 | 3.43 | .454 | 2 | .636 | --- |
| | Self-employed | 67 | 17.37 | 2.53 | | 180 | | |
| Social spontaneity | Civil servant | 25 | 20.84 | 3.48 | | | | |
| | Worker | 85 | 20.80 | 3.74 | .205 | 2 | .815 | --- |
| | Self-employed | 67 | 21.16 | 3.43 | | 180 | | |
| Cognitive spontaneity | Civil servant | 25 | 14.44 | 2.18 | | | | |
| | Worker | 85 | 14.87 | 3.25 | .469 | 2 | .626 | --- |
| | Self-employed | 67 | 15.12 | 2.99 | | 180 | | |
| Manifest joy | Civil servant | 25 | 20.56 | 3.76 | | | | |
| | Worker | 85 | 20.85 | 3.68 | .468 | 2 | .627 | --- |
| | Self-employed | 67 | 21.27 | 3.15 | | 180 | | |
| Sense of humor | Civil servant | 25 | 19.60 | 4.36 | | | | |
| | Worker | 85 | 19.49 | 4.55 | .513 | 2 | .599 | --- |
| | Self-employed | 67 | 20.19 | 4.02 | | 180 | | |
| Overall playfulness score | Civil servant | 25 | 92.40 | 14.47 | | | | |
| | Worker | 85 | 92.92 | 16.41 | .486 | 2 | .616 | --- |
| | Self-employed | 67 | 95.12 | 14.22 | | 180 | | |

*p<.05

According to Table 13, the difference on physical spontaneity ($F_{(2,180)}$=.454; p>.05), social spontaneity ($F_{(2,180)}$=.205; p>.05), cognitive spontaneity ($F_{(2,180)}$=.469; p>.05), manifest joy ($F_{(2,180)}$=.468; p>.05), and sense of humor ($F_{(2,180)}$=.513; p>.05) levels of the children were observed to be insignificant according to the profession of the father. Similarly, pre-school children's overall playfulness scores did not show a significant difference according to father's profession ($F_{(2,180)}$=.486; p>.05). In other words, the playfulness of the children whose father are civil servant, worker or self-employed were similar both in overall and in all sub-dimensions.

## DISCUSSION and CONCLUSION

Current research aimed to discover children's playfulness level in Turkey and the variables affecting playfulness level. It was concluded that the playfulness level of the children participating in the study was high. Regarding the variables, the playfulness level of the children attending pre-school education for 2 years or more were found to be higher than children received 1 year education; the playfulness level of 5-years-old children were found to be higher than 4-years-old ones in some sub-dimensions, although it didn't create a significant difference in overall score. Other variables did not make a significant difference in the playfulness levels of the children. These results were discussed through the relevant literature to identify the implications for pre-school educators.

In the study, the playfulness levels of the children were observed to be high both in overall (M = 4.1) and in all sub-dimensions. Regarding the ranking of the scores, physical spontaneity dimension was observed to have the highest average score, whereas cognitive spontaneity dimension had lowest score. In similar studies, the playfulness levels of children were found to be high (Keleş & Yurt, 2017; Zachopoulou, Trevlas, & Tsikriki, 2004), the highest average score was observed in physical spontaneity dimension (Barnet, 1990. 1991a; Zachopoulou, Trevlas, & Tsikriki, 2004), and cognitive spontaneity had lower average score than other dimensions (Keleş & Yurt, 2017; Macun & Güvendi, 2019; Zachopoulou, Trevlas, & Tsikriki, 2004). Physical spontaneity is one of the basic features of pre-school children who express their emotions through movement (Zachopoulou, Trevlas, & Tsikriki, 2004). Children show this feature in the game activity that requires the most movement. Therefore, high levels of playfulness in physical spontaneity can be considered as an expected result.

In the research, the overall playfulness of the children was analyzed according the certain variables and playfulness levels of the children were found to be similar for both 4- and 5-years-old ones. Similarly, Pinchover (2017) concluded that there is no direct relationship between playfulness and children's age, and playfulness level of children is similar. Regarding the sub-dimensions of playfulness in the study, the playfulness levels of 5-years-old children was observed to be significantly higher than 4-years-old ones in terms of physical spontaneity, social spontaneity and cognitive spontaneity. In the study in which Macun and Güvendi (2019) examined the playfulness levels of pre-school children, the playfulness levels of children were found to differ in favor of 5-year-old children in overall and in the sub-dimensions. Barnet (1991b), reported that social spontaneity and cognitive spontaneity levels of children increased with age. With the increase in the age of the children, their skills develop, and children become more conscious regarding playing and winning (Howard, 2002). Therefore, an increase in playfulness level can be observed with age. However, Saunders, Sayer, and Goodale (1999) found that younger children had higher average playfulness score. The reason for this difference in the results of the studies may be the experience that 5-years-old children have gained in terms of playfulness skills. Experiencing playfulness and sense of humor at a young age, allows children to communicate with others and to show playfulness behaviors at later ages (Youell, 2008).

The gender variable, whose effect has been widely investigated in studies on playfulness, did not create a significant difference on the playfulness levels of children in the current study. While some studies show that gender is a significant factor on children's playfulness levels (Barnett, 1991b; Cornelli Sanderson, 2010; Saunders, Sayer, & Goodale, 1999; Tae-Hyung, Tae-Hyun, & Jae-Shin, 2014; Zachopoulou, Trevlas, & Tsikriki, 2004), some studies concluded that it has no effect (Keleş & Yurt, 2017; Macun & Güvendi, 2019; Rentzou, 2013). The fact that gender has no effect on the playfulness levels of children shows that playfulness is a personality trait (Howard, Bellin, & Rees, 2002; Rentzou, 2013). However, regarding the average scores that children got from the sub-dimensions, the girls were observed to have higher averages than boys in all dimensions, except physical spontaneity. Similar studies also found that boys had a higher average than girls in the physical spontaneity subdimension of playfulness (Barnett, 1991b; Tae-Hyung, Tae-Hyun, & Jae-Shin, 2014; Zachopoulou, Trevlas, & Tsikriki, 2004). Preferring more active games (Fabes, Martin, & Hanish, 2003) and being physically more active than girls (Choi & Hyun, 2004) can be considered as a factor for boys having higher scores in physical spontaneity.

Another variable that makes a significant difference on the playfulness levels of the children is the duration of attending a pre-school education institution. The playfulness levels of children who attended pre-school education for two years or more (22.01 ± 3.30) were higher than the children who attended 1 year or less (20.27 ± 3.50) ($p < .05$). In their research, Kapıkıran, İvrendi, and Adak (2006) found that children's social skill behaviors develop positively as school attendance time increases. Pre-school education offers children the opportunity to play with their friends. Children playing with their friends in school environment regulate their behavior towards other children. Play tools in schools also satisfy the needs of children (Brewer & Kieff, 1996). School experience at an early age

shows that children's behavior is affected by classroom experiences (Howard, Jenvey, & Hill, 2006). In the study, children's school experiences were found to create a positive effect on their playfulness levels.

In the study, the number of children in the family was observed to be insignificant on children's playfulness level. Regarding the differences in the sub-dimensions of the scale, the average scores were observed to be close to each other, which led to the conclusion that the playfulness levels of children with different number of siblings are similar. Similarly, Macun and Güvendi (2019) concluded that the number of siblings did not make a significant difference on the playfulness level of the children. In the research examining children's play behaviors, Öztürk and Ahmetoğlu (2018) revealed that the number of siblings was not effective on the play behaviors. However, in some studies, it was concluded that the number of siblings caused differences in some sub-dimensions of the scale (Keleş & Yurt, 2017; Rentzou, 2013). The reason of these differences in the research results may be due to the age or gender difference of the siblings. In their studies examining the effect of the gender on children's playmate selection, Alexander and Hines (1994) found that children tend to choose playmates of the same sex. Moreover, the age differences between siblings can create differences on children's play skills (Youngblade & Dunn, 1995). While pre-school children mostly prefer to play imaginary and symbolic games, they switch to play regular games in primary school (Aksoy, 2014). Game preferences that differ with age can also change the level of sibling exposure.

Other variables addressed in the study (age, education level, working status of the mother and profession of the father) did not create significant differences in children's playfulness levels. Similarly, in the study of Macun and Güvendi (2019), education level and working status of the mothers/fathers were not found to be effective on the playfulness levels of the children. In the study examining children's play behaviors Camgöz (2010) concluded that the education level and professional status of the parents have not created a significant difference. However, Öztürk and Ahmetoğlu (2018) reported that the education level of the father had an effect on the children's play behavior, while the age of the parents and the education level of the mother had no effect on the children's play behavior. The differentiation of the study results according to family variables suggests that different characteristics of the families may have different effects on the playfulness level of the children. Alessandri (1992) observed that mothers who had experienced negative situations in the past, had negative communication with their children while playing games. John, Halliburton, & Humphrey (2012) reported that while playing with children, mothers tend to engage in empathic conversations and teaching, while fathers tend to engage in physical play, act like they are in their child's age, and follow the child's play. Karaca, Gündüz, and Aral (2011) discovered that age and education levels of families have an impact on children's positive social behavior. To better understand the effect of the parents on the child's playfulness level, the correlations between the characteristics of the families and the playfulness levels of the children should be further examined in future researches.

**Conclusion**

The playfulness levels of the children in pre-school period provide important information to educators. Knowledge of play and playfulness, which are among the basic elements of pre-school education, allows to understand children's play worlds and support the essence of playfulness by freeing them (Singer, 2015). Understanding children's perceptions of play and playfulness approach allows to transfer the play into classroom activities and integrate them into other activities (Howard, Bellin, & Rees, 2002). In the study, the high playfulness levels of the children indicate that they intrinsically have a playful mood (Young, 2008). The increase in children's ages and duration of pre-school education make a positive difference on their playfulness levels, which shows that receiving pre-school education from an early age will support children intrinsic playfulness feelings. In addition, the lack of significant differences according to other variables revealed that children's playfulness levels were based on internal emotions rather than external factors.

**Limitations of the Study and Suggestions for Future Research**

This study which has been carried out on children attending pre-school education institutions, has expanded the scope of researches on children's playfulness level in Turkey. However, the study has some limitations. Data were collected from 181 participants, who were attending a pre-school educational institution in a province of Turkey. It should be considered that children's playfulness may vary according to cultural differences or demographic characteristics of the participants. Considering that the participants were from similar environments, it should be considered that there may be differences in the playfulness levels of the children living under different conditions. In addition, the results should be supported and confirmed by other researches because it is one of the few studies addressing the playfulness level of pre-school children in Turkey.

For future researches, conducting empirical studies in Turkey on different sample groups, in which playing behavior of the children are also observed, is very important. In addition, it is suggested to conduct longitudinal studies to better understand the change of children's playfulness according to age and school attendance; and investigate parents and teachers' attitudes by using interview and observation methods to better understand the effect of the number of children in the family and the characteristics of the parents as well as teachers (e.g. Carter, 1993; Pinchover, 2017; Trawick-Smith, & Dziurgot, 2010) on children's playfulness levels.

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IOJPE

ISSN: 1300 – 915X
www.iojpe.org

*International Online Journal of Primary Education* *2021, volume 10, issue 1*

# EFFECTS OF PERFORMANCE RANKING ON STUDENTS' VOICE AND AGENCY IN THE MATHEMATICS CLASSROOM

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**Received:** February 25, 2021 **Accepted:** April 06, 2021 **Published:** June 30, 2021

**Suggested Citation:**
Njiru, S. M., & Karuku, S. (2021). Effects of performance ranking on students' voice and agency in the mathematics classroom. International Online Journal of Primary Education (IOJPE), 10(1), 137-147.



**Abstract**

The modalities of performance ranking in high stakes testing to a greater extent affect Mathematics teaching and learning. While performance ranking has the potential of being a critical catalyst in the process of making Mathematics classrooms a place of positive competition, it fails to balance the most crucial aspects in Mathematics discourses-the voice and agency of teachers and students. The proactive engagement of all students and teachers equitably with the process of Mathematics teaching and learning is a necessary condition for ensuring excellent students Mathematics learning outcomes. The purpose of the study was to investigate the effects of performance ranking on voice and agency in Mathematics teaching and learning in secondary schools in Embu, Kenya. The study employed a qualitative research approach. Six teachers and eight students were randomly sampled for interviews, while three teachers and eighteen students were engaged in focus group discussions. The data analyzed demonstrated that top ranked students become powerful independent learners who are capable of critiquing work presented to them by their teachers while low ranked students are guided as to whom to seek help from by the performance ranking data. This paper recommends that performance ranking should be used as a tool to give students voice and agency by ranking students on the basis of marks scored on continuous assessment tests, students' entry mark and value addition.

**Keywords**: Performance ranking, mathematics, teaching, learning, voice, agency.

## INTRODUCTION

Performance rankings in education have been a common feature all over the world. The government and the news agencies of particular countries obtain and publish the rankings data in an attempt to compare the relative performance of individual students (or schools) based on academic performance (Ball, 2009, Hazelkorn, 2008; Leckie & Goldstein, 2019; Wilson & Piebalga, 2008). At the school level, the rankings are at times published on school notice boards to compare the relative performance of individual students in the same grade or the relative performance of sections (streams) in a given grade.

Performance rankings are intended to serve several purposes for students, parents, teachers, school administrators, policy makers, and politicians. To some, performance rankings are a mechanism for providing feedback to those who provide resources to run the schools on those schools that are doing well and those that require intervention. The rankings also enable parents make informed choices about schools for their children, since such rankings provide a basis for making comparisons. The rankings thus increase the transparency and the quality of educational processes, thus contributing to academic excellence (Neves, Pereira, & Nata, 2014). They can also induce organizational changes in schools that are underperforming (Neves, Pereira, & Nata, 2014) by borrowing the educational practices and policies of the top-performing schools, or by performing a root cause analysis to uncover

root causes for underperformance and correct deficiencies. They also provide incentives for behavioral change by stimulating inter-school or inter-student competition.

Critics of performance rankings have several reservations. To begin with is the fact that though performance rankings tend to change behavior positively, they are deleterious to the education process. The rankings lead to having important areas in the syllabus ignored following the excessive focus on improving the rank positions in the league tables.Thus, for example, there is evidence that performance rankings encourage unethical practices such as grade inflation and exclusion of students who would drag down the overall performance score of the school (Neves, Pereira, & Nata, 2014) to the detriment of student choice. These practices, which are exacerbated by the publication of school rankings, ultimately lead to growing disparities between schools. To be sure, there is a fundamental distinction between public and private schools in their ability to choose their own students and in the kind of incentives they may get from responding to market pressures. Private schools are particularly more subject to market pressures than public schools, and this may contribute to their temptation to engage in 'gaming' to improve their ranking. As a result, performance rankings have been criticized for sustaining a hierarchy of power and interests that favor established interests (Kell & Kell, 2014; Neves, Pereira, & Nata, 2014). Schools at the bottom of the rank in the school league tables attract below average students and in experienced theachers, as the best performing schools siphon the above average students and experienced teachers. Under these circumstances, rankings can be seen as a contributing factor to affirming social division, negating the redistribution of resources designed to redress inequity and social injustices (Kell & Kell, 2014)

Secondly, the validity and reliability of performance rankings have been put into question, owing to the embedded methodological and philosophical shortcomings. In particular, the rankings have been criticized for promoting unfair competition (for example, between public and private schools, or between schools and/or students from different socioeconomic backgrounds) and, therefore, reinforcing the existing inequalities. Performance rankings have also been criticized for glorifying examination results at the expense of the authentic goals of education. Indeed, performance rankings are said to use simplistic outputs as proxies for school quality, whereby the notion of efficiency is seen as unproblematic, and methods are considered to be ideology-free. For example, league tables do not consider the school's context, as some serve the underprivileged students population doubling their functions. In addition to providing good education they ensure students health is taken care of through provision of well balanced diet. This impact negatively on the time and energy such schools can dedicate to improvement of academic performance of students (Neves, Pereira, & Nata, 2014). Therefore, the low ranked schools are stigmatized and their image in the public domain is often irreversibly damaged. Instead of channeling resources to the low ranked schools for improvement purposes the low performance is often accompanied by more punitive measures, more monitoring and diminished resources. Such schools find themselves subject to uncertainty around government support and are threatened with closure (Kell & Kell, 2014).

A number of methodologies for performance rankings for schools exist; some compare school average scores, derived from students' aggregate scores in high-stakes standardized tests. Others compare schools using value-added measures of school performance, which is a measure of the progress made by an individual student or a group of students in comparison to the average progress made by similar students nationally between key stages. Still others compare schools using contextualized value-added scores, which in addition to controlling for students' prior attainment at earlier key stages, factors in a wide range of non-school factors associated students' progress such as age, gender, special educational needs, and ethnicity (Foley & Goldstein, 2012; Leckie & Goldstein, 2019).

This paper focuses on an aspect of performance rankings that is rarely considered in the literature; namely, the effect of performance rankings on students' voice and agency. Whereas the notions of voice and agency have been central to the scholarship on classroom discourse processes and participatory structures that empower learners to engage in more authentic learning (Cook-Sather, 2006; Nel, 2017; van Lier, 2008), the relationship between performance rankings, on the one hand,

and students' voice and agency, on the other has been under-researched. Cook-Sather (2006) defines voice as "having presence, power and agency, the opportunity to speak one's mind, be heard and perhaps have an influence on outcomes" (p. 5). Agency on the other hand is, according to Van Lier (2008), the ability to control one's behavior, to engage in behavior that affects other entities and the self and to produce actions that can be evaluated (p. 172). In the teaching-learning contexts, agency is an action taken by a student in controlling classroom discourse on their behalf and on behalf of other students (Nel, 2017). Hence, students' voice and agency have an emancipatory role in the classroom as they empower students to be actively engaged in the classroom discourse (Khuzwayo & Bansilal, 2012). It is thus critical for teachers to tailor their pedagogical strategies in a manner that support students' development of voice and agency in the classroom (Morgan, 2016). This can help in development of positive attitudes by students, leading to good academic performance.

Regardless of the positive effects studies have shown that, performance ranking can have several negative effects on teaching and learning. For instance, it can lead to the introduction of inequity in the classroom through the use of instructional strategies that favour or promote voice of one student over another. The favoured sections of students often perceive the classroom as being places for positive competitions, while the other section finds it as a place of discrimination (Bicknell & Riley, 2012). On the other hand, a student agency can act as an incentive or a deterrent depending on the student's position in performance rankings (Wilkins, 2012). This paper seeks to demonstrate that students are socialized to demonstrate agency and voice in ways that resonate with their position in performance rankings. The next section reviews the literature related to performance rankings as they related to voice and agency in the classroom.

**Literature Review**

Critics of performance rankings have argued that the rankings promote educational inequalities as some schools are viewed as better than others. This is because the rankings, though certainly not perfect, are appropriate mechanisms for picking among thousands of schools and determining learning options for children that are most in line with an individual's wants and needs. For example, rankings build an institutional reputation by providing a list of top public and private schools in the country (Hazelkorn, 2008). In this respect, prospective students and their parents identify their school of choice based on the quality of academics, resources available, future career opportunities, and even school popularity and reputation. Therefore, publication of performance ranking data may lead to schools that are perceived to be doing well to enjoy the privilege of attracting students of high levels of ability while those perceived to be doing badly attracting low achieving students (Kellaghan, 1996). It may also lead to the transfer of more able teachers, lower morale in individual schools and create a big achievement gap between secondary schools. Although Burgess, Propper and Wilson (2002) argue that, provision of information on school performance is a pre-requisite for informed parental choice, OECD (2012) observe that, where parents with social and/or economic advantage are encouraged to support schools with good results, morale and performance in poorer performing schools can be affected negatively.

Secondly, performance ranking builds the capabilities and confidence in top ranked teachers to autonomously plan their teaching in response to learner's abilities (Batra, 2005). According to Andersson and Norén (2011), any practice in teaching and learning worthy of its name should contribute to processes of subjectification that allow the teachers to become more autonomous and independent in their thinking. Their decisions are embraced by the school administrators because they have confidence in them. Being an incentive to them it encourages positive competition in that low ranked teachers design their instructional techniques in order to obtain the top rank to enjoy teacher agency in teaching. The dissemination of ranking data creates competition among teachers which in turn motivate them to design their instructional practices for students' learning (Chapman & Synder, 2000). Thus, performance ranking may help to raise academic standards, provide feedback on the teacher's effectiveness in teaching and student achievement. It also communicates to the students, parents and others what has been taught (Amunga, Amadalo, & Maiyo, 2010).

Further, performance ranking puts the Mathematics students at the center of Mathematics discussions so as to obtain the top rank as opposed to the traditional Mathematics classrooms which was the domain of the teacher (Khuzwayo & Bansilal, 2012). In the traditional classrooms the teacher decides the content and pedagogical strategies without involving the students. The picture changes when learners are granted voice and agency in Mathematics classrooms. Thus, students are provided with an opportunity to create their own knowledge and engage in strategic as opposed to executive help seeking (Karabenick & Newman, 2013).

Finally, performance ranking in secondary schools is used in informing policymaking (Downes, Vindurampulle & Victoria, 2007). For example, performance ranking data is utilized in the identification of schools and students whose achievements are below average. High performing schools can be used for benchmarking purposes and remedial efforts geared towards schools and students who are struggling in terms of education gains. Further, the practice points out the areas the schools are performing below expectations hence helps to direct resources in the schools affected to ensure they are not left behind as far as education matters are concerned.

Opponents of performance ranking observe that it invites top ranked students voice at the expense of the low ranked ones in Mathematics classrooms (Morrison, 2008). Students at the bottom of the rank are viewed as weak and lazy by both students and teachers despite the effort they put in their studies (Dunne, Humphreys, Sebba, Dyson, Gellannaugh, & Muijis, 2007). The class disrespect could lead to teachers losing control of the classroom discourse. Besides losing control of the class, teachers fear that top ranked students will not only take over learning but also deny the low ranked students' opportunities of contributing ideas in the Mathematics classroom discourse (White, 2003). Moreover, performance ranking invites the top ranked student's dominancy in Mathematics lessons making them ill prepared for the real world where they should learn to accommodate the will of others seeing their needs going unmet (Morrison, 2008).

An additional constraint of performance ranking is the conventional system of ranking used in internal and national examinations. The methodology of ranking which employs student's raw scores is blind to issues such as the socioeconomic conditions of the students, location of the schools and school management styles. Thus, deflect teachers and students from creating personal meaning towards teaching and learning instead focuses all their effort towards the incentives (Niesche & Keddie, 2016). In other words teachers may tailor their instructional strategies towards test taking skills in order to obtain a top rank because of the benefits associated with the top rank such as internal promotions. Such kind of performance orientation complicates teacher-teacher relationship in the department and in the institution at large. The low ranked teachers feel less powerful and act subserviently to avoid being reprimanded. The low ranked teachers' subservience manifests itself in not questioning or challenging the top ranked teachers' decisions (Morrison, 2008). Consequently, performance ranking renders many teachers voiceless in Mathematics matters and dependent on the top ranked ones.

**Purpose of the Study**

The purpose of this study was to investigate the effects of performance ranking on students and teachers voice and agency in teaching-learning process in secondary schools in Kenya in the participants' natural settings.

## METHOD

**Participants and Context of the Study**

The study adopted a qualitative approach and a case study design. Random sampling was used to select the schools to be in the study. Mathematics students were chosen because they are directly affected by performance ranking as far as voice and agency is concerned. Teachers were chosen because they are key to major decisions as per the performance ranking outcomes.

The study was carried out in Kenya. There are forty seven counties in Kenya and in each county there two major categories of secondary schools namely; public and private. Public schools are further categorized into four groups depending on students performance and learning resources available ( Makori, Onyura, Cheboiwo, Yegon, & Kandie, 2015) namely; National, Extra County, County and Sub-County schools. The study was carried out in secondary schools in Embu County which has two National, fourteen Extra County, twenty two County, one hundred and forty eight Sub-County and eight private schools. Study participants were nine Mathematics teachers and twenty six students from seven public and two private secondary schools in Embu County, Kenya.

**Data Collection and Data Analysis**

Multiple data collection methods were employed in this study namely; face to face semi-structured interviews, focus group discussions and document analysis. Multiple data collection methods was for triangulation purposes in order to ensure credibility and validity of the study findings (Plano Clark & Creswell, 2008). Six interviews and one focus group discussion lasting between 40 to 60 minutes were conducted with Mathematics teachers while eight interviews and three focus group discussions lasting between 30 to 40 minutes were conducted with student-participants. The interviews were audio recorded, transcribed and subjected to qualitative data analysis (Suter, 2012). Further, schools ranking data, students group organization record and teacher duties and responsibilities record documents were carefully read and re-read to trace the position in the performance data of those in leadership positions (O'Leary, 2014). The study participants were guaranteed anonymity and quotations from the interviews reported accordingly (Sim & Waterfield, 2019).

## FINDINGS and DISCUSSION

The interviews and focus group discussions focused on a range of topics, from the methodology of performance rankings, to their effects on voice and agency in Mathematics teaching and learning. In brief four major themes emerged from the analysis of the interviews, focus group discussions and document analysis: while (1) performance rankings are popular in guiding resources allocation to students, (2) the ranking data guides in selection students' group leaders since they need to be at the forefront in Mathematics learning. In addition, (3) performance ranking has greater influence on teacher promotion. Finally, (4) performance ranking present data that can be used to identify successful and unsuccessful Mathematics classes hence provides opportunities for benchmarking.

**Allocation of Mathematics Revision Resources**

Teaching and learning resources provide students with curiosity and independence in Mathematics classrooms (Kartika, 2018). The independence encourages arguments and disagreements in Mathematics classrooms providing learners with opportunities to increase understanding of the subject matter. Studies have shown that inadequate teaching and learning resources in secondary schools are the cause of poor performance (Kaimenyi, 2013). According to Kaimenyi (2013), in classrooms where the resources are adequate, students scored higher than in those classes which lacked the resources. Therefore, the school management should ensure that the students have the necessary materials for learning and revision during examination preparations (Kimeu, Ronoh, & Tanui, 2015). Such materials include revision books, past papers, and sample examination papers.

While equitable provision of learning opportunities may seem to be an ultimate challenge, Mathematics teachers play a crucial role in creating appropriate learning environment for students through resources allocation. Through appropriate resource allocation strategies teachers can accomplish remarkable feats thus improving students' achievement in Mathematics. Performance ranking of students is among strategies teachers employ in the allocation of resources.

Out of the teachers interviewed majority had no particular modalities of allocating Mathematics resources. But even in the absence of any particular modalities, there are hints of problems in the practice. The top ranked students enjoyed the privilege of getting a lion's share in the resource allocation whiles those who were at the bottom of the rank missed out in the allocation.

> *In the allocation of Mathematics textbooks, there is no particular order because I share a textbook between two students. But the revision books are given, to the top students in Mathematics. If those at the bottom of the rank are given, they just keep them, and the rest of the students will not have an opportunity to use them. In situations when those at the bottom of the rank require the revision books, I give them, and I encourage them to share with the rest of the students (Form 1 Teacher in an Extra County school).*

The students interviewed had similar views to those of the teachers interviewed. In many occasions Mathematics teachers availed Mathematics revision books in the classroom and encouraged the top ranked students to pick them in order to score highly and support teachers' efforts in Mathematics teaching.

> *Mathematics revision resources are availed by the teacher and the best students in Mathematics pick them from the Mathematics teacher. The top students are generous with their knowledge and revision books. The majority of the students, especially the low achievers in Mathematics are against having revision books because they are afraid of losing them (Form 4 student in a Sub-County school).*

> *…top students have the best Mathematics revision books. Immediately they learn of availability of a new revision book they pester the Mathematics teacher to issue the book to them… (Students FGD in an Extra county school).*

Providing adequate Mathematics teaching and learning resources such as revision books to students at the top of the rank is a motivation for them to continue working hard to improve their rank. The practice encourages students' voice and agency in Mathematics learning. They enjoy the privilege of controlling all other students in the classroom during the Mathematics learning and group discussions.

Most importantly, students at the top of the rank are empowered in their learning through being able to access Mathematics revision materials leading to un-even allocation among the students. The lack of equity in the practice has a negative effect on Mathematics teaching and learning as the students at the bottom of the rank feel left out thereby developing negative attitudes towards Mathematics teachers and the subject (Mensah, Okyere, & Kuranchie, 2013).

**Influence of Performance Ranking in Selection of Leaders in Mathematics Classrooms**

In appointment of study group leaders, Mathematics teachers appoint group leaders considering their performance in Mathematics. The idea behind the practice is to give the students at the top of the rank agency in Mathematics classrooms in order to influence the other students to work hard. The move keeps students on their toes, which lead to a high concentration in Mathematics lesson translating to high scores in the subject.

> *In appointing study group leaders in Mathematics, I consider the performance of students in Mathematics. The one in charge of the group should be at the top of the other students in performance. This is because they have the command of the group and what they propose is taken very seriously by the rest of the members (Form 1 teacher in a private school).*

> *….When low achievers in Mathematics are appointed leaders in study groups, they often feel insecure and threatened when told to lead in groups which comprise top achievers in Mathematics. In case the Mathematics teacher insists, the students respond by withdrawing from participation or looking to the teacher to give legitimacy to their responses within groups due to lack of confidence( Form 2 teacher in a sub- County school).*

The appointment into a leadership position in the Mathematics classrooms was given to those students with leadership qualities. In most cases, students with leadership qualities were the ones at the top of the rank because they were confident and focused. The low achievers in most cases were shy and suffer from inferiority complex. Most importantly, the appointment was taken as a reward to the top achievers. In tandem with the study findings, World Bank (2001) observed that as a result of

performance ranking, the teachers and the school management are able to identify low performing students as well as those better performing which further guides them in the creation of study groups bearing in mind the differences in performance among the students.

Teachers have a belief that students at the top of the rank should have voice and agency in Mathematics learning thereby impart the spirit of working hard to other students. The result will be a formation of motivated teams in Mathematics learning, translating into high concentration in Mathematics lessons leading to an improvement of students' scores in the subject.

**Appointment/Promotion of Mathematics Teachers**

Internal appointments in the Mathematics department provide teachers with voice in Mathematics teaching. The policy guidelines on teacher appointment and promotion into administrative position puts into considerations on teacher academic and professional qualifications, students' performance in national examinations, participation in co-curricular activities and a teacher's professional conduct (Republic of Kenya, 2005). The promotion and appointments give teachers agency in teaching in various institutions.

Administrators use performance ranking in Mathematics in the appointment and promotion of Mathematics teachers. The Head of the Mathematics Department is required to be at the forefront in influencing the quality of Mathematics teaching among Mathematics teachers in the department. It is a challenge for a Head of Department to devote enough time and energy in preparation for their classes in addition to the administrative duties. The administrators promoted the hard-working Mathematics teacher to head the department as far as students mean score was concerned.

> *Sometimes, I wish I could just teach - there is so much administrative work in the Mathematics department, paperwork, and follow-up of discipline to do when you are ahead of the department in Mathematics. Teaching suffers on account of this. Therefore, in internal appointments in the department, performance ranking is considered to have the very committed head of the Mathematics department. This is because if his/her classes mean score is below those of other teachers somehow, the head of the department lacks the moral authority to monitor standards if his/her own is lacking in rigor (Form 3 teacher in a national school).*
>
> *…… teacher whose classes perform better in comparison to the others is usually given privilege in any appointments not necessarily in the Mathematics department. This is because even the employers of teachers recognize and promote the teachers whose subjects are performed well comparatively (form 4 teacher in an Extra- County school).*

The findings are in line with views of Pope (2019) who found that performance ranking helps in improving teacher performance and as a result, the best performing teachers are identified and promoted into their various departments. Such school practices are considered a motivation to the teacher so that they can inspire the rest of the staff to assist students in their studies creatively. Further, the teacher at the top of the rank has great influence in the school as directives they issue are taken seriously by the administrators and other teachers. They are considered to have great authority in the subject they teach and considered to have the best Mathematics pedagogical strategies. Being the leader in the department, they enjoy being at the forefront in the development of students mathematical thinking (Boyd & Ash, 2018).

**Identification of Benchmarking Classes and Schools**

Identification of benchmarking classes gives teachers voice in the school because they at the center in decision making as far as which direction Mathematics teaching should take in particular schools. According to Nyaoga, Mundia, and Irungu (2013), education benchmarking is a study of how other schools or classes carry out their day-to-day activities for students' academic achievement. Benchmarking, as a tool, can be utilized by secondary schools administrators to change performance from low grade to high grade (Amunga, Ondigi, Ndiku, & Ochieng, 2013). The practice enables the

schools to identify their performance gaps and address them by sharing with the best performing schools.

Performance ranking influences in the identification of the benchmarking classes in the school. It is the duty of the school administrators to ensure that all efforts are geared towards ensuring that students' performance is excellent in the subject. For instance, benchmarking with well-performing schools to learn the strategies they employ in order to have exemplary results. Therefore, performance ranking should be encouraged so that the well-performing schools are known and poor performing schools can visit them for benchmarking.

> *Performance ranking in Mathematics is good because, through it, one can identify the secondary schools which have a record of exemplary performance in Mathematics. Like last year, my students performed poorly in Mathematics, and this year, I am planning to take them to one of the schools which registered good performance so that they learn the tricks behind the good performance. I believe they will register good grades this year (Form 4 teacher in a sub-County school).*

Learning is a continuous process, and therefore benchmarking in education is gainful to both the students and teachers. Students get an opportunity to learn from the experience of other students and teachers learn from the experience of other teachers handling the same subject. During the benchmarking process, the students and teachers assess how the best performing schools get their success. First, the process enables them to identify their performance gaps for continuous improvement. Secondly, it enables the parties concerned to develop an improvement mindset and understanding best practices for good results based on the benchmarking outcomes.

Similar to the study findings, Chemers, Hu, and Garcia (2011) opined that through performance ranking, schools stakeholders can observe the best performing schools as well as those poorly performing ones. The low performing schools get a chance to benchmark with those better-performing schools to enhance their performance. Further, the class at the top of the rank in a school with more than one stream is used for benchmarking within the school. The class enjoys agency in Mathematics teaching and control the direction in which learning should proceed.

**Conclusion**

The aim of this paper was to demonstrate that performance ranking has influence on the voice and agency in Mathematics teaching and learning. The paper has demonstrated that performance ranking forms a basis in which the Mathematics teachers are evaluated and eventually appointed in leadership positions in the school giving them voice in Mathematics teaching. Secondly, performance ranking guides Mathematics teachers in the appointment of discussion group leaders. They do so based on the students' abilities and leadership qualities. In most cases, the students with leadership qualities are the ones at the top of the rank because they are confident and focused. Therefore performance ranking outcomes are of help to the teachers because the leaders should be the ones to impart the spirit of working hard to the other students. Most importantly, the appointment to student leadership position is taken as a reward to the top achievers giving them agency in Mathematics learning. Therefore, using the performance ranking, the teachers and the school management can identify low performing students as well as those better performing hence forming study groups bearing in mind on the differences in performance among the students. Further, performance ranking guides teachers in allocating revision resources whereby the students at the top of the rank are provided with adequate Mathematics resources in appreciation of their good work. The practice aimed at encouraging the students to keep on working hard so that the class-mean score improves. Finally, performance ranking influences in the identification of the benchmarking secondary schools in Mathematics in the county. Benchmarking with good performing school was found to be crucial to remain competitive and to achieve better educational outcomes. In this paper, we have demonstrated that benchmarking is gainful to both the students and teachers. Students get an opportunity to learn from the experience of other students and teachers learn from the experience of other teachers handling the same subject. During

the benchmarking process, the students and teachers assess how the best performing schools acquire their success. Further the process enables them to identify their performance gap for continuous improvement as well as enabling the other parties concerned to develop an improvement mindset and understanding best practices for good results based on the benchmarking outcomes.

**Recommendations**

This study recommends that performance ranking should be used as a tool to give students voice and agency in teaching and learning by ranking students and classes on the basis of marks scored on continuous assessment tests, students' entry mark and value addition. The practice will help in identifying the Mathematics classes and students at the top of the rank to act as a bench-mark. During the benchmarking process, the students and teachers assess how the best performing schools acquire their success. This process, therefore, enables them to identify their performance gap for continuous improvement as well as enabling the other parties concerned to develop an improvement mindset and understanding best practices for good results based on the benchmarking outcomes.

**Limitations of the study**

Based on the findings from this study, the authors recommend further research to explore how contextual value-added data may be used in the newly introduced competency based curriculum in Kenya since the new curriculum de-emphasizes the standardized testing that was evident in the old curriculum. In addition, one of the limitations of this study was that it did not consider other factors that could contribute to the students' and teachers' agency and voice in the mathematics classroom, including the teaching-learning environment. As such, there is need for further research that isolates these other factors with a view to establish the actual contribution of performance ranking in the teaching-learning process.

**Acknowledgements**

The authors wish to acknowledge the great support in gaining entry to the secondary schools in Embu County to collect data by the office of the County Director of Education Embu County. The authors are also grateful to the school administrators, Mathematics teachers and students who took part in the study.

**Disclosure Statement**

The authors reported that there was no conflict of interest in this study.

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IOJPE

ISSN: 1300 – 915X
www.iojpe.org

*International Online Journal of Primary Education* *2021, volume 10, issue 1*

# EFFECTS OF PRIMARY SCHOOL TEACHER PERSONALITY AND NETWORK INTENTIONS ON CHANGE: MEDIATING ROLE OF PROFESSIONAL LEARNING

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**Received:** February 03, 2021 **Accepted:** April 27, 2021 **Published:** June 30, 2021

**Suggested Citation:**
Er, E. (2021). Effects of primary school teacher personality and network intentions on change: Mediating role of professional learning. *International Online Journal of Primary Education (IOJPE), 10*(1), 148-159.



**Abstract**

This study aims to examine the mediating role of professional learning on change in teacher practice through the proactive personality and network intentionality. This research also seeks to better comprehend and capture the antecedences and consequences of the network intentions. 438 primary school teacher from 24 schools participated in the study from Istanbul. Network intentionality scale, proactive personality scale, teacher professional learning scale, and change in teacher practices scale were used to collect data. All the measures were conceptualized as individual-level constructs. The results of the study show that there are positive correlations between proactive personality network intention, professional learning and change in teacher practice. Also, the study revealed that proactive personality has positive effects on the network intentions; network intentions has a both direct and indirect effect on the change in teacher practice. These results explicitly indicated that change in teacher practice is closely associated with teacher professional learning, teacher personality, and network intentions. Because of the change in teacher practice is closely related to group dynamics and learning, planning a change strategy about understanding the role of learning and having a relationship with a colleague is so crucial for schools.

**Keywords:** Professional learning, network intention, proactive personality, change in teacher practice, primary education.

## INTRODUCTION

During the last few decades, the social side of teachers' professional learning has been a trend topic in the field of educational management and administration (Baker-Boyle & Yoon, 2020; Baker-Boyle & Yoon, 2018; Van Waes, Van den Bossche, Moolenaar, De Maeyer, & Van Petegem, 2015; Liou & Daly, 2014; Yoon, Koehler-Yom, & Yang, 2017). Some scholars have stressed that developing teacher learning programs is closely related to the extent to which teachers have the right to build collegial relationships with other teachers (Baker-Boyle & Yoon, 2011; Diehl, 2020; Li & Krasny, 2020; Sinnema, Daly, Liou, & Rodway, 2020). Therefore, one of the promising ways conducive to heightening teacher learning is to establish teacher collaboration networks. While teacher learning plays a central role in elevating student learning outcomes, available research has shown that these programs mostly remain ineffective in bringing significant change in teacher's instructional practices and thereby improving student learning (Burt & Keenan, 1998). Thus, this paper investigates the role of "tendency to learning from peer network" and "proactive personality" in sustaining change in practice and professional teacher learning.

Professional development efforts typically include a range of formal policies and procedures to improve teacher performance. However, empirical evidence indicates that school-based and ongoing teacher learning may yield higher quality student outcomes than the top-down and mandated learning activities where teachers are sent randomly (Baker-Boyle and Yoon, 2010; Porter, Garet, Desimone, Yoon, & Birman, 2000). Teacher networks have been shown to provide sustainable professional support and are important sources of teacher knowledge (Lieberman, 2000). Despite the interest and noted value of developing networks and professional communities, little research effort has been devoted, so far, to investigating the structure of teacher networks and how they impact teachers' active participation in professional development programs (Penuel & Riel 2007).

In literature, teacher interaction is represented by several concepts such as professional learning communities, organizational learning, and communities of practice, peer learning networks, and advice networks. These concepts highlighted the importance of teachers learning through interaction. Teachers' professional learning and changing the instructional practices are the expected results of a well-designed teacher development program. Thus, understanding the potential reasons for teachers to change their instructional practices by using a personal network intention lends credence to discovering more about the dynamics of the teacher learning communities.

Although there is an empirical association between teacher professional development and changing practice, little is known about how and why teachers change their instructional practices (Boyle, Lamprianou, & Boyle, 2005; Porter et al., 2000). Research also revealed that change in teacher practice is mainly driven by teacher beliefs, attitudes, and perceptions on instruction rather than knowledge. Thus, there are two mainstream teacher change approaches, namely one highlighting the role of the structure and process of change, the so-called linear model. The other, called the complex model, is a rather dynamic process that includes different points of view, interpretations, and actors' connections. Such models are driven by the relationships between peers and represent an informal and interactive perspective on teacher learning and change. While a range of educational scholars acknowledges the importance of interpersonal relationships and social interaction for teacher development (Daly, Moolenaar, Bolivar, & Burke, 2010; Martin & Dawson, 2009; Wubbels, Brok, Tartwijk, & Levy, 2012), there is little evidence for the informal social interactions and their effects on change in teachers practices.

Extant research has shown that personal characteristics may affect professional interactions and the ability to share knowledge (Talebizadeh, Hosseingholizadeh, & Bellibaş, 2021). Although teachers' personality traits have long been examined, little research effort has been spent investigating the role of personality in teachers' professional learning. Therefore, teachers' proactive personality is a potential construct to enhance or constrain teachers' intentions on developing professional learning networks. In this regard, there is a need for further analysis regarding teacher professional learning networks, along with how these networks are associated with teacher personality and professional learning and instructional practices. The current study seeks to contribute to the literature by explaining the link between proactive personality and network intentions on change in teacher practice, with the mediating role of teacher professional learning. The study has some potential contributions to the literature in several ways. First of all, the changes in teachers' instructional practices are examined in terms of network intention variables. In addition, the mediating level of professional learning on the effect of personality and network intentions on change was examined.

## Theoretical Framework

### Social network theory

Social network theory is important for educational science research, as it structurally enables original evaluations of the whole network and each actor that makes up the network. Since the teaching profession includes competence areas that can be gained through continuous professional development on the job, it is predicted that continuous professional development should be achieved by the efficient use of the school's own resources. The position of teachers in social networks and thus their level of benefiting from the social capital of the school has determinant effects in the context of developing learning and teaching practices (Penuel, Riel, Krause, & Frank, 2009). Social network theory has significant potential for analyzing educational organizations. Especially since the 1990s, with the spread of social networks primarily in the behavioral sciences field, it has also started to attract attention in the educational sciences field (Er, 2017). The social network approach, which has been popular in social sciences for a while, has been used later in educational sciences.

The use of social network theory and methods to understand how teacher collaboration can help or constrain teaching and educational change is an evolving trend in teacher professional development research (Coburn, & Russell, 2008; Daly, Moolenaar, Bolivar, & Burke, 2010; Datnow, 2012;

Moolenaar, Sleegers, & Daly, 2012). However, as the professional networks of teachers affect student success through collective competence (Moolenaar, Sleegers, & Daly, 2012), it plays an important role in achieving a structure suitable for the purposes of the school. Social network analysis in educational research typically provides an alternative way of addressing the teachers, not as isolated actors but as individuals surrounded by others. Therefore, a social network approach offers a powerful lens to examine the degree to which social systems influence individuals' emotions, behaviors, and expectations (Siciliano, 2016). There are three avenues of studies that combine social network theory and education. First, studies that include the structure and characteristics of social networks, second, studies that address the results revealed by social networks, and finally, studies that examine the variables that lead to the formation of social networks. An important strength of the current study is that it covers the structure of social networks, the causes that arise, and the consequences of social networks. In other words, this study examined the current structure of collaborative professional learning networks between teachers, the change in professional learning and teaching practices as the results of the proactive personality and social network structure that is thought to be effective in the emergence of this structure.

**Change in teacher practice**

How teachers change their teaching practices and who are more effective in this change process is an important area of educational research. A study conducted in the literature on the teaching practices of teachers in the early years of the profession showed that the social networks in which teachers participate in the process of making sense of new practice and moving from interpretation to practice are decisive (Frank, Kim, Salloum, Bieda, & Youngs, 2020). Other studies have focused on the change of teaching practices and the impact of school administrators' leadership (Özdemir, 2019; Parise & Spillane, 2010).

In recent years, studies on teacher failure and the social aspect of professional learning and change have been found in research on teacher change in educational sciences. In educational change literature, it can often be said that teachers seen as only practitioners of change planning. According to the social network approach, the main factor behind successful educational reforms is not well-planned reforms or technical support but the intimate and constructive relationships that teachers provide with their colleagues (Daly, 2010). In this context, it can be said that the colleagues with whom teachers relate have a significant influence on the change in their professional practice. Research that emphasizes the importance of social networks in teachers' professional changes presents change-oriented behavior in a collective context, emphasizes the relationship between individual views and group characteristics, and focuses on teacher failure (Moolenaar, Sleegers, & Daly, 2012; Moolenaar, 2012; Spillane, Kim, & Frank, 2012).

**Teacher professional learning**

A growing body of educational researchers has related teacher professional development to the quality of teachers' instructional practices, and eventually, student learning outcomes (Meiers, 2007; Timperley, & Alton-Lee, 2008). Effective professional development results in the changing daily practices of the teachers and improvements in student learning outcomes (Darling-Hammond, Hyler, & Gardner, 2017). The development of teachers in professional learning community studies discussed in the context of the sharing of expertise and other resources among the social capital (Liou & Daly, 2014). In this sense, it is important for teachers to develop a common purpose in school and support mutual professional sharing processes in their professional learning. In recent years, it has been emphasized that individual variables, as well as school or group-level variables, have become important, especially in studies on concepts that are considered effective in teachers' professional learning (Kılınç, Polatcan, Atmaca, & Koşar, 2021; Mockler, 2020).

**Teacher proactive personality**

The quality of educational systems is closely related to the professional development levels of teachers. This situation is related to the organization of activities based on continuous and active participation and the individual involvement of teachers in these activities. Accordingly, teachers with

personality traits that facilitate their professional learning and development will make it easier to reach the expected educational goals. Personality is one of the important variables in understanding the effectiveness of teachers (Rushton, Morgan, & Richard, 2007). Although many studies have been conducted on the relationship between personality and the professional characteristics of teaching, it is observed that the nature of the relationship teachers establish with their students and the increasing expectation of leadership for teaching, especially on proactive personality, has been intensified. Morgan & Richard, 2007). Although many studies have been conducted in which the relationship of personality with the professional characteristics of teaching is discussed, it is seen that research on proactive personality is intensified, especially with the nature of the relationship teachers establish with their students and the expectation of leadership towards increased teaching. Proactive personality traits include an individual's willingness to influence and change their environment (Bateman & Crane, 1993). A proactive personality positively affects people's creativity by making it easier for them to acquire new skills (Joo & Lim, 2009). Individuals with proactive personality traits try to intervene in the environment for their own purposes rather than adapting to environmental conditions (Bateman & Crane, 1993). However, it seems that proactive employees evaluate opportunities for change, make more intensive efforts and take the initiative to achieve set change goals, and try different ways to change results (Bateman & Crant, 1999). The proactive personality has been the subject of many studies to reach organizations matches and predict employee performance (Chackoria, 2019; Gevorkin, 2011; Huber, 2017; Ng, Eby, Sorensen, & Feldman, 2013; Patterson, 2018; Turner, 2003).

Teachers' proactive personality traits positively influence school climate perceptions and creativity levels (Gao, Chen, Zhou, & Jiang, 2020). Other studies have found associations with proactive personality with problem-solving skills (Şener, 2019), perceived organizational support (Yan, 2015), and access to organizational support networks (Chan, 2006). For reasons such as the difference in problems encountered in the teaching profession, the need to produce alternative solutions, and the development of students' original thinking skills inside and outside the classroom, proactive teacher behavior has begun to be among the variables that need to be focused on. The study hypotheses are given below:

$H_1$: Proactive personality has positive effects on network intentions.

$H_2$: Proactive personality has positive effects on the teacher's professional learning.

$H_3$: Network intentions have positive effects on the teacher's professional learning.

$H_4$: Network intentions have positive effects on the change in teacher practices.

$H_5$: Teacher professional learning has positive effects on the change in teacher practices.

$H_6$: Network intentions have positive effects for change in teacher practices and would be mediated by teacher professional learning.

The summary of paths based on the hypotheses presented in the Figure 1.

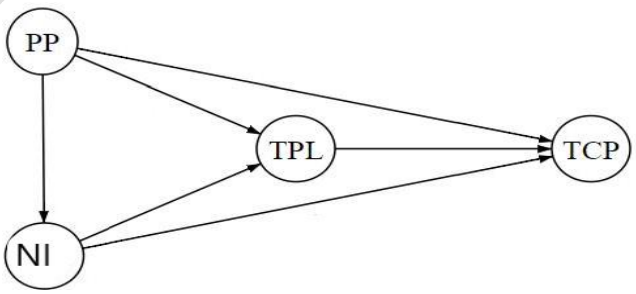


**Figure 1.** Hypothetical model

## METHOD

### Sample and Context

A total of 24 elementary schools in Istanbul participated in this study. Stratified sampling technique was used to determine the participants of the study. This method of sampling enable representing all subgroups among the population (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2021). Data for this study were collected in all 24 elementary schools of the Istanbul European Side School District, located in Turkey. Istanbul European School District is managed under 25 site administration which coordinates resources and human capital. The schools in the district mostly are located in urban areas, and while the schools in the district differed regarding students' SES. We purposely selected this large district to ensure data from multiple schools. Data were gathered in 2020 from 438 teachers reflecting a response rate of 92.4%. Of the educators, 45.2% of the respondents were male and 54.8% female. These numbers nearly represent the gender ratio in Turkish elementary education across the country. While 364 (83.1%) of the teachers had a bachelor's degree, only 74 teachers (16.9%) had completed a graduate degree. The average teaching year of the participants was 9.2, with a standard deviation of (SD=8.3).

### Instrumentation

All the measures were conceptualized as individual-level constructs. Each of four construct was assessed using a Likert scale; network intentionality scale (1=strongly disagree to 5=strongly agree) proactive personality (1-totally disagree to 7-totally agree) teacher professional learning (1-totally disagree to 5-totally agree), change in teacher practices (1-disagree to 4-agree).

### Network intentionality

The original scale consists of 14 items and 4 sub-dimensions. Cronbach's Alpha reliability coefficient, calculated from the total score of the scale in the validity and reliability study conducted by Cohen, Klein, Daly, and Finnigan (2011). The Turkish adaptation of this scale was conducted by Er (2017). In Turkish adapted form there are three sub dimensions. The scale evaluated the degree to which an individual intends to sustain social relationships using four dimensions. The scale explains 66.3% of the total variance. A sample item is "I actively seek new friendships across the organization." The Cronbach's Alpha reliability coefficient for total of the scale was calculated as .88. The sub dimensions reliability scores were calculated as .83 for actively seeking relationships, .86 for having the right set of relationships, assessing the relationships and .81 for liking to connect

### Teacher proactive personality

The scale, developed by Bateman and Crant (1993), was adapted into Turkish by Akın, Abacı, Kaya, and Arıcı (2011). Rising scores indicate increased proactivity. The measure is of the Likert Scale (1=strongly disagree and 7=strongly agree). An example item is "I'm constantly looking for new ways to improve my own life." The Cronbach's Alpha reliability coefficient is calculated as .80.

### Teacher professional learning

Perceptions of Professional learning of the teachers were measured with 27-item Teacher Professional Learning Scale developed by Liu and colleagues (2016) and adapted into Turkish by Gümüş, Apaydın, and Bellibaş (2018). A sample item is "I work together with colleagues to plan educational activities." The Cronbach's Alpha reliability coefficient is calculated as .91. The sub dimensions reliability scores were calculated as .88 for collaboration, .82 for reflection, .85 for experimentation and .84 for reaching the knowledge base.

### Change in teacher practice

Change in teacher practice was measured by the extent to which teachers change their classroom practices using borrowed items from Geijsel and colleagues (2009). The Turkish adaptation of this 8-item scale was conducted by Polatcan (2020). A sample item is "I focus more on increasing pupils." The Cronbach's Alpha reliability coefficient is calculated as .83.

IOJPE
ISSN: 1300 – 915X
www.iojpe.org
International Online Journal of Primary Education 2021, volume 10, issue 1

**Analytic Strategy**

Participants' perceptions on the proactive personality, professional learning, and changing practice were examined in regard of their network intentions. Cronbach's Alpha coefficients (α) and descriptive statistics between the variables were calculated. Also, confirmatory factor analysis (CFA) was performed to ensure the construct distinctiveness of the proposed model. Two steps were taken to test the hypotheses. First, correlation analysis was performed to examine the relationships between teachers' network intentions, proactive personality, professional learning, and change in teacher practice. Second structural equation modeling was applied to test the relationships between variables.

## RESULTS

CFA was performed to explain the goodness of fit of the study variables. Results of the analysis illustrated that $\chi^2$/df, RMSEA, SRMR, CFI, GFI were at the acceptable level. Table 1 shows the CFA results of the scales.

Table 1. CFA results

| | $\chi^2$/df | RMSEA | SRMR | CFI | GFI |
|---|---|---|---|---|---|
| Proactive personality | 2.47 | .07 | .03 | .89 | .90 |
| Teacher professional learning | 2.49 | .08 | .02 | .90 | .93 |
| Change in teacher practice | 2.54 | .06 | .02 | .92 | .95 |
| Network intention | 2.57 | .06 | .03 | .91 | .91 |

Table 2 shows the means, standard deviations and correlation among variables

Table 2. Means, standard deviations and correlation among variables

| | Mean | SD. | PP | NI | Act. | Like | Bel. | Asse. | TPL | Col. | Ref. | Exp. | Reac | CTP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PP | 5.45 | .92 | - | | | | | | | | | | | |
| NI | 4.16 | .49 | .41** | - | | | | | | | | | | |
| Act. | 4.10 | .66 | .37** | .88** | - | | | | | | | | | |
| Lik. | 4.20 | .53 | .44** | .92** | .83** | - | | | | | | | | |
| Bel. | 4.01 | .68 | .40** | .81** | .76** | .90** | - | | | | | | | |
| Asse. | 3.98 | .61 | .27** | .80** | .81** | .77** | .84** | - | | | | | | |
| TPL | 3.90 | .44 | .24** | .59** | .48** | .63** | .57** | .55** | - | | | | | |
| Col. | 4.01 | .54 | .32** | .62** | .51** | .67** | .44** | .47** | .91** | - | | | | |
| Ref. | 3.89 | .56 | .20** | .44** | .47** | .51** | .33** | .21** | .88** | .84** | - | | | |
| Exp. | 3.97 | .60 | .19** | .40** | .35** | .55** | .34** | .25** | .93** | .77** | .90** | - | | |
| Reac. | 4.08 | .71 | .22** | .33** | .29** | .47** | .37** | .35** | .92** | .80** | .89** | .88** | - | |
| CTP | 3.20 | .49 | .36** | .31** | .30** | .46** | .29** | .31** | .50** | .45** | .48** | .42** | .50** | - |

**: Correlation is significant at the .01 level (2-tailed). **SD**: Standart deviation PP: Proactive personality, **NI**: Network intention, **Act**: Actively seeking relationships, **Like**: Liking to connect, **Bel**: Belief in having the right relationships, **Asse**: Assessing relationships, **TPL**: Teacher Professional learning, **Col**.: Collaboration, **Ref.**: Reflection, **Exp.**: Experimentation, **Reac.**: Reaching the Knowledge Base, **CTP**: Change in teacher practices.

The mean scores show a high level of teacher proactive personality (Mean=5.45, SD=.92), teacher network intention (Mean=4.16, SD =.49), teacher professional learning (Mean=3.90, SD=.44) and change in teacher practice (Mean=3.20, SD=.49). At the same time there are positive and moderate level relations between proactive personality and teacher network intention ($r$=.41, p<.01) and change in teacher practice ($r$=.36, p<.01). In addition there are positive and moderate level relations between teacher professional network and teacher professional learning ($r$=.59, p<.01). Finally there is a small relationship between teacher professional network and change in teacher practice ($r$=.21, $p$ < .01).

The fit indices, x2/sd=2.34, RMSEA=.06, AGFI=.92, GFI=.91, CFI=.91, IFI=.93, NFI=.91 yielded acceptable compliance (İlhan & Cetin, 2014). It can be said that the theoretical model created in this direction is compatible with the obtained data and is verified. The tested structural model is presented in Figure 2.

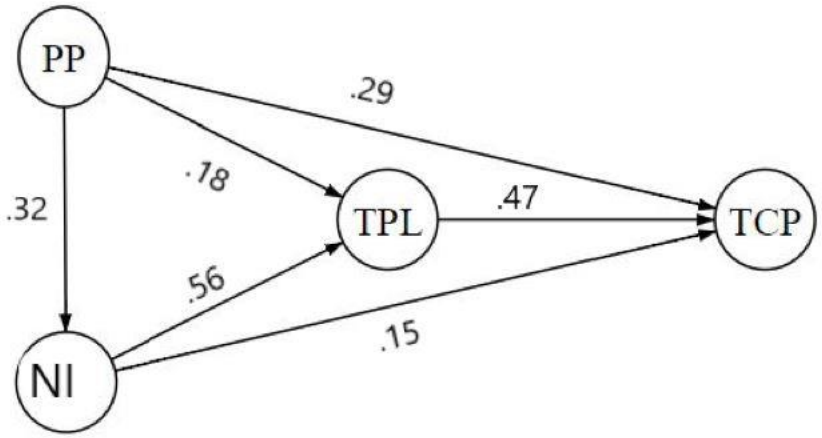


**Figure 2.** SEM model results

Table 3 shows the standardized direct, indirect, and total effects on change in teacher practice.

**Table 3.** Standardized direct, indirect, and total effects on change in teacher practice

| | β | SE | p |
|---|---|---|---|
| **Direct Effect** | | | |
| PP→NI | .32 | .06 | .00 |
| PP→TPL | .18 | .08 | .00 |
| NI→TPL | .56 | .12 | .00 |
| NI→TCP | .15 | .09 | .00 |
| TPL→TCP | .47 | .11 | .00 |
| **Indirect Effect** | | | |
| PP→NI→TCP | .04 | | |
| PP→NI→TPL | .18 | | |
| NI→TPL→TCP | .26 | | |
| **Total Effect** | | | |
| NI→ TCP | .41 | | |

Total effects of teacher professional network on teacher on change in teacher practice is significant ($\beta$=.41). This revealed that teacher professional learning shapes the change attitude. Additionally, this study showed that there are some statistically significant indirect effects from proactive personality and teacher professional network on change in teacher practice. Also, there is some evidence for explaining the teacher professional learning by teacher professional network and proactive personality traits.

In order to interpret these effects more accurately, Cohen's $f^2$ analysis results (small=$f^2 \geq .02$, medium=$f^2 \geq .15$, large=$f^2 \geq .35$) were examined (Cohen, 1988). These results showed that the effect sizes of proactive personality ($f^2$=.32) on change in teacher practice and network intentions ($f^2$=.41) were large. These results revealed that current model was significant.

## DISCUSSION and CONCLUSION

The study found a positive relationship between proactive personality and network intention. In the literature, there are studies where proactive personality and professional learning are associated (Er & Çalık, 2020; Tunca, Elçi, & Murat, 2018; Van der Heijden et al., 2015). However, in the current study, proactive personality is associated with changes in teachers practice. Our findings also found

support from several pieces that evidenced a positive link between proactive personality and innovation and change in the literature (Li, Liu, Liu, & Wang, 2017).

The results revealed a moderate association between participants' professional learning networks and professional learning. The paradigm on the rise in teachers' professional learning emphasizes that learning activities based on participatory, reciprocal relationships, and interaction and performed as part of a community (Duncan-Howell, 2010; Krutka et al., 2016; Sinnema et al., 2020). In this context, it can be said that teachers can't learn independently of each other, and from the point of view of educational organizations, learning should be considered collectively.

It is seen that positive relations have been achieved between the professional learning of teachers and the change in teaching practices. Accordingly, it can be said that a positive and moderate link has been established between learning and change. It is possible to establish similarities with studies in the literature that have established a relationship between teacher exchange and professional learning (Guskey, 2008; Timperley & Alton-Lee, 2008; Polatcan, 2020).

As part of the study, it is seen that teachers' professional learning networks have an impact on their professional practice. Accordingly, the Professional Learning Network has a positive and decisive impact on the exchange of teachers. In the literature, some studies establish a relationship between the exchange of teachers and the learning network they participate in (Daly, Moolenaar, Bolivar & Burke, 2010). However, proactive personality traits were found to be effective in establishing a professional learning network of teachers. In other words, the personality traits of teachers also affect community participation and learning activities.

According to research results, teachers' professional learning has an impact on the change in their practice. Accordingly, three variables can be listed as personality, learning, and networking among the determining factors in changing teachers. According to the results obtained in this study, it is seen that the proactive personality variable affects teachers' professional learning processes and that the professional learning network affects the change in teaching practices.

Potentially, this study can make some significant contributions to practitioners and researchers in terms of understanding the supporting factors for teacher learning, better understanding the structure and results of teacher learning. In this context, it would be useful to consider vocational learning based on research results by considering the individual characteristics of teachers and the structure of the professional group in which they participate. As increasing the number of teachers with whom teachers establish professional relationships affects professional learning and change, emphasis should be placed on individual-group harmony. It is recommended to support original areas where teachers can work together and produce.

The results obtained in the current study clearly show the impact of personality, network intentions, and professional learning on changing teachers' professional practice. Accordingly, it is meaningful to define a successful educational reform based on the relationship between learning and individual variables. However, the study found that proactive personality traits influence teachers' network intentions. This indicates the importance of personality traits in teachers' potential to learn from each other. In other studies, teacher learning can be studied more extensively at the individual, group, and school levels. However, the nature of teachers' professional learning networks is strongly associated with the resources transferred between actors in the network. Therefore, change in educational reforms can be seen as a result of strong professional interactions. Examining the change in teacher practices through a series of time-based studies is important for achieving broader findings. In addition, it is important to examine the teacher professional network structure, including the density, reciprocity, and demographic composition of a social relationship pattern.

This study has some key implications for policy, practice, and research. This research has some potential contribution to the Turkish Educational System’s school-based transformation process in line with the “Turkey’s Education Vision 2023”. This study also sheds light on developing the school

principal's leadership practices in regard to social capital and teachers' individual professional learning needs. Furthermore, this study provides an understanding of teachers' interactions and personality characteristics for explaining the professional learning and change.

**Limitation of the study**

The study has some limitations that should be taken into account when interpreting its results. First, this study only including the data through self-reported measures. Therefore participants may falsify the results of the study. Second, network intentions as a social construct were examined from an individual perspective. However, there should be some dyadic data to confirm the results revealed from individuals. Finally, change in teachers practice should be measured with a longitudinal perspective because of the nature of the change phenomena.

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IOJPE

ISSN: 1300 – 915X
www.iojpe.org

*International Online Journal of Primary Education* *2021, volume 10, issue 1*

# A RASCH MODEL ANALYSIS OF PRIMARY SCHOOL STUDENTS' CONCEPTUAL UNDERSTANDING LEVELS OF THE CONCEPT OF LIGHT

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**Received:** December 05, 2020 **Accepted:** March 08, 2021 **Published:** June 30, 2021

**Suggested Citation:**
Bozdağ, C. H., & Türkoğuz, S. (2021). A Rasch model analysis of primary school students' conceptual understanding levels of the concept of light. *International Online Journal of Primary Education (IOJPE), 10*(1), 160-179.



**Abstract**

The study determines the conceptual understanding levels of primary school students on the concept of light according to the Rasch Model with a Four-tier Light Conceptual Understanding Test (LCUT). The participants were 355 (164 girls and 191 boys) primary school students studying at a public school in Izmir city center. In the study, the Rasch Model, which is included in the Latent Trait Theory, was used. Also, the data regarding the answers given and the level of confidence in the responses were associated with the Rasch analysis of LCUT. The results of Rasch analysis showed that LCUT was in full harmony in the context of infit, outfit, and point measurement correlation statistics, and is a valid and reliable measurement tool for conceptual understanding. Moreover, these results explained that the students' average conceptual understanding ability regarding the Light unit was above the average item difficulty.

**Keywords:** Conceptual understanding, primary school, four-tier diagnostic test, light unit, Rasch model.

## INTRODUCTION

The evaluation of the training process is as important as its planning and implementation. Measurement and evaluation make a great contribution to the education process by determining the development levels of individuals' knowledge and skills (Çetin, 2019). However, measurement and evaluation in education is done indirectly with measurement tools consisting of multiple variables, and therefore this contribution is possible with and data based on consistent, valid and reliable measurement processes and measurement tools. Likewise, correct statistics, analysis and calculations may the educational value of these data increase. After all, the sensitivity of the measurement data increases with the quality of structural statistic analyzes used in the measurement tools and contributes to the studies in educational assessment indirectly.

In the measurement and evaluation processes, two theories are used, namely, Classical Test Theory (CTT) and Latent Trait Theory (LTT) (Kan, 2006; Keeves, 1998; Kelecioğlu, 2001). CTT is a long-known theory where evaluation is made according to the whole test, not to each item (Bulut, 2018). Therefore, the contribution of different items to the individual's success is considered to be equal (Anshel, Weatherby, Kang, & Watson, 2009). The search for an alternative theory for CTT has started due to the following limitations: 1) the estimation of individuals' abilities based on their total score, 2) the scores of the individuals depend on the test applied, 3) item statistics depend on the characteristics of the group to which the test was applied (Bulut, 2018; Demirtaşlı, 1996; Hambleton & Jones, 1993; Kelecioğlu, 2001). Accordingly, with the claim that it can overcome these limitations, LTT was introduced at the end of the 1930s (Doğan & Tezbaşaran, 2003). According to LTT, there is a relationship between the individuals' ability, which is not directly observed in a certain area, and

their answers to the test items, consisting of questions that examine this area; this relationship can be expressed mathematically (Kelecioğlu, 2001).

The two most widely used and open-to-develop models of LTT developed as an alternative to CTT are the "Item Response Theory" (IRT) and the "Rasch Model" (RM) (Akın & Baştürk, 2012). IRT assumes that a person's performance can be predicted in a test thanks to multiple features (Bulut, 2018). RM, on the other hand, is a technique developed by George Rasch in 1960 and evolved from IRT (Doğru, 2019). RM determines the difficulty levels of the items and the ability levels of the individuals. According to the model, it attempts to determine the probability of what an individual with a certain ability level can do against the desired task (Rasch, 1961).

Although CTT is still widely preferred today in the analysis of a measurement tool, the biggest limitation of CTT is that the characteristics of participants depend on the item and item characteristics on the participant characteristics (Demirtaşlı, 1996). Accordingly, the contribution of different items in predicting individuals' ability levels is equal. On the other hand, RM is different from many other statistical models since it is a probabilistic model (Boone & Scantlebury, 2006). In RM, the characteristics of an item can be calculated independently of the ability level of the participants, and the ability levels of the participants can be estimated independently from the item sample they answered. Also, the contribution of different items in predicting individuals' ability levels is not equal (İlhan & Güler, 2017). According to RM, an individual with a higher ability than others is more likely to correctly answer another item that measures the same structure. Similarly, a question that is easy for any individual is likely to be answered correctly, and a difficult question is unlikely to be answered (Bond & Fox, 2007). Accordingly, the mathematical expression describing the relationship between the test items and the person is shown in Formula 1.

$$P(X_{ni}=1)=\frac{e^{B_n-D_i}}{1+e^{B_n-D_i}}$$

In the formula, ($B_n$) is a parameter that shows the person's ability. If a person with $B_n$ ability answers a test item with $D_i$ difficulty, it will simply either succeed or fail (Planinic, Boone, Susac & Ivanjek, 2019). Accordingly, the possibility of a person answering an item correctly (P) is related to the person's ability ($B_n$) and the difficulty of the answered item ($D_i$) (Boone & Scantlebury, 2006). According to RM formula, the probability of a correct response is expressed as $B_n$-$D_i$. If the person's ability equals item difficulty ($B_n$=$D_i$), then the probability of a correct response is 50%. If the difference between person ability and item difficulty increases positively ($B_n$>$D_i$), then the person has a higher probability of a correct response to the question (Planinic, Ivanjek, & Susac, 2010; Xiao, Han, Koenig, Xiong, & Bao, 2018).

Undoubtedly, in the analysis of a measurement tool with RM, associating the ability of the person with each item (a) facilitates the development of tools that provide useful data, and (b) provides data that can be safely used for both descriptive and parametric statistics (Boone & Noltemeyer, 2017). Therefore, instead of evaluating the raw scores in the analysis of the questionnaires and tests frequently used in education and social sciences, the analyses to be conducted with RM made it possible to reach more objective measurement results that were stripped of many statistical limitations (Boone & Noltemeyer, 2017; Gülkaya, 2018; Preece, 1979; Uzunsakal & Yıldız, 2018). This has enabled RM to have a wide application area and accelerate studies, such as in the fields of health studies, marketing, education, social sciences, and economics.

In studies on education, researchers have started to use RM widely recently (Baharun, Razi, Abidin, Musa, & Mahmud, 2017; Boone & Noltemeyer, 2017; Çetin, 2019; İlhan & Güler, 2017; Maat, 2015; Othman, Salleh, Hussein, & Wahid, 2014). In particular, RM is highly preferred in studies where measurement tools are developed and analyzed in education (Boone & Scantlebury, 2006; Boone, Townsend, & Staver, 2011; Planinic, Ivanjek, & Susac, 2010; Sondergeld & Johnson, 2014; Wei, Liu, Wang, & Wang, 2012). Additionally, conceptual understanding levels can also be analyzed with RM (Liu, 2010; Kauertz & Fischer, 2006; Mešić et al., 2019; Siang, 2011; Wei, Liu, & Jia, 2014).

One of the integral parts and subjects of everyday life in the field of science is light. The light concept is used as the primary tool in many fields from physics to biology, medicine to astronomy. Therefore, students have difficulties in many scientific fields and subjects without understanding the light concept and its properties (Djanette, Fouad, & Djamel, 2013). The studies related to the light concept in the literature focuse on the framework of determining misconceptions (Aydoslu, 2018; Blizak, Chafiqi, & Kendil, 2009; Epik et al., 2002; Fariyani, Rusilowati, & Sugianto, 2017; Galili & Hazan, 2000; Kaplan, 2017; Taşlıdere & Eryılmaz, 2015; Wahyuningsih, Rusilowati, & Hindarto, 2017), determining the conceptual understanding levels within the framework of CTT (Andersson & Bach, 2005; Ayvacı & Candaş, 2018; Demirci & Ahçı, 2016; Kara, Avcı, & Çekbaş, 2008; Şahin, İpek, & Ayas, 2008), mental models (Uzun & Karaman, 2016), cognitive structure (Apaydın, Akman, Taş, & Peker, 2014; Özcan & Tavukçuoğlu, 2018), and teaching methods and techniques (Altun, 2006; Benek & Kocakaya, 2012; Mazlum & Yiğit, 2017; Şenel, 2016). On the other hand, RM-based studies on light are limited (Aminudin, Kaniawati, Suhendi, Samsudin, Coştu, & Adimayuda, 2019). However, the literature has signed that there are not any studies focused on developing a measurement tool on light and analyzing the conceptual level of understanding with RM.

The starting point of this study is the idea that RM provides statistically more reliable evaluation results. The model explains how a person's performance for a particular feature can predict a person's response (eg, true or false) in a particular test item containing that feature (Boone, 2016; Boone & Scantlebury, 2006). These features that are taken into consideration, such as scientific learning, scientific inquiry, or attitude toward science, are defined as "latent/implicit features" (Boone & Scantlebury, 2006; Planinic, Boone, Susac, & Ivanjek, 2019; Xiao et al., 2018). The latent feature used in the assessment of competencies often constitutes a skill. In this study, the latent feature is the conceptual understanding ability about light subject. On the other hand, the quality, reliability, and validity of the test tool used are closely related to the determination of the conceptual understanding level. In this context, the study searches for answers to the questions below.

**Research Questions**

1- Is the conceptual understanding test developed on the Light unit a valid and reliable measurement tool according to RM?
2- Can RM adequately explain students' conceptual understanding levels on the concept of light?
3- According to RM, what level are the students' conceptual understanding level on the concept of light?

## METHOD

**Research Model**

We analyze LCUT according to the “partial credit or point model” of RM. The model proposed by Masters in 1982 is a suitable model for polytomous items that require multiple stages and are given partial points if different stages are completed during the analysis process (Kaskatı, 2011; Yüksel, 2012). In the Partial Credit Model (PCM), each item has its own ordered scale structure (Gülkaya, 2018). In this model, instead of a binary result as yes/no for items, partial scores can be obtained by considering the answers given when reaching the result (Uzunsakal & Yıldız, 2018). It is useful in situations where students do not mark only as true or false; thus, student competencies can be determined in more detail. So, in the study, we determine the competencies of students on the concept of light from a basic level to a detailed level using PCM.

**Participants**

The participants were 355 students randomly selected, consisting of 164 girls (46.2%) and 191 boys (53.8%) in the fifth-grade of a state primary school in İzmir city centre. In the study, we chose the sample to represent the general population by using random sampling method from students with similar socio-economic characteristics. The most important feature of this sampling method is that all units in the general population have an equal and independent chance to be selected for the sample (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2014).

IOJPE
ISSN: 1300 – 915X
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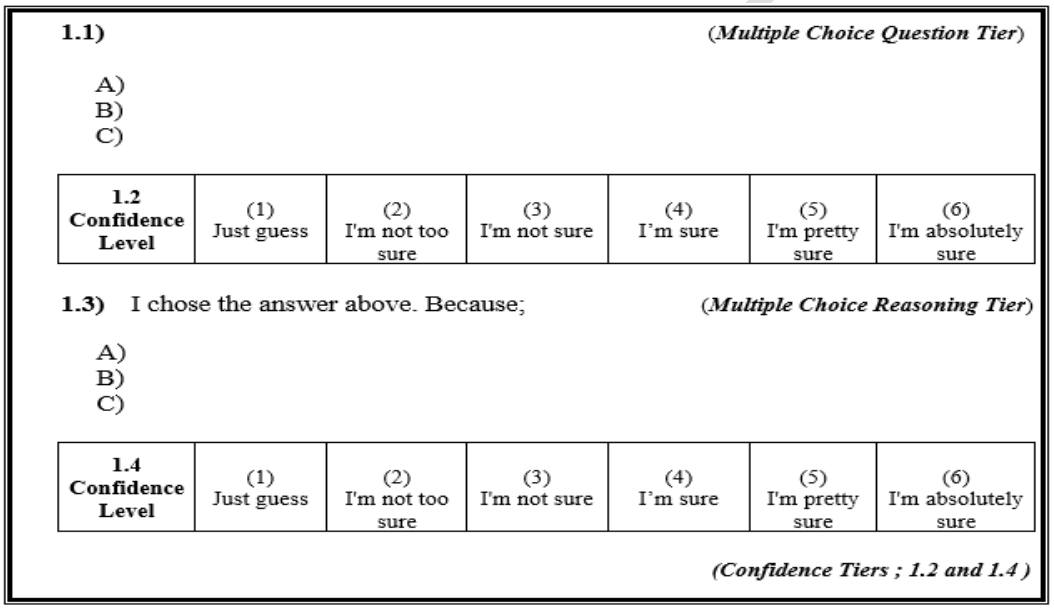
International Online Journal of Primary Education 2021, volume 10, issue 1

**Development of Data Collection Tool**

In the study, we developed the Four-tier Light Conceptual Understanding Test (LCUT) and analyze it with RM. We used a 4D model (Defining, Designing, Developing, Disseminating), which helps the researcher to design a product that will help the student develop their skills in the learning process (Irawan, Nyoman Padmadewi, & Artini, 2018), in the development of LCUT. In the 'defining' stage, we conducted a literature review on the subject of light and four-tier tests. During the 'designing' stage, we examined the structure of the four-tier test. The first tier of the four-tier test is the multiple choice question tier; the third tier is the reasoning tier for the response to the first tier. The second and the fourth tiers are the confidence tiers. There are six options which are rated between "1" and "6" in the confidence tier, respectively: "Just guess", "I'm not too sure", "I'm not sure", "I'm sure", "I'm pretty sure", and "I'm absolutely sure." The design of the four-tier test is shown in Figure 1.



**1.1)** ***(Multiple Choice Question Tier)***

A)
B)
C)

| **1.2 Confidence Level** | (1) Just guess | (2) I'm not too sure | (3) I'm not sure | (4) I'm sure | (5) I'm pretty sure | (6) I'm absolutely sure |
|---|---|---|---|---|---|---|

**1.3)** I chose the answer above. Because; ***(Multiple Choice Reasoning Tier)***

A)
B)
C)

| **1.4 Confidence Level** | (1) Just guess | (2) I'm not too sure | (3) I'm not sure | (4) I'm sure | (5) I'm pretty sure | (6) I'm absolutely sure |
|---|---|---|---|---|---|---|

***(Confidence Tiers ; 1.2 and 1.4 )***

**Figure 1.** The design of Four-tier test

In the 'developing' stage, we considered studies on the literature about conceptual understanding levels and misconceptions on the subject of light, achievements regarding the subject of light in the curriculum of the science course, textbook, achievement tests, the suggestions of the course teachers and experts, and the opinions of the students and the answers given in the open-ended exams. In this stage, we developed LCUT consisting of fourteen questions and then we examined these items by the opinions of a faculty member, a field expert, and two science teachers. Considering experts' evaluations, we took into two questions determined to have the same content into the same question root, and canceled one question. A Turkish teacher and 20 students in higher education examined LCUT, which consisted of twelve questions, in terms of reading and understanding. In accordance with the feedback of languege expert, we eliminated the deficiencies in the form of spelling errors and we developed the final measurement tool. We applied LCUT to 355 fifth-grade students in approximately one class hour. Sample questions related to the questions in LCUT are presented in Figure 2. The distribution of the questions in LCUT according to the achievements of the science education program (MNE, 2018) is given in Table 1.

IOJPE
ISSN: 1300 – 915X
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International Online Journal of Primary Education 2021, volume 10, issue 1

**Table 1.** Achievement distribution of questions

| UNIT | SUBJECT | ACHIEVEMENT | QUESTION |
|---|---|---|---|
| SPREADING THE LIGHT | Spreading the light | 1-Observing that the light coming from a source follows a linear path in all directions, it shows with drawing. | Q1, Q10 |
| | Reflaction of light | 1-Observes the reflactions of light on smooth and rough surfaces and shows them by drawing. | Q4, Q6 |
| | | 2-Explains the relationship between the incoming beam, reflected beam and the normal of surface. | Q2, Q3 |
| | Encounter of light with a substance | 1-Categorizes the substances according to their light transmittance status. | Q7, Q8 |
| | Full shadow | 1-Observes how the full shadow is formed and shows it with simple beam drawings. | Q11, Q12 |
| | | 2-Discovers the variables that affect the full shadow with experiments. | Q5, Q9, Q12 |

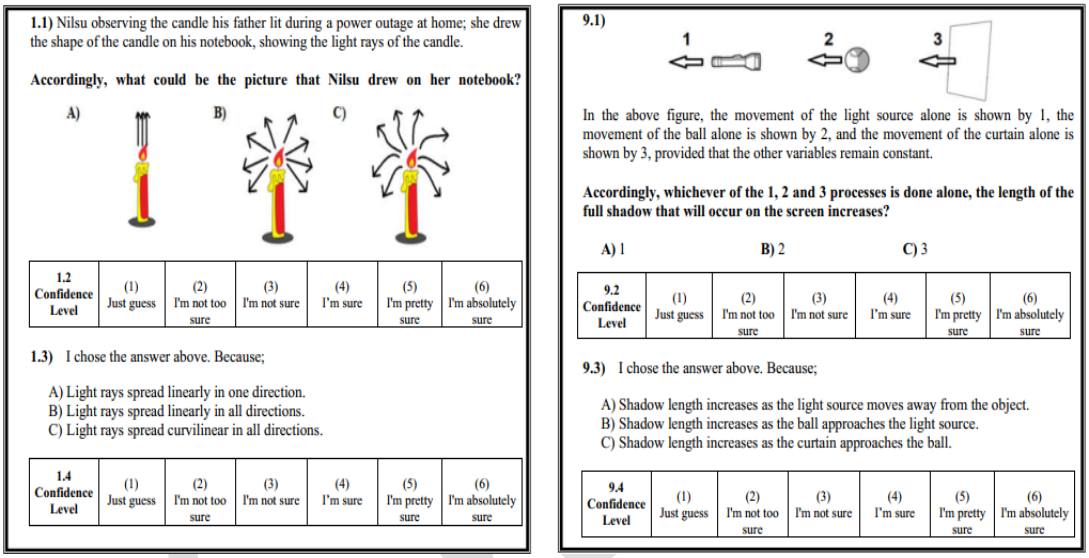


**Figure 2.** LCUT sample questios

## Analysis of Data

### Scoring Categories for LCUT

Due to the four-tier test, we gathered the answer combinations for the responses given to the tiers in each test item under six categories as Scientific Knowledge, Misconception, Lucky Guess, False Positive, False Negative, and Lack of Knowledge (See Table 2).

**Table 2.** Scoring Categories for LCUT

| CATEGORY | SK | *LG* | | | FP | FN | MC | *LK* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.TIER** | T | *T* | *T* | *T* | T | F | F | *T* | *T* | *T* | *F* | *F* | *F* | *F* | *F* | *F* |
| **2.TIER** | S | *S* | *NS* | *NS* | S | S | S | *S* | *NS* | *NS* | *S* | *S* | *NS* | *NS* | *NS* | *NS* |
| **3.TIER** | T | *T* | *T* | *T* | F | T | F | *F* | *F* | *F* | *T* | *F* | *T* | *T* | *F* | *F* |
| **4.TIER** | S | *NS* | *S* | *NS* | S | S | S | *NS* | *S* | *NS* | *NS* | *NS* | *S* | *NS* | *S* | *NS* |

SK: Scientific Knowledge, LG: Lucky Guess, FP: False Positive, FN: False Negative, MC: Misconception,
LK: Lack of Knowledge, T: True, F: False, S: Sure (Confident Level>3,5), NS: Not Sure: (Confident Level<3,5)

Although six scoring categories are used for four-tier tests, in the study, we determined the conceptual understanding levels of students based on a Rasch analysis, and therefore, we arranged the 3 different

scoring categories for the correct answers given at each tier for RM: Conceptual Understanding, Misconception, and Confidence Level (See Table 3).

**Table 3.** Scoring categories for Rasch analysis

| CATEGORY | TIER | SCORE | EXPLANATION |
|---|---|---|---|
| CONCEPTUAL UNDERSTANDING | 1.Tier | 1 | If the student responds correctly to 1. Tier (Question Tier) |
| | | 0 | If the student responds incorrectly to 1.Tier |
| | 3.Tier | 1 | If the student responds correctly to 3. Tier (Reasoning Tier) |
| | | 0 | If the student responds incorrectly to 3.Tier |
| | 1. and 3. Tier | 1 | If the student responds correctly to 1.and 3. Tier |
| | | 0 | In all other alternatives |
| | All Tiers | 1 | When the student responds correctly to 1. and 3.Tier with confidence |
| | | 0 | In all other alternatives |
| MISCONCEPTION | 1.Tier | 1 | If the student responds incorrectly (accompanied by misconception) to 1. Tier |
| | | 0 | If the student responds correctly to 1.Tier |
| | 3.Tier | 1 | If the student responds incorrectly (accompanied by misconception) to 3. Tier |
| | | 0 | If the student responds correctly to 3.Tier |
| | 1. and 3. Tier | 1 | If the student responds incorrectly to 1. and 3. Tier |
| | | 0 | In all other alternatives |
| | All Tiers | 1 | If the student responds incorrectly to 1. and 3.Tier with confidence |
| | | 0 | In all other alternatives |
| CONFIDENT LEVEL | 2.Tier | 1 | CL >3.5 (Sure) |
| | | 0 | CL < 3.5 (Not Sure) |
| | 4.Tier | 1 | CL >3.5 (Sure) |
| | | 0 | CL < 3.5 (Not Sure) |
| | 2. and 4. Tier | 1 | CL >3.5 (Sure) for 2, and 4. Tier |
| | | 0 | In all other alternatives |

CL: Confident Level, The threshold value was considered as 3,5 to determine CL

Table 3 shows that since a certain score is taken based on the responses given in each tier of each test item, PCM was used in the analyses to be conducted. Within the framework of PCM, partial scores can be obtained based on the responses given for the tiers of each item of the four-tier test. Therefore, we converted response alternatives related to the tiers in each test item specified in Table 2 were converted into partial scoring in line with the scoring categories in Table 3.

**Table 4.** PCM scoring key

| CATEGORY | SCORES | | |
|---|---|---|---|
| | Conceptual Understanding | Misconception | Confident Level |
| SK | 4 | 0 | |
| LG | 3 | 0 | |
| FP | 1 | 1 | |
| FN | 1 | 1 | |
| LK (Alternatives with correct answers) | 1 | 1 | |
| LK (Alternatives with wrong answers) | 0 | 3 | |
| MC | 0 | 4 | |
| S | | | 3 |
| PS | | | 1 |
| NS | | | 0 |

SK: Scientific Knowledge, LG: Lucky Guess, FP: False Positive, FN: False Negative, MC: A Misconception,
LK: Lack of Knowledge, S: Sure (Confident Level [CL]>3.5 for 2-4.tiers), NS: Not Sure: (CL<3.5 for 2-4 tiers),
PS: Partial Sure (CL>3.5 for 2.tier, CL<3.5 for 4.tier or vice versa)

As a result, the scoring key (0-1-3-4) for conceptual understanding, misconception, and confidence level was created for the four-tiers (See Table 4).

**Rasch Model Analysis Findings**

We analysed by the data through WINSTEPS software to answer research questions. In the first part, we tested LCUT's reliability and its validity. In the second part, we examined students' responses on LCUT in the scope of conceptual understanding, misconception, and trust level.

**Findings on Validity and Reliability**

In this part, we evaluated LCUT's reliability and its validity through WINSTEPS software. In Rasch analysis, reliability is examined under two headings: person reliability and item reliability. Person reliability refers to the consistency of student responses and item reliability refers to the quality of test items. Accordingly, Table 5 shows the analysis results on person reliability for students and item reliability for LCUT's items.

**Table 5.** Rasch analysis results about person and item for LCUT

| PERSON | Total Score | Count | Measure | Model S.E. | Infit Mnsq | Infit ZSTD | Outfit Mnsq | Outfit ZSTD |
|---|---|---|---|---|---|---|---|---|
| **MEAN** | 28.8 | 12.0 | 52.48 | 2.23 | 1.01 | .0 | 1.02 | .1 |
| **P. SD** | 9.9 | .0 | 4.41 | .65 | .38 | 1.0 | .68 | .8 |
| **S. SD** | 10.0 | .0 | 4.42 | .65 | .38 | 1.0 | .68 | .8 |
| **MAX.** | 47.0 | 12.0 | 66.39 | 7.48 | 2.56 | 2.5 | 5.67 | 3.1 |
| **MIN.** | 8.0 | 12.0 | 43.06 | 1.90 | .18 | -2.9 | .17 | -1.9 |
| REAL RMSE=2.51, TRUE SD=3.63, SEPARATION=1.45, Person RELIABILITY=.68, S.E.of Person Mean=.24 | | | | | | | | |
| MODEL RMSE=2.53, TRUE SD=3.75, SEPARATION=1.61, Person RELIABILITY=.72 | | | | | | | | |
| **ITEM** | **Total Score** | **Count** | **Measure** | **Model S.E.** | **Infit Mnsq** | **Infit ZSTD** | **Outfit Mnsq** | **Outfit ZSTD** |
| **MEAN** | 866.1 | 355.0 | 50.0 | .41 | .98 | -0.1 | 1.02 | .4 |
| **P. SD** | 264.3 | .0 | 4.10 | .08 | .13 | 1.7 | .26 | 1.7 |
| **S. SD** | 276.1 | .0 | 4.28 | .08 | .13 | 1.7 | .27 | 1.7 |
| **MAX.** | 1300.0 | 355.0 | 55.94 | .60 | 1.19 | 2.7 | 1.39 | 2.9 |
| **MIN.** | 456.0 | 355.0 | 42.33 | .36 | .81 | -3.1 | .54 | -1.9 |
| REAL RMSE=.42, TRUE SD=4.08, SEPARATION=9.62, Item RELIABILITY=.99, S.E. of Item Mean = 1.24 | | | | | | | | |
| MODEL RMSE=.42, TRUE SD=4.08, SEPARATION=9.80, Item RELIABILITY=.99 | | | | | | | | |

The results in Table 5 show that while the person reliability for LCUT is in the range of .68-.72, the Cronbach alpha value is .76 and the item reliability for LCUT is .99. In this case, are the results reliable or not? To decide to this, the ideal value of person reliability should be greater than .80 (Bond & Fox, 2007; Linacre, 2014), however, the values greater than .60 can be accepted as reliable, repeatable, and valid for measurement (Zain, Mohd, & El-Qawasmeh, 2011), and even values greater than .67 can be considered reasonable (Fisher (2007). Moreover, person reliability is also equivalent to Cronbach alpha (KR-20), which is CTT reliability (Linacre, 2014). For a measurement tool to be considered reliable, the Cronbach alpha coefficient must be greater than .70 (Büyüköztürk et al., 2014). In additon, item reliability, the acceptable value should be greater than .80, and values in the range of .67-.80 may be reasonable (Fisher, 2007; Linacre, 2014). Overall, the results in Table 5 show that the person, Cronbach's alpha and item reliability coefficients for the measurement reliability of LCUT can be accepted within the range of the reliability criteria.

A Rasch analysis allows person and item separation coefficients to evaluate internal consistency of a test. The person separation coefficient refers to the range of measured ability scores, and the item separation coefficient refers to the spread of item difficulty levels. Separation coefficient values are between 0 and infinite, and higher values indicate better separation (Boone & Noltemeyer, 2017). Linacre (2019) states that the item separation coefficient should be 3 or above. In terms of person separation coefficient, 1.50 is weak, but acceptable, 2.00 is good, and 3.00 is considered excellent (Duncan et al., 2003; Fisher, 2007; Linacre, 2019). Therefore, Table 5 shows that both the person (1.61) and item (9.80) separation coefficients of RM are appropriate and acceptable for the test's internal consistency.

The determining that the scores of a measurement tool are meaningful, useful, and purposeful by analyzing the construct validity results in RM is likely. The point measurement correlation (Ptmea Corr), infit mnsq and outfit mnsq statistics in the analysis of RM can determine the construct validity of a test. Table 6 shows that the results of the Ptmea-Corr analysis on each item in LCUT.

**Table 6.** Item analysis results based on RM for LCUT's construct validity

| ITEM | TOTAL SCORE | TOTAL COUNT | MEASURE | MODEL S.E | INFIT | | OUTFIT | | PTMEA-AL | | EXACT MATCH | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | MNSQ | ZSTD | MNSQ | ZSTD | Corr. | Exp. | OB% | EXP% |
| **S1** | 1300 | 355 | 42.33 | .60 | .82 | -1.2 | .54 | -1.9 | .36 | .27 | 76.6 | 73.2 |
| **S2** | 664 | 355 | 53.00 | .36 | 1.06 | .9 | 1.09 | .9 | .52 | .55 | 23.4 | 23.7 |
| **S3** | 1068 | 355 | 47.48 | .40 | .87 | -1.8 | .83 | -1.1 | .49 | .43 | 42.2 | 37.4 |
| **S4** | 1006 | 355 | 48.43 | .38 | .81 | -3.1 | .76 | -1.9 | .53 | .46 | 40.8 | 33.8 |
| **S5** | 456 | 355 | 55.94 | .39 | 1.11 | 1.5 | 1.39 | 2.8 | .50 | .57 | 24.3 | 32.1 |
| **S6** | 1269 | 355 | 43.35 | .54 | .82 | -1.5 | .69 | -1.3 | .39 | .30 | 70.5 | 65.0 |
| **S7** | 782 | 355 | 51.46 | .36 | 1.15 | 2.3 | 1.16 | 1.6 | .48 | .53 | 21.7 | 21.1 |
| **S8** | 840 | 355 | 50.70 | .36 | 1.02 | .4 | 1.02 | .2 | .52 | .51 | 19.9 | 20.6 |
| **S9** | 776 | 355 | 51.54 | .36 | 1.02 | .3 | 1.04 | .4 | .51 | .53 | 22.3 | 20.6 |
| **S10** | 1058 | 355 | 47.64 | .40 | .95 | -.6 | 1.36 | 2.2 | .43 | .44 | 36.1 | 35.1 |
| **S11** | 657 | 355 | 53.09 | .36 | .96 | -.6 | .98 | -.1 | .56 | .55 | 21.7 | 23.7 |
| **S12** | 517 | 355 | 55.02 | .38 | 1.19 | 2.7 | 1.36 | 2.9 | .48 | .56 | 18.5 | 27.2 |
| **Mean** | 866.1 | 355 | 50.00 | .41 | .98 | -.1 | 1.02 | .4 | | | 34.8 | 34.4 |
| **P.SD** | 264.3 | | 4.10 | .08 | .13 | 1.7 | .26 | 1.7 | | | 19.0 | 16.6 |

In Table 6, the Ptmea-Corr values are in the range of .36-.56 for LCUT's items. While Bond and Fox (2007) stated that the correlation coefficient should have values greater than .30, Othman et al. (2014), on the other hand, stated that values less than .35 mean weak and low correlation, values between .36-.67 mean moderate and reasonable correlations, values between .68-1.00 represent strong and high correlation values. The results in Table 6 explain that the Ptmea-Corr values have a moderate and reasonable correlation in comparison with these threshold values (Bond & Fox, 2007). This means that each test item can distinguish the ability of the participants.

Fit statistics in RM were also evaluated for determining the construct validity. Linacre (2002) states that fit statistics values between .50-1.50 are suitable values for measurement. Considering these statistics in Table 6, the values of infit mnsq statistics are in the range of .82-1.19 and outfit mnsq statistics in the range of .54-1.39. In addition, the standardized z values (ZSTD) in Table 6 are between -3.1/2.7 for infit, and are between -1.9/2.9 for outfit. ZSTD values should be between -2.0/2.0, but ZSTD values that are not within the desired limits can be ignored if infit and outfit mnsq statistical values have acceptable values (Bond & Fox, 2007; Linacre, 2014). Therefore, these results indicate that all the items in LCUT are in harmony for the measurement in the range of Linecra's fit statistics values.

RM is based on the unidimensionality of the test items. In other words, the test is expected to measure a single structure. Linacre (2006) suggests to check the multidimensional of test. In this case, Principal Compenent Analysis (PCA) should be performed to evaluate dimensionality. So, the data obtained from the Winsteps software were applied PCA. Consequently, the raw variance explained by measures for LCUT was 42.3% and, the eigenvalues of the unexplained variance in 1st, 2nd, 3rd, and 4th contrasts were 1.4, 1.3, 1.2, and 1.1, respectively. The results verify that data have a unidimensionality within the criteria determined by Linacre (2006). Overall, we can suggest that the conceptual understanding test (LCUT) developed on the concept of light is a valid and reliable measurement tool according to RM.

**Findings on Person-Item Wright Map**

RM allows the comparison of difficulty levels of each test item with the person's ability level in a common metric unit of measurement. Therefore, the Winsteps software allowed the association of item difficulty level with person ability levels by converting them into common measurement values. Thus, a common measurement unit on the same linear scale called Person-Item Map (Wright Maps)

can explain person ability and item difficulty measurements (Bond & Fox, 2007). Accordingly, the person-item map in Figure 3 shows the distribution of test items and persons in a common measurement metric. The person-item map is arranged in two vertical histograms. The right side is for participating students, and the left side is for test items. Vertical movement on the person-item map indicates that the ability of the participants ranked from highest to lowest in the right side, and test items ranked from hardest to easiest in the left side. “M”, on the separation line in the middle of the person-item map, means the average of item difficulty and person ability, “S” (Single) means one standard deviation distance from the average, “T” (Twice) means two standard deviations from the average.

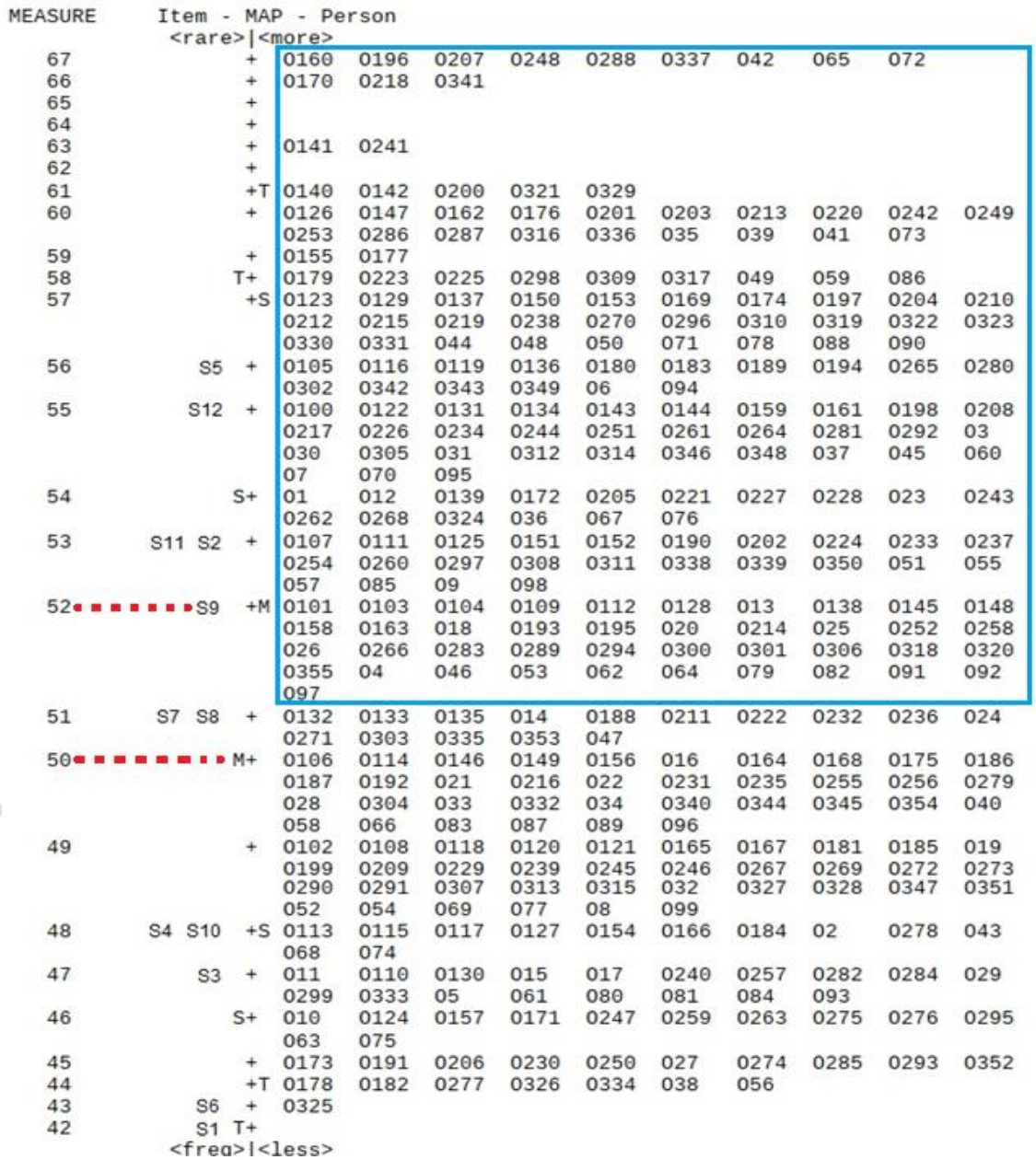


**Figure 3.** Conceptual understanding person-item map

Figure 3 shows a great distribution of the test items according to difficulty level and the person ability level. This distribution indicates that the item and person separation are high and test difficulty is appropriate. On the other hand, since the Winsteps software determines a common measurement value, it makes possible to compare the average values of person ability and item difficulty.

Accordingly, the average measurement values in the distribution is 50 for item difficulty and is 52 for person ability. Consequently, these values are quite close to each other. This indicates that the range of test items is suitable for the group of participants, that is, test items are not too difficult or too easy for students. According to the person-item map, the questions below the average item difficulty (S1-S3-S4-S6-S10) are relatively easy questions, while the questions above the average item difficulty (S2-S5-S7-S8-S9-S11-S12) are relatively difficult questions. On the basis of person's ability, we determined that the questions equal to and above the average person ability were the items coded as S2, S5, S9, S11, S12 (difficult for students), and also the most difficult questions were S5 and S12. On the other hand, although items coded as S7 and S8 are above the average item difficulty, they remain below the average person's ability. Accordingly, items coded as S1, S3, S4, S6, S7, S8 and S10, which are below the average person ability, are easy questions for students. The questions coded as S1 and S6, which all participants responded correctly, are below the lowest person ability.

Undoubtedly, this assessment is likely to conduct in the context of average person ability and item difficulty measurement for each person. Therefore, these findings of Rasch analysis indicate that RM allows to determine the conceptual understanding level regarding the subject of light.

**Findings on Students' Conceptual Understanding Levels**

The person-item maps can help to identify students with the highest ability and lowest ability. For example, Figure 3 shows that the ability level of many students is even above the item coded as S5, which is determined to be the most difficult question. Therefore, the ability level of students who are above the item coded as S5 in Figure 5 is above the difficulty level of all questions and is at a level that can answer all questions correctly. Among the students who are above the item coded as S5, a total of nine students coded as O42, O65, O72, O160, O196, O207, O248, O288, and O337, have the highest conceptual understanding level. On the other hand, the student coded as O325, which is at the bottom of the person-item map, has the lowest ability.

In Figure 3, the number of students at and above average person ability is 207. Accordingly, 58.3% of the students (207/355*100=58.3) are at or above the level of average person ability. Considering this result, the conceptual understanding level of students about the concept of light is at a medium level. While the questions above the average person ability (S2-S5-S9-S11-S12) are relatively difficult for students, the questions below the average person ability (S1-S3-S4-S6-S7-S8-S10) are easy questions.

In the evaluation of the achievement distribution of the questions, the students have low conceptual understanding abilities in terms of full shadow (S5-S9-S11-S12) and reflaction laws (S2), while they have high conceptual understanding abilities in light diffusion (S1-S10) and the reflaction of light (S3-S4-S6). In addition, the conceptual understanding abilities in the subject of light with a substance (S7-S8) are relatively moderate because the fact that question items coded as S7 and S8 are below the average ability level.

RM also provides a comparison of students' ability with other variables. Figure 4 shows that comparison of students' ability levels with confidence levels. In the Figure 4, the dashed blue lines show the relationship between the students, while the dashed red lines indicate the relationship between the questions.

Figure 4 explains that 275 students (77.5%) answered all questions with a high level of confidence. According to the conceptual understanding person-item map, 58.3% of the students were evaluated in the scientific knowledge category by answering the questions correctly with a high level of confidence. This means that there are students who think that the wrong answers are correct within the group of students with a high level of 77.5% confidence. Students in this group are evaluated in the category of misconception due to their wrong answers.

When Figure 4 was examined in the context of questions, items coded as S1 and S6 are at the lowest difficulty level and were responded highly confidently by all students. In fact, there is a similar situation in questions coded as S3, S4, and S10. Students responded to items coded as S3, S4, and

S10, which were not difficulty to answer, with a high level of confidence. On the other hand, although items coded as S5, S9, S11, and S12 were difficult questions, many students responded these items with a high level of confidence. Responding by students with high confidence in difficult items as well as in easy items indicates that the level of conceptual understanding in these questions is low, but the possibility of misconceptions is high.

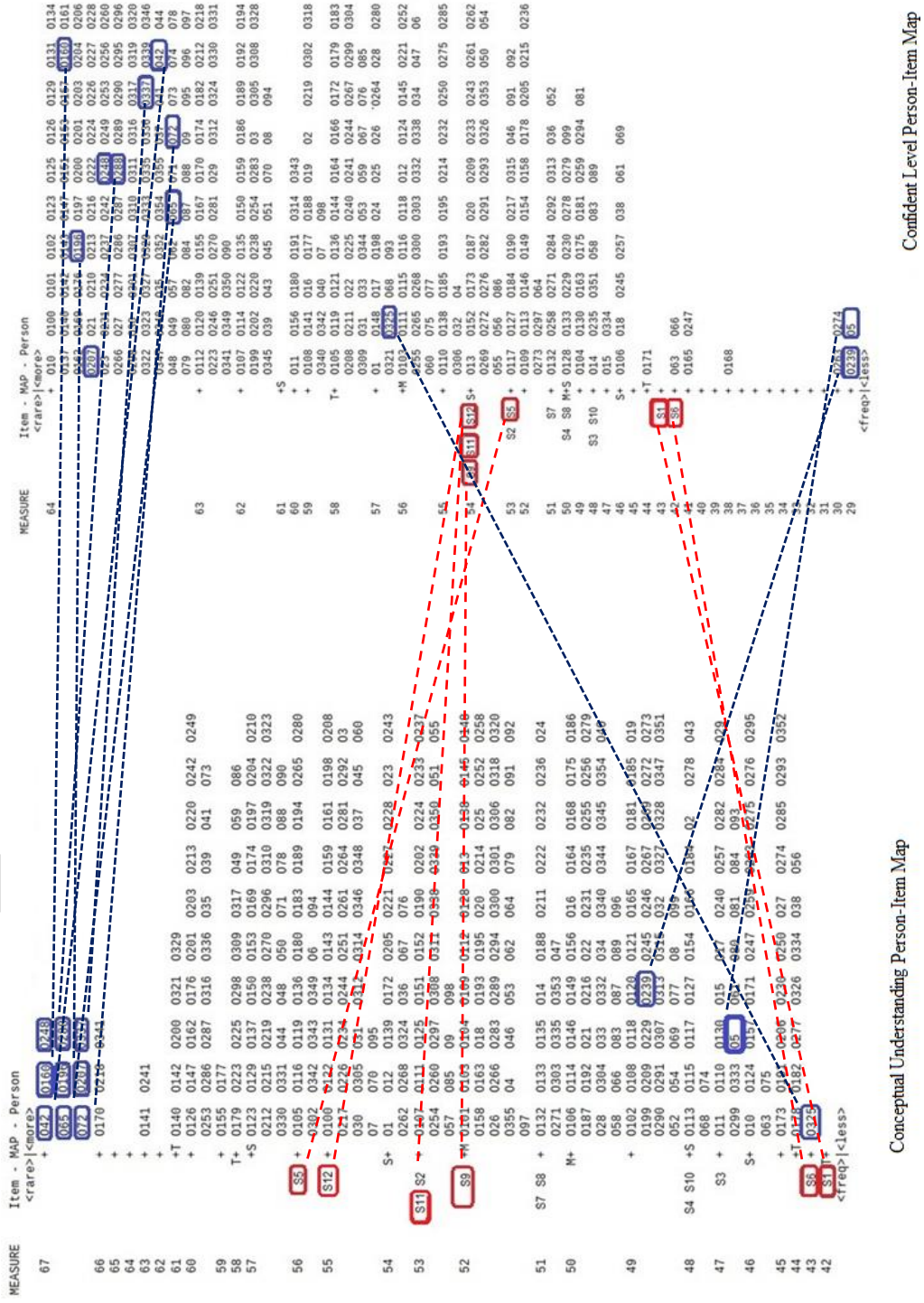


**Figure 4.** Comparison of conceptual understanding and confidence level person-item maps

IOJPE
ISSN: 1300 – 915X
www.iojpe.org
International Online Journal of Primary Education 2021, volume 10, issue 1

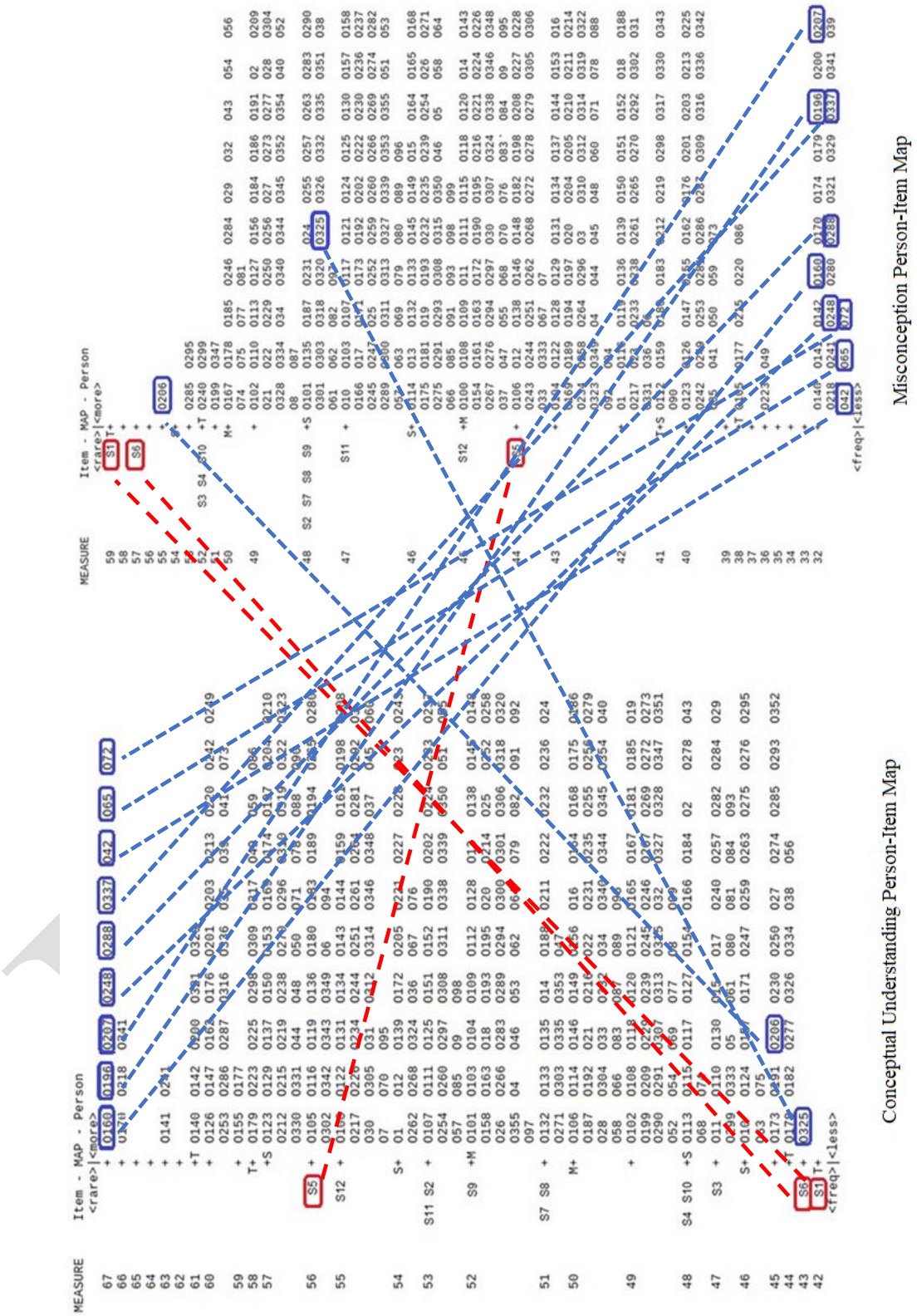


**Figure 5.** Comparison of Conceptual Understanding and Misconception Person-Item Maps

As a result of the comparison of conceptual understanding and confidence level for person ability in Figure 4, students coded as O42, O65, O72, O160, O196, O207, O248, O288, and O337 have the highest person ability and confidence level. This high connection shows that students are at a high cognitive level in terms of conceptual understanding, that scientific knowledge is fully and accurately placed in their cognitive structures, and therefore they are very confident in their responses. On the other hand, student coded as O325 has the lowest ability level and a medium level of confidence in terms of conceptual understanding. This low connection indicates that student coded as O325 does not reach correct answers in terms of conceptual understanding, but is confident in most of the answers to the questions in the test.

As a result of the comparison of conceptual understanding and confidence level's person item maps, achieving the result that students are sure of their answers, even if they respond incorrectly, required a comparison on the misconception person-item map in the continuation of this study.

Figure 5 provides a comparison of the conceptual understanding person-item map and the misconception person-item map. In the evaluation map of the conceptual understanding, the questions that are difficult to answer by the students are at the left top of the map, the questions that are easy to answer are at the left bottom. Moreover, in the misconception person-item map, the questions that are answered incorrectly (the questions with the misconception) are below in right of the map.

According to Figure 5, the question, which is the most difficult to answer and best determines the misconception, is the test item coded as S5. In other words, the students answered the item coded as S5 with the highest rate of misconception. Additionally, the questions that are difficult to answer correctly and that best determine the misconception are the test items coded as S11 and S12 after the question item coded as S5. On the other hand, the questions, which are the easiest questions under all students' abilities and unable to detect the misconception, are the test items coded as S1 and S6. These data coincide with the data obtained from the person-item map analysis.

In Figure 5, students coded as O42, O65, O72, O160, O196, O207, O248, O288, and O337 have high ability in terms of conceptual understanding and have the lowest potential in terms of misconception. Similarly, the findings show that student coded as O325 has the lowest conceptual understanding ability and the highest potential misconceptions, and different student coded as O206 has the highest misconception potential and the lowest conceptual understanding.

## DISCUSSION and CONCLUSION

In this study, we preferred RM, which provides a detailed analysis of the data obtained from the measurement tools and allows the researchers to convey the test-scale performance in the best way (Boone & Noltemeyer, 2017). In this context, we developed a four-tier LCUT with RM and then analyzed the data obtained from this scale. In the development process of LCUT, we provided LCUT's validity and reliability with RM.

In terms of validity, RM analysis provides appropriate data on the construct validity of the measurement tool (Wei, Liu, Wang, & Wang, 2012). Accordingly, we evaluated infit and outfit mnsq statistics to determine the construct validity. All these statistics were in the range of .54-1.39. These results show that all the items in LCUT are in the appropriate range for measurement (Linacre, 2002), and are in harmony. Additionally, we analyzed Ptmea Corr statistics for the consistency between the scores of the students in the test items and their ability measurements. As a result of the analysis, we determined that all items were in the desired range (in the range of .36-.56) and positive. According to the infit and outfit mnsq statistics, all items fit RM very well. As a matter of fact, since Rasch measurement is based on individual response models that reflect individuals' reasoning skills, good model-good data compliance shows that students' reasoning about the measurement tool items is consistent (Wei, Liu, Wang, & Wang, 2012).

When the data fit RM, the test items measure the intended unidimensional structure (Wei, Liu, Wang, & Wang, 2012). RM is a unidimensional measurement model (Eggert & Bögeholz, 2010; Linacre, 2006; Planinic, Ivanjek, & Susac, 2010); unidimensionality is the basic condition of construct validity (Rasch, 1961). In this context, we conducted a unidimensional assessment with the PCA for determining the construct validity of LCUT. Since the results obtained for the explained variance and the unexplained variance are within the specified criteria, we determined that the data showed a unidimensional feature.

To determine the measurement reliability of LCUT, we examined person and item reliability, and also separation coefficient values. First, we determined that the person reliability was .68-.72. We interpreted this reliability in the same way as traditional Cronbach Alpha (Linacre, 2014), and concluded that it was reliable, repeatable, and reasonable value in the .67-.69 measurement range (Fisher, 2007; Zain, Mohd ve El-Qawasmeh, 2011), and therefore the person reliability of IKAT was satisfactory level. In fact, considering CTT perspective, this reliability value may indicate the existence of a strong relationship between the observed person scores and the true scores without errors (Cronbach alpha=.76). Second, we found that item reliability for the quality of test items was .99. In the literature, values of .80 and above are accepted appropriate for item reliability (Fisher, 2007; Linacre, 2014), and therefore we decided that the item reliability of LCUT was appropriate value. The separation coefficient is the spread estimate of items and ability, since they are expressing statistically different levels of performance-difficulty. In the study, we observed that the separation coefficient was 1.61 for the person and 9.80 for the item. In addition, according to Linacre's (2016) guidelines, it is possible to make an assessment by associating the reliability of the person with the level of performance that the test can distinguish (separation unit 3-4 for .90, separation unit 2-3 for .80 and separation unit 1-2 for .50). The person separation coefficient determined as 1.61 indicates that people can be evaluated at two performance levels. Therefore, we can talk about the existence of a match between the person reliability coefficient (.68-.72) and the determined performance levels. Consequently, the fact that the person and item spread estimations specified as the separation coefficient are within the specified criteria also contributes to the reliability of the measurement tool (Duncan et al., 2003; Fisher, 2007; Linacre, 2019).

Rasch analysis has many advantages in determining students' competencies. The most important advantages are the representation of the person and test items on the same equal linear scale (Bond & Fox, 2007). In this way, RM enables the comparison of the ability level of the participants and difficulty level of the test items by matching them to the determined theoretical latent feature with positioning in a common metric (Clements, Sarama, & Liu, 2008). The common metric where the ability level and test items are located is defined as the "Wright Map." In the conceptual understanding person-item map, it was determined that 207 of 355 students were above the average ability level, and that the conceptual understanding level was 58.3%. Therefore, on the map, we observed that the ability level of more than half of the students is above the difficulty level of the questions. Rasch analysis can help to determine the conceptual understanding level with item difficulty level in its model (Wei, Liu & Jia, 2013). Considering this opinion, we found that the students' ability is above the average item difficulty level, that the majority of the students match the items difficulty level very well. In other words, the vast majority of the students have the ability to understand the latent feature to be measured (Baharun et al., 2017). On the other hand, it is possible to find the study findings that the difficulty of the item is higher than the person's ability, and therefore the participants have low conceptual understanding ability (Siang, 2011). In limited studies conducted with Rasch analysis on the concept of light (Aminudin et al., 2019; Mesic et al., 2019), results indicated that the average difficulty level was above the average ability, and the students were at a low conceptual understanding level. Therefore, the study results that were based on the analysis of the four-tier test with RM are important in terms of contributing to the limited study findings in the literature.

The literature emphasizes the need to conduct a confidence level analysis to see to what extent students believe in their abilities (Aminudin et al., 2019). In the confidence level analysis of the study, students answered the questions with a 77.5% confidence level throughout the test. In this context, the study results indicate that students' confidence levels in their answers were quite high. On the other hand, the clear difference between the proportion of students who are evaluated at the scientific knowledge level by responding correctly to all tiers (58.3%) and the confidence level in the test (77.5%) indicates that some students are quite sure of these answers, even if they responded incorrectly. This difference points out the existence of students who are evaluated in the misconception category as well as highly skilled students among high-confidence students. In a comparison of the conceptual understanding person-item map with the misconception person-item map, we determined that the data on the maps confirm each other, and that there was a linear relationship between the students' confidence level and their misconceptions. Indeed, Aminudin et al. (2019) determined that high-ability students are at a low level of misconception and low ability students at a high level of misconception as a result of their studies.

In the comparison of the conceptual understanding level and the difficulty levels of the items, we determined that the students had difficulty in answering some questions of the test (S5-S12), so the difficulty level of these questions was above the ability level of most students. On the other hand, all students answered two questions (S1-S6) of the test, correctly. In other words, the ability level of all students are above the difficulty level of these questions. As a matter of fact, according to the Rasch analysis, the person is more likely to respond to a lower item on the scale and less likely to respond to a higher item on the scale (Boone, 2016). On the other hand, it is possible to determine the students with the lowest and highest conceptual understanding on person-item maps (Bond & Fox, 2007). In this aspect, we determined that the student with the lowest ability in terms of conceptual understanding was student coded as O325, and the students with the highest ability were students coded as O42, O65, O72, O160, O196, O207, O248, O288, and O337. Wright maps allow item difficulty and person ability to be compared (Liu, 2010). As a matter of fact, thanks to the person-item maps showing the data of both participants and test items, the most difficult and easiest questions of the test can be easily determined without the need for another calculation.

In the person-item map of the conceptual understanding, we determined that the seven questions that were above the average item difficulty were the questions that the students had difficulty in answering. We listed these questions in the turn of items coded as S5, S12, S2, S11, S9, S7, and S8 starting from the most difficult one. Items coded as S1, S3, S4, S6, and S10 that are below the average item difficulty level, are the questions that the students have no difficulty in answering. Four questions (S5-S9-S11-S12) in LCUT are to measure students' the conceptual understanding of full shadows. These questions have difficult to answer, therefore, students' conceptual understanding is the lowest level in this test items. As a matter of fact, studies on the concept of light indicate that students have lacks of knowledge about shadow formation and shape (Blizak, Chafiqi & Kendil, 2009; Epik et al., 2002; Galili & Hazan, 2000; Taşlıdere & Eryılmaz, 2015), and factors affecting the shadow formation (Galili & Hazan, 2000), and a full shadow. On the other hand, the most basic concepts in the light diffusion unit are the diffusion and reflaction of light. In this context, the light, which is an integral part of our daily life, and connected concepts are fully and correctly must understand. However, studies display that student's experience mental confusion about light and have low levels of conceptual understanding due to the missing experiences they have in daily life (Ayvacı & Candaş, 2018; Şahin, İpek & Ayas, 2008). In the results of Rasch analysis for LCUT, the ability level of question items coded as S3 (about normal of the surface), S4 and S6 (about reflaction of light on smooth and rough surfaces) are below the average difficulty level. Inadditon, the ability level of question item coded as S2 (about the laws of reflaction) is above the average difficulty level and is challenges for students. These results support the findings of the studies in the literature, which students have a lack of knowledge about the reflaction of light and the laws of reflaction (Aydoslu, 2018, Fariyani, Rusilowati & Sugianto, 2017; Kaplan, 2017; Wahyuningsih, Rusilowati & Hindarto, 2017). For example, Fariyani, Rusilowati, & Sugianto (2017) and Wahyuningsih, Rusilowati, &

Hindarto (2017) determined that students with a low level of conceptual understanding have alternative concepts in terms of laws of reflaction, incoming beam, reflected beam, and normal of surface.

If light encounters a substance, the substances are classified as transparent, translucent, and opaque according to their light transmission. However, the results of study point out that student has lack knowledge in the context of classification of substances to light transmittance. As a matter of fact, in the results of Rasch Analysis, the items coded as S7 and S8 (about light transmission status) are the questions on average item difficulty, but below the average person's ability. Accordingly, we conclude that the students' conceptual understanding level for item coded as S7 and S8 is at a medium level. This result of the study coincides with the studies in the literature and indicates that students have difficulty in classifying substances according to light transmission (Kaplan, 2017). On the other hand, the ability level of question items coded as S1 and S10 (about the diffisuon of light) indicates that students are at a very high level of conceptual understanding.

RM is a theory-based approach to scale development through hypothesis testing (Clements, Sarama & Liu, 2008). The construct validity of the measurement tool is ensured when the data fit RM. To answer the first question of the study, we examined infit and outfit mnsq, point measurement correlation, and reliability statistics. As a result, we observed that these statistical values were within the desired limits. Accordingly, LCUT is a useful measurement tool with measurement reliability and validity that allows measuring the level of conceptual understanding of light. In conclusion, we determined that students' level of conceptual understanding toward the concept of light is above medium level. Overall, the results on the conceptual understanding level by Rasch analysis for LCUT are coherent with studies related to conceptual understanding on light in literature and so, will contribute to the field with this aspect.

**Possible Research Limitations**

There are some potential limitations of the current study. First, RM was used instead of CTT in determining the level of conceptual understanding, but only fifth-grade students and fith-grade Light Unit were preferred for rasch analysis. The results indicate that the measurement tool developed for determining the conceptual understanding level is a valid and reliable measurement tool according to RM, and that the conceptual understanding level can be determined by RM. However, it would be appropriate to compare the analyses with the Light unit and other units, and at other grade levels regarding the effectiveness of RM. On the other hand, multi-tier tests in the literature mostly diagnose misconceptions and present them to the educator. However, in the study, we examined the test parameters of RM on LCUT and so did not diagnose misconceptions. Therefore, the data of the study were limited by the statistical parameters of RM, and RM was not used to determine misconceptions.

**Suggestions for Future Research**

In line with the findings and comments of the research, we suggested in the following:

- Should be given priority to the use of the analyses that is free from the limitations of CTT, conducted within the framework of LTT instead of the analyses based on CTT, as it gives clearer results during the evaluation of the participants.
- Increasing the use of Wright Maps in evaluations based on Rasch analysis will provide satisfying results in terms of evaluation of tests.
- Analysis results based on RM can be confirmed with exploratory and confirmatory factor analyses in the future research.
- The frequent use of multi-tier tests, such as four-tier tests, where the participants can be assessed about how confident they are with their answers rather than multiple-choice tests, will provide more accurate and reliable results in the diagnosis of conceptual understanding and misconceptions.

- It will be beneficial to employ various methods and techniques in order to make the knowledge gained by students' daily life activities permanent in subjects such as light, which is an integral part of daily life.
- Since the data obtained from multi-tier tests are used in the diagnosis of misconceptions, it will be appropriate to conduct the analyses based on RM regarding possible misconceptions.

**Disclosure Statement**
No potential conflict of interest was reported by the authors.

**Data Availability Statement**
The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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ISSN: 1300 – 915X
www.iojpe.org

*International Online Journal of Primary Education* *2021, volume 10, issue 1*

# CLASSROOM TEACHERS' VIEWS ON THE PHYSICAL LEARNING ENVIRONMENTS OF PRIMARY SCHOOLS IN TURKEY

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**Received:** September 02, 2020 **Accepted:** March 19, 2021 **Published:** June 30, 2021

**Suggested Citation:**
Gültekin, M., & Özenç Ira, G. (2021). Classroom teachers' views on the physical learning environments of primary schools in Turkey. *International Online Journal of Primary Education (IOJPE), 10*(1), 180-192.



**Abstract**

School buildings with inadequate infrastructure and old-fashioned architectural styles cause problems, especially in developing countries. This study aims to examine the views of primary school teachers on the physical learning environments of primary schools. A case study method was adopted in this study. The participants of the study consisted of 14 classroom teachers working in rural and urban areas. The synchronous online focus group interviews were conducted using Zoom, a commercial web conference service, as a data collection method. A content analysis method was used in the analysis of the data. The analyses of the semi-structured interviews with the classroom teachers produced four categories-i.e., planning-related shortcomings, infrastructure deficiency, child-friendly schools, and the advantages of these schools. Responses of classroom teachers working in urban areas mostly focused on the crowding of schools. On the other hand, the answers from the classroom teachers working in rural areas mostly focused on the physical infrastructure of primary schools. Furthermore, suggestions from all participants pointed out that primary schools must have a more child-friendly characteristic. The physical learning environments of primary schools require compliance with the needs of modern pedagogy. In light of the findings, some suggestions were have been made for primary schools in Turkey.

**Keywords:** The physical learning environment, primary school, school buildings.

## INTRODUCTION

The term "learning environment" refers to visual, auditory, and kinesthetic factors enhancing the physical aspects of human comprehension (Kopec, 2006). The learning environment influences human behavior and has both direct and indirect impacts on learning and teaching performance (Higgins, Hall, Wall, Woolner, & McCaughey, 2005; Stricherz, 2000; Şensoy & Sağsöz, 2015; Trosper, 2017), which can contribute to holistic development of children (Nair & Fielding, 2013). The learning environments of modern school buildings have been described as aesthetic, appealing, child-friendly, and providing learning pathways (Craissati, Devi Banerjee, King, Lansdown, & Smith, 2007; Higgins et al., 2005), which attracts more attention in the literature and in the school reform initiatives. Within the growing shifts in school facilities, the physical environments of the school include the whole physical spaces of the school where intentionally support comprehension and teaching (Churchill, 2014). From this perspective, stereotyped old-fashioned schools do not allow for multiple interactions between space and pedagogy. Only schools embracing new learning environments could allow to social and individual learning (OECD, 2013). These schools have a powerful effect on developing specific teaching strategies or the discipline in a way that stereotyped old-fashioned schools could not (Wright, Thompson, & Horne, 2021). Therefore, the pedagogy, cognition, and perception play a vital role in the function of the physical learning environment of schools (Pereira, Kowaltowski, & Deliberador, 2018).

The pedagogy plays a decisive role in remodeling school buildings and the function of school places. Today, constructivist approaches (i. e. student-centered education) are adopted, which impacts on the teacher role and the style of use of the physical space. Constructivist approaches focus on the subjective nature of knowledge, individual experience, constructivist activity, teacher-student interaction, and social activity (Stipanovic & Pergantis, 2018). The constructivist approach supports deliberate interactions between students and, in turn, affects the styles and strategies of teaching, like group work and individual work, affecting the physical spaces and places of schools which play a role in facilitating or restricting human actions (Benade, 2019). Thus, modern pedagogy has an extensive demand for redesigning physical learning environments. Nair and Fielding (2013) stressed that the current physical environments of schools should meet the following learning approaches (p.19): Independent study, peer tutoring, team collaborative work, one-on-one learning with teachers, project-based learning, technology-based learning with mobile computers, distance learning, research via the internet with wireless network, student presentations, performance and music-based learning, seminar-style instruction, community service learning, naturalist learning, social/emotional learning, art-based learning, learning by building.

As mentioned above, the current learning environments need common areas where students can work together. In specific corners of the school, students can relax, do reading activities and work independently. Learning areas such as science and art centers and workshops can certainly enhance student's learning. Therefore, the physical learning environments of schools should be developed within the entire school infrastructure. Modern schools that allow the development of 21st-century skills to learners have flexible learning spaces and sustainable design, and provide meaningful community participation (Hanover Research, 2011). Aiming to be more flexible, inclusive, and sustainable, 21st-century school buildings often feature open learning spaces rather than traditional square-shaped classrooms. Physical learning environments are used as optimized by combining various activity areas or replacing them in a multi-purpose way (Bardone & Gargiulo, 2014).Despite improved understanding of the modern school buildings and learning environments, school buildings, having inadequate infrastructure and old-fashioned architectural styles, remain problematic in developing countries such as Turkey (Akbaba & Turhan, 2016; OECD, 2018). However, some school reform initiatives in Turkey have gained momentum in recent years. Some steps have been taken by the Republic of Turkey Ministry of National Education to improve the schools. The Private Education Institutions Standards Directive, including the optional and compulsory spaces in primary schools, is one of them (Republic of Turkey Ministry of National Education, 2020). The Let Schools Be Life Project, like the other, aimed to make schools a livable and safe area as a social center. For this purpose, amongst the Ministry of National Education the Ministry of Forestry and Water Affairs, the Union of Municipalities of Turkey was signed a protocol and was given to the coordination of the Ministry of National Education General Directorate of Lifelong Learning, located in all provinces in Turkey and has been active since the 2011 school year. Let Schools Be Life Project aimed to open schools affiliated with the Ministry of Education to the service of parents and the neighborhood, to transform students and parents into living safe areas, to use schools for sports, cultural and social services, and to reorganize school gardens with afforesting (Republic of Turkey Ministry of National Education, 2020a). Furthermore, Educational Buildings Minimum Design Standards Guide was revised by the Republic of Turkey the Ministry of Education in 2015. This guide stated that its goal was to "construct repaired education and training facilities to meet the expectations and needs of today, by developments in technology in education and training, by the current legislation, region, and plot conditions, in a safe, economical, aesthetic, and accessible environment for everyone to improve the quality of education" (Republic of Turkey Ministry of National Education, 2015, p. 2). In the Republic of Turkey Ministry of Education's 2015-2019 Strategic Plan, the priorities of education venues were to provide sufficient areas for sports and cultural activities (Directorate of Strategy Development, 2015). In addition to these studies, in the Republic of Turkey Ministry of Education's 2019-2023 Strategic Plan document, "school building, garden, gym, laboratories, and other such

facilities" have been stated in the priority areas (Republic of Turkey Ministry of National Education, 2019b).

Although given educational policies can evaluated as positive developments, the literature indicated the need to improve the physical conditions of primary schools in Turkey (Başar, 2000; Akbaba & Turhan, 2016; Radmard, Karataş, & Öksüz-Gül, 2021; Yılmaz, 2012). Schools need to meet the requirements of modern education. The school buildings are typical and old-fashioned. Schools should be restructured to develop individualized education and to support teaching and learning since the functionality of the learning environment depends on how it is structured and organized. A well-designed school encourages better student performance and makes a strong statement to the general public about the importance of education. For this reason, school buildings are a crucial factor in educational growth (Mcmichael, 2004). Given the importance for educational growth of the physical learning environments, restructuring of current school buildings is essential and this study sought to understand the classroom teacher's views that might help to alleviate the problem of school reconstruction. Although an increasing number of scientific studies focusing on the importance of physical conditions of schools, knowledge on the conditions of primary schools (according to rural and urban schools) is insufficient. Correspondingly, this study aimed to examine the views of primary school teachers on the conditions of physical learning environments of primary schools. To this end, the authors sought to answer the following questions:

1. What are the views of classroom teachers working in a rural area and those working in an urban area about the conditions of physical learning environments of primary schools?
2. What do classroom teachers working in a rural area and those working in an urban area suggest for enhancement of physical facilities of primary schools?

## METHOD

### Research Design

In this study, a qualitative approach was adopted to provide a deeper understanding of the views of classroom teachers regarding the conditions of the physical learning environments of primary schools in Turkey. The study was designed by a case study method, exploring a bounded system or multiple bounded systems (Merriam, 2009). This methodology allows for researchers to understand the case themselves through an interpretation of the data (Creswell, 2007). This is why, in this study, each condition of rural and urban primary schools is specified as 'the case'. A case study requires the study of a real-life, a contemporary context or setting; because of that, interview techniques, focus group interviews, and document analysis are used predominantly (Creswell, 2013).

### Participants

The participants of the study consisted of 14 primary school teachers who participated voluntarily. The participants were chosen using maximum variation sampling, one of the purposeful sampling strategies, providing 'high-quality, detailed descriptions of each case useful for documenting uniqueness, and important shared patterns that cut across cases and derive their significance from having emerged out of heterogeneity' (Patton, 2002, p. 235). The participating teachers were determined through criterion sampling. The study inclusion criteria for participants were (1) voluntary participation, and (2) serving as a classroom teacher in rural and urban areas. The participants of the study were divided into two groups as those working in a rural area and those working in an urban area in order to be able to compare the views of the participants more clearly. The descriptive information of the participants was presented in Table 1.

According to Table 1, three of the participants were women. Six participants have completed a master's degree. All participants have been teaching primary school students for at least four years. Six of them have been working in rural areas. Primary school teachers from the western and eastern regions of Turkey participated in the study.

**Table 1.** Participant's descriptive information

| Participant | Gender | Grade | Education Level | Professional Experience (Year) | Location |
|---|---|---|---|---|---|
| Emrah | Male | 1 | BSc | 13 | Adıyaman (in an urban area) |
| Serhat | Male | 4 | MSc | 16 | Adıyaman (in a rural area) |
| Hasan | Male | 3 | BSc | 18 | Adıyaman (in an urban area) |
| Çağrı | Male | 4 | BSc | 4 | Ağrı (in a rural area) |
| Suat | Male | 2 | MSc | 4 | Ağrı (in a rural area) |
| Özge | Female | 1 | BSc | 11 | Çanakkale (in an urban area) |
| Seniha | Female | 2 | BSc | 13 | Çanakkale (in an urban area) |
| Gökhan | Male | 4 | BSc | 36 | Çanakkale (in an urban area) |
| Mehmet | Male | 3 | BSc | 30 | Çanakkale (in an urban area) |
| Faruk | Male | 3 | BSc | 10 | Gaziantep (in a rural area) |
| Murat | Male | 4 | MSc | 16 | Gaziantep (in an urban area) |
| Aslı | Female | 2 | MSc | 16 | İstanbul (in an urban area) |
| Kenan | Male | 2 | MSc | 13 | Kahramanmaraş (in an urban area) |
| Veli | Male | 4 | MSc | 15 | Malatya (in an urban area) |

* The names of the participants replaced with pseudonyms.

### Data collection

In the study, an introductory form and standardized interview techniques were used to collect data. The interview questions were prepared by the researchers after literature reviews. In the literature, 21st-century learning environments are depicted as a social environment, physical environment, and digital environment (EDUSPACES21, 2016). In the study, the interview questions focused on the physical learning environments of primary schools. The interview consisted of five open-ended questions.

The synchronous online focus group interviews were conducted using Zoom, a commercial web conferencing service, as a data collection method. The focus group interview was used to obtain in-depth information through a discussion and unstructured interview, using the effect of group dynamics in an environment where individuals can express themselves freely. The focus group interview aims to collect rich data in a social context (Patton, 2002). The interviews lasted 90 minutes, totaling 180 minutes. Interviews were finished once data saturation had been achieved. All interviews were videotaped and transcribed with the permission of participants.

### Data analysis

In this study, a content analysis method was used, referring to 'any data reduction and sense-making effort that takes some qualitative material and attempts to identify core consistencies and meanings' (Patton, 2002, p. 453). When analyzing the data, the researchers followed three steps as suggested by Merriam (2009); creating categories, sorting categories, and naming categories. After all interviews were transcribed to the Microsoft Word program, the researchers independently encoded the data, and categorized it according to themes to ensure reliability. Second, they reviewed their codes and themes together. Lastly, codes and themes were edited and interpreted. In order to provide internal validity of the study, the member control technique was used during data collection. Direct quotes from classroom teachers were added to study to ensure external validity.

## FINDINGS

In this section, the themes emerging from the data within the scope of the research questions were presented under two topics; views on the physical learning environments of primary schools, and suggestions for enhancement the physical facilities of primary schools.

**Views on the physical learning environments of primary schools**

The teachers were asked what their views were regarding the physical learning environments of primary schools. The analysis of their responses shows that the responses from both groups can be divided into four categories: planning-related shortcomings, infrastructure deficiency, child-friendly schools, and the advantages of these schools. The views on the physical learning environments of primary schools were presented in Table 2.

**Table 2.** Views on the physical learning environments of primary schools

| Primary school teachers working in urban area | | Primary school teachers working in rural area | |
|---|---|---|---|
| **Answers** | ***f*** | **Answers** | ***f*** |
| *Planning-related shortcomings* | | *Planning-related shortcomings* | |
| Schools with shared yards | 2 | Schools with shared yards | 2 |
| Transforming secondary and high schools into primary schools | 2 | Adding a new school building to the school area | 1 |
| Overcrowded schools | 4 | Overcrowded schools | 2 |
| Total | 8 | School location | 1 |
| *Infrastructure deficiency* | | Total | 6 |
| Acoustic insulation | 1 | *Infrastructure deficiency* | |
| Classrooms and other physical learning areas (art, sport, and welcoming areas) | 11 | Classrooms and other physical learning areas (art, sport, and welcoming areas) | 6 |
| Heating | 2 | Heating | 3 |
| Technology | 1 | Technology | 2 |
| Equipment | 5 | Equipment | 5 |
| Security | 2 | Hygiene | 2 |
| Total | 22 | Total | 18 |
| *Child-friendly schools* | | *Child-friendly schools* | |
| Attractiveness | 5 | Attractiveness | 4 |
| Green spaces and soil at the school courtyard | 7 | Green spaces and soil at the school courtyard | 2 |
| Child-scale areas | 4 | Child-scale areas | 1 |
| Community-connected areas | 1 | Community-connected areas | 2 |
| A building with minimal floors | 3 | Sports, culture, and arts | 2 |
| Total | 26 | Total | 13 |
| *Advantages* | | *Advantages* | |
| Technology | 3 | Technology | 1 |
| Large playground | 1 | A building with minimal floors | 1 |
| Hygiene | 1 | Indoor sports hall | 1 |
| Indoor sports hall | 1 | Total | 3 |
| Visual art room | 1 | | |
| Drama room | 1 | | |
| Total | 8 | | |

The answers about planning-related shortcomings pointed out primary and secondary school buildings with shared yards, transforming secondary and high schools into primary schools, overcrowded schools, and adding a new school building to the school area. The participants stated that the proximity of primary and secondary school buildings create some problems for all students to benefit from the playground. The answers given by Çağrı, and Emrah were as follows:

> *The primary school and secondary school, unfortunately, share the same building. We see the disadvantages of this, especially during the breaks, that primary and secondary school students cannot move comfortably* (Çağrı).

> *We use the playground with middle school. We are experiencing the troubles that middle school students suffer. All students find it challenging to benefit from the same playground* (Emrah).

Transforming secondary and high schools into primary schools also causes primary school children to be educated in a school that does not meet their developmental needs. A similar planning issue restricting to meet the developmental needs of students is to add a new school building to the school area, causing the schoolyards to shrink. In addition, the location and environmental conditions of the school are mentioned in the teacher response. The answers from Murat, and Serhat were as follows:

> *Our school was first a high school building. It became primary school later. The trucks are passing in front of our school* (Murat).
>
> *The population of Kahta district is 80,000-90,000. Although some regions are newly developed, there is no detailed planning. For example, a new school building is added to a standard schoolyard* (Serhat).

The overcrowding of schools is the main problem affecting directly students' learning and childhood development. The participants' views demonstrate that primary schools in an urban area are the most affected by this problem. Overcrowding of schools can restrict the provision of education and training in classrooms, resulting in insufficient playgrounds areas and security problems. The responses of participants show that schools were more crowded in urban areas. The answers given by Serhat and Veli were as follows:

> *There are 20 classrooms in our school. Several classes overlap as students step onto the playground for physical education class* (Serhat).
>
> *Especially in Adıyaman, Urfa, and Gaziantep, there is an increase in the number of students due to immigration. Besides, there is migration from villages to cities. The number of students in village schools is fewer, and the number of students in central schools is very high* (Veli).
>
> *The place that causes bullying among students at school is mostly the school canteen. In the school canteen, older students challenge younger students. In our school, living spaces are lacking, with constantly limited opportunities, there is inevitably tension among the children at school. There are 700-800 students in primary school. The school capacity is not enough for this number of students. We cannot do education and training under these circumstances. When the bell rings, it becomes very difficult to observe our students due to the crowd* (Kenan).

The answers about infrastructure insufficiency of primary schools include acoustic insulation, inadequate physical learning environments, heating, technology, equipment, security, and hygiene. The lack of infrastructure of primary schools in rural and urban areas points to crucial points regarding the effective learning and teaching practices in schools. The answers from the participants were as follows:

> *Since our school building is older, physical environments are not sufficient. The school was built in 1975. There is no place for sports, artistic performances, storage* (Mehmet).
>
> *We did not have a library at the school. We have only an archive room. We are trying to get our radiators repaired* (Suat).
>
> *There are no empty classrooms or rooms in our school. There were three under the stairs to store the belongings found in our school, we organize them as storage. We even arranged the staircase on the ground floor like a tea room. Unfortunately, we do not have any room for a playground, or library or any activity outside the classroom* (Faruk).
>
> *There are 11 stair ramps on five floors of the school. Therefore it is not safe. Students occasionally fall and get injured. The school is old and not earthquake-proof. In the last two or three years, There have been major earthquakes in Elazığ and Malatya in the last 2-3 years. Our school was also affected by these earthquakes. The cracking occurred in the walls. The inspectors stated that this was okay* (Hasan).

> *We don't have a place for theater or music at school. However, the families in the school where I work are sending their children to courses outside of school because of the high economic situation, and make up for this deficiency of the school* (Kenan).

According to teachers' views, child-friendly schools include attractiveness, green spaces and soil at the school courtyard, children-scale areas, community-connected areas, a building with minimal floors, as well as sports, culture, and arts. The views of participants were presented as follows:

> *The school is built as a rectangular box and the school architecture is unappealing. Right and left classes are lined up, the classic school is here* (Hasan).
>
> *More vivid and interesting colors should be used in primary schools. The classroom environment should be transformed into environments where the imagination and creativity of children are supported by removing only the table and the board* (Özge).
>
> *In our student days, the classes turned it into reinforced concrete due to the mud. This was good for cleaning but not for children's games* (Kenan).
>
> *We have a 6-storey building. The playground covered by asphalt is a problem for children. There is no green space in our school* (Aslı).
>
> *The desks in the classrooms are quite old, some high and some low; they are not suitable for students. There is only one basketball hoop in the playgrounds and it is not suitable for children. For this reason, children do not enjoy the game they play* (Kenan).
>
> *I think the school where I work is small and has few floors, which is suitable for primary school children* (Seniha).
>
> *We can only host parents in our classrooms or use areas such as a warehouse. This situation affects parents' opinions about the school. We do not have an area where we can organize activities with parents outside of school, and we do not have such a point of view* (Kenan).

The participants' responses point out how primary schools in urban areas have more advantages in terms of physical learning environments. Many schools in the city have a sports halls, drama rooms, and libraries. The participants' answers about the advantages of their schools are as follows:

> *There is an English class, gym class, painting class. I think these areas are beneficial for children* (Seniha).
>
> *There is a theater area (stage) in the basement of the school. We use this scene on certain days and weeks* (Aslı).
>
> *It is an advantage that our school has two floors. Children do not have difficulty entering the classroom during break. The school where I used to work was a five-storey school. It was not a suitable building for primary school students. Compared to other schools in the district center, our school has enough school courtyards* (Hasan).
>
> *In recent years, large investments such as Fatih Project have been made by the government to improve the physical and technological infrastructure of schools. However, it is still not enough. The technological infrastructure of schools in rural areas needs to be improved* (Veli).
>
> *We bought projectors and computers for our classes with our own means. Many teachers at my school use their own projectors and computers. By the way, there is an effort to bring smart boards to the classrooms within the Fatih Project, and this is a good development* (Hasan).

**Suggestions for enhancement of physical facilities of primary schools**

The answers of participants delineated that although primary schools in urban areas were more crowded, rural primary schools have more infrastructure deficiency. Child-friendly areas are needed for both schools. To minimize these problems, suggestions for improving the physical facilities of primary schools were given in Table 3.

The participants' suggestions are as follows:

> *We cannot provide the education we want due to the physical inadequacy of the school. We can provide classical/traditional education* (Gökhan).
>
> *We organize competitions, trips to support children's social interactions. We arrange folk dances, choir, gymnastics courses, and intelligence games. With these activities, the physical conditions of our schools have improved over the last five years* (Mehmet).
>
> *There is no point in having a single school entry. An entire building should have more than one exit door. It doesn't make much sense to me that children enter and exit the same door in a restricted way. If there is more than one exit door, it will provide us much more comfort for evacuation in an event such as an earthquake* (Kenan).

**Table 3.** Suggestions for improving the physical facilities of primary schools

| **Primary school teachers working in urban area** | | **Primary school teachers working in rural area** | |
|---|---|---|---|
| **Answers** | ***f*** | ***Answers*** | ***f*** |
| Elimination of physical infrastructure deficiencies | 7 | Elimination of physical infrastructure deficiencies | 4 |
| Supporting the physical environments to modern education approaches | 2 | Supporting the physical environments to modern education approaches | 2 |
| Renovation, the rebuilding of the school | | Renovation, the rebuilding of the school | |
| Increasing teacher competencies for effective use of learning spaces | 2 | Increasing teacher competencies for effective use of learning spaces | 2 |
| Not rushing to open schools if the infrastructure is not completed. | 2 | Not rushing to open schools if the infrastructure is not completed. | 1 |
| Tracking the shortcomings of newly opened schools | 2 | Tracking the shortcomings of newly opened schools | 1 |
| Determining the number of students in schools according to the capacity of the school | 4 | Supporting the curriculum the effective use of learning spaces | 1 |
| Schools have multiple entrances | 2 | Areas reserved for out-of-class activities | 1 |
| Taking stakeholders' views in the design of school buildings | 2 | Total | 12 |
| Covering the school floor with soft material | 2 | | |
| The playgrounds in kindergartens for primary schools | 1 | | |
| Wider classes | 1 | | |
| Using every area of the school as a learning area | 1 | | |
| Reflection of regional features to the architectural structure | 1 | | |
| Teachers' room where students can be observed | 1 | | |
| Total | 30 | | |

## DISCUSSION and CONCLUSION

Today, the developing understanding of physical learning environments has provided the basis for the restructuring of schools around the world. Nevertheless, there are steps that must be taken in primary school buildings, especially in developing countries, to support the physical learning environments to encourage the development of children. This study aimed to investigate primary school teachers' views on the physical learning environments of primary schools. For this purpose, six classroom teachers working in urban areas, and eight classroom teachers working in rural areas were interviewed. Teachers' views on the physical learning environments of primary schools are divided into four categories: as planning-related shortcomings, infrastructure deficiency, child-friendly schools, and the advantages of these schools. The answers from the classroom teachers working in urban areas mostly

focused on the crowding of schools and classrooms. On the other hand, the answers of classroom teachers working in rural areas generally focused on the physical infrastructure of primary schools. The participating teachers specifically cited the deficiency of physical infrastructure facilities. This result is compatible with PISA 2015 report results emphasizing the lacking of educational materials and the physical infrastructures of schools of Turkey. This report pointed out that the lack or insufficiency of textbooks, technology equipment, library, or laboratory materials and the physical infrastructure of the school disrupt the educational activities (Hacettepe University, 2020). A vast body of research utters a truism about the importance of the school infrastructure to meet the needs of modern schools. Even though scientific studies do not indicate a direct link between student achievements and advanced facilities, it indicate that student achievement is lower in poor school infrastructure (Stricherz, 2000). It is alarming that the findings reflect the quantitative fact about school facilities over a decade ago and implicate urgent needs of school infrastructures.

A key finding from this study that multi-storey school buildings, the transformation of high schools or secondary schools into primary school buildings, and the lack of large space allocated for schools, crowded student population minimize the use of the physical learning environments effectively. These findings are very valuable in that the physical structure of the school can affect students' attitudes and behaviors as well as social interaction (Frith, 2015). Various studies conducted in Turkey pointed to similar results obtained from this study. Highlights of the literature with the results of this research include; insufficient support of physical learning areas to learning (Akbaba & Turhan, 2016; Yılmaz, 2012); technological infrastructure deficiency (Göçen, Eral, & Bücük, 2020), crowded schools (Köse & Barkul, 2012); the deficiencies of playgrounds (Akbaba & Turhan, 2016; Işıkoğlu-Erdoğan & Şimşek, 2014; Şişman & Gültürk, 2011). The findings of the study revealed that the school was crowded in indoor circulation areas. Furthermore, the responses of the participants pointed out that the indoor circulation areas of the schools should be large and allow for freedom of movement. Furthermore, physical spaces should allow for flexible arrangements in the classroom to minimize infrastructure problems and make the optimum use of school and (or) classroom spaces. Şensoy and Sağsöz (2015) on the design of flexible classrooms; proposed that two classrooms can be combined as needed, and that physical space arrangement can be made for collaborative work through moving walls to better implement the constructivist teaching approach in learning areas. These results reveal that the building structure characteristics of primary schools in both rural and urban areas strongly impact the provision of contemporary education and training. The answers from the teachers on the advantages pointed out that the FATİH project contributed to schools in terms of the technological infrastructure.

As another critical finding of the study is that primary school buildings should have a structure that supports the physical, affective, cognitive, kinesthetic, and intellectual development of primary school children, that is; primary school buildings should be child-friendly. Child-friendly schools envisage making a physical arrangement that meets the needs of the child for different learning styles and physical characteristics. For this, there should be areas, classrooms, and equipment suitable for children between the ages of 6-10 in primary schools. A child who has just started primary school should be able to participate in a wide learning community with the school's facilities. Schools should support the interaction between children and adults positively to adapt to social life. The prominent concept at this point is that spaces allow interaction, in other words, they contain community-related areas (Nair & Fielding, 2013). Schools allow direct or conscious interactions with the community, making it easier for children and adults to be included in the school community on certain days and events. The community-related areas of school can make it easier for children to model school belonging and positive behavior patterns. Similarly, Güner and Kartal (2020) recommend that the physical learning environments of schools should support teacher-child-family interaction.

Another critical finding of the study is attractiveness. Teachers stated that primary school-age children do not perceive schools as attractive places. The teachers reported that they paid attention to the attention of children in terms of classroom layout, color of the cabinets, shape and color of the

materials used. Additionally, the answers from teachers showed that the architectural characteristics of the school are not very suitable for children. The fact that schools are arranged attracted and suitably is related to a positive attitude towards schools (Adıgüzel, 2012), which in turn, has the potential to enhance student learning (Higgins et al., 2005). It can be stated that after pre-school education, primary schools are a less attractive and motivating place for pupils in Turkey. Similarly, Göçen, Eral, and Bücük's (2020) study reveal that the architecture of buildings and the characteristics of physical learning environments should encourage children to develop positive attitudes towards learning. Thus, these results provide important clues for redesigning primary schools according to the aesthetic tastes of the child.

The findings of the study also revealed that the most important learning area emphasized by the participants emerges as the playground, where children socialize by playing. It was emphasized by the participants that the playgrounds should be especially rich in equipment; the ground should be covered with soft surfaces such as grass, soil or rubber. Many participants reported that there were no toys or benches in the playgrounds. One participant (Aslı) stated that having a park-like playground in kindergartens would be very valuable for primary school children. The participants stressed that the playgrounds should provide opportunities for children to learn about ecology and nature. The Turkish primary school curricula aim to develop knowledge, skills and attitudes about science literacy of children. For this purpose, out of school activities such as planting seedlings and growing vegetables in playgrounds have the potential to support children's learning in various ways. However, further understanding of the potential contribution of this subject to the child development in primary school contexts is needed. Thus, Radmard, Karataş, and Öksüz-Gül (2021) stressed that to improve students' environmental literacy and to provide more sustainable schools and ecological learning concepts should have a more prevalent place in academic works in Turkey. Primary schools should create opportunities for the implementation of eco pedagogy.

The last findings of the study were suggestions offered by teachers to improve the quality of physical learning environments of primary schools. All participating teachers agreed that physical infrastructure deficiencies should be eliminated, physical learning areas should support modern educational approaches, and old schools should be rebuilt. Furthermore, teacher competencies should be increased to benefit from learning areas in the most effective way. In this context, the views of the participants revealed the security problem of schools, crowdedness, and improvement of the playground. The participants expressed the views on reflecting regional features to the architectural structure, taking the views of teachers in the design of the physical learning environments of the schools, and the children's scale of the schools (small, low-rise, the suitability of the materials to children). It has been reported that the curriculum should especially support activity areas where children can interact with the community. These results are compatible with the literature. The scientific studies indicated that the arrangement of primary school buildings and classrooms contributes the development of students' basic language skills (Tanner, 2009), and wider and more orienting corridors resulted in better learning progress. Thus, the physical areas of school should be wider to movement and circulation. In this study, participants stated the importance of wider scale areas for student development. Besides, participants indicated the using of individual display to promote child's interest for school. Previous studies have confirmed that individual display also plays a role in developing a sense of belonging of children, and the layout of classroom impacts on attitudes to express of children, and the importance of environmental arrangements for individual differences (Barrett, Davies, Zhang, & Barrett, 2015). Finally, the findings of this study pointed out the conflict between the current teaching approach and learning environments, similar to the findings of previous studies (Mellor, 2016).

**Limitations of the Study**

Although this study descripts the views of classroom teachers, it had some limitations. First of all, the study was designed with a case study; the data collection method was focus group interviews only. The data triangulation may contribute to achieving a broad picture of the conditions of primary schools. The second limitation of the study is the sample size. Despite the maximization of participants

working in rural and urban schools from the east and west regions of Turkey have the potential to give some common and exclusive findings, the sample size (the participants) could be larger to provide a higher level of data saturation. Despite the qualitative study allow analytical generalization to draw theoretical inferences from the findings (Yıldırım & Şimşek, 2016), fewer participants can be at risk for data saturation.

**Implications and Recommendations**

The following implications can be given for the physical learning environments of primary schools:

- First of all, the infrastructure problems of the schools should be solved and the schools should be restructured.
- Classes should be large enough to accommodate individual and group work.
- Primary schools should not be crowded.
- Primary school buildings should have minimal floors.
- Primary schools should be an area of interest for students. Therefore, students' views should be taken into account in the architectural and physical space arrangements of the school. 21st-century schools can be the basis for necessary adjustments.
- Primary schools should be an area where students socialize. For this, the playground, classrooms and common areas of the school should meet the social needs of the students.
- Schools must be safe. Safe schools should not be thought of as places only monitored by cameras. Furthermore, the fact that the interactive environments in the school allow social interaction, adult support, and more activities for children to help create a safe school.
- The school and the ground should be environmentally compatible and sufficient to facilitate the curriculum.
- Cafeterias should be large enough to reduce crowded accommodation.
- There should be special areas in the school that welcome parents.
- Playgrounds should be large so that primary and secondary school students can be separated from each other.
- Teachers should be informed about the arrangement of learning environments so that they can effectively benefit from all areas of the school.

**Ethical Considerations**

An ethical approval was obtained from the Ethics Committee to conduct the study (Project number: E-30237869-050.99-66327).

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IOJPE

ISSN: 1300 – 915X
www.iojpe.org

*International Online Journal of Primary Education* *2021, volume 10, issue 1*

# INVESTIGATION OF THE VIEWS OF PRE-SERVICE TURKISH TEACHERS IN TERMS OF SPEED READING

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**Received:** June 25, 2020 **Accepted:** September 19, 2020 **Published:** June 30, 2021

**Suggested Citation:**
Geçgel, H., Kana, F., & Yalçın Akkaş, İ. (2021). Investigation of the views of pre-service Turkish teachers in terms of speed reading. *International Online Journal of Primary Education (IOJPE), 10*(1), 193-206.



**Abstract**

The aim of this study is to reveal the views of pre-service Turkish teachers in terms of the speed reading. To that extent, case study design was adopted in the research. The study group consists of 85 3rd and 4th grade pre-service teachers from a state university in the West of Turkey. A semi-structured interview form was used as a data collection tool in the research. The descriptive analysis method was used in the data analysis of the research. Accordingly, speed reading is a requisite in Turkish teacher education. Most of the pre-service teachers consider speed reading as an essential ability. Some participants stated that they had a high concentration level when reading. The participants claim that speed reading will improve their exam performance, allow them to save time and, to read more books, and it will also contribute them in their future professions.

**Keywords:** Reading, speed reading, reading speed, pre-service Turkish teachers.

## INTRODUCTION

Today, there is a great deal of information that needs to be accessed in an extremely limited time. Books, newspapers, magazines, articles, business-related reports, e-mails have become indispensable parts of daily life as well as the internet and social media. People need new methods that will help individuals to save time to spend for all these responsibilities in a 24-hour time slot, and one of these methods is speed reading. When speed reading is mentioned, biases come into people's mind and a reading type independent from comprehension is recalled. However, reading cannot be thought without comprehension. To better understand speed reading, it is necessary to know the concept of reading well first.

According to Gündüz and Şimşek (2011), reading is an activity of seeing, perceiving, understanding, and making sense of words, sentences or a text with all its elements. They do not mean basic reading, but functional reading, which enhances one's world of feeling and thought. In this respect, reading makes important contributions to the development of personality and the enrichment of individual and social life. Reading is an activity that enables knowledge, development, and fun. It consists of the functions of the brain such as vision, perception, vocalization, comprehension, and configuration. Harris and Sipay (1990, p. 10) describe reading as meaningfully interpreting the language of writing. Dökmen (1994, p. 15) states that reading is not all about seeing words and sentences, but that mental

activities must occur for reading to take place. Güneş (2009, p. 3) referred to reading as decoding writings. In addition to this statement, he expressed that reading is about capturing the generic meaning and so fronted silent reading. According to the constructivist educational approach applied in the Turkish language curriculum since 2005, reading has been treated as a process that improves mental structure.

According to the constructivist approach, reading is an active process in which the individual creates new meanings by integrating the information in the texts one reads with preliminary information and expands vocabulary. In this process, individuals explore, interpret and remake sense of the meaning of the writings. The process of reading is mental and complex. Accordingly, individuals use various mental processes such as sorting, classifying, associating, questioning, analysis-synthesis, evaluation. The information passed through these processes is re-interpreted with the preliminary information of the individual and subjected to a new process (Güneş, 2009, p. 3). Reading is the best way to manage the reading process. A good reader determines the important information in the text s/he reads, integrates the new information with his / her preliminary information, makes inferences, interprets and relates it to daily life (Ateş, Güray, Döğmeci, & Gürsoy, 2016). Individuals need to have high-level thinking skills to make inferences from the text (Özdemir & Kiroğlu, 2019).

Gündüz and Şimşek (2011:145-161) define speed reading as a text length and a type of visual reading that can be done in unit time. Arıcı (2012) defines speed reading as reading many words in a given time. According to Ruşen (2006), speed reading increases the level of comprehension of individuals by the number of words they read. Maviş (2006: 73) describes reading speed as the duration of reading by understanding a text and states that reading speed is determined by the reader's purpose, comprehension strength, the difficulty level of the subject and material. Speed reading is known in society as the number of words an individual reading in a minute. In the constructivist approach, speed reading is the research, discovery, interpretation, re-interpretation of lines, which are called writing, and their configuration in the mind. Speed reading is not a simple form of reading, but a process that works as a mental process by understanding (Güneş, 2009, p. 5). Research on speed reading (Akçamete, 1989; Dökmen, 1994; Tazebay, 1997; Avcıoğlu, 2000; Coşkun, 2002; Dedebali, 2008; Karadağ, Keskin, & Arı, 2019) focused on the number of words read by the individual. Richadeau, Gauquelin, and Gauquelin (1990, p. 39-40) express that our eyes move forward by making leaps and pauses on the text.

Kavcar, Oğuzkan, and Sever (1995) and Ruşen (2006) emphasize that eye training and visual perception are important in speed reading. Akyol (2007) emphasizes habits in speed reading, while Brook (1936) emphasizes that line length is important. Ruşen (2006, p. 49) states that the basis of reading is the individual's desire to acquire new knowledge or the idea that previous knowledge must be reinforced. In addition to speed of reading, it is also important to understand what is read (Tazebay, 1995; Güneş, 2000; Garland & Çalışkan 2004). When the post-graduate research on speed reading are examined (Dedebali, 2008; Bozan, 2012; Ciftcibasi, 2013; Kaçar, 2015; Soysal, 2015; Ilter, 2018; Torppa, Vasalampi, Eklund, Sulkunen, & Niemi, 2018; Astari, 2019; Babayiğit, 2019; Çelik, 2019; Mergen, 2019; Muñoz, Vejarano, & Vargas, 2019; Yurdakal, 2019; Bergmann, & Bristle, 2020; Durukan, 2020) many studies with secondary school and high school students were conducted. In contrary, no study was conducted at universities. In this respect, this study aims to determine the opinions of pre-service Turkish teachers about fast reading. For this purpose, answers to the following questions have been investigated in this study:

1. What is the reading speed of pre-service Turkish teachers?
2. What is the perception of pre-service Turkish teachers about their own level of reading?
3. What kind of activities do pre-service Turkish teachers intend to do about speed reading?
4. Is speed reading seen as a need for pre-service Turkish teachers?
5. What do pre-service Turkish teachers think about the articles that should be read in a short time?
6. What are the reading concentration levels of preservice Turkish teachers?

7. How is the relationship between preservice Turkish teacher reading speeds and comprehension levels?
8. What are the opinions of preservice Turkish teachers on speed reading?

## METHOD

### Research Design

The case study design was used in this research. The case study is expressed as an in-depth investigation and description of a current situation (Merriam, 2013, p. 40). In a case study, there is a case of an intensive study of an event about how and why questions are being answered in case studies. In the study, the opinions of the pre-service teachers about speed reading were examined which is one of the methods of reading skills included in the four basic language skills. When pre-service teachers start their profession following their graduation, they will give their students speed reading techniques and ask them to read and understand texts quickly. Getting their opinion on speed reading before they start their profession will allow them to experience awareness regarding this process.

### Research Group

In the study, a simple random sampling method was used (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2014). In this study, 85 pre-service Turkish teachers who studied during the 2019-2020 academic year were selected as a sampling group.

### Data Collection

A semi-structured interview form was presented to the students in the study. The interview form consists of questions which has been prepared by the researchers and reviewed by the faculty members who experts in their field. A semi-structured interview form was administered to the students after the interview questions were received from the field experts. In accordance with the feedback received from the student, the questions were revised and modified.

### Data Analysis

The data in the study was obtained by interview form. Then, the codes were analyzed by considering categories. Descriptive analysis was used to evaluate interview forms. Descriptive analysis is the encoding of qualitative data based on a predetermined framework (Büyüköztürk et al., 2014, p. 240). The data obtained in the research were analyzed in accordance with the pre-determined themes.

### Validity and Reliability of Research

To ensure the structural validity of the research, pre-service teachers with different grade point averages and different levels were included in the research. The data obtained in the study were analyzed by different researchers, ensuring that the findings and analyses were consistent with each other. To ensure the internal validity of the study, the data obtained from the study group were included in the findings section via extracts. The findings of the study were generalized to ensure the external validity. To ensure the internal reliability of the research, some other researchers examined and verified the data (Merriam, 2013).

### Ethical Consideration

The permission of the Ethics Committee for the research was obtained by the resolution of the Social Sciences and Educational Sciences Ethics Committee at Çanakkale Onsekiz Mart University dated 16.04.2020 No. 03. Besides, the participants of the study declared that they participated voluntarily in the research.

## RESULTS

In this part of the study, the views of pre-service Turkish teachers in terms of speed reading were examined.

**Speed Reading Competencies**

**Table 1.** Opinions of pre-service Turkish teachers about their reading speed competency

| Codes | *f* (79) |
|---|---|
| Yes, I consider my reading speed is sufficient. | 45 |
| No, I do not consider my reading speed is sufficient | 30 |
| I consider it is partly sufficient/ It could be a lit bit quicker/Average | 10 |

When Table 1 was examined, it was seen that pre-service Turkish teachers (n=45) find their reading speed enough. In contrary, some students do not find their reading speeds enough (n=30), some others find their reading speed partially enough. Those who said, "Yes, I consider my reading speed sufficient." expressed their opinion as:

*"Yes, I consider it is sufficient. For example, I can finish a novel book in average thickness. I do not have any problem with solving paragraph questions"* (A12).

*"I consider it is sufficient. When I start to read a book, I can finish it in a very short time. I did not have any difficulty in finishing the exams that I had in the past."* (A15).

*"I do not consider it is sufficient. I consider I can read neither quick or slow. I think that I have stabilized my reading skill as I can understand what I read"* (A18).

*"I consider my reading speed is sufficient because I can solve questions very quickly. The only problem with my reading is that I do not understand what I read. I mean, the questions that I solve after a quick reading are often wrong."* (A25).

*"I consider it is sufficient because I read for fun. As I read the books that I like, I have no intention to read them very quickly. Just opposite, I like reading them slowly, having fun."* (A24).

Those who said "No, I do not consider my reading speed is sufficient." express their opinion as follows:

*"I am not a good reader. I do not consider I am sufficient in that because it requires too many different texts."* (A1).

*"I do not consider it is sufficient for exams, but I am very comfortable when I am reading a novel. I feel nervous when I must compete in exams; therefore, I may not understand what I read. I am not concerned with how fast I read when I am reading books. I am engrossed in the book and forget about all the rest."* (A22).

*"I do not consider it is sufficient because I cannot understand what I am reading when I read fast. I spend time as much as necessary for reading rather than spending more. I do not have much time to go back when I am solving questions or reading book."* (A23).

Those who said "I consider it is partly sufficient/it could be a little bit faster/average" expressed their opinion as:

*"I consider my reading speed is at an average level. I consider my reading speed satisfactory when I am reading and having fun. However, I do not consider my reading speed is enough especially when I have to finish reading something in a very limited time."* (A9).

*"I consider it is partly sufficient although it is not too slow because human always wants to be faster no matter how fast they are. I also want to be faster."* (A44).

Although pre-service teachers consider their reading speed enough, there are also pre-service teachers who do not see their reading speed enough.

**The Level of Being Reader**

**Table 2**. Opinions of pre-service teachers regarding being a reader no matter if they are a good or bad one

| Codes | *f* (85) |
|---|---|
| I fell myself as a good reader. | 53 |
| I fell myself as a bad reader. | 15 |
| I fell myself as an average reader. | 14 |
| It changes based on time and condition. | 1 |
| I find it useless to put myself in a category. | 2 |

When the table 2 was examined, pre-service Turkish teachers (n=53) express that they consider themselves to be good readers. Some pre-service teachers think of themselves as bad readers (n=15) and who think they are average readers (n=14). Some think it differs based on time and conditions if they are good or bad readers, and some do not put themselves in any category. Those who said I consider I am a good reader" expressed their opinions as follows:

*"I am a good reader because I never give a break when I am reading. If I have started, I finish it. Then I immediately start a new book. I cannot stay away from books."* (A3).

*"I consider that I am slightly a good reader. The reason why I say "slightly" is that I cannot spare much time to reading. Except those, I can read long texts on various topics. There are news sources I keenly follow."* (A22).

*"I consider I am a good reader. There have been no exams which I took and failed to finish all the questions on time. My immediate friends also say that I read fast. In general, I am a good reader because I immediately buy or find a new book when I do not have any to read. I am very careful about finishing a book that I have started."* (A36).

*"I consider I am a good reader. The advantage that it brings about is that I am studying at the department. To be honest, I was the kind of person who liked reading before I started to study at this department."* (A44).

Those who said "I consider I am a bad reader" expressed their opinions as:

*"I am generally a bad reader. It is not a habit for me to read. The books that I read are not various."* (A5).

*"I do not consider it is insufficient. This makes me neither good nor bad because it limits me in the things that I plan to do even if it satisfies me. Therefore, it is not sufficient."* (A16).

Those who said "I consider I am an average reader" expressed their opinions as:

*"I am not one of the bad readers. I do not avoid reading. I like reading and talking about what I have read, but I cannot claim that I am a very good reader. There are better readers than I am."* (A15).

*"I consider I am an average reader. The book series I like consists of three books and I finished it in two days. I consider it was normal considering that the average page number of each was 300. However, it took me weeks to finish a thin book (Açlık Oyunları), which was made obligatory by the school (Sergüzeşt)* (A19).

Those who said "It changes based on time and conditions" expressed their opinion as:

*"My mind regarding these changes from time to time because I sometimes read very much, and I feel I read very fast and I am a good reader. However, I feel my reading speed went back."* (A2).

When the opinions of the teacher candidates are examined, the teacher candidates generally see themselves as good readers.

**Speed Reading Activities**

**Table 3.** Opinions of pre-service teachers regarding the activities they have executed, or they plan to improve their reading speed.

| Codes | f (84) |
|---|---|
| I participated. | 5 |
| I participated; I am thinking of participating. | 1 |
| I participated; I do not think that I will participate. | 1 |
| I did not participate. | 4 |
| I did not participate; I do not think I will participate | 44 |
| I did not participate; I do not think I will participate. | 29 |

When Table 3 was examined, pre-service Turkish teachers (n=44) were found not to have participated in any seminar, congress, course etc., and they did not intend to participate in the future. Some pre-service teachers have not previously participated in an activity related to speed reading and are not considering participating (n=29). Those who said: "I participated; I don't think I will participate." expressed their opinions as:

*"The thing that I do about speed reading is normal reading because I speed up reading and my vocabulary treasure extends."* (A3). *"There were such activities when I was in secondary and high school. Therefore, I can claim that am a speed reader. I received training on speed reading."* (A28).

*"I received training on speed reading. I benefitted a lot from it. But I do not care about reading fast very much. I prefer reading and interpreting the meaning to speed reading. I think everything is fast enough. I prefer to be left alone and read."* (A69).

Those who said "I did not participate; I think I will participate" expressed their opinions as:

*"I never thought about it before. I am trying to improve it by reading a lot. However, I have started to think about receiving training on speed reading. I only need to see the outcomes of the training that I would receive."* (A9).

*"I thought about it when I was in high school. There was a training session on speed reading. My reading speed was not so slow at those times. However, I still thought that I needed to improve it. However, I did not receive any training on that. Now I am thing about it. Why not?"* (A16).

*"I am not thinking about participating anything paid. I would participate in any seminar or congress if they are on education if they teach me how to read fast, how I can be more beneficial to my students, advantages and disadvantages. If I believe that they would be beneficial upon such briefing, I can receive such training, but they should be free of charge, you know we are students."* (A19).

Those who said "I did not participate; I do not think I will participate" expressed their opinion as:

*"I have never thought about any activity. I can improve myself reading more."* (A4).

*"Speed reading is a need for me, not a target. I do not feel any need to participate in such activities as I read for fun."* (A24).

The pre-service teachers did not participate in activities related to speed reading and do not think to participate.

**Need for Speed Reading**

**Table 4.** Opinions of pre-service teachers regarding speed reading

| Codes | *f* (84) |
|---|---|
| Yes, I feel it is a need. | 67 |
| No, I do not think it is a need. | 12 |
| I am neutral. | 2 |
| Partly. | 2 |
| Sometimes. | 1 |

When Table 4 was examined, pre-service Turkish teachers (n=67) consider speed reading necessary. Some do not consider speed reading necessary (n=12). Some are neutral about the need for speed reading, those who partly or sometimes consider it as a need. Those who said "Yes, I consider it as a need" expressed their opinion as:

*"I think speed reading is necessary for every individual. I want to be able to read fast especially in important exams to save time."* (A5).

*"Maybe, this outcome will contribute positively to me. In the exam, I can be faster especially in paragraph type questions and have an advantage over others. Thus, I have a chance to go back to the unanswered questions."* (A67).

*"I certainly consider it is a need. We use reading skill in every aspect of our life. As we, as teachers, will be responsible for helping our students gain these skills, we are supposed to have such skills first. We save more time in this way."* (A23).

*"Speed reading is a need in today's conditions because there is too much information that we need to learn and there are many books to read. Due to the other responsibilities that we are supposed to fulfil, speed reading techniques may facilitate our task."* (A80).

*"Yes, I consider. Because I think that there are many things that I do not know about speed reading techniques. It helps me be more conscious. I can teach my students when I become a teacher."* (A13).

*"It is not an urgent need actually, but it is a need which may be beneficial to everyone as it is to me. Speed reading is a habit which may help me gain psychomotor skills. It is also helpful in improving thinking skills"* (A16).

Those who said "No, I do not consider it is a need" expressed their opinions as:

*"No. I can read as fast as I need. I do not need more than that. Speed reading is not important but the quality of reading and understanding what you read is."* (A24).

*"I think it will open new doors to my personal development rather than being need."* (A31).

*"Speed reading is not a need. But it may be beneficial in personal development by saving time."* (A58).

Those who said "partly" expressed their opinions as:

*"Partly. I spend too much time reading. I do not have so much time. But I have no concern about reading and finishing a book very quickly. I have fun reading both novel and history book. The time that I spend is very valuable."* (A14).

*"Speed reading helps us in exams. Except for exams, I consider it is better to read slowly and understand what you read rather than speed reading."* (A79).

When the opinions of the teacher candidates were examined, it was stated that the pre-service teachers saw speed reading as a need.

**Text Reading Processes**

**Table 5.** Opinions of pre-service Turkish teachers regarding long texts which need to be read in a very short time

| Codes | *f* (83) |
|---|---|
| Yes, it bores. | 52 |
| No, it does not bore. | 13 |
| It bores sometimes. | 18 |

When Table 5 was examined, it is seen that some think that "texts, articles, books, etc., which they are too long to read and need to be read in a short time are boring" (n=52); those who do not think that

they are boring (n=13), and those who sometimes find it boring (n=18). Those who said "Yes, it bores" expressed their opinions as:

*"It bores. Because a book of a text can be free when it is read. The books that are read as they have been assigned as homework may push people away from reading."* (A3).

*"Yes, some texts bore me out. The reason for that is that they contain too many terminologies specific to some fields, and difficult language used in texts may negatively affect readers."* (A5).

*"Yes, because I prefer reading at the time and place which I want. I do not like anything beyond my control, as I do not like reading the things which are beyond my interest. I cannot focus on what I read"* (A16).

Those who said "No, it does not bore" expressed their opinion as:

*"It does not bore me out as I have the habit of reading. I have experienced such cases before, and I read all of them sparing enough time for each."* (A27).

*"If I have to read this, and if I am aware of its necessity, it does not bore me out. If the topic is beautiful and attracts me, it does not bore me."* (A28).

Those who said "Sometimes it bores" expressed their opinion as:

*"It does not bore me as I like reading a lot. I may get bored if I read long and boring texts."* (A20).

*"It sometimes bores and sometimes does not because it changes depending on whether the text is of my interest or not or my preparedness."* (A23).

*"I feel bored sometimes but if the text is of my interest or an attracting one, I cannot even understand how fast I read"* (A29).

The preservice teachers stated that long texts bored them. While the pre-service teachers and students are reading texts, they pay attention to the length of the texts.

**Level of Focusing on the Read Texts**

**Table 6.** Opinions of pre-service Turkish teachers regarding the level of concentration that they have

| Codes | *f* (85) |
|---|---|
| High level. | 13 |
| Enough. | 8 |
| Average level. | 14 |
| Low level. | 15 |
| Changing. | 35 |

When Table 6 was examined, it was seen that there are those (n=35) who think that their concentration level varies according to situation and conditions, those who find their concentration level high (n=13), those who find their concentration level sufficient (n=8), average (n=14), and low (n=15) those who said "high level" expressed their opinion as:

*"I have deep concentration when I am reading because of the topic and way of writing are important factors for me. I do not want to miss any of them."* (A3).

*"I completely get isolated from the outer world when I am reading. I act as the third person watching the events in the book. I do not have any problem with concentrating on what I read."* (A16).

*"I do not see or hear any distractor around me when I am reading. After I start reading, if it is a book, I completely concentrate on the book. If it is a paragraph, I concentrate on it at the time when I start reading. But I may have to read two or more times in exams because of the stress I have to have full concentration."* (A19).

Those who said Average level" expressed their opinions as:

*"I think my concentration level is average. It changes depending on the text that I read."* (A66).

Those who said "low level" expressed their opinion as:

*"I lose my concentration very easily. I have a concentration problem. My concentration level is a little bit problematic."* (A25).

*"I do not think that I have good concentration, I can easily lose my concentration." (A62)*

Those who said "changing." expressed their opinion as:

*"It changes depending on what I read. I can easily concentrate if it is something short to read. My concentration level decreases when I read long texts."* (A1).

*"My concentration level changes depending on the situation I am in. If I am at a comfortable level with a peaceful mind, I can concentrate and read better. I think I am better at that."* (A8).

*"The language used in a book is the most determining factor. I read a good book very carefully and curiously."* (A14).

Pre-service Turkish teachers stated that their concentration levels generally changed. Each pre-service Turkish teacher stated that their level of concentration on the texts they read is different.

**Reading Speed and Comprehension Levels**

When Table 7 was examined, it was seen that pre-service Turkish teachers (n=28) think that there is an inverse proportion between reading speed and comprehension level. Some think that there is parallelism between reading speed and comprehension level (n=26), that reading at normal speed will help them understand better (n=15), and that this relationship is variable.

**Table 7.** Opinions of pre-service Turkish teachers regarding the relationship between their reading speed and their comprehension levels

| Codes | f (84) |
|---|---|
| Reading speed and comprehension is parallel with one another. | 26 |
| There is an inverse proportion between reading and speed. | 28 |
| I understand better at normal speed. | 15 |
| Good | 5 |
| The relationship between reading speed and comprehension is changeable. | 10 |

Those who said, "Reading speed and comprehension rate are parallel." expressed their opinion as:

*"My reading speed and comprehension level are directly proportional, so as I read faster, I do not löse anything in comprehension and I have more fun reading."* (A8).

*"When I have full concentration, my reading speed and comprehension level come to a balance. I understand every word and sentence when reading. I can have a mental image of what I have read."* (A16).

*"I believe that I have improved my reading speed with the book that I bought and read last summer. Therefore, I can read faster, and I have realized that I understand faster and more comfortable when I read fast."* (A27).

*"My reading speed and comprehension level are directly proportional. As my reading speed increases, my comprehension level also increases."* (A29).

Those who said "there is an inverse proportion between reading speed" expressed their opinion as:

*"Reading fast sometimes affects my comprehension level. I fail to achieve reading fast and storing what is important in the read text"* (A1).

*"When my reading speed sometimes exceeds my comprehension level, I tend to reread texts. I happen to waste time because of that."* (A5).

Those who said "I understand well at normal speed" expressed their opinion as:

*"Without reading fast, I can understand words and sentences, paragraphs in the first reading. This is closely related to how interesting the text is. I think I can read a hundred-page book in one hour or 80 minutes."* (A19).

*"I start to ruminate if I read slowly. I go back and reread, which causes a waste of time. If I read very fast, I cannot fully understand the content. I feel that I can fully understand what I read when I read at an average speed."* (A46).

Those who said the relationship between reading speed and comprehension is changeable" expressed their opinion as:

*"When I concentrate on the text that I am reading, I can both read fast and understand what I am reading. If I ski through a text which is not of my interest as my perception level decreases."* (A2).

*"If the topic and content are very interesting, my reading and comprehension level increase."* (A14).

Pre-service teachers have different opinions about reading speed and comprehension rate. They stated that the relationship between speed and comprehension rate varies. They think they will understand when they read fast.

**Advantages of Speed Reading**

**Table 8.** Views of pre-service Turkish teachers regarding the advantages of speed reading

| **Codes** | ***f* (152)** |
|---|---|
| I read more books. | 31 |
| My performance in exams increase. | 30 |
| It helps save time. | 29 |
| My comprehension level increases. | 10 |
| It is beneficial. | 9 |
| It helps my personal development. | 4 |
| My speaking ability improves. | 4 |
| It provides Professional advantage and it is a necessity. | 4 |
| It provides an advantage. | 3 |
| I feel bored less when I am reading. | 2 |
| It improves my communication skills. | 2 |
| My vocabulary treasure improves. | 2 |
| My point of view is developed. | 2 |
| My imagination power improves. | 2 |
| I can think practically and make up my mind very quickly. | 2 |
| My interest in reading increases/my reading speeds up | 2 |
| I can find the answers very practically. | 1 |
| It helps me think fast. | 1 |
| It increases my life quality. | 1 |
| It facilitates my life. | 1 |
| It improves my thinking skill. | 1 |
| My achievement increases in many fields. | 1 |
| The joy I have from reading increases and become more intellectual. | 1 |
| MY reading skills improve. | 1 |
| My comprehension skill improves. | 1 |
| I can study more. | 1 |
| My reading skill improves. | 1 |
| I can read the homework, article etc. better faster. | 1 |
| I feel better. | 1 |
| My self-confidence increases. | 1 |

When Table 8 was examined, pre-service Turkish teachers (n=31) think that speed reading will bring the advantage of more book reading. Some think that speed reading will improve their exam performance (n=30), save their time (n=29), increase their level of comprehension (n=10), be useful (N=9).

The opinions of pre-service teachers regarding this issue are as follows:

*"If I read fast, I feel more motivated to read more and I also save time. Speed reading provides me with many advantages. In brief, it makes life easier. Of course, it is a necessity of my profession."* (A1).

*"I believe that it will bring any contributions in the short term and long term. I believe that it will contribute to my exam performance positively."* (A7).

*"Reading fast and understanding what you read brings many advantages for readers. The increase in comprehension level, thinking very practical quick decision making etc. contribute to us in many ways."* (A8).

*"It saves time. It improves thinking skill. It supports imagination power. It helps gain reading habit. All of this help teach both students and their parents as part of our profession."* (A16).

*"We will take the KPSS exam very soon. The faster we read questions in the exam and the better we understand them, the more beneficial they will be. In addition to these, there are many books and texts that we need to read as tur Turkish teachers of the future. Speed reading will help us to accomplish all these."* (A18).

*"It will help me overcome the stress resulted from the KPSS exam and time management in the exam. In the long run, it helps me speed up my reading and helping more students get informed about speed reading, reading books and articles."* (A23).

The preservice teachers stated that fast reading has many advantages. They stated that they can be successful both in their lessons and in their private lives thanks to these advantages.

## DISCUSSION and CONCLUSION

Speed reading is a skill of training. For the sake of being a fast reader, it is not desirable to increase reading speed superficially (Güneş, 2009: 11). The pre-service teachers who participated in the research stated that they considered themselves enough in speed reading. They state that they have lost their ability to read fast in the environments such as noise, distraction and stress while skimming through the texts with many words with their eyes and solving the paragraph questions. In an overview of the research results (Karadağ, Keskin & Arı, 2019; Bergmann & Bristle, 2020), it is seen once again that the reading rate and accurate word recognition are critical for a qualified skill of reading/comprehension. Speed develops more quickly in the training of speed-reading techniques, and comprehension follows it. Speed reading exercises should be performed for at least twenty-one days for comprehension to take place and the speed to settle permanently. Harris and Sipay (1990), who think that speed reading can be taught, state that for this, we must know some of the characteristics of the student population that we have.

Pre-service teachers who consider themselves good reader claim that they do not give break while reading, and they prefer to qualify works, write long articles on different subjects. Pre-service teachers have stated that they do not receive professional support for speed reading, that vocabulary is important in speed reading, and that they are considering taking special courses on the issue. Some pre-service teachers state that everything in their lives is fast, and reading does not need to be so fast. According to Dökmen (1994), the reading speed of high school students was determined to be 136.4 words per minute and the reading speed of university students was found to be 145.4 words per minute. The findings of researches (Akçamete, 1989; Coşkun, 2002; Babayiğit, 2019; Bergmann & Bristle, 2020; Durukan, 2020) revealed that the text type was effective at the reading speed and comprehension level of the students. Bozan (2012) and Bergmann & Bristle (2020) stated that the reading speed and reading comprehension levels of the students involved in the study were found to be low and that there was a great need for further studies on this subject.

Pre-service teachers think that speed reading is a need to be able to take exams more quickly and become better equipped for their profession. Students preparing for exams, people who must follow the printed press, professionals who want to improve themselves, especially teachers, anyone who is anxious to manage time more efficiently, who competes with time, can participate in speed reading training. It is possible for students who often take exams to succeed in exams using their time allocated for each question appropriately (Gündüz & Şimşek 2011; Ilter, 2018; Mergen, 2019; Muñoz, Vejarano & Vargas, 2019). Pre-service teachers state that they read more books thanks to speed reading, their exam performance increases, they save time, and their comprehension levels increase.

Pre-service Turkish teachers feel that they get bored when they must read too long texts, too tick books and too long articles. They claim that nobody can be forced to read, some texts have a difficult language, so they cannot read fast, and they can't concentrate on the texts they read. They state the most important reason for their inability to concentrate on the texts they read as a distraction. In a research conducted by Kemiksiz (2019) and Astari (2019), pre-service teachers with positive perceptions of speed reading emphasized the facilitative role of speed reading in one's life and stated that those who use this skill can improve themselves and compete with other people through this development.

As a result, speed reading is a skill training. Speed reading techniques can be applied to improve reading speed and readers' comprehension rate. Many of the pre-service Turkish teachers who find their reading speed enough or who do not find it enough also see speed reading as a need. A few of the participants stated that they had a high concentration level when reading. Participants claimed that speed reading would improve their exam performance, save time, and benefit from professional and personal development.

Many pre-service Turkish teachers who find their reading speed enough compare themselves to their surroundings. What makes them feel they are enough or fast is they are reading faster or more books than those around them. They use a subjective criterion by evaluating in this way. However, there are no clear values or objective criteria for reading speeds.

Some pre-service Turkish teachers who previously received training on speed reading and those who did not are also in doubt about the realization of speed reading and how useful it will be. Some of them think, "I read for pleasure, speed reading is unnecessary", while others think, "I already read regularly, so I can increase my reading speed by reading more." However, research shows that reading speed will be increased by 30% by reading more. Speed reading techniques can increase their speed at least twice, while those who receive good training on these techniques and work to improve their skills increase their reading speed more than twice or even 1000 words per minute.

Many pre-service Turkish teachers who find their reading speed enough or who do not find it enough also see speed reading as a need. Very few of the participants stated that they had a high concentration level when reading. Participants say that speed reading will improve their exam performance, save time, read more books, and benefit from their professional and personal development.

Pre-service Turkish teacher stated that they did not receive speed reading training at the university. Education about speed reading should be given in teacher training. Experimental studies about speed reading should be done. It should be noted that the texts in Turkish textbooks should not be too long.

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IOJPE

ISSN: 1300 – 915X
www.iojpe.org

*International Online Journal of Primary Education* *2021, volume 10, issue 1*

# EXAMINATION OF THE EFFECTIVENESS OF NATURALISTIC TEACHING EDUCATION PROGRAM DEVELOPED FOR PRE-SCHOOL TEACHERS IN TURKEY

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**Received:** September 17, 2020 **Accepted:** January 11, 2021 **Published:** June 30, 2021

**Suggested Citation:**
Çelik, S., Diken, İ. H., & Gürgür, H. (2021). Examination of the effectiveness of naturalistic teaching education program developed for pre-school teachers in Turkey. *International Online Journal of Primary Education (IOJPE), 10*(1), 207-234.



**Abstract**

In the current study, face-to-face and web-based naturalistic teaching teacher education program for pre-school teachers (NTEPP), who are among the main stakeholders of inclusive education, was developed and examined its effectiveness on teacher outcomes (naturalistic teaching knowledge level, interactional behavior levels, and level of using naturalistic teaching strategies in the education processes). In addition, opinions the targeted teachers on the programs were gathered. A total of 30 teachers in the Face-to-Face (Experimental-1=14) and Web-based (Experimental-2=16) NTEPP groups participated in the study, which was designed with the "embedded design, one of the mixed research methods." In the study, face-to-face and web-based programs were found to be effective in increasing teachers' total scores for naturalistic teaching knowledge, interactional behaviors, and naturalistic teaching strategies used in leisure time and art activities. However, the results revealed that the face-to-face education program had a more permanent effect on the total scores for naturalistic teaching knowledge and naturalistic teaching strategies used in leisure time activities compared to the web-based program. Accordingly, it was determined that web-based programs, the contents of which were designed with visual and written materials, could be as effective as face-to-face programs on teachers' targeted performance levels. Finally, it was observed that teachers' opinions on the programs were quite positive.

**Keywords:** Inclusive education, inclusive pre-school education, naturalistic teaching approach, professional development.

## INTRODUCTION

Naturalistic teaching is defined as an approach/process in which teaching is embedded in the natural daily lives of children (e.g., daily routine, activities and transitions for school and home settings; Charlop-Christy, LeBlanc, and Carpenter, 1999; Halle, Albert, and Anderson, 1984; Koegel, O'Dell, and Koegel, 1987). This approach is an "evidence-based" practice and is based on "developmentally appropriate principles" (National Professional Development Center [NPDC], 2014; National Autism Center [NAC], 2015). This approach has increasingly become important in inclusive pre-school education in recent years in that it can be easily implemented without disrupting the education process, includes appropriate principles for child development, and ensures the easy reinforcement and generalization of skills and behaviors (Allen & Cowan, 2008; Dunst, Raab, & Trivette, 2011; McWilliam, 2016; Rakap, 2019; Rakap & Parlak-Rakap, 2011). According to the results of studies, the lack of knowledge and education of teachers is among the main systemic problems experienced in the inclusive pre-school education and that the naturalistic teaching approach is among the key issues

on which knowledge and education are needed (Bruder, 2016; Sucuoğlu, Bakkaloğlu, İşçen-Karasu, Demir, & Akalın, 2013). Therefore, especially in recent years, in order to eliminate their lack of knowledge and education in the process, researchers aimed to develop programs including the teaching of evidence-based practices such as naturalistic teaching to pre-school teachers in inclusive education (Aldemir, 2017; Dick, 2017; Rakap, 2019; Storie, Grygas-Coogle, Rahn, & Riggie-Ottley, 2017; Ünal, 2018).

In recent years, it has begun to be discussed which components and presentation forms should and to what the content of teacher education programs should be prepared (Bruder, 2016). In fact, "face-to-face" education programs that were called as traditional methods in the early years have been replaced by different forms of presentation such as "web-based programs". In addition, education programs have turned into "multi-component" programs supported by several ways such as coaching, counseling, and providing feedback on performance (Aldemir, 2017; Dick, 2017; Gianoumis, Seiverling, & Sturmey, 2012; Harjusola-Webb, & Hess Robbins, 2012; Pianta, Mashburn, Downer, Hamre, & Justice, 2008; Tate, Thompson, & McKerchar, 2005; Ünal, 2018). In this context, web-based programs, which are independent of time and space, can be followed individually and can spread all over the countries, have increasingly gained momentum (Storie et al., 2017; Ünal, 2018). Moreover, "web-based education programs," an alternative education approach, have been becoming more important since the education and training process is being conducted at home due to the COVID-19 pandemic, and in such cases that may occur later. At this point, the contents of these programs designed in different ways have also started to be supported with many different visual and written materials (Dick, 2017; Harjusola et al., 2012; Rakap, 2019). Furthermore, although the effects of these programs designed with different forms of presentation and various materials on targeted teacher behaviors have been compared in recent studies, which practices are more "maintened", "efficient" and "useful/functional" has started to be discussed (e.g., Dick, 2017; Frantz, 2017; Rakap, 2019; Stahmer, Rieth, Lee, Reisinger, Mandell, & Connell, 2015; Ünal, 2018). However, both in the international literature and Turkish literature, there is no study in which natural teaching strategies, methods and techniques were used as a "package teacher training program" with guidebooks, expert and sample application videos, and the effect of this package program has been examined. Furthermore, there is no study compare the effectiveness and maintenance of the naturalistic teaching teacher education program which was developed with two different presentation styles (face-to-face and web-based), with the data obtained from many quantitative and qualitative data collection procedures. Such a study can be a guide for how pre-school teachers in inclusive education will be able to improve their professional skills with regard to evidence-based practices such as naturalistic teaching in the best way. In addition, this study may contribute to the development of quality proceses in inclusive pre-school education institutions. The aim of the current study was to develop to evaluate the effectiveness of a "*Face-to-Face and Web-based Pre-School Naturalistic Teaching Teacher Education Program (NTEPP)*" for pre-school teachers in inclusive education in Turkey. In line with this aim, answers to the following research questions were sought:

1. What are the opinions of pre-school teachers regarding their knowledge and experience in inclusive education and the naturalistic teaching process?
2. Is there a significant difference between the total scores for naturalistic teaching knowledge of pre-school teachers in inclusive education, who participated in the Face-to-Face NTEPP (Experimental-1 group) and Web-based NTEPP (Experimental-2 group), in the pre-test, post-test and follow-up measurements in-group and between-group?
3. Is there a significant difference between the total scores for interactional behaviors of pre-school teachers in inclusive education, who participated in the Face-to-Face NTEPP (Experimental-1 group) and Web-based NTEPP (Experimental-2 group), in the pre-test, post-test and follow-up measurements in-group and between-group?
4. Is there a significant difference between the total scores for naturalistic teaching strategies used in the classrooms of pre-school teachers in inclusive education, who participated in the

Face-to-Face NTEPP (Experimental-1 group) and Web-based NTEPP (Experimental-2 group), in the pre-test, post-test and follow-up measurements in-group and between-group?

5. What are the opinions of pre-school teachers in inclusive education about the NTEPP (social validity) offered in two different ways: face-to-face and web-based?

## METHOD

### Research Design

This study was designed with the "*embedded design, one of the mixed research methods*." This study was based on a quasi-experimental process. The qualitative data collection techniques were embedded in this process to support and diversify quantitative data (e.g., focus group interviews), and thus, multi quantitative and qualitative data were collected simultaneously in the process. The formulized expression of the research method is Quantitive (+qualititative) (Cresswell, 2011; 2014; Morse, 1991). The embedded design scheme of the study is presented in Figure 1.

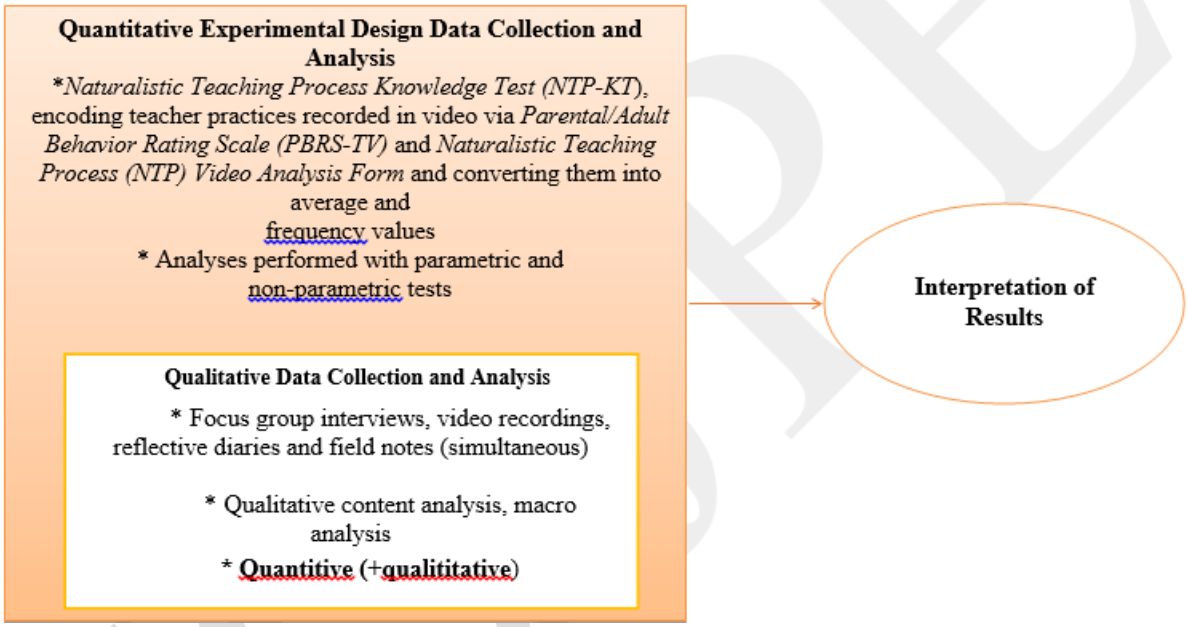


**Figure 1.** The embedded design scheme of the study (adapted to study from Creswell, 2011, p. 541.)

The research process, the visual of which is presented in Figure 1, can be summarized as follows: Focus group interviews were conducted with the participants before and after the implementation of the education programs. In the pre-implementation interviews, the prior knowledge, opinions and experiences of the participants regarding inclusive education and naturalistic teaching practices were determined, and the need for education programs was revealed. In the post-implementation interviews, experience, opinions, suggestions regarding the completed education programs were received; thus, social validity data were also obtained. Simultaneously with this process, the participants' naturalistic teaching knowledge levels were measured with NTP-KT in three different measurements consisting of pre-test, post-test and follow-up, and the practices they performed in their classrooms were video-recorded in two different activities, leisure time and art activities. During the implementation of the programs, data were collected through weekly reflective diaries related to the participants' experiences on naturalistic teaching practices in the education processes. Furthermore, quantitative log records were kept for the Web-based NTEPP participants' duration of following the programs. Moreover, the researcher took field notes and wrote his observations on the whole process. In the data analysis stage, all quantitative and qualitative data collected were analyzed separately and integrated in the writing of results.

**Participants and the Setting**

A total of 30 pre-school teachers (Experimental-1=14, Experimental-2=16), who were working in two independent kindergartens in Eskişehir province in Turkey and were involved in the inclusive education process, constituted the participants of the study. In the follow-up sessions of the study, one teacher was appointed to another school within the province. Therefore, follow-up data could not be collected from one participant. Consequently, the pre-test measurement of the study included 30 individuals, the post-test measurement included 30 individuals, and the follow-up measurement included 29 individuals.

**Table 1a.** Descriptive statistics on the demographic characteristics of the participants ($n_{total}$=30)

| Group | Variables | f | % |
|---|---|---|---|
| Experimental-1 (Face-to-Face NTEPP) N=14 | **Age Group Provided with Education (Mean=4.36, Std.Dev.=.745)** | | |
| | 3-4 years | 2 | 14.3 |
| | 4-5 years | 5 | 35.7 |
| | 5-6 years | 7 | 50.0 |
| | **Professional Seniority (Mean=8.57, Std.Dev.=3.251)** | | |
| | 4 years | 1 | 7.1 |
| | 5 years | 2 | 14.3 |
| | 7 years | 2 | 14.3 |
| | 8 years | 2 | 14.3 |
| | 9 years | 3 | 21.4 |
| | 10 years | 1 | 7.1 |
| | 11 years | 2 | 14.3 |
| | 17 years | 1 | 7.1 |
| | **Inclusive Education Experience (Mean=5.29, Std.Dev.=4.375)** | | |
| | 2 years | 5 | 35.7 |
| | 3 years | 1 | 7.1 |
| | 4 years | 3 | 21.4 |
| | 6 years | 2 | 14.3 |
| | 9 years | 1 | 7.1 |
| | 11 years | 1 | 7.1 |
| | 17 years | 1 | 7.1 |
| | **Number of Students Involved in Inclusive Education** | | |
| | 0 student | 3 | 21.4 |
| | 1 student | 8 | 57.1 |
| | 2 students | 2 | 14.3 |
| | 3 students | 1 | 7.1 |
| | **Diagnoses of Students Involved in Inclusive Education** | | |
| | ASD | 8 | 57.1 |
| | Speech and Language Disorder | 2 | 14.3 |
| | Visual Disability | 1 | 7.1 |
| | **Number of Undiagnosed Students with Special Needs** | | |
| | 1 student | 11 | 78.6 |
| | 2 students | 3 | 21.4 |
| | **Types of Developmental Disabilities in Classrooms** | | |
| | Language and Speech Disorder | 10 | 71.4 |
| | ADHD | 3 | 21.4 |
| | Disability in Social Skills | 1 | 7.1 |
| | **Seminars Received** | | |
| | Special Education Seminar | 8 | 57.1 |
| | Teaching with Simultaneous Prompting | 1 | 7.1 |

f: Frequency, %: Percentage values, ASD: Autism Spectrum Disorder, ADHD: Attention Deficit and Hyperactivity Disorder

**Table 1b.** Descriptive statistics on the demographic characteristics of the participants ($n_{total}$=30)

| Group | Variables | f | % |
|---|---|---|---|
| Experimental -2 (Web-based NTEPP) N=16 | **Age Group Provided with Education (Mean=4.19, Std.Dev.=.750)** | | |
| | 3-4 years | 3 | 18.8 |
| | 4-5 years | 7 | 43.8 |
| | 5-6 years | 6 | 37.5 |
| | **Professional Seniority (Mean=10.63, Std.Dev.=4.097)** | | |
| | 5 years | 2 | 12.5 |
| | 6 years | 2 | 12.5 |
| | 8 years | 2 | 12.5 |
| | 9 years | 1 | 6.3 |
| | 11 years | 2 | 12.5 |
| | 12 years | 2 | 12.5 |
| | 14 years | 2 | 12.5 |
| | 15 years | 1 | 6.3 |
| | 16 years | 1 | 6.3 |
| | 18 years | 1 | 6.3 |
| | **Inclusive Education Experience (Mean=5.81, Std.Dev.=5.115)** | | |
| | 1 year | 2 | 12.5 |
| | 2 years | 6 | 37.5 |
| | 5 years | 2 | 12.5 |
| | 6 years | 1 | 6.3 |
| | 10 years | 2 | 12.5 |
| | 13 years | 1 | 6.3 |
| | 14 years | 1 | 6.3 |
| | 16 years | 1 | 6.3 |
| | **Number of Students Involved in Inclusive Education** | | |
| | 0 student | 7 | 43.8 |
| | 1 student | 8 | 50.0 |
| | 2 students | 1 | 6.3 |
| | **Diagnoses of Students Involved in Inclusive Education** | | |
| | ASD | 4 | 25.0 |
| | Speech and Language Disorder | 2 | 12.5 |
| | Mental+Visual Disability | 1 | 6.3 |
| | Physical Disability | 1 | 6.3 |
| | Cerebral Palsy | 1 | 6.3 |
| | **Number of Undiagnosed Students with Special Needs** | | |
| | 0 student | 4 | 25.0 |
| | 1 student | 8 | 50.0 |
| | 2 students | 4 | 25.0 |
| | **Types of Developmental Disabilities in Classrooms** | | |
| | Speech and Language Disorder | 9 | 56.3 |
| | Learning Disability | 1 | 6.3 |
| | ADHD | 1 | 6.3 |
| | Disability in Social Skills | 1 | 6,3 |
| | **Seminars Received** | | |
| | Special Education Seminar | 9 | 56.3 |

f: Frequency, %: Percentage values, ASD: Autism Spectrum Disorder, ADHD: Attention Deficit and Hyperactivity Disorder

While determining the participants, prerequisite features were first determined, and then, the Eskişehir Odunpazarı Counseling and Research Center (CRC) was contacted. Thus, the numbers of independent kindergartens affiliated to Odunpazarı district in the city center, pre-school teachers working in these schools, students with special needs and undiagnosed developmental disabilities in inclusive education were reached. Face-to-face interviews were conducted with kindergarten principals and the list of schools and teachers volunteering to participate in the study was prepared. The conditions of voluntary schools such as the numbers of classrooms and students with special needs and undiagnosed developmental disabilities in inclusive education were evaluated. At the end of the process, two schools with higher numbers of classrooms and students with special needs and undiagnosed developmental disabilities in the inclusive education process compared to other schools were selected

to collect a large number of quantitative and qualitative data in a valid and reliable manner. In the final step, these two schools were randomly assigned to the Experimental-1 and Experimental-2 groups. The prerequisite features required in the selection of the participants are listed below, and the demographic characteristics of the participants are presented in Table 1a, Table 1b.

- Working as a pre-school teacher in kindergartens,
- The kindergartens, where the participants work, are located in the same socio-economic region,
- The presence of students with diagnosed with developmental disabilities or undiagnosed (students with typical development) involved in the inclusive education process in the classrooms of the participants,
- Participants' non-participation in any in-service training on naturalistic teaching,
- The presence of internet connection of Web-based NTEPP participants at their homes and schools,
- Web-based NTEPP participants' possession of skills to use information and communication technologies.

The characteristics of the study setting are as follows: The schools, where teachers in the Experimental-1 and Experimental-2 groups work, are both in an environment with a mild-socio-economic level. While the Experimental-1 group school consisted of 14 classrooms, including 7 morning classrooms and 7 afternoon classrooms, the Experimental-2 group school consisted of 15 classrooms, including 7 morning classrooms and 9 afternoon classrooms. In the classrooms, there are basic learning centers such as block, playing house, book corner included in the Preschool Education Program. The size of each class varied between 15 and 25. While the daily course of education of the Pre-school Education Program is flexible by its nature, the half-day education course is conducted in schools within the scope of the basic draft program in Table 2.

**Table 2.** Half-day education courses of pre-schools

| **List of Sequentially Functioning Activities of the Morning and Afternoon Groups** |
|---|
| Time of Free Play (Start Time of Day) |
| Gathering and Cleaning |
| Breakfast Time |
| Gathering and Cleaning |
| Art Activity |
| Reading-Writing/Science and Nature/Experiment/Game and Music Activities |
| General Evaluation of the Day, Gathering Time, Preparations for Going Home |

**Dependent Variable**

In the study, the effectiveness of the Face-to-Face and Web-based NTEPP on multiple dependent variables was tested. Dependent variables were the participants' naturalistic teaching knowledge level, interactional behavior levels, and level of using naturalistic teaching strategies in their classrooms.

**Data Collection Tools**

In this study, many quantitative and qualitative data collection tools were used.

**Quantitative Data Collection Tools**

*Naturalistic Teaching Process Knowledge Test (NTP-KT):* Pre-test, post-test and follow-up measurements of pre-school teachers' naturalistic teaching knowledge levels were measured with "Natural Teaching Process Knowledge Test (NTP-KT)". The NTP-KT is a knowledge test prepared in cooperation with the The Scientific and Technological Research Council of Turkey 1001 project team under the leadership of the first author. This knowledge test contains information, definitions, and case study questions. It consists of 58 questions and can be solved in an average of 70 minutes. Each item of the test consists of five options, and these options include a correct answer. The lowest and highest scores to be obtained from the test are 0 and 58, respectively. The increase in the scores obtained from the test indicates an increase in natural teaching knowledge levels, and the decrease in the scores indicates a decrease in the knowledge levels.

The steps of "determining the scope of the test," "determining target behaviors," "writing questions and placing them in the table of signs," "arrangement of test questions," "implementation and scoring of the test," "performing validity and reliability studies and finalizing the test as a result of the analyses" were conducted, respectively, while preparing the knowledge test (Şeker & Gençdoğan, 2006). During these steps, the following studies were conducted: The content/scope of this test is parallel to the content of education programs and contains the topics of "Definition and Characteristics of the Types of Developmental Disabilities," "Naturalistic Teaching Process," "Qualified Adult-Child Interaction Strategies," "Naturalistic Teaching Strategies," and "Environmental Arrangements." The "Renewed Bloom's Taxonomy of the Cognitive Domain" consisting of "remembering, understanding, applying, analyzing, evaluating and creating" dimensions was used to measure which target behaviors pre-school teachers gained after the education programs (Bloom, 2001). The opinions of two domain experts were consulted for the content and face validity of the questions, and the questions were rearranged in line with these opinions. Item analyses were performed for item discriminant validity. In this context, 27% sub-super groups were determined from the data obtained from the participants' responses to the test items, and the differences between the items mean scores were tested using the independent samples t-test. The test items that were found to have low discrimination were excluded from the test.

*Parental/Adult Behavior Rating Scale (PBRS-TV):* In the pretest, posttest and follow-up measurements, the levels of interactional behaviors established by pre-school teachers with children were evaluated by the PBRS-TV. This scale, which was developed and used by Gerald Mahoney was also used with teachers under the name of the Maternal Behaviors Rating Scale (MBRS) in 2008, aims to measure the levels of interactional behaviors established by adults with children in the play setting. The validity and reliability studies of the scale in Turkey were performed with 123 mother-child dyads by Diken, Topbaş, and Diken (2009). The PBRS-TV consists of three subscales, including "Sensitivity-Responsivity," "Affect-Expressiveness," and "Achievement-Orientation." There is a total of 12 items under three subscales. These items are *being sensitive, being responsive, being effective,* and *being creative* in the subscale of "Sensitivity-Responsivity" and *acceptance, enjoyment, using verbal reinforcers, being warm,* and *being emotionally expressive* in the subscale of "Affect-Expressiveness." The "Achievement-Orientation and Directiveness" subscale includes the items of *being achievement-oriented, directive,* and *interaction pace* (Diken, Topbaş, & Diken, 2009).

*Naturalistic Teaching Process (NTP) Video Analysis Form:* The intended use of the form is to watch participants' videos containing their leisure time and art activities during the pre-test, post-test and follow-up measurements, and to write the naturalistic teaching strategies used in the activities watched on the form and to convert them into total frequency values. In the preparation of the form, the strategies to be included in the form and the formal structure of the form were first determined by a detailed literature review. The strategies, methods, and techniques to be included in the form are parallel with the content of the education programs developed in the study, and its physical structure includes the sections in which explanations about the implementation process of the strategies (start and end time intervals, context and transcriptions of the strategies used by teachers in classrooms), and the observations in the video recording will be written. This form was designed to get total scores/frequencies from the main/basic strategies because naturalistic teaching strategies are an integrated process consisting of many sub-methods and techniques. Thus, by avoiding performing many different tests on the many methods and techniques included in the main/basic strategies, it was attempted to prevent results from becoming complicated and to prevent the study from moving away from its aim. Finally, the opinions of two domain experts were obtained for the content and formal structure of the form, then, the form was rearranged in line with these opinions, and a pilot study was carried out on whether the form worked or not by watching five videos of teachers' activities.

*Log Records:* "Access log records" were used to determine the number and time of displaying the education site and guide resources of the Web-based NTEPP participants.

**Qualitative Data Collection Tools**

*Focus Group Interviews:* The prior knowledge, opinions, and experiences of the participants regarding inclusive education and the naturalistic teaching process were determined before the implementation, and their opinions and experiences regarding the programs were determined through focus group interviews after the implementation. The reason for selecting this type of interview was to obtain participants' opinions that emerged interactively in depth and to understand and describe them (Kruger & Casey, 2000; Patton, 2002).

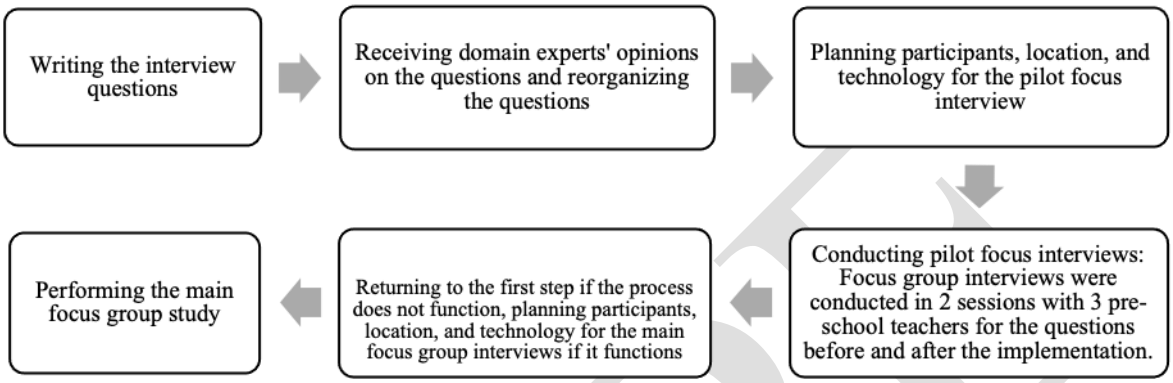


**Figure 2**. The preparation process for focus group interviews

It is necessary to make some preparations before conducting focus group interviews (Kruger and Casey, 2000; Patton, 2002). These preparations and the steps followed are presented in Figure 2. As a result of the preparation process, *pre-implementation focus group interview questions* consisted of three basic topics including "students with special needs and their characteristics," "inclusive pre-school education experiences," and "practices carried out in the daily education process," and *post-implementation focus group interview questions* consisted of three basic topics including "content and implementation processes," "contributions," and "aspects requiring improvement" of the education programs.

*Video Recordings:* Videos were collected to evaluate the naturalistic teaching strategies used by the participants in leisure time (an unstructured activity) and art activities (a structured activity) at three different times (pre-test=30, post-test=30, follow-up=30, a total of 178 videos). These activities were selected because leisure time was the most important unstructured activity in pre-school education programs, and the participants included structured art activities in their daily plans almost every day. Leisure time activities were recorded for approximately 10-15/20 minutes, and art activities were recorded until the end of the activities because it is indicated in the literature that interactional behaviors can be analyzed by recording them for an average of 15-20 minutes, and it is possible to get an impression on free play times during this period (Karaaslan and Mahoney, 2013; Karaaslan, Diken and Mahoney, 2013; Mahoney and Perales, 2003). The interruption of art activities that were carried out as a whole, during video shoots was not found appropriate by domain experts. The videos recorded enabled the authors to check the codings they made by watching videos repeatedly and to perform reliability studies. All video recording data were written on the "*NTP Video Analysis Form*" and used to convert them into total frequency values.

*Naturalistic Teaching Process (NTP) Reflective Diary Form:* Participants' experiences of participating in weekly education programs were collected through the "*NTP Reflective Diary Form*." This form is a semi-structured document prepared by the researcher. The reason for this was that teachers did not have the experience and time to write a reflective diary every week and that data could be collected from teachers in a focused and easy way. In the preparation stage, face and content validity studies were performed by receiving the opinions of two domain experts. The content of the form included questions about "knowledge gained from education on a weekly basis," "reflecting the knowledge gained to the class/implementing it in the class," and "the contributions of knowledge to students."

*Field Notes:* The researcher wrote down everything she observed during the whole process and took field notes. She used these data to support and diversify the results of the study.

**Independent Variable and Research Process**

The independent variables of the study were the Face-to-Face and Web-based NTEPP. The Face-to-Face and Web-based NTEPP are five-week teacher education programs. The contents of the education programs, which were in parallel with each other, were presented to the Experimental-1 group through face-to-face sessions conducted by the researcher and to the Experimental-2 group through the website. Nevertheless, this study consisted of five basic stages: preparation, pre-test, implementation, post-test, and follow-up. All of these stages are presented in Figure 3, and the process of developing education programs that constituted the basis of the study is explained in the next section.

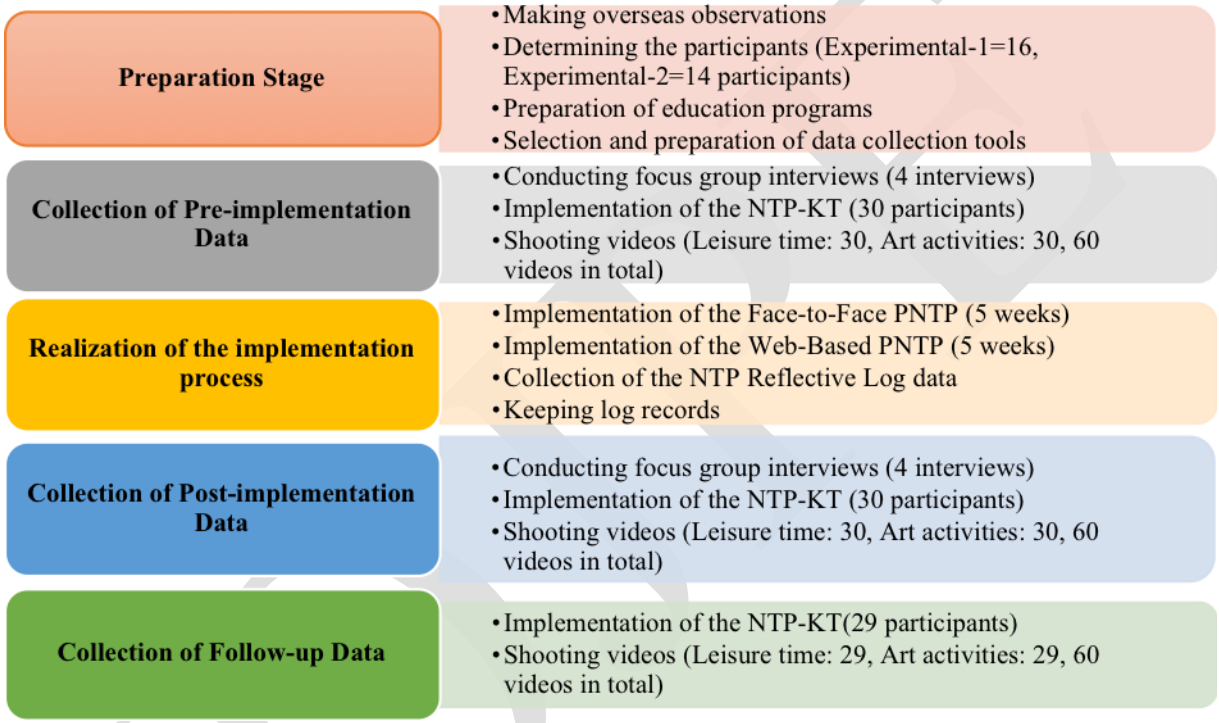


**Figure 3.** Research Process

**Development Process of the Education Programs**

The program development model used in the development process of the education programs is the TABA Model (Ornstein & Hunkins, 2008). This model consists of the basic steps of determining the need for an education program through pre-implementation focus group interviews, determining general and special objectives, creating the program content, and implementing and evaluating the program based on the "deductive approach." The content of the program consisted of the following 5-week content with the data obtained from a detailed literature review and focus group interviews:

1. Definition and Characteristics of the Types of Developmental Disabilities (Intellectual Disability, Down Syndrome, Hearing Disability, Visual Disability, Speech and Language Disorder, Autism Spectrum Disorder, Attention Deficit and Hyperactivity Disorder, Cerebral Palsy)
2. Introduction to the Naturalistic Teaching Process
3. Qualified Adult Behavior Strategies
   3.1. Being Sensitive-Responsive (Being Sensitive, Being Responsive, Being Effective, Being Creative)
   3.2. Being Emotionally Expressive (Acceptance, Enjoyment, Being Warm, Using Verbal Reinforcers)

3.3. Being Achievement-Oriented-Directive (Being Achievement-Oriented, Being Directive, Interaction Pace)
4. Naturalistic Teaching Strategies
   4.1. Modeling
      4.1.1. Modeling without Expecting a Response
         4.1.1.1. Bombardment of Words
         4.1.1.2. Parallel Speech
         4.1.1.3. Self-speech
      4.1.2. Making choice
      4.1.3. Modeling by using expansion
         4.1.3.1. Expansion by adding words
         4.1.3.2. Expansion by correcting/displacing
      4.1.4. Mand-modeling
5. Environmental Arrangements (Making Inaccessible, Leaving Missing, Giving Limitedly/In Pieces, Creating Surprising/Unexpected Conditions)

The Face-to-Face and Web-Based NTEPP consists of various basic tools and materials. They are five guide booklets prepared based on the topics in the content, and 221 expert and sample application videos. These tools and materials were embedded in a website in the Web-Based NTEPP, and all the contents of these tools and materials were embedded in PowerPoint presentations and presented to the participants through face-to-face sessions in the Face-to-Face NTEPP. The website of the program can be accessed at https://www.dogalogretimprojesi.com/

**Analysis of Data**

The frequency and average values obtained by encoding the NTP-KT and all recorded videos in the pre-implementation, post-implementation and follow-up measurements through the PBRS-TV and NTP Video Analysis Form were analyzed by parametric and non-parametric tests. The analyses were performed on the total scores obtained from three different measurements. The normal distribution condition of each data set was evaluated before deciding on the tests to be performed. In this context, kurtosis and skewness values, graphical methods (histogram, box plot diagram, stem-leaf diagram, Q-Q graph and P-P graph, etc.) and statistical tests (Kolmogorov-Smirnov and Shapiro-Wilk tests, etc. compliance tests) were used (Huck, 2008; Pallant, 2011; Tabacknick & Fidell, 2007). All focus group interviews were analyzed by content analysis (inductive thematic analysis) method, and then all related results were combined. The content analysis allowed the researcher to interpret the data by creating themes within the data (Patton, 2002). The qualitative data obtained from reflective diaries and field notes that were analyzed by the macro analysis method, which provides a holistic and wide view of a lot of data, played a supportive role for all results (Patton, 2002).

**Reliability and Validity Studies**

The "*Inter-Observer Reliability*" data were collected on whether the total score, average and frequency values calculated for the dependent variables of the study (naturalistic teaching knowledge level, interactional behavior levels, and levels of naturalistic teaching strategies used in classrooms) were correct, and the "*Implementation Reliability*" data were collected to determine whether the independent variables (education programs) were implemented as planned. These data calculated using the formula of "Consensus/Consensus + Dissensus X 100" ranged from 85.8% to 98.6%. In the *validity studies*, while time, external factors, measurement/testing before the experiment, separate measurement tools and testing, biased grouping and the loss of participants were considered to ensure the internal validity of quantitative data, measurement-independent variable interaction, biased selection-independent variable interaction, test response interaction of independent variables (Karasar, 2011) were considered for external validity. Long-term interaction, depth-oriented data collection, triangulation, expert review, participant confirmation and contrast case analysis factors were taken into account in the internal validity of qualitative data, and detailed description and detailed sampling factors were taken into account in their external validity (Daymon & Halloway, 2010; Patton, 2002).

**Research Ethics**

The ethical considerations that were considered during the research process were as follows: Obtaining the necessary permissions, protection of the confidentiality of the participants' identities, non-corruption of the nature of the place investigated, respecting the institution/school culture, clear transfer of research aims to the participants, respecting the groups with sensitivity to various situations (inclusive students, etc.), being aware of possible hierarchical power relations in the data collection process (relations between the researcher-school principals and teachers, etc.), and informing the participants about the results of the study (Cresswell, 2011).

## RESULTS

By the nature of the mixed research method, the results were presented in a supportive and integrated manner. The results are explained by the order of the research questions.

**Determination of the Participants' Knowledge, Opinions, and Experiences Regarding Inclusive Education and the Naturalistic Teaching Process before the Implementation**

Four main themes and ten sub-themes were reached by inductive analysis from the data obtained from the focus group interviews before the implementation. All themes are presented in Figure 4, and then these themes are explained in paragraphs.

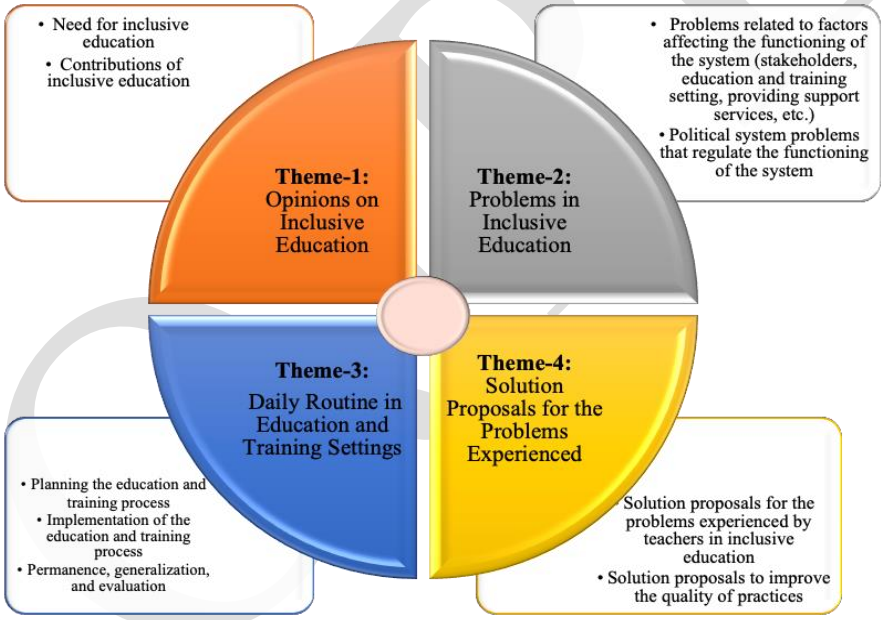


**Figure 4.** List of themes and sub-themes resulting from the analysis of focus group interviews before the implementation

During the interviews, it was observed that the vast majority of the participants emphasized that inclusive education, which is a legal right in international and national legislation and plays a significant role in the acceptance of individual differences, is a system that should be present in Turkey. In addition to the need for inclusive education, the participants also mentioned many contributions of inclusive education to students, families, teachers, and peers. In the analysis, it was found that the emphasis was placed, especially on “recognizing and accepting differences” within the context of contributions. The teachers emphasized that they play a unique role in ensuring the social acceptance of students with special needs and that their acceptance of students with special needs quickly reaches other individuals (students, families, etc.) included in inclusive education by creating a snowball effect. According to the opinions of the participants who described themselves with the metaphor "***We are not Superman!***" in the theme of the problems experienced, their lack of knowledge about approaches/methods such as naturalistic teaching was addressed as one of the main

problems in conducting the inclusive education process. According to the opinions, this lack of knowledge and education is attempted to be solved through individual efforts. It was considered that it was difficult, even impossible, to overcome the lack of methodological knowledge in this way. Furthermore, these studies based on individual efforts lead to a significant loss of time and occupational burnout, which makes the acceptance of students with special needs difficult, and this behavior may adversely affect the perspectives of other stakeholders (students, students' families, etc.) in the system towards students in inclusive education. In the theme of teachers' solution proposals for the problems, the need for preparing education programs on approaches/methods such as naturalistic teaching should be among primary suggestions. Thus, the atmosphere of the class will be positively affected, and the social acceptance of students with special needs in the classroom and other settings will become easier, which may result in the happiness of all stakeholders with the process. In line with these results, it is observed that the need referring to the subject of the study was also revealed. The summarized visual of all these issues associated with each other is presented in Figure 5.

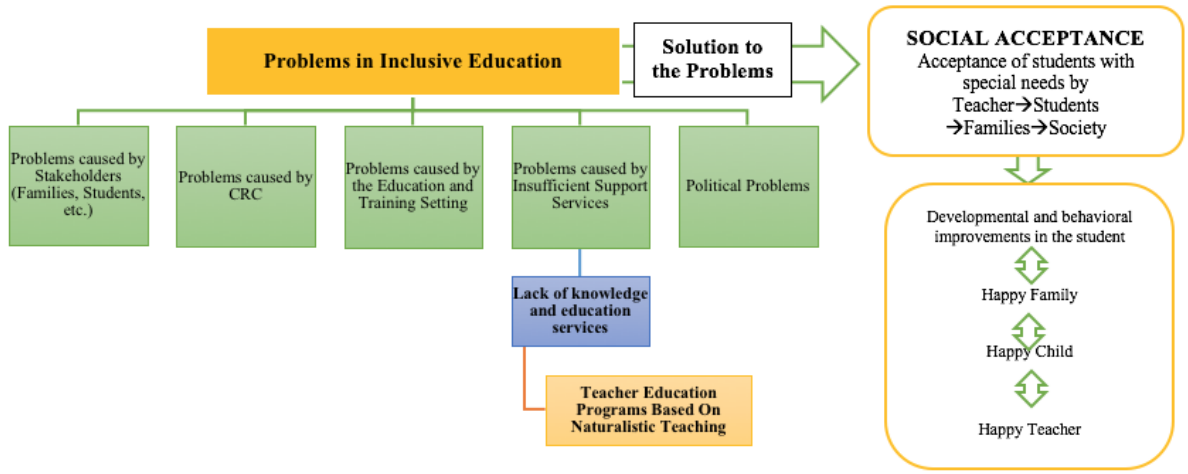


**Figure 5.** Issues associated with the main theme of problems in inclusive education

**Effect of the Education Programs on the Participants' Naturalistic Teaching Knowledge Levels**

The 3x2 mixed-design ANOVA (split-plot design ANOVA) test was performed to determine whether the interactions of the measurement time, group, measurement time, and group factors, which are the variables of the study, led to a significant difference in the participants' total scores for the NTP-KT. The descriptive results related to mean, standard deviation, minimum and maximum values of the total scores of the groups included in the analysis are presented in Table 3, and the results of the mixed design ANOVA analysis are presented in Table 4.

**Table 3.** Descriptive statistics related to the total scores for the NTP-KT of the Experimental-1 and Experimental-2 groups

| Group | Measurement Time | N | Mean | SD | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Experimental-1 Face-to-Face NTEPP | Pre-test | 14 | 40.714 | 3.851 | 36.00 | 47.00 |
| | Post-test | 14 | 49.928 | 5.327 | 41.00 | 57.00 |
| | Follow-up | 14 | 47.574 | 4.569 | 40.00 | 55.00 |
| Experimental-2 Web-Based NTEPP | Pre-test | 16 | 41.687 | 4.269 | 32.00 | 49.00 |
| | Post-test | 16 | 47.312 | 3.772 | 39.00 | 53.00 |
| | Follow-up | 15 | 43.800 | 3.648 | 38.00 | 52.00 |

SD: Standard deviation, N: Number of People

According to the descriptive statistics, results revelaed that the total mean scores for the NTP-KT of the Experimental-1 and Experimental-2 groups increased from pre-test to post-test and decreased from post-test to follow-up.

**Table 4.** Mixed Design ANOVA Results of the pre-test/post-test/follow-up total scores for the NTP-KT of the Experimental-1 and Experimental-2 groups

| Source of Variance | SS | df | MS | F | p | $n_p^2$ |
|---|---|---|---|---|---|---|
| Intergroup | | | | | | |
| Group | 74.287 | 1 | 74.287 | 2.064 | .162 | |
| Error | 971.897 | 27 | 35.996 | | | |
| Intragroup | | | | | | |
| Measurement time | 771.869 | 2 | 385.934 | 40.306 | .000* | .599 |
| Measurement*group | 96.558 | 2 | 48.279 | 5.042 | .010* | .157 |
| Error | 517.051 | 54 | | | | |
| Total | 1.914,611 | 32 | | | | |

*p<.05, SS: Sum of Squares, df: Degree of freedom, MS: Mean of Squares, $n_p^2$= Partial Effect Size

When the ANOVA summary chart was examined, it was observed that the change in the total mean scores for the NTP-KT in the pre-test, post-test, and follow-up measurements did not differ by groups ($F_{(1,27)}$=2.064, p>.05). This result can be interpreted that changes in the groups at different measurement times were similar. Furthermore, a significant difference was found between the mean scores for the NTP-KT in the repeated measurements of the participants, regardless of the groups ($F_{(2,54)}$=40.306; p<.05; $n_p^2$=.599). According to Cohen (1988) and Huck (2008), while an effect size value of .01-.06 refers to a small effect, a value of .06 and above refers to a medium effect, and a value of 0.14 and above refers to a large effect. Accordingly, it can be said that the measurement time, in other words, both education programs had a large effect on the participants' scores for the NTP-KT. Finally, it was determined that the measurement time and group interaction were statistically significant and had a significant effect on the participants' scores for the NTP-KT ($F_{(2,54)}$=5.042; p<.05; $n_p^2$=.157). This result can be interpreted that participation in the face-to-face and web-based programs had different effects on the participants' total scores for the NTP-KT in at least one of the three measurement times.

A series of independent samples t-tests were performed to determine whether there was a significant difference in the total mean scores for the NTP-KT in each measurement between the groups. All results of the analyses are presented in Table 5.

**Table 5.** Independent samples t-test results in which the total scores for the NTP-KT obtained from three measurements were examined by groups

| Measurement Time | Group | N | Mean | SD | df | t | p | $n^2$ |
|---|---|---|---|---|---|---|---|---|
| Pre-test | Experimental-1 | 14 | 40.714 | 3.851 | 28 | -.652 | .520 | - |
| | Experimental-2 | 16 | 41.684 | 4.269 | | | | |
| Post-test | Experimental-1 | 14 | 49.928 | 5.327 | 28 | 1.567 | .128 | - |
| | Experimental-2 | 16 | 47.312 | 3.772 | | | | |
| Follow-up | Experimental-1 | 14 | 47.571 | 4.569 | 27 | 2.465 | .020* | .183 |
| | Experimental-2 | 15 | 43.800 | 3.648 | | | | |

Experimental-1 Face-to-Face NTEPP, Experimental-2 Web-Based NTEPP
*p<.05, N= Number of People, SD= Standard deviation, df= Degree of freedom, $n^2$= Effect Size

It was found that there was no significant difference in the pre-test and post-test between the follow-up test total mean scores for the NTP-KT of the groups. However, there was a statistically significant difference in the follow-up test, and this value indicated a large effect ($t_{(27)}$=.020; p<.05, η2=.183). When these results were interpreted, it can be stated that both education programs were effective in increasing the naturalistic teaching knowledge levels of the participants. Furthermore, the results indicated that a significant difference in the joint interaction between the measurement time and group variables observed in the mixed design ANOVA analysis occurred in the follow-up measurement. This result can be interpreted that the knowledge obtained from the Face-to-Face NTEPP was more permanent compared to theWeb-Based NTEPP. The findings obtained from the analysis of focus

group interviews, reflective diaries, and field notes also support these results. For example, teacher Eda summarized that the programs increased their naturalistic teaching knowledge levels by stating, "*You caught us at the point where we were missing because we, as pre-school teachers, are unaware of many topics and practices in inclusion. With this education, we have learned a lot of scientific and practical information we didn't know…*". These results are presented graphically in Figure 6.

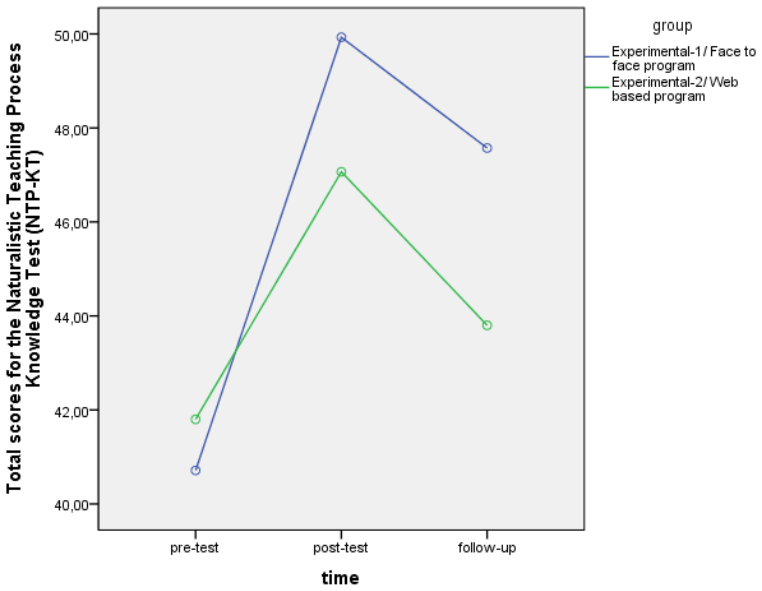


**Figure 6.** Effect of the interaction between the measurement time and education group on the total mean scores for the NTP-KT

**Effect of the Education Programs on the Participants' Interactional Behavior Levels**

While seeking an answer to the third question of the study, the presence of more than one dependent variable first suggested the mixed design MANOVA analysis, based on the presence of two different education groups, three different measurement times, and three subscales of the PBRS-TV. However, there are many prerequisites for performing mixed design MANOVA analysis, such as sample size, normality, and linearity (Pallant, 2011; Tabachnick & Fidell, 2007). In the study, due to a small sample size, the presence of a correlation of less than 0.60 between univariate and multivariate normality and the dependent variables, nonlinear distributions of the dependent variables at independent variable levels, and failure to meet the homogeneity conditions of the variance-covariance matrix, multiple 3x2 mixed design ANOVA analyses were performed instead of this analysis. This method can be preferred by many researchers (Tabachnick & Fidell, 2007).

The descriptive results related to mean, standard deviation, minimum and maximum values of the total scores of the Experimental-1 and Experimental-2 groups from the subscales of the PBRS-TV at different measurement times are presented in Table 6. The mixed design ANOVA analyses performed separately for each subscale are presented in Table 7, and the results of Sidak's multiple comparison test, which was performed to determine between which measurement times the significant differences found in the total scores obtained from the scales occurred, are indicated in the source of difference in Table 6.

When the data were analyzed, it was found that the total mean scores of the participants in both the Experimental-1 and Experimental-2 groups from the three subscales of the PBRS-TV increased from pre-test to post-test and that these scores in the post-test were preserved in the follow-up test. The participants were expected to get a mean score of 3 from the "Achievement-Orientation-Directiveness" subscale and a mean score of 5 from other subscales. In this context, it can be said that both education programs increased the participants' total mean scores obtained from three subscales

from pre-test to post-test at an average value, which was quite close to the desired level, which also preserved in the follow-up measurement.

**Table 6.** Descriptive statistics related to the total scores of the Experimental-1 and Experimental-2 groups in three subscales of the PBRS-TV

| Group | Subscales | Measurement Time | N | Mean | SD | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| Experimental-1 Face-to-Face NTEPP | *Being Sensitive-Responsive* | Pre-test | 14 | 1.57 | .852 | 1 | 3 |
| | | Post-test | 14 | 3.36 | 1.008 | 2 | 5 |
| | | Follow-up | 14 | 3.36 | 1.151 | 2 | 5 |
| | *Being Emotionally Expressive* | Pre-test | 14 | 1.79 | .975 | 1 | 4 |
| | | Post-test | 14 | 3.43 | 1.016 | 2 | 5 |
| | | Follow-up | 14 | 3.36 | 1.216 | 2 | 5 |
| | *Being Achievement-Oriented-Directive* | Pre-test | 14 | 1.64 | .929 | 1 | 3 |
| | | Post-test | 14 | 2.93 | .616 | 2 | 4 |
| | | Follow-up | 14 | 2.71 | .914 | 1 | 4 |
| Experimental-2 Web-Based NTEPP | *Being Sensitive-Responsive* | Pre-test | 16 | 1.56 | .727 | 1 | 3 |
| | | Post-test | 16 | 3.38 | 1.025 | 2 | 5 |
| | | Follow-up | 15 | 3.07 | 1.100 | 1 | 4 |
| | *Being Emotionally Expressive* | Pre-test | 16 | 1.50 | .730 | 1 | 3 |
| | | Post-test | 16 | 3.38 | 1.025 | 2 | 5 |
| | | Follow-up | 15 | 3.07 | 1.100 | 1 | 4 |
| | *Being Achievement-Oriented-Directive* | Pre-test | 16 | 1.88 | 1.088 | 1 | 5 |
| | | Post-test | 16 | 3.06 | .680 | 2 | 4 |
| | | Follow-up | 15 | 2.67 | .976 | 1 | 5 |

SD: Standard deviation, N: Number of People

When the mixed ANOVA summary chart was examined, it was observed that the change in the total mean scores obtained from the "Sensitivity-Responsivity" subscale of the PBRS-TV did not differ by groups ($F_{(1,27)}$=.066; p>.05). Similar results were also achieved for the subscales of "Affect-Expressiveness" ($F_{(1,27)}$=.372) and "Achievement-Orientation-Directiveness" ($F_{(1,27)}$=.005) (p>.05). These results can be interpreted that changes in the groups at different measurement times followed a similar path for all three subscales. Furthermore, it was found in the analyses that measurement and group interaction was not statistically significant in all three subscales, respectively ($F_{(2,54)}$=.424; $F_{(2,54)}$=.278; $F_{(2,54)}$=.061; p>.05).

These results can be interpreted that two education programs did not have a different effect on the total mean scores obtained by the participants from three subscales according to the measurement time. At this point, it is possible to say that both programs were effective in increasing and maintaining the interactional behavior levels of the participants.

The findings supporting these results were also achieved in the focus group interviews conducted after the implementation, weekly reflective diaries, and the researcher's field notes. In the analysis of the interviews, it was found that both education groups mentioned a number of contributions through which the knowledge obtained from the programs was transferred to the practices in the education process (start of using quality interaction and other naturalistic teaching strategies in the education process, etc.). For example, teacher Gamze exemplified that she started to be a sensitive-responsive teacher rather than exhibiting directive behaviors after the education by stating, "*For example, the child was standing in the middle, I was directing him right away, go there, play here. But now, I pay much attention to what he cares about. I name what he is interested in and what he touches and shows…".* A sample field note taken is as follows: *"He was a very exhausted and unenthusiastic teacher. Now I see that he participates in children's plays and follows their interests warmly. The power of a teacher comes from love!"*

**Table 7.** Mixed ANOVA results of the total scores of the Experimental-1 and Experimental-2 groups from the PBRS-TV

| | Source of Variance | SS | df | MS | F | p | $n_p^2$ | Source of Difference |
|---|---|---|---|---|---|---|---|---|
| *Sensitivity-Responsivity* | Intergroup | | | | | | | |
| | Group | .116 | 1 | .116 | .066 | .799 | | |
| | Error | 47.263 | 27 | 1.750 | | | | |
| | Intragroup | | | | | | | |
| | Measurement time | 56.836 | 2 | 28.418 | 46.890 | .000* | .635 | 1<2<br>1<3 |
| | Measurement*group | .514 | 2 | .257 | .424 | .656 | | |
| | Error | 32.727 | 54 | .606 | | | | |
| | Total | 137.456 | 86 | | | | | |
| *Affect-Expressiveness* | Intergroup | | | | | | | |
| | Group | .788 | 1 | .788 | .372 | .547 | | |
| | Error | 53.143 | 27 | 2.116 | | | | |
| | Intragroup | | | | | | | |
| | Measurement time | 53.393 | 2 | 26.697 | 51.260 | .000* | .655 | 1<2<br>1<3 |
| | Measurement*group | .290 | 2 | .145 | .278 | .758 | | |
| | Error | 28.124 | 54 | .521 | | | | |
| | Total | 135.738 | 86 | | | | | |
| *Achievement-Orientation-Directiveness* | Intergroup | | | | | | | |
| | Group | .005 | 1 | .005 | .005 | .945 | | |
| | Error | 30.730 | 27 | 1.138 | | | | |
| | Intragroup | | | | | | | |
| | Measurement time | 27.638 | 2 | 13.819 | 32.535 | .000* | .546 | 1<2<br>1<3 |
| | Measurement*group | .052 | 2 | .026 | .061 | .941 | | |
| | Error | 22.937 | 54 | .425 | | | | |
| | Total | 81.362 | 86 | | | | | |

*p<.05, SS= Sum of Squares, df: Degree of freedom, MS: Mean of Squares, $n_p^2$= Partial Effect Size
Source of Difference =1:Pre-test, 2:Post-test, 3:Follow-up measurement

## Effect of the Education Programs on the Participants' Use of Naturalistic Teaching Strategies in Education Processes

*Leisure Time Activities:* The Friedman test analyses were performed to examine the change in the total scores for naturalistic teaching strategies of the two education groups within themselves from the pre-test, post-test, and follow-up measurements of leisure time activities. The descriptive results related to mean, standard deviation, median, minimum and maximum values of the total scores of the groups analyzed are presented in Table 8, and the Friedman test results are presented in Table 9.

**Table 8.** Descriptive statistics related to the total scores for Naturalistic Teaching Strategies of the Experimental-1 and Experimental-2 groups from three different measurements of leisure time activities

| Group | Measurement Time | N | Mean | SD | Mv | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| Experimental -1 Face-to-Face NTEPP | Pre-test | 14 | 3.64 | 5.486 | 1.50 | 0 | 19 |
| | Post-test | 14 | 29.50 | 23.167 | 23.50 | 2 | 70 |
| | Follow-up | 14 | 30.93 | 25.254 | 20.50 | 1 | 74 |
| Experimental -2 Web-Based NTEPP | Pre-test | 16 | 1.56 | 4.211 | .00 | 0 | 17 |
| | Post-test | 16 | 15.25 | 13.621 | 11.50 | 0 | 44 |
| | Follow-up | 15 | 6.40 | 8.131 | 2.00 | 0 | 26 |

N= Number of people, SD= Standard deviation, Mv= Median values

When the descriptive data were analyzed, the results revealed that there was an increase of 26 points in the total mean scores of the Experimental-1 group from pre-test to post-test and there was an increase of 14 points in the Experimental-2 group and that there was a decrease of 1 point in the Experimental-1 group from post-test to follow-up and there was a decrease of 9 points in the Experimental-2 group.

**Table 9.** Friedman test results related to the total scores for Naturalistic Teaching Strategies of the Experimental-1 and Experimental-2 groups from the measurements of leisure time activities at three different times

| Group | Measurement Time | N | Mean R. | χ2 | df | p | Kendall's W |
|---|---|---|---|---|---|---|---|
| Experimental-1 Face-to-Face NTEPP | Pre-test | 14 | 1.21 | 33.138 | 2 | .000* | .473 |
| | Post-test | 14 | 3.79 | | | | |
| | Follow-up | 14 | 4.07 | | | | |
| Experimental-2 Web-Based NTEPP | Pre-test | 16 | 1.87 | 26.574 | 2 | .000* | .354 |
| | Post-test | 16 | 4.00 | | | | |
| | Follow-up | 15 | 2.93 | | | | |

*p<.05, N= Number of People, Md= Median; Mean R.= Mean rank, χ2= Chi-square value, df: Degree of freedom, Kendall's W= Kendall's coefficient of concordance

In the Friedman test results, it was found that there was a significant difference between the total scores for naturalistic teaching strategies of the Experimental-1 and Experimental-2 groups in the leisure time activity in three different measurements and that this difference indicated a large effect [$\chi2$ (2, n=14)=33.138, p<.05, Kendall's W=.473; $\chi2$(2, n=15)=26.574, p<.05, Kendall's W=.354]. These results can be interpreted that both education programs led to a significant difference between the total scores at any two measurement times. The results of the Wilcoxon signed-rank test that was performed to determine the source of the significant difference that emerged, in other words, between which measurements it occurred, are presented in Table 10. Since pairwise comparisons were performed between the measurements on the same data sets obtained from three different measurements of the groups in these tests, the Bonferroni correction (p=.05/3=.017) was performed by dividing the value of significance by three for each analysis to reduce the possibility of finding significant results by chance. Thus, it was aimed to reject a truly correct null hypothesis, in other words, to control Type 1 error (Alpha error), which means finding something that is not really significant significant (Pallant, 2011, p. 237).

In the Wilcoxon signed-rank test results, it was determined that there was a significant difference between the pre-test/post-test (z=-3.296; p<.017; r=.88) and pre-test/follow-up total scores for naturalistic teaching strategies (z=-3.297; p<.017; r=.88) obtained by the Experimental-1 group from the measurement of leisure time activities, and that there was no significant difference between the pre-test/follow-up total scores for naturalistic teaching strategies. When the mean rank and totals of the difference scores were taken into consideration, this difference was observed to be in favor of positive ranks, in other words, the post-test scores. Similar results were also achieved for the Experimental-2 group.

**Table 10.** Wilcoxon signed-rank test results related to the total scores for Naturalistic Teaching Strategies of the Experimental-1 and Experimental-2 groups obtained from leisure time activities

| Group | | N | Mean R. | Sum of R. | z | p | r |
|---|---|---|---|---|---|---|---|
| **Experimental-1 Face-to-Face NTEPP** | ***Post-test/Pre-test*** | | | | | | |
| | Negative Rank | 0 | .00 | .00 | -3.296 | .001* | .88 |
| | Positive Rank | 14 | 7.50 | 105.00 | | | |
| | Equal | 0 | | | | | |
| | ***Follow-up/Post-test*** | | | | | | |
| | Negative Rank | 7 | 7.00 | 49.00 | -.220 | .826 | - |
| | Positive Rank | 7 | 8.00 | 56.00 | | | |
| | Equal | 0 | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Experimental-2 Web-Based NTEPP | ***Follow-up/Pre-test*** | | | | | | |
| | Negative Rank | 0 | .00 | .00 | -3.297 | .001* | .88 |
| | Positive Rank | 14 | 7.50 | 105.00 | | | |
| | Equal | 0 | | | | | |
| | ***Post-test/Pre-test*** | | | | | | |
| | Negative Rank | 2 | 2.00 | 4.00 | -3.184 | .001* | .79 |
| | Positive Rank | 13 | 8.92 | 116.00 | | | |
| | Equal | 1 | | | | | |
| | ***Follow-up/Post-test*** | | | | | | |
| | Negative Rank | 10 | 7.85 | 78.50 | -2.310 | .021 | - |
| | Positive Rank | 3 | 4.17 | 12.50 | | | |
| | Equal | 2 | | | | | |
| | ***Follow-up/Pre-test*** | | | | | | |
| | Negative Rank | 1 | 3.00 | 3.00 | -2.695 | .007* | .69 |
| | Positive Rank | 10 | 6.30 | 63.00 | | | |
| | Equal | 4 | | | | | |

*p<0.017 (Bonferroni correction), N= Number of People, Mean R.= Mean rank, Sum of R.= Sum of ranks, Effect Size $r=z/\sqrt{r}$

A series of the Mann-Whitney U tests were performed for the *intergroup comparison* of the total scores for naturalistic teaching strategies used in leisure time activities in the pre-test, post-test, and follow-up measurements.

**Table 11.** Mann-Whitney U test results in which the total scores for Naturalistic Teaching Strategies obtained from the measurement of leisure time activities at three different times were compared by groups

| Measurement Time | Group | N | Mean R. | Sum of R. | U | z | p | r |
|---|---|---|---|---|---|---|---|---|
| Pre-test | Experimental-1 | 14 | 18.36 | 257.00 | 72.000 | -1.782 | .075 | - |
| | Experimental-2 | 16 | 13.00 | 208.00 | | | | |
| Post-test | Experimental-1 | 14 | 18.29 | 256.00 | 73.000 | -1.624 | .104 | - |
| | Experimental-2 | 16 | 13.06 | 209.00 | | | | |
| Follow-up | Experimental-1 | 14 | 20.00 | 280.00 | 35.000 | -3.064 | .002* | .81 |
| | Experimental-2 | 15 | 10.33 | 155.00 | | | | |

* Experimental-1= Face-to-Face NTEPP, Experimental-2= Web-Based NTEPP *p<.05, N= Number of People, Mean R.=Mean rank, Sum of R.= Sum of ranks, U=Mann-Whitney U value, Effect Size $r=z/\sqrt{r}$

In the analyses, it was observed that there was a significant difference between the total scores for naturalistic teaching strategies of the groups measured in the same activity, and this difference indicated a large effect (U=35.000; z=-3.064; p<.017, r=.81). In brief, the fact that no significant difference was found between the total scores for naturalistic teaching strategies measured in the leisure time activities of the groups in the pre-test and post-test can be interpreted that both education programs were effective in increasing the initial total scores of the participants. However, it can be said that the Face-to-Face NTEPP had a more permanent effect on the total scores for leisure time naturalistic teaching strategies of the participants.

*Art Activities*

The change between the total scores for naturalistic teaching strategies obtained by the Experimental-1 and Experimental-2 groups from the measurement of art activities at three different times was analyzed by the Friedman test analyses. The descriptive results related to mean, standard deviation, median, minimum and maximum values of the total scores of the groups included in the analysis are presented in Table 12, and the Friedman test results are presented in Table 13.

**Table 12.** Descriptive statistics related to the total scores for Naturalistic Teaching Strategies obtained by the Experimental-1 and Experimental-2 groups from the measurement of art activities at three different times

| Group | Measurement Time | N | Mean | SD | Md | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| Experimental-1 Face-to-Face NTEPP | Pre-test | 14 | 15.71 | 13.903 | 15.00 | 0 | 43 |
| | Post-test | 14 | 40.50 | 31.334 | 37.00 | 4 | 110 |
| | Follow-up | 14 | 26.71 | 21.265 | 20.50 | 5 | 78 |
| Experimental-2 Web-Based NTEPP | Pre-test | 16 | 5.13 | 10.138 | 3.00 | 0 | 42 |
| | Post-test | 16 | 18.88 | 18.195 | 19.00 | 0 | 66 |
| | Follow-up | 15 | 14.73 | 10.089 | 15.00 | 1 | 35 |

N= Number of People, SD= Standard deviation, Md= Median values

It was found that there was an increase of 35 points in the total mean scores of the Experimental-1 group from pre-test to post-test and there was an increase of 14 points in the Experimental-2 group and that there was a decrease of 14 points in the Experimental-1 group from post-test to follow-up and there was a decrease of 4 points in the Experimental-2 group.

**Table 13.** Friedman test results related to the total scores for art activity Naturalistic Teaching Strategies of the Experimental-1 and Experimental-2 groups measured at three different times

| Group | Measurement Time | N | Mean R. | $\chi 2$ | Df | p | Kendall's W |
|---|---|---|---|---|---|---|---|
| Experimental-1 Face-to-Face NTEPP | Pre-test | 14 | 1.36 | 9.571 | 2 | 0.008* | 0.342 |
| | Post-test | 14 | 2.50 | | | | |
| | Follow-up | 14 | 2.14 | | | | |
| Experimental-2 Web-Based NTEPP | Pre-test | 16 | 1.37 | 9.390 | 2 | 0.009* | 0.313 |
| | Post-test | 16 | 2.23 | | | | |
| | Follow-up | 15 | 2.40 | | | | |

*p<.05, N= Number of People, Md= Median; Mean R.= Mean rank, $\chi 2$= Chi-square value, Df: Degree of freedom, Kendall's W= Kendall's Coefficient of Concordance

It was determined that there was a significant difference between the total scores for art activity naturalistic teaching strategies of the Experimental-1 and Experimental-2 groups in three different measurements within themselves and that this difference indicated a large effect [$\chi 2(2, n=14)= 9.571$, $p<.05$, Kendall's W=.342; $\chi 2(5, n=15)=9.390$, $p<.05$, Kendall's W=.313]. The results of the Wilcoxon signed-ranks tests that were performed to determine between which measurements this difference occurred are presented in Table 14, and it is observed in the results that there was a difference with a significant and large effect.

**Table 14a.** Wilcoxon signed-rank test results related to the total scores for Naturalistic Teaching Strategies of the Experimental-1 and Experimental-2 groups obtained from art activities

| Group | | N | Mean R. | Sum of R. | z | p | r |
|---|---|---|---|---|---|---|---|
| Experimental-1 Face-to-Face NTEPP | ***Post-test/Pre-test*** | | | | | | |
| | Negative Rank | 2 | 5.00 | 10.00 | -2.671 | .008* | .71 |
| | Positive Rank | 12 | 9.92 | 95.00 | | | |
| | Equal | 0 | | | | | |
| | ***Follow-up/Post-test*** | | | | | | |
| | Negative Rank | 9 | 9.33 | 84.00 | -1.978 | .048 | - |
| | Positive Rank | 5 | 4.20 | 21.00 | | | |
| | Equal | 0 | | | | | |
| | ***Follow-up/Pre-test*** | | | | | | |
| | Negative Rank | 3 | 7.17 | 21.50 | -1.947 | .052 | - |
| | Positive Rank | 11 | 7.59 | 83.50 | | | |
| | Equal | 0 | | | | | |

IOJPE
ISSN: 1300 – 915X
www.iojpe.org
International Online Journal of Primary Education 2021, volume 10, issue 1

**Table 14b.** Wilcoxon signed-rank test results related to the total scores for Naturalistic Teaching Strategies of the Experimental-1 and Experimental-2 groups obtained from art activities

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Experimental-2 Web-Based NTEPP** | ***Post-test/Pre-test*** | | | | | | |
| | Negative Rank | 4 | 3.75 | 15.00 | -2.557 | .011* | .64 |
| | Positive Rank | 11 | 9.55 | 105.00 | | | |
| | Equal | 1 | | | | | |
| | ***Follow-up/Post-test*** | | | | | | |
| | Negative Rank | 7 | 10.36 | 72.50 | -0.710 | .478 | |
| | Positive Rank | 8 | 5.94 | 47.50 | | | |
| | Equal | 0 | | | | | |
| | ***Follow-up/Pre-test*** | | | | | | |
| | Negative Rank | 2 | 7.75 | 15.50 | -2.529 | .011* | .65 |
| | Positive Rank | 13 | 8.04 | 104.50 | | | |
| | Equal | 0 | | | | | |

*p<.017 (Bonferroni correction), N= Number of People, Mean R.= Mean rank, Sum of R.= Sum of ranks, Effect Size $r=z/\sqrt{r}$

A series of Mann-Whitney U tests were performed for the intergroup comparison of the total scores for art activity naturalistic teaching strategies of the participants measured at three different times.

**Table 15.** Mann-Whitney U test results in which the total scores for art activity Naturalistic Teaching Strategies measured at three different times were compared by groups

| Measurement Time | Group | N | Mean R. | Sum of R. | U | z | p | r |
|---|---|---|---|---|---|---|---|---|
| Pre-test | Experimental-1 | 14 | 19.04 | 266.50 | 62.500 | -2.073 | .038* | .37 |
| | Experimental-2 | 16 | 12.41 | 198.50 | | | | |
| Post-test | Experimental-1 | 14 | 19.54 | 273.50 | 55.500 | -2.351 | .019 | - |
| | Experimental-2 | 16 | 11.97 | 191.50 | | | | |
| Follow-up | Experimental-1 | 14 | 17.50 | 245.00 | 70.000 | -1.532 | .126 | - |
| | Experimental-2 | 15 | 12.67 | 190.00 | | | | |

Experimental-1: Face-to-Face NTEPP, Experimental-2: Web-Based NTEPP
*p<.05, N= Number of People, Mean R.= Mean rank, Sum of R.= Sum of ranks, U=Mann-Whitney U value, Effect Size $r=z/\sqrt{r}$

When Table 15 was examined, it was found that there was a significant difference between the total pre-test naturalistic teaching strategies scores measured in the art activities of the Experimental-1 and Experimental-2 groups and that this difference indicated a large effect (U=62.500; z=-2.073; r=.37; p>.05). This situation, which can also be observed in descriptive statistics values, can be interpreted that the total naturalistic teaching strategy levels used by both groups in the art activities were not similar before the implementation. However, it was considered that this situation that was observed only in this data set and analysis of the study might be due to the fact that the "total scores for naturalistic teaching strategies obtained by several participants from the art activity had extreme values in the data." In the literature, this incident is expressed among the limitations of the "quasi-experimental design," and it is indicated that the extreme values taken by several participants may affect the results of the analysis performed with a group having a small sample size (Cresswell, 2011). To make a decision according to the split-plot in such a data set, or to equalize the groups by extracting extreme values from the data are among the recommended methods (Pallant, 2011; Tabachnick & Fidell, 2007). However, since studies were conducted with a special and small target group in this study, the choice of non-foreign intervention to the test process, and the fact that it was observed that the difference in the intergroup pre-test scores found only in this analysis was not very big on the chart, no reduction was made in the data by deleting the extreme values, and the analyses were performed with normal data.

When all the results are summarized, it is possible to state that both education programs had an effect on the participants with regard to using and maintaining naturalistic teaching practices in art activities. The findings supporting these results were also achieved in the focus group interviews conducted after

the implementation, weekly reflective diaries, and the researcher's field notes. In the analysis of the interviews, one of the topics that were observed to be discussed within the professional contributions acquired by the participants from the programs was the use of naturalistic teaching strategies in daily education and training process after the education. The participants exemplified and stated that they started to use both environmental arrangements and other naturalistic teaching strategies in their daily activities after the teaching education process. For example, teacher Leyla, one of the Web-Based NTEPP participants, exemplified that she started to use making inaccessible, one of the environmental arrangement strategies, and expansion and bombardment of words from other naturalistic teaching strategies in the education process by stating, "*In the art activity, I give the paper to students and wait for them to ask for their paint…they come and either raise their fingers or ask me to give it. I immediately expand it by saying, give the paint. I say what they cannot say in the form of bombardment during the day*." Finally, a sample field note regarding this issue was as follows: "*Is this a teacher just sitting in his chair during a leisure time activity that I have seen? It makes me surprised that he makes children's plays fun by creating surprising situations, presents linguistic models to children by naming what they do, and expands their reactions. The power of this teacher comes from his effort to reflect what he has learned into practice*.

**Examination of the Participants' Opinions and Experiences on the Education Programs**

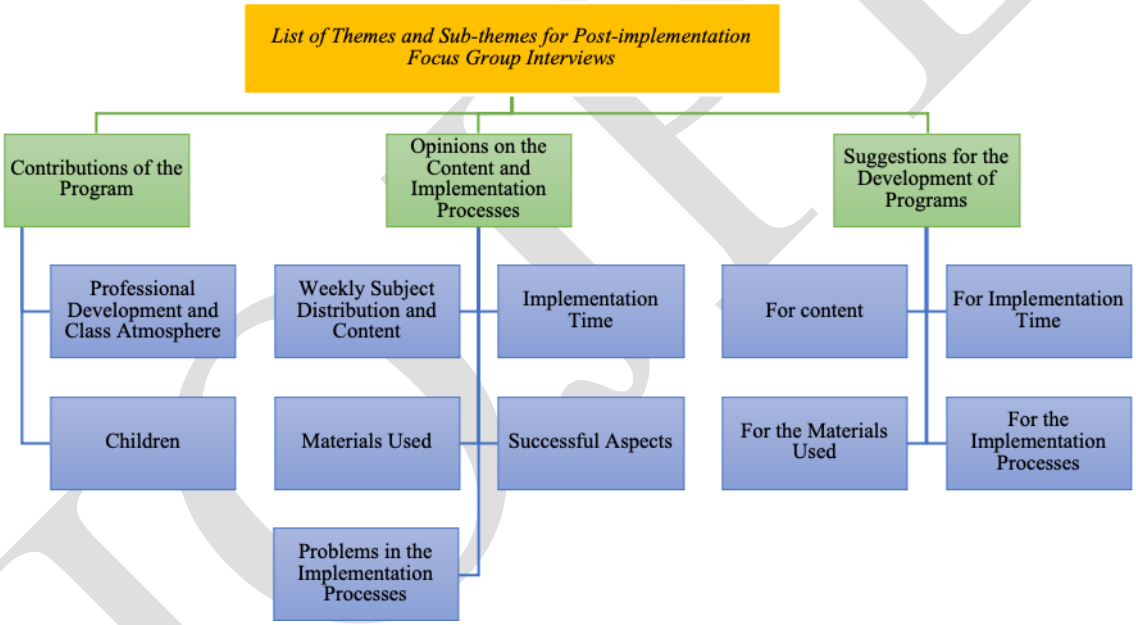


**Figure 7.** List of Themes and Sub-themes for Post-implementation Focus Group Interviews

At this stage, focus group interviews were conducted with the participants as before the implementation. As a result of the analysis from the interview data, a total of three main themes and eleven sub-themes showed in Figure 7 were achieved. First, it was revealed in the analyses that all participants acquired a large number of contributions through which they could obtain knowledge about the naturalistic teaching process from the programs professionally, and then they could transfer this knowledge to various practices. These contributions were better observing students and directing students and their families to institutions that make a diagnosis or evaluation when required, naming naturalistic teaching practices that were performed in the daily education process and realizing these practices in a more conscious way, and starting to use newly learned practices. The participants of both programs indicated that with these practices they implemented, children became more active in their classrooms, and a more entertaining atmosphere was formed. Under the main theme of "Opinions about the content of the programs and implementation processes," it was found that all participants in both education groups considered the content of the programs as holistic, interrelated

and sufficient, and they considered the materials used as linguistically clear and understandable materials with visuals, many colors, and case study consisting of pill knowledge. Furthermore, it was observed that the participants generally described education programs with the words of "effective," "successful," "touching education," and "fun." Moreover, it was determined that the education programs were described by the metaphor of "***life buoy***." The opinions of teacher Aslı about this subject are as follows: *"... the seminar has provided things that will save our lives in practice. It has become a life buoy for us. In other seminars, they just tell us, clap your arm, you can swim. I can't swim… I will somehow go ashore now, but in the meantime, I will have learned to swim..."* Along with these positive opinions, it was observed that the participants also provided some opinions regarding the aspects of the programs that needed to be developed and the problems experienced during the implementation process. The participants who attended both the face-to-face and web-based programs stated that they had difficulty in following the programs due to their personal responsibilities, that they needed "repetition of knowledge, application practice, and therefore, time" in order to internalize the naturalistic teaching strategies they learned from the programs and to specialize in practice, and that a large class size and the lack of auxiliary staff in practice were complicating factors. These results make it necessary to consider the variables that will increase motivation in participation in education programs prepared for teachers, and the factors affecting the functioning of teacher education programs in the inclusive education process in Turkey.

The suggestions for the solution of these problems mentioned by the participants in the analysis of the interviews were listed as the implementation of programs during the seminar period, the inclusion of more sample videos that may contribute to the implementation processes and coping strategies with classroom management/problem behaviors in the programs, and the operation of the coaching system. Furthermore, it was remarkable that the participants associated their suggestions for the problems experienced in the implementation of evidence-based applications such as naturalistic teaching in the education processes with the functioning of inclusive pre-school education in Turkey. In this context, the participants emphasized that the inclusive school education system, which is functioning systematically in our country, should be developed, that class sizes should be reduced for the qualified functioning of this system, that supports for auxiliary staff and materials should be provided, that different teacher education programs on evidence-based practices such as naturalistic teaching should be developed, and that the cooperation processes with families and CRC should be accelerated. For example, teacher Deniz, one of the Face-to-Face NTEPP participants, stated, *"...they should assist each other...The main problem is that there is no inclusive system understanding. Applications and problems are reflected in the parts of the whole system. If these problems are resolved, teacher training programs work in a more qualified manner*".

In conclusion, the results of this study have formed a basic frame regarding the functioning of inclusive early childhood education in Turkey and teacher education programs from support services in this process.

## DISCUSSION and CONCLUSION

In the study, the prior knowledge, opinions, and experiences of pre-school teachers regarding inclusive education and the naturalistic teaching process were first examined before the implementation, and thus, the need for professional education programs was also revealed. The first main conclusion obtained from the study is that pre-school teachers indicated that inclusive education is a system that should be present in Turkey and made a lot of contributions to them, students, and families with regard to many issues such as recognizing and accepting differences. These results suggested that teachers might basically have a moderate approach to inclusive education. Nevertheless, it was determined that the moderate approaches of teachers towards inclusive education could be affected by various factors. The participants listed these factors as stakeholders, education and training setting, insufficient support services and problems related to the political system at the upper level, especially the lack of knowledge about students with special needs and their

characteristics, and practices that can be easily applied in classrooms such as the naturalistic teaching approach. It was indicated that the improvement of the participants' lack of knowledge through professional development programs could result in the "social acceptance process" of children with special needs and their families spreading from teachers, students, and families to the society. All these results that are associated with each other are also supported by many research results in the international and national literature (Bailey & Winton, 1987; Bozarslan & Batu, 2014; Diamond & LeFurgy, 1994; Emam & Mohamed, 2011; Kasari, Freeman, Bauminger, & Alkin, 1999; Krischler, Pit-ten Cate & Krolak-Schwerdt 2018; Rakap, Parlak-Rakap, & Aydın, 2016; Rakap & Rakap, 2014; Sucuoğlu, Bakkaloğlu, Akalın, Demir, & İşçen-Karasu, 2015; Sucuoğlu et al., 2013; Winton, Turnbull, Blacher, & Salkind, 1983). In the studies, teachers' lack of knowledge and education on evidence-based practices that they can transfer into education processes is considered as one of the biggest systemic problems experienced in inclusive education, and it is considered that a solution to the problem of methodological knowledge can be produced through professional development programs including visual and written materials (Boyd, Kucharczyk, & Wong, 2016; Bruder, 2016).

According to one of the main results of the study, the five-week face-to-face and web-based programs developed were effective in increasing the participants' total scores for naturalistic teaching knowledge, interactional behaviors established by them with children, and naturalistic teaching strategies they used in leisure time and art activities. However, it was found that the face-to-face education program had a more permanent effect on the participants' total scores for naturalistic teaching knowledge and naturalistic teaching strategies used in leisure time activities compared to the web-based program. When the literature is reviewed, it is possible to find studies in which the effects and permanency of both face-to-face and web-based programs on targeted teacher behaviors are examined independently of each other (Christensen-Sandfort, & Whinnery, 2013; Harjusola-Webb & Robbins, 2012; Kohler, Anthony, Steighner, & Hoyson, 2001; Malmskog & McDonnell, 1999; Marsicano, Morrison, Moomaw, Fite, & Kluesener, 2015; Wolery, Anthony, Caldwell, Snyder, & Morgante, 2002). However, there was no study in which the effects and permanency of naturalistic teaching-based face-to-face and web-based education programs in the pre-school inclusive education process on the targeted performances of participants were compared. The results of the aforementioned studies revealed that both web-based and face-to-face education programs had a successful effect on the targeted performance levels of participants. In the literature, it is remarkable that the features of face-to-face or web-based practices such as their permanence and forms of presentation were discussed rather than their effects. At this point, it is discussed that face-to-face education programs have limitations, such as the fact that they may be time-consuming for researchers and participants. With regard to permanence, there are research results revealing that services such as counseling and coaching provided with web-based programs or longer-term education may have a more effective and permanent effect on the knowledge, skills, and behaviors that are aimed to be acquired by participants and may result in the transfer of the practices learned to the education process with a higher level of reliability (Kohler et al., 2001; Stahmer et al., 2015; Tate et al., 2005). In accordance with these results, it can be said that web-based programs, the contents of which were designed with visual and written materials, could be as effective as face-to-face programs on teachers' targeted performance levels; however, with which components and in which forms the programs on permanence should be presented to teachers is on the agenda of scientific discussion. In the focus of the discussions, it is suggested in the literature that multi-component education programs can be designed, and it is also emphasized that these designs depend on the situations of the country, the researcher and the participants such as source, time and motivation (Frantz, 2017; Dick, 2017; Han, 2012; Hemmeter, Snyder, Kinder, & Artman, 2011). In this study, the fact that the face-to-face education program had a more permanent effect on the participants' naturalistic teaching knowledge levels compared to the web-based program was considered to be due to systemic (infrastructure-based) problems in Turkey, along with the individual and motivational issues affecting the participants' time periods to follow the web-based program. In this context, it was revealed that the internet infrastructure should be developed, or the videos should be prepared in accordance with this

infrastructure so that teachers working in schools affiliated to the Ministry of Education in Turkey can watch the videos in the prepared web-based program without interruption. It is recommended to find the factors that will increase motivation with respect to teachers' more frequent participation in web-based programs.

Another result obtained from the study was that the teachers' opinions about the programs were quite positive. In the literature, it was also remarkable that social validity data were collected in the studies on teacher education programs, and in these data, it was observed that teachers found both face-to-face and web-based education programs prepared with written and visual materials effective and successful (Dick, 2017; Frantz, 2017; Gianoumis et al., 2012; Marsicano et al., 2015). Nevertheless, in the interviews, it was indicated that some problems, such as excessive class size, the lack of auxiliary staff and materials, and inadequate cooperation with stakeholders, were experienced in the transfer of knowledge obtained from the programs into practice, and that these problems could be basically solved by transforming inclusive pre-school education in Turkey into a more functional and qualified system. In the studies in the literature, inclusive pre-school education was discussed as an ecological system approach, and it was stated there were many factors that affect the quality of the system (Odom, 2002; 2016; Odom et al., 1996; Odom et al., 2002). It is observed that these factors that affect and are affected by each other include issues such as legal regulations, cooperation between stakeholders, providing support services, and arrangement of the education and training setting and process (Odom, 2016). It is overemphasized that any problem occurring in these factors, which are described as inseparable parts within the system, grows like a snowball and disrupts the holistic and qualified functioning of practices (Odom, 2002; 2016; Odom et al., 1996; Odom et al., 2002).

In brief, it is observed that web-based programs, the content of which is designed with visual and written materials, can be as effective as face-to-face programs on the targeted performance levels of teachers and have gained importance with their functionality in recent years. Nowadays, when the COVID-19 epidemic covering the whole world is experienced, it is observed that web-based programs, which can be followed at home and can spread all over the countries, have increasingly gained momentum and that these programs will continue to gain momentum in the future. However, it can be said that with which components, and in which forms the programs on permanence should be presented to teachers is on the agenda of scientific discussion. Nevertheless, it can be stated that the knowledge obtained from teacher education programs can be better reflected in classroom settings by resolving the infrastructural and systemic problems in Turkey.

The results of this study should be interpreted with some of its limitations. It is important to be able to ensure control in a lot of quantitative and qualitative data that should be collected due to the nature of the mixed method (Cresswell, 2014). Therefore, this study was carried out with a quasi-experimental design with 30 pre-school teachers who were a special study group and voluntarily agreed to participate in the education programs in Eskişehir province (limited sample size) in Turkey. Based on the need to focus on examining the effects of teacher education programs on targeted teacher behaviors and to provide time control, the effects of programs on child outcomes and families could not be examined. Furthermore, naturalistic teaching is a holistic approach containing many strategies, methods, and techniques. Therefore, in the study, which of the strategies, methods, and techniques included in the naturalistic teaching approach were used most or least by teachers was not compared with each other, and all analyses were performed on the total scores obtained from naturalistic teaching practices.

Within the context of the problems mentioned above, some suggestions that can be made for a more qualified functioning of the international inclusive education system and inclusive education system in Turkey and for further studies can be listed as follows: In the literature, inclusive education is discussed as an "*ecological system,*" in which many individuals and services (stakeholders, physical arrangements, support special education services, etc.) should work together. In this context, it is quite important to develop a qualified and functioning system for inclusive education both in Turkey and in other developing countries. Within the system, it is recommended to carry out studies on issues such

as preparing various professional development programs for the solution of the lack of knowledge and education of teachers, developing a physical environment and material opportunities, planning the services to be provided to children with special needs and their families, and increasing cooperation between stakeholders. In order to find solutions to the lack of knowledge and education in inclusive pre-school education, it may be suggested to develop and implement various education programs on different evidence-based practices such as naturalistic teaching for teachers and families and to make them widespread. There is a limited number of studies on the relevant subject in the international literature and in the literature in Turkey, and it is possible to carry out different scientific studies in which the effects and permanence of naturalistic teaching approach-based face-to-face and web-based teacher education programs on teachers, children, and families' performances are compared. Professional development programs on different evidence-based practices can be developed, and their effectiveness and permanence can be evaluated.

## Acknowledgments

This study is a part of the Scientific and Technological Research Council of Turkey (TUBITAK) 1001 Program project no.114K164 and was supported within the scope of the Anadolu University Scientific Research Projects (BAP) project no.1505E433. This study is part of the first author's doctoral thesis.

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IOJPE

ISSN: 1300 – 915X
www.iojpe.org

*International Online Journal of Primary Education* *2021, volume 10, issue 1*

# INVESTIGATION OF VERBS USED BY PRE-SERVICE PRIMARY SCHOOL TEACHERS IN THE CONTEXT OF HIERARCHY OF NEEDS WITH THE SOM-WARD METHOD

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**Received:** June 04, 2020 **Accepted:** February 24, 2021 **Published:** June 30, 2021

**Suggested Citation:**
Yazar, I., Hazar, D., Keşan, C., & Özer, M. (2021). Investigation of verbs used by pre-service primary school teachers in the context of hierarchy of needs with the SOM-Ward method. *International Online Journal of Primary Education (IOJPE), 10*(1), 235-250.



**Abstract**

The current study examines the verbs used by pre-service primary school teachers in everyday language in the context of the hierarchy of needs using the SOM-Ward clustering method. The study group of this survey research consists of 271 pre-service primary school teachers studying at a public university in Turkey. In this research, pre-service primary school teachers were asked to list the most 10 frequently used verbs in everyday language. Descriptive analysis was conducted by coding the verbs according to the themes of the hierarchy of needs. The intercoders reliability was calculated as 96 percent. The mean ranks were calculated on the data obtained according to this coding. Through the SOM-Ward clustering analysis, it was observed that the pre-service primary school teachers were separated into four clusters. Although not hierarchic, the C1 cluster is compatible in terms of basic needs; biological and physiological needs were preferred, and then the personal preferences of individuals were prioritized in determining the needs. Individual preferences prevent the hierarchical approach in determining the needs of the C2-C3-C4 clusters; it was seen that the love, safety and the aesthetic needs of those who formed these clusters are far greater than their basic needs. This reveals that there may be greater and higher priority life needs than biological and physiological needs in an individual. In addition, it was determined that the needs of esteem and superiority shown in the pyramid did not play a decisive role in the clusters since they did not make a significant impact.

**Keywords:** SOM-Ward analysis, verb, hierarchy of needs, primary school.

## INTRODUCTION

Language is accepted as the greatest ability that people acquire unconsciously and also it is a nested system which is shaped by the communities. The communities use it, and the language forms the basis of the agreements that society considers appropriate. Although the carrier characteristics of the common culture come to the fore in the formation of this basis, it is not possible to explain many differences regarding the use of language within the same cultural structure by using a random approach. As a result of the combination of human creativity and flexibility brought by individual language, which is unique

to the person, emerging of these differences is quite normal in terms of daily language. The language usage patterns of each individual in every society throughout history have been different. These forms of use contain many clues that have not been explicitly stated but noticed about the individual using them. Signs such as the spoken words, the chosen words, and the phonetic and morphological features of the language produced are included as aids which identify the language user. For example, while speaking on the phone, it is possible to make inferences about the speaker's age, gender, mood, education level, society in which he grew up, and culture, even if the speaker himself does not say these things. In this regard, the examination and understanding of the differences in everyday language use are primarily related to the knowledge of the individual who uses the language and the language used.
In today's world, it is seen that studies are conducted for the different uses and subtleties of language, and functional features of a language are emphasized in this context. Within this approach, language is seen as a part of daily activities and evaluated in these relations. Everyday linguists study language considering variables such as the orientation and actions of the speaker and the listener. Austin (2009) mentions that this language, which is used for everyday purposes such as betting, has an indispensable value for human life since everyday language has a long historical background and it uses the features of everyday language for different purposes while making various distinctions in the historical process (Austin, 2009, p. 16). It is seen that human beings can distinguish the male from the female, the living being from the abiotic, the friend from the enemy, and the good from the bad, thanks to daily language, which is one of the most natural elements as a means of communication in its great variety of forms in the universe of life. These distinctions, which extend almost to infinity in everyday language, are not without reason and support. In every distinction and awareness created, humanity's everlasting worldly efforts have a purpose, reflection and trace (Çelebi, 2014, p. 74-77).

In our study, while evaluating the factors related to individual's daily language, basic needs and analyses related to Maslow's classification were taken into consideration, rather than reasons such as mental association, socio-economic status or educational level differences. Because human beings exist in the historical process, they continue their lives as social beings in relation to the dynamic structure and perception of the value of the society they live in today. The individual has been living in a programmed way from the first moment he was born in order to meet his needs and to adapt to the conditions of his universe. Especially, the feeling of hunger in the first moment the individual opens his eyes to the world clearly shows the individual's need for nutrition. Vital findings reveal the unlimited efforts of the individual to meet their needs from birth to death. The individual, who must meet his needs due to his physiological structure, must live in production and consumption to fulfill the requirements that have a vital function for life. From past to present, individuals have been trying to meet their needs primarily to produce and consume. In this context, since the individual must meet his physiological needs, s/he focuses primarily on basic needs such as nutrition and shelter. Besides physiological needs, needs such as security, love, esteem and self-actualization are among the goals that the individual wants to achieve. Today, no matter how unlimited the individual's needs are, human beings can only meet their needs at a certain level according to their situation. For example, while the primary need for a child living in Africa is only nutrition, the needs in different geographies may reflect different variables.

The individual fulfills his needs in certain steps. It is not expected for the individual to meet the need for security or love and esteem without fulfilling the need for nutrition and shelter. In this regard, Maslow has made some insights by creating a hierarchy of needs. According to these findings, it was underlined that each goal determined in the context of the hierarchy of needs is related to the other, and the target or need that has the best probability in this context is a preliminary step that must be fulfilled in the required conditions. According to Maslow, it is predicted that the individual who meets the needs or needs at any step will be satisfied with the target in the next step of the hierarchy. In this context, in terms of the hierarchy of needs, the individual cannot move to the need for security without meeting his physiological needs. This situation also reveals that the needs of individuals are conducted in steps (Shi & Lin, 2021; Toker, 2007, p. 94-95; Walsh, 2011, p. 791).

The hierarchy of needs was originally introduced as a five-step structure including "physiological-biological needs, security needs, love-belonging needs, esteem needs and self-actualization," but over time, it was transformed into an eight-step structure with the addition of "cognitive needs, aesthetic needs and transcendence" (Maslow, 1970, p. 176). Physiological-biological needs are our basic needs such as food, water, air, sleep, warming and reproduction, which are necessary for us to continue our lives. These needs are more important than any other needs. The need for security means safety/security so we can survive; we need a home, a neighborhood, an economy, and our health security. The feeling of being loved, accepted, the desire to belong, and the need to be alone are included in the step of the needs for love-belonging. These needs are met by friendship, family relationships, and membership in social groups. Every person should feel valued, respected and confident. These esteem needs are met by participating in social activities, acquiring hobbies, and achieving academic success. The need for self-actualization is the state of self-realization of the person completely. Realizing every need may bring about the state of being. For a person to do this, they must have fulfilled their above needs completely. With these determinations, Maslow contributed to psychology by directing the attention to the positive aspects of human nature, aspects which give mental health and focus on human potential (Kleinman, 2014, p. 137-142). However, differences can be put forward in the hierarchy of needs for each culture because the situation of providing priority for the needs and their satisfaction caused by different cultures or significantly differentiating environmental adaptation problems may change the priority of advancement in the steps of the hierarchy of needs (Abdullah & Gallagher, 1995; Hagerty, 1998; Hofstede, 1980; Martinez, 2020; Montag, Sindermann, Lester, & Davis, 2020; Nevis, 1983, Rama, Harris, Speegle, Nelson, Moen, & Harris, 2020; Taormina & Gao, 2013; Ye, Ng, & Lian, 2015). For example, the Chinese hierarchy of needs is composed of belonging, physiology, safety, self-actualization in the service of society, respectively, as explained by Nevis (1983). While Maslow's hierarchy of needs stems from Western culture and focuses on the inner needs of individuals, the Chinese hierarchy of needs stems from Eastern culture and focuses on requirements of the social order (Awanis, Schlegelmilch, & Cui, 2017; Nevis, 1983; Scheffer & Heckhausen, 2018; Schwartz, 1990). Different ethnic groups in Iran emphasized basic needs, esteem needs, and self-actualization as interpreted by Mousavi and Dargahi (2013).

The individual primarily uses the communication elements in meeting his needs. This process, which starts with body language communication with the individual's arrival in the world, moves to verbal communication in proportion to psycho-motor and physical developments over time, and written communication channels can be used eventually. The ability of the individual to use language proficiency in expressing himself is extremely important.

Today, generations that grow up in the age of information and communication, adopting the technology-oriented life philosophy can reveal negative results in the development of language skills. The increase in the number of digital natives who are unable to express their troubles, explain their curiosity and have difficulty in putting together three or five sentences because of the onset of the information age may be among the most important problems of societies in this century. This situation should be evaluated as a corruption, both in the individual and in the culture of a society. Together with the changing world, our needs also change. According to Nair (2020), the hierarchy of needs for the 21st century is composed of physiological needs, psychological needs, spiritual needs, self-esteem and existential needs.

In this context, this study is important because it determines and expresses individual needs of pre-service primary school teachers, uses different language skills such as reflection and presentation, and shows what language proficiency and everyday language vocabulary mean to the individual and how much these things are kept in mind and how and to what extent they can be used.

The verbs we use during conversation find a parallel in the different steps in the eight-tier structure of the hierarchy of needs. For example, while the verbs of hunger and shopping show the behaviors of the biological-physiological need level, understanding is an example of the behaviors of the aesthetic needs level and dancing is an example of the cognitive needs level.

The verbs that individuals use in everyday language and the existence of clusters with similar characteristics according to these verbs are questioned within the scope of this research. When the verbs are evaluated according to Maslow's hierarchy of needs, what behaviors are seen in clusters with similar characteristics, their usage frequency, and their hierarchical structures are also revealed.

**SOM-Ward Clustering Method**

Self-Organizing Maps (SOM) is an effective software tool in which the results obtained using nonlinear relations between the multi-dimensional input data and the geometric connections between the data are usually converted into two-dimensional images. This method can also be considered an abstraction process, as it shortens information while preserving the most important topological-metric properties of key data components. The process consists of visualization and abstraction stages in which complex processes such as process analysis, machine detection, control and communication are evaluated (Kohonen, 1990).

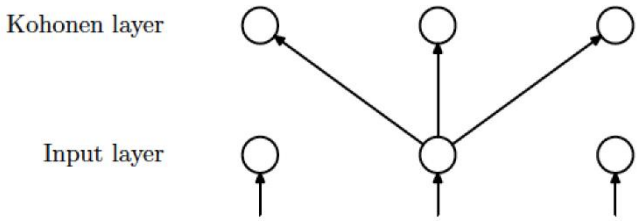



**Figure 1**. SOM structure

As shown in Figure 1, SOM consists of two interconnected layers, the input layer and the Kohonen layer. The number of neurons in the input layer is equivalent to the number of attributes of the objects, and each neuron in the input layer has a feedforward link with every neuron in the Kohonen layer. After the input data are normalized, inputs are calculated in the Kohonen layer with $y_j = \sum_{i=1}^{d} w_{ji} x_i$. Here $w_{ji}$ is the weight value of the communication from the input neuron at i to the output neuron at $j$ in the Kohonen layer. Under a winner-takes-all paradigm, the neuron in the Kohonen layer with the biggest $y_j$ value will be chosen as the winner neuron (Gan, Ma, & Wu, 2007). The SOM algorithm starts by being initialized with all the connection weights in the network having small random values. Then, the algorithm continues with the competition, cooperation and adaptation processes (Haykin, 1999).

In the competition process, an object is randomly selected from the input layer $x = (x_1, x_2, \dots, x_d)^T$ (d is the size of the input layer). $d^*$ is the total number of neurons in the Kohonen layer, and the weight vector of the neuron at the j in the Kohonen layer is determined by $w_j = (w_{j1}, w_{j2}, \dots, w_{jd^*})^T, j = 1,2, \dots, d^*$. The winner neuron of the input object is denoted by $i(x) = \arg min \|x - w_j\|, 1 \le j \le d^*$.

The collaboration process is the process of determining the topological neighborhood so that the winner neuron is at the center of collaborative neurons. The winning neuron is t, and its topological neighborhood is determined by $h_{j,t}$. $d_{t,j}$ is shown as the distance between the winner neuron t and the stimulated neuron j.

$h_{j,t}$ is the symmetry of the maximum point defined by $d_{t,j} = 0$. The width of $h_{j,t}$ decreases regularly compared to the adjacent neighborhood of $d_{t,j}$ and drops to zero in the case of $d_{t,j} \to \infty$. The lateral distance is defined by $d_{t,j} = |t - j|$ in lattice. $r_t$ and $r_j$ are discrete vectors that determine the positions of the stimulated neuron $t$ and the winner neuron $j$ in the two-dimensional lattice model, and the adjacent neighborhood of $d_{t,j}$ is determined by $d_{t,j} = \|r_t - r_j\|$.

In the adaptation process, $w_j$ that is the weight vector of the neuron $j$ varies according to input object x. When the learning rate parameter is $\eta(s) = \eta_0 \exp\left(-\frac{s}{\tau_2}\right), s = 0,1,2, \dots$ and $\sigma(s) = \sigma_0(-\frac{s}{\tau_1})$, the neighborhood function is defined as $h_{ij(x)}(s) = \exp\left(-\frac{d^2_{i(x),j}}{2\sigma^2(s)}\right), s = 0,1,2, \dots$. If the given weight vector of

neuron j is $w_j^{(s)}$, the new weight vector is determined by $w_j^{(s+1)} = w_j^{(s)} + \eta(s)h_{ij(x)}(s)(x - w_j^{(s)})$. Constants can be taken as $\eta_0 = 0.1, \sigma_0 = lattice\ radius, \tau_1 = \frac{1000}{\log \sigma_0}, \tau_2 = 1000$ (Haykin, 1999).

The current study works to order pre-service primary school teachers by their overall similarity according to the verbs they use most frequently in daily life. For this purpose, the verbs used by pre-service primary school teachers in daily life were evaluated according to Maslow's hierarchy of needs. The most frequently used hierarchy steps in daily life were determined according to the verbs evaluated by using Maslow's hierarchy of needs. Pre-service primary school teachers with similar characteristics were divided into clusters using the nonparametric regression method. Thus, the study aims to determine needs most frequently expressed by pre-service primary school teachers in Turkish culture today and to examine the characteristics of the groups formed according to the priority of the needs. This study is important in terms of examining the needs and priorities shaped by cultures, especially changing Turkish culture, and analyzing the characteristics of the pre-service primary teacher groups that have been ordered by overall similarity concerning prior needs.

## METHOD

The research examines the groups formed by those who have similar characteristics, classifying the data obtained according to the hierarchy of needs by identifying the verbs used in daily life by students studying in the primary school teaching program. In this context, the study is a survey study. Field survey studies are conducted to determine the current status of the event or problem to be investigated (Çepni, 2018). The survey method requires a sample, data collection, data analysis, and construction of quantitative descriptors of the sample of study (Groves, Fowler, Couper, Lepkowski, Singer, & Tourangeau, 2009).

### Study Group

The study group of the research consisted of 271 undergraduate students studying in a public university in the faculty of education in the primary school teaching program.

### Data Collection Tool

"Write down the top ten verbs you use most frequently in your daily life in order of priority." was the instruction given to the students. They wrote the most frequently used verbs in daily life from first to tenth. The implementation of the data collection tool took about 20 minutes. When the data were examined, those who did not write ten of the most frequently used verbs in daily life were not taken into consideration, and the first ten verbs of those who wrote more than ten were evaluated.

### Data Analysis

The data, that is, the verbs that students use in daily life, are classified themes according to the steps of the hierarchy of needs. Descriptive analysis was performed. The coding process for the themes determined according to Maslow was carried out independently by five researchers who are experts in their field. The reliability coefficient that shows the internal validity between coders was calculated using the formula $\Delta = \mathrm{C} \div (\mathrm{C} + \partial) \times 100$ (Miles & Huberman, 1994). Here, $\Delta$ refers to the coefficient of reliability, $\mathrm{C}$ is the number of terms with which consensus is reached, $\partial$ is the number of terms with which there is no consensus. The adjustment among coders is expected to be at least 80% (Patton, 2002). As a result of the calculations, it was seen that the percentages of adaptation ranged between 51 and 96 percent and the highest compliance percentage of coders was used. The explanation of the themes is given in Table 1.

**Table 1**. Themes (Maslow, 1970)

| Theme | Explanation |
|---|---|
| Biological and physiological needs | Air, food, water, shelter, temperature, sexuality, sleep |
| Security needs | Protection from natural events, safety, order, law, stability, fearlessness |
| Love and belonging needs | Friendship, sincerity, trust and acceptance, love and interest exchange, attachment, belonging to a group (family, friend, work) |

| | |
|---|---|
| Esteem needs | (i) Self-respect (dignity, success, mastery, independence) and (ii) the desire to be respected by others (for example, position, prestige) |
| Cognitive needs | Knowledge and understanding, curiosity, discovery, search for meaning and predictability |
| Aesthetic needs | Seeking beauty and knowing its value, balance, shape, etc. |
| Self-actualization | Realizing personal potential, striving for personal satisfaction, personal development and culmination |
| Transcendence | The individual is motivated by values beyond his own self (mystical and certain experiences related to nature, aesthetic experiences, sexual experiences, service to others, science engagement, religious belief, etc.) |

These themes were then coded numerically for each student's answer, respectively. Some examples of these coding are in Table 2.

**Table 2**. Examples of themes

| **Theme** | **Examples** | | | |
|---|---|---|---|---|
| Biological and physiological needs | to be hungry | to cry | to touch | to handwash |
| Security needs | to keep up | to cheat | to kill | to escape |
| Love and belonging needs | to appreciate | to fall in love | to be moved | to break up |
| Esteem needs | to arrange | | | |
| Cognitive needs | to understand | to express | to know | to explore |
| Aesthetic needs | to paint | to do personal care | to draw | to brush hair |
| Self-actualization | to play basketball | to go to events | to read news | to learn English |
| Transcendence | to pray | to render | to break the fast | to do sahur* |

(* Sahur means a meal before dawn during Ramadan)

The numerical data of five students, which are coded according to the high compatible coding of researchers being expert in their fields, are shown in Table 3:

**Table 3**. Examples of coding

| **Student** | **A1** | **A2** | **A3** | **A4** | **A5** | **A6** | **A7** | **A8** | **A9** | **A10** |
|---|---|---|---|---|---|---|---|---|---|---|
| **S1** | 1 | 1 | 1 | 1 | 3 | 5 | 1 | 6 | 1 | 1 |
| **S2** | 1 | 1 | 1 | 1 | 3 | 2 | 7 | 1 | 1 | 5 |
| **S3** | 2 | 1 | 1 | 1 | 2 | 5 | 1 | 2 | 1 | 1 |
| **S4** | 1 | 1 | 1 | 2 | 1 | 1 | 5 | 1 | 3 | 2 |
| **S5** | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 7 |

The numbers 1-8 refer to the biological and physiological needs theme, security needs theme, love and belonging needs theme, esteem needs theme, cognitive needs theme, aesthetic needs theme, self-actualization theme and transcendence theme in Table 3, respectively. To make the data mathematically meaningful, the mean ranks of the answers were calculated. The answers given by each student are coded according to the themes. As an example, the codes of the five students are as in Table 3. Then, the rows with the codes in each student (in each line) were added, and the data were calculated as in Table 4. For example, in Table 3, the columns representing the order in which theme 1 is in line S1 are calculated as 1 + 2 + 3 + 4 + 7 + 9 + 10=36 and expressed in Table 4.

**Table 4**. Rank sum

| **Student** | **Biological and physiological needs** | **Security needs** | **Love and belonging needs** | **Esteem needs** | **Cognitive needs** | **Aesthetic needs** | **Self actualization** | **Transcendence** |
|---|---|---|---|---|---|---|---|---|
| | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ | $x_6$ | $x_7$ | $x_8$ |
| **S1** | 36 | 0 | 5 | 0 | 6 | 8 | 0 | 0 |
| **S2** | 27 | 6 | 5 | 0 | 10 | 0 | 7 | 0 |
| **S3** | 35 | 14 | 0 | 0 | 6 | 0 | 0 | 0 |
| **S4** | 25 | 14 | 9 | 0 | 7 | 0 | 0 | 0 |
| **S5** | 42 | 3 | 0 | 0 | 0 | 0 | 10 | 0 |

Then, how many times the student wrote each theme (in each line) was calculated according to Table 3 (Table 4). For example, the first student wrote verbs on theme 1 in seven rows, no verb was written for themes with codes 2, 4, 7, and 8 and one verb was written for themes with codes 3, 5, and 6. As a result, the first row of Table 5, 7,0,1,0,1,1,0,0, respectively, was calculated. These calculations were made for other students and the data of the first five students are shown in Table 5.

**Table 5**. Number of themes

| Student | Biological and physiological needs | Security needs | Love and belonging needs | Esteem needs | Cognitive needs | Aesthetic needs | Self actualization | Transcendence |
|---|---|---|---|---|---|---|---|---|
| | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ | $x_6$ | $x_7$ | $x_8$ |
| **S1** | 7 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| **S2** | 6 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |
| **S3** | 6 | 3 | 0 | 0 | 1 | 0 | 0 | 0 |
| **S4** | 6 | 2 | 1 | 0 | 1 | 0 | 0 | 0 |
| **S5** | 8 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |

Then, the rank-sum values in Table 4 were divided by the number of themes in Table 5 and the mean ranks of themes were obtained and is shown in Table 6. Instead of undefined values (0 ÷ 0), 0 was written.

**Table 6**. Mean rank of themes

| Student | Biological and physiological needs | Security needs | Love and belonging needs | Esteem needs | Cognitive needs | Aesthetic needs | Self actualization | Transcendence |
|---|---|---|---|---|---|---|---|---|
| | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ | $x_6$ | $x_7$ | $x_8$ |
| **S1** | 5.142857 | 0 | 5 | 0 | 6 | 8 | 0 | 0 |
| **S2** | 4.5 | 6 | 5 | 0 | 10 | 0 | 7 | 0 |
| **S3** | 5.833333 | 4.666667 | 0 | 0 | 6 | 0 | 0 | 0 |
| **S4** | 4.166667 | 7 | 9 | 0 | 7 | 0 | 0 | 0 |
| **S5** | 5.25 | 3 | 0 | 0 | 0 | 0 | 10 | 0 |

For the answers given by students to be meaningful in accordance with the order (since ten answers were given), each numerical value was subtracted from 11 and made ready for analysis. The first five students belonging to these data are shown in Table 7.

**Table 7**. Optimized data for analysis

| Student | Biological and physiological needs | Security needs | Love and belonging needs | Esteem needs | Cognitive needs | Aesthetic needs | Self actualization | Transcendence |
|---|---|---|---|---|---|---|---|---|
| | $x_1$ | $x_2$ | $x_3$ | $x_4$ | $x_5$ | $x_6$ | $x_7$ | $x_8$ |
| **S1** | 5.857143 | 0 | 6 | 0 | 5 | 3 | 0 | 0 |
| **S2** | 6.5 | 5 | 6 | 0 | 1 | 0 | 4 | 0 |
| **S3** | 5.166667 | 6.333333 | 0 | 0 | 5 | 0 | 0 | 0 |
| **S4** | 6.833333 | 4 | 2 | 0 | 4 | 0 | 0 | 0 |
| **S5** | 5.75 | 8 | 0 | 0 | 0 | 0 | 1 | 0 |

All these calculations are done in Excel. SOM-Ward cluster analysis was applied to the data obtained from Excel using the Viscovery SOMine program.

The SOM-Ward method, one of the nonparametric regression techniques, creates a nonlinear representation of data distribution by reducing multidimensional data spaces to lower dimensions and helps define visually homogeneous data groups (Augustin et al., 2018). Pre-service primary school teachers were ordered by their overall similarity regarding their frequently used verbs coded according to the hierarchy of needs. Clusters were generated by using SOM-Ward cluster analysis. Converting into lower-dimensional abstraction process was carried out by using the two-sided t-test with a confidence

of 95% to identify each cluster of all pre-service primary teacher characteristics that differ significantly from the study sample. Thus, we can see visual clusters with homogeneous data. Viscovery also automatically calculated the absolute profile median, frequency, mean, standard deviation for quantitative variables, percentage for discrete variables, t-test scores, and p-value for the t-test.

## RESULTS

As a result of the analyses, there are four clusters that show similar characteristics with the pre-service primary school teachers' daily life verbs coded according to the hierarchy of needs. These clusters are named C1, C2, C3, and C4. The number (N), absolute profile median, frequency, and mean of the eight themes in these four clusters are shown in Table 8:

**Table 8**. Characteristics of clusters

| | N | Absolute profile median | Frequency | $x_1$ | $x_2$ | $x_6$ | $x_7$ | $x_3$ | $x_5$ | $x_4$ | $x_8$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **C1** | 123 | .3223 | 45.39 | 6.211 | 1.95 | .09 | 3.60 | .54 | 2.50 | .00 | .016 |
| **C2** | 74 | .3680 | 27.31 | 5.348 | 7.42 | .05 | 2.51 | .74 | 3.58 | .122 | .34 |
| **C3** | 63 | .9620 | 23.25 | 5.926 | 4.00 | .07 | 1.70 | 6.44 | 2.31 | .00 | .00 |
| **C4** | 11 | 2.4844 | 4.05 | 5.669 | 2.03 | 5.91 | 3.27 | 1.82 | 2.82 | .00 | .00 |

Through processing the data in SOM-Ward analysis, 45.93, 27.31, 23.25 and 4.06 percent constituted C1, C2, C3, and C4 clusters, respectively. With the map obtained from SOM-Ward analysis, the sequence of verbs of the students also reveals in which cluster they will occur. The map of the clusters is given in Figure 2.

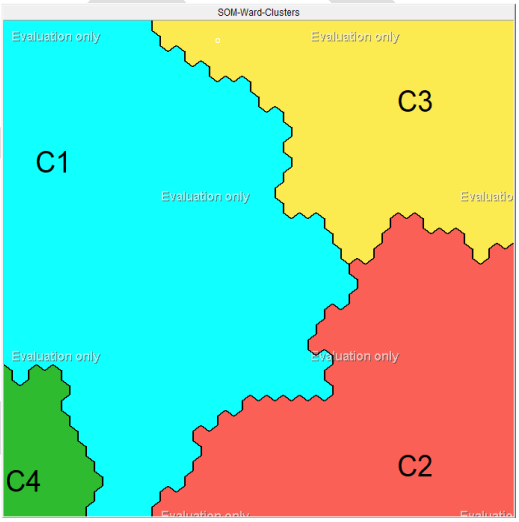



**Figure 2**. SOM-Ward cluster map

**Table 9**. Analysis results of C1

| | Mean | Std.Dev. | Diff. mean | Profile | p | t-test |
|---|---|---|---|---|---|---|
| $x_1$ | 6.211 | .75 | 5.5 | .3223 | .00 | 5.053 |
| $x_2$ | 1.95 | 2.13 | -50.3 | -.6149 | .00 | 11.13 |
| $x_6$ | .09 | .41 | -71.3 | -.1739 | .0088 | 2.639 |
| $x_7$ | 3.60 | 2.96 | 26.4 | .2617 | .0001 | 4.038 |
| $x_3$ | .54 | 1.34 | -73.1 | -.5099 | .00 | 8.63 |
| $x_5$ | 2.50 | 3.15 | -9.5 | .0836 | .2105 | 1.255 |
| $x_4$ | .00 | .00 | -100 | -.0607 | .3629 | .9114 |
| $x_8$ | .016 | .180 | -83.8 | -.1032 | .1218 | 1.552 |

**Table 10**. Cluster profile values of C1

| Characteristic Attribution | Profile Value | Mean of Cluster | Cluster Profile Comparison |
|---|---|---|---|

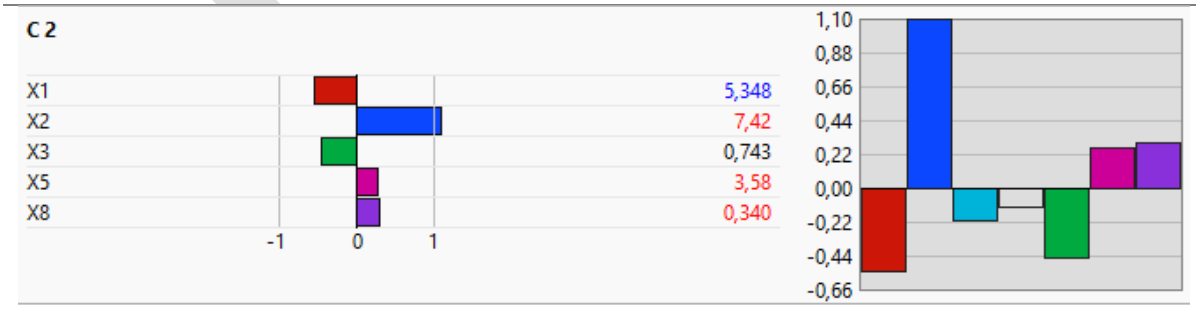

The largest cluster is C1. This cluster with 123 students constitutes 45.93 percent of the entire sample. Analysis results for each attribute in cluster C1 are in Table 9. The calculations here are calculated at the level of p=.05 (95%) significance. According to the t-test, the hierarchy of needs levels with p <.05 ($x_1$, $x_2$, $x_3$, $x_6$, $x_7$) were the features that differ significantly from the sample of the whole study while determining the characteristics of the C1 cluster. When the situations with p<.05 are evaluated, the verbs regarding biological-physiological needs ($x_1$), self-actualization ($x_7$), security needs ($x_2$), aesthetic needs ($x_6$) and the need for love-belonging ($x_3$) in the cluster are significantly different from other clusters. According to the profile value comparison in Table 10, it is seen that while biological-physiological needs and the need for self-actualization are positively distinct, the need for safety, aesthetics and love-belonging are negatively distinct in C1. Therefore, it is seen that the C1 cluster is composed of students who use verbs for biological-physiological and self-fulfillment needs more frequently and use verbs less often for the need for safety, aesthetic needs and love-belonging.

**Table 11**. Analysis results of C2

| | Mean | Std.Dev. | Diff. mean | Profile | p | t-test |
|---|---|---|---|---|---|---|
| **$x_1$** | 5.348 | .859 | -9.2 | .5362 | .00 | 5.719 |
| **$x_2$** | 7.42 | 1.92 | 89 | 1.0894 | .00 | 14.76 |
| **$x_6$** | .05 | .23 | -82.7 | -.2016 | .0417 | 2.046 |
| **$x_7$** | 2.51 | 2.96 | -12 | -.1184 | .2329 | 1.196 |
| **$x_3$** | .74 | 1.58 | -63.2 | -.4413 | .0000 | 4.618 |
| **$x_5$** | 3.58 | 3.20 | 29.5 | .2604 | .0084 | 2.657 |
| **$x_4$** | .122 | 1.046 | 266.2 | .1617 | .1029 | 1.637 |
| **$x_8$** | .340 | 1.522 | 239.3 | .2946 | .0028 | 3.017 |

**Table 12**. Cluster profile values of C2

| Characteristic Attribution | Profile Value | Mean of Cluster | Cluster Profile Comparison |
|---|---|---|---|




C2 is the second largest cluster of the sample. This cluster, which has 73 students, constitutes 27.31 percent of the sample. The analysis results for each attribute in the C2 cluster are shown in Table 11. According to the t-test, the hierarchy of needs levels with p<.05 ($x_1$, $x_2$, $x_3$, $x_5$, $x_6$, $x_8$) were the features

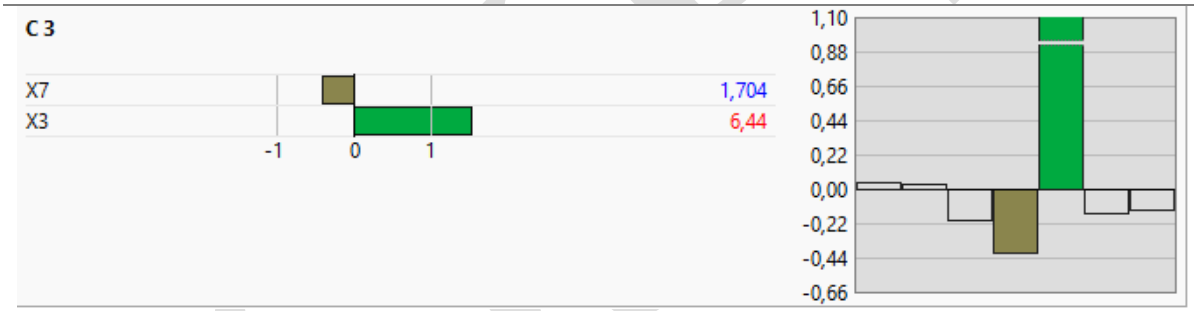
that differ significantly from the sample of the whole study while determining the characteristics of the C2 cluster. The calculations here are calculated at the level of p=.05 significance. Verbs regarding biological-physiological needs, safety needs, aesthetic needs, love and belonging needs, cognitive, and transcendence needs were significantly determinative in C2 (p<.05). When the profile value comparison is considered in Table 12, while the security needs, cognitive needs and transcendence were positively effective, biological and physiological needs, aesthetic and love-belonging needs came out as negative in C2. From this viewpoint, student teachers in the C2 cluster use verbs more frequently for security needs, cognitive and transcendence needs but fewer verbs for biological and physiological needs, aesthetic needs and love-belonging needs.

**Table 13**. Analysis results of C3

| | Mean | Std.Dev. | Diff. mean | Profile | p | t-test |
|---|---|---|---|---|---|---|
| $x_1$ | 5.926 | 1.253 | .7 | .0383 | .7290 | .3469 |
| $x_2$ | 4.00 | 2.75 | 2 | .0242 | .8271 | .2186 |
| $x_6$ | .07 | .28 | -77.1 | -.1880 | .0885 | 1.709 |
| $x_7$ | 1.70 | 2.13 | -40.2 | -.3978 | .0003 | 3.687 |
| $x_3$ | 6.44 | 1.74 | 218.7 | 1.5261 | .0000 | 25.54 |
| $x_5$ | 2.31 | 2.81 | -16.5 | -.1457 | .1874 | 1.322 |
| $x_4$ | .000 | .000 | -100.0 | -.0607 | .5830 | .5496 |
| $x_8$ | .000 | .000 | -100.0 | -.1231 | .2654 | 1.116 |

**Table 14**. Cluster profile values of C3

| Characteristic Attribution | Profile Value | Mean of Cluster | Cluster Profile Comparison |
|---|---|---|---|
| C 3 | | | |
| X7 | | 1,704 | |
| X3 | | 6,44 | |




C3 is the third-largest cluster of the sample. This cluster, with 63 students, constitutes 23.25 percent of the sample. The analysis results for each attribute in the C3 cluster are shown in Table 13. According to the t-test, the hierarchy of needs levels with p<.05 ($x_3$, $x_7$) were the features that differ significantly from the sample of the whole study while determining the characteristics of the C3 cluster. Verbs regarding the need for self-realization and love-belonging were significative in the C3 cluster (p <.05). According to the profile value comparison in Table 14, it is seen that the verbs for the love-belonging need are positively while self-fulfillment needs are negatively decisive in the C3 cluster. It is seen that C3 consists of students who use verbs for the love-belonging needs of the C3 cluster more frequently and use fewer verbs for the need of self-realization.

**Table 15**. Analysis results of C4

| | Mean | Std.Dev. | Diff. mean | Profile | p | t-test |
|---|---|---|---|---|---|---|
| $x_1$ | 5.669 | 1.315 | -3.7 | -.2168 | .4638 | .7336 |
| $x_2$ | 2.03 | 2.55 | -48.3 | -.5911 | .0451 | 2.013 |
| $x_6$ | 5.91 | 2.30 | 1795.1 | 4.3777 | .0000 | 34.29 |
| $x_7$ | 3.27 | 2.83 | 14.9 | .1481 | .6170 | .5006 |
| $x_3$ | 1.82 | 2.40 | -10.1 | -.0704 | .8121 | .2379 |
| $x_5$ | 2.82 | 3.57 | 1.9 | -.0168 | .9549 | .0566 |
| $x_4$ | .000 | .000 | -100.0 | -.0607 | .8375 | .2053 |
| $x_8$ | .000 | .000 | -100.0 | -.1231 | .6775 | .4163 |

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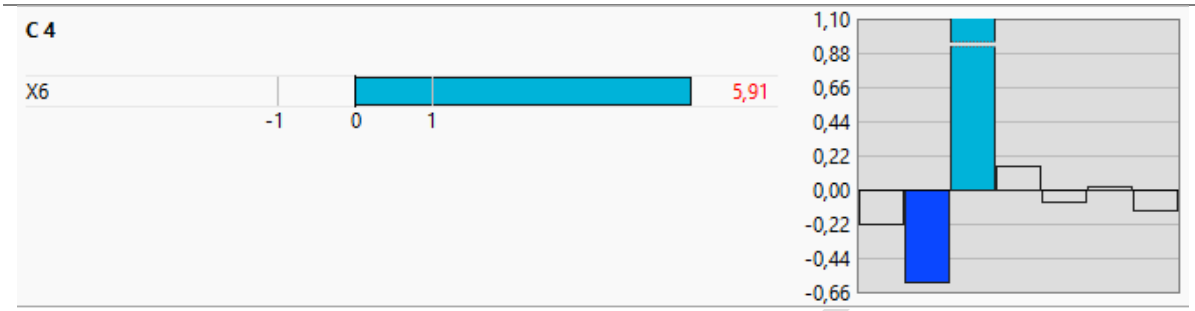
**Table 16**. Cluster profile values of C4

| Characteristic Attribution | Profile Value | Mean of Cluster | Cluster Profile Comparison |
|---|---|---|---|
| C 4 | | | |
| X6 | | 5,91 | |




C4 is the last set of the sample. This cluster, which has 11 students, constitutes 4.06 percent of the sample. The analysis results for each attribute in C4 are found in Table 15. According to the t-test, the hierarchy of needs levels with $p<.05$ ($x_6$) was the feature that differs significantly from the sample of the whole study while determining the characteristics of the C4 cluster. The verbs-regarding the safety and aesthetic needs in C4 were significant ($p<.05$). When the profile value comparison in Table 16 is examined, it is seen that the verbs for aesthetic needs are positively decisive in C4, while the verbs for safety needs are negatively decisive. It is seen that it consists of students using verbs more frequently for aesthetic needs and using fewer verbs for security needs in C4.

These clusters are examined according to the hierarchy of needs in the following figures. The distribution of clusters according to biological-physiological needs is shown in Figure 3:

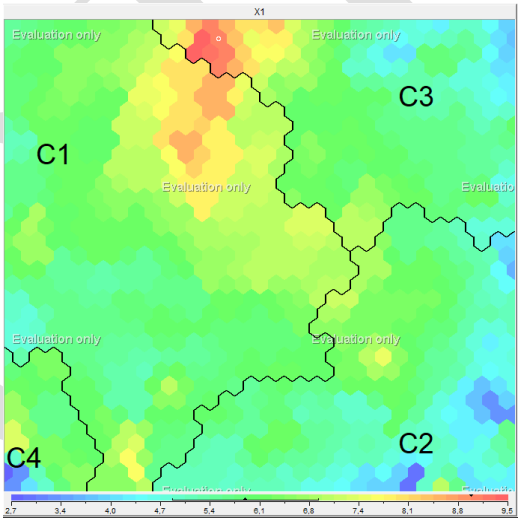



**Figure 3**. The distribution of verbs for biological physiological needs in clusters.

According to Figure 3, it is seen that the frequency of use of verbs for biological-physiological needs is indicated in green in all clusters. Regions marked in blue in C2, C3, C4 show the frequency of use is low. This situation also lowers the mean of the cluster. It has been shown with the statistical data above those verbs for these needs are more decisive in C1. Frequent use of verbs for biological-physiological needs in all clusters (i.e., all students) is compatible with being the first step of Maslow's hierarchy of needs.

In Figure 4, the red and green regions show that verbs for security needs are used less often in C1, while they are used more frequently in C2. Verbs for security needs are more decisive in C2 as shown (Figure 4). Security needs are felt the most intensely and take priority in C2, while they are at the lowest level in the C1 and C4 clusters.

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When Figure 5 is examined, it can be understood from the intensity of the blue colors that the verbs for love-belonging needs are used less frequently in clusters C1, C2 and C4; however, the intensity of the green and red colors shows they are used more frequently in C3. It is seen that students who use the verbs for their love-belonging needs more frequently are significantly effective in forming C3.

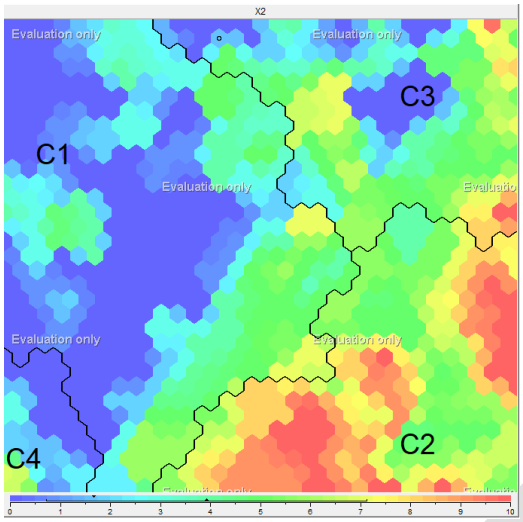


**Figure 4**. The distribution of verbs for security needs in clusters.

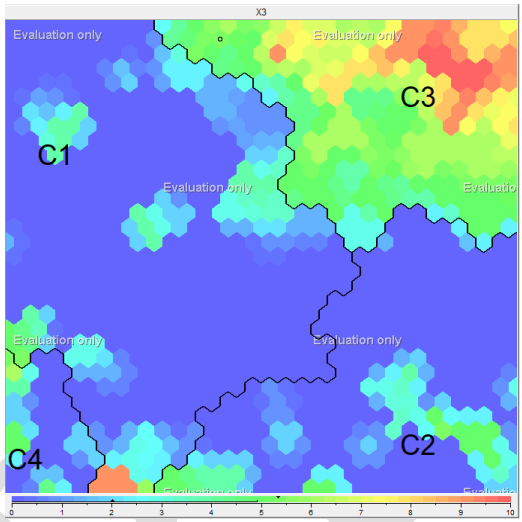


**Figure 5**. The distribution of verbs regarding love-belonging needs in clusters.

When Figure 6 is examined, it is seen that verbs for respect needs are not used frequently by the students in the sample. This situation is the same in all clusters, and verbs for this theme have not been decisive in the formation of clusters. It has been observed that verbs related to respect needs are not used frequently in students' daily lives.

When Figure 7 is examined, it can be seen that the verbs for cognitive needs are used in all clusters at low and medium levels, and frequently used by students in the C1 and C2 clusters (displayed in red). Considering the mean and descriptive statistics of the clusters in themselves (Tables 11-12), it is seen that verbs for this theme play an important role in the formation of C2.

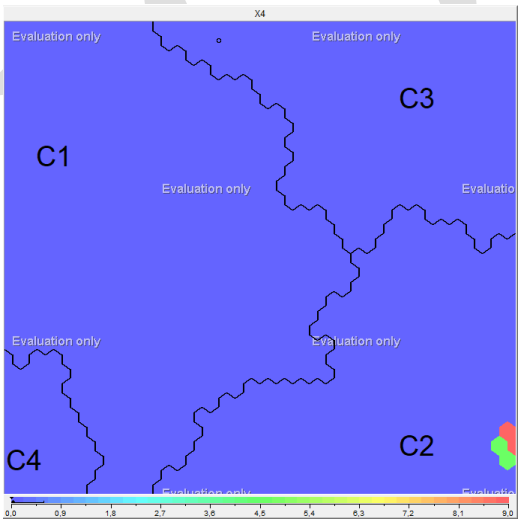


**Figure 6**. The distribution of verbs for esteem needs in clusters

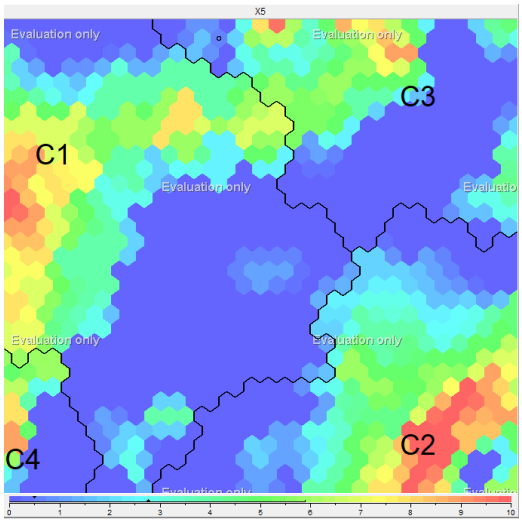


**Figure 7**. The distribution of verbs for security needs in clusters

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When Figure 8 is examined, it is seen that the verbs for aesthetic needs are not used frequently in clusters C1, C2, and C3, but they are used more frequently in cluster C4. When the data in Tables 15-16 are examined, it is seen that students who use the verbs for aesthetic needs more frequently play a statistically significant role in the formation of the C4 cluster.

When Figure 9 is examined, it is seen that the students who use the verbs for the need of self-actualization more frequently gather in C1. When Tables 9-10 are analyzed, it is seen that students who use verbs for this theme more frequently are statistically significant in forming C1. According to Tables 13-14, it is seen that the usage of verbs for self-actualization needs played a statistically significant role in the formation of the C3 cluster, but students used these verbs less.

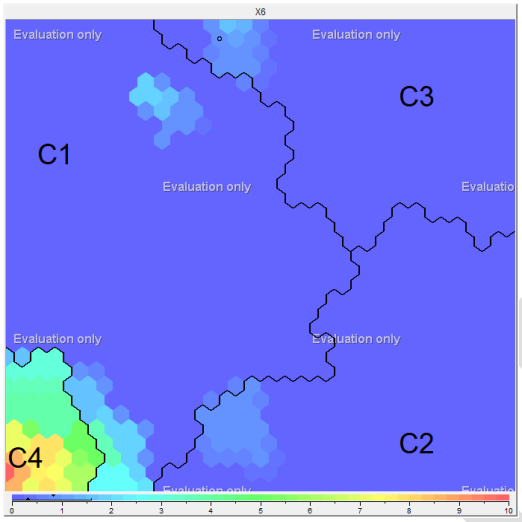


**Figure 8**. The distribution of verbs for aesthetic needs in clusters

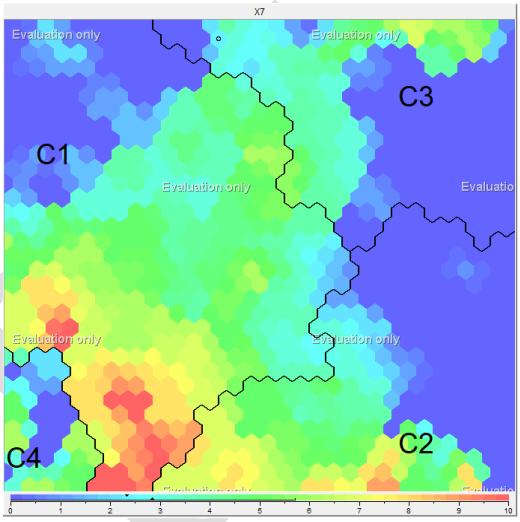


**Figure 9**. The distribution of verbs for self-actualization needs in clusters

When Figure 10 is examined, it is seen that the frequency of using the verbs for transcendence needs of students is low. The C2 cluster has red and green areas due to the usage of the more frequent verbs of some students. According to Tables 11-12, it is seen that the verbs of this theme are statistically significant in the formation of C2.

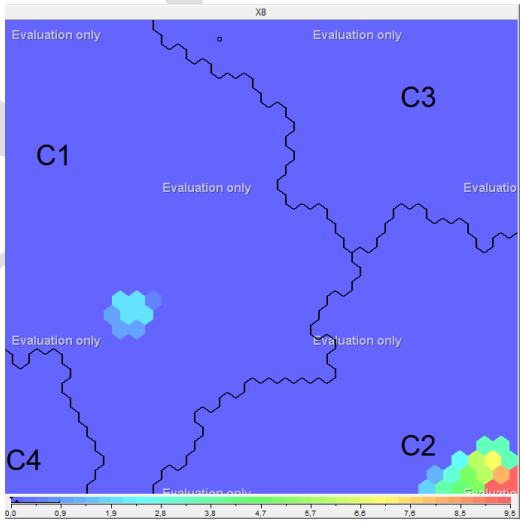


**Figure 10**. The distribution of verbs for transcendence needs in clusters

## DISCUSSION and CONCLUSION

As a result of the evaluation of the study carried out for the pre-service primary school teachers to determine the most frequently used verbs in daily life in the order of priority and within the given period in the context of the hierarchy of the needs with SOM-Ward Cluster Analysis, it was observed that the verbs for biological-physiological needs were used by all students at a medium level. According to the students' similarity in the verbs they use more frequently, the SOM-Ward Cluster Analysis method was evaluated, and clusters were created by assembling similar students according to their attributes. When the four clusters formed in this way are examined, the following conclusions are reached:

The first cluster (C1) consists of students who use biological-physiological and self-realization needs more frequently. Considering that the realization levels of needs are also hierarchical according to Maslow's approach, the expected hierarchical progress did not occur despite the students forming the C1 cluster providing basic level proficiency; instead, there was a leap to the highest level that the individual prioritized. It reveals that students in C1 are selective after meeting their basic needs. The second cluster (C2) consists of students who use verbs for security and biological-physiological needs more frequently. Although those in this group have identified security needs first, there is not a significant difference compared to biological-physiological needs. However, awareness has been raised in the identification and hierarchy of needs. The third cluster (C3) consists of students who use verbs more about love and belonging needs. The needs of the students in this cluster reflect a priority of individual preferences rather than a hierarchical structuring. It was also noteworthy that the love and belonging needs were significantly prioritized over biological-physiological needs in this cluster, while self-actualization needs were not felt. The fourth cluster (C4) consists of students who use the verbs for aesthetic needs more frequently. In this cluster, there was a situation which was in contradiction to the hierarchy of needs, where individual preferences come to the fore rather than the hierarchical approach of the needs. The preference of aesthetic needs in this cluster as the primary and sole choice, while making an obvious difference as they are never used in the other clusters, reveals the characteristic attitude of the individuals forming this cluster. The needs of the sample of the study are incompatible with Maslow's hierarchy of needs in general (Abdullah & Gallagher, 1995; Hagerty, 1998; Hofstede, 1980; Martinez, 2020; Montag et al., 2020; Mousavi & Dargahi, 2013; Nair, 2020; Nevis, 1983; Rama et al., 2020; Taormina & Gao, 2013; Ye et al., 2015). The reason for it may be the change in prior needs of pre-service primary school teachers, the prior needs of individuals of Turkish culture or the prior needs of our age.

The approach put forward by Maslow's hierarchy of needs is compatible with cluster C1 in our study, although the expected stages do not follow the most basic need; biological and physiological needs were preferred, and then personal preferences of individuals were prioritized in determining the needs.

According to the pyramid, those in the clusters of C2, C3 and C4 do not comply with the theoretical approaches proposed in the context of the hierarchy of needs; individual preferences take priority over the hierarchical approach in determining needs. It has been observed that the safety, love-belonging and aesthetic needs of those who form these clusters are beyond the basic needs step. It reveals that there can be greater and higher priority needs in an individual's life other than biological and physiological needs.

It was determined that the needs of esteem and transcendence did not play an important role in the clusters since they did not make a significant difference. It suggests that the individuals involved in the study do not adequately reflect the verbs based on the need for esteem or transcendence in their daily lives, and this situation has negative effects on professional life and social life.

According to results of the study, the following suggestions could be implemented: The deficiencies in the most basic needs in the hierarchy of needs should be met in those whose experience a lack in these needs; activities such as courses, seminars, and social events on an institutional basis should be developed in order to overcome the deficiencies in the need for self-actualization; solutions for issues such as safety, law, stability, fearlessness, and shelter should be found to address the security concerns

of those who make the first step of the hierarchy such concerns by identifying the need for security as a priority; the reason why the need for respect is hardly mentioned should be examined and an awareness that this is a need and significant value in education, professional life, and society should be created, and attitudes and behaviors which support it should be developed; the need for superiority, which is not found in the clusters and which constitutes a significant deficiency in the students' individual lives should be met through efforts that make individuals aware of values beyond their own self in various fields such as mystical experiences, nature-related experiences, aesthetic experiences, service to others, science engagement, and belief.

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