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Predispositions define a pro-environmental attitude

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ABSTRACT

The awareness of pressing environmental issues such as climate change, pollution and deforestation – all anthropogenic effects – has tremendously increased during the last few years. Recently initiated by Swedish climate activist Greta Thunberg, both students and the general public demand political changes to find immediate solutions to combat the destruction of our planet. It has been suggested that pro-environmental attitude strongly depends on sociodemographic factors and cultural context. In our study, we investigated the relationship between gender, age, education level, pro-environmental behavior (Fridays for Future movement participation) and environmental attitude in 221 high-school students in the region Ostwestfalen-Lippe in Germany. We found significant relationships between all assessed factors and environmental attitude, such as younger students or female students showing a more pro-environmental attitude than older students or male students respectively. Our results suggest influential implications in the field of environmental attitude research by using predisposition data to create effective programs about environmental awareness in school.

Keywords: Environmental attitude; Germany; Fridays for Future movement; NEP; students

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INTRODUCTION

The digital age has sped up technological advancements, accompanied by industrialization and urbanization. This has led society to face an inevitable challenge unprecedented in the history of humankind; dealing with the consequences of human impacts on the environment. Confronting these issues is indisputable as the population has exponentially surged to amounts more than Mother Earth is able to handle. Global warming caused by greenhouse gases results in disastrous climate change (Intergovernmental Panel on Climate Change (IPCC) 2014; Kerr 2007), deforestation eradicates animal habitats (Symes et al., 2018; Werth & Avissar 2002), and millions of people are still left without basic needs such as food and clean water (Gerten et al. 2011; Kang, Khan & Ma 2009). Until recently, both scientists and the general public alike have realized the necessity to respond and counteract the destruction of our planet. This has been reflected by research and political initiatives as well as by popular scientific books and documentaries (Attenborough, 2020; Rich, 2019; Wallace-Wells, 2019). Although it seems that the majority of people agree on the need to change our behavior, some remain skeptical and/or even apathetic. In our study, we aim to explore if environmental attitude is a facet of the human psyche, if it can be discovered early on in life and if it reflects internal opinions and actions regarding world-wide ecological problems.

From a psychological standpoint, two aspects are of great interest: environmental attitude and pro-environmental behavior. Environmental attitude defines the way people are aware of their surroundings, adapt their behavior and treat the ecological environment protectively (Domingues & Gonçalves, 2020; Milfont, 2007). Kaiser, Roczen & Bogner (2008) proposed a "pro-environmental competence model" stating that a pro-nature attitude is the decisive motivational basis for ecological behavior. This positive relationship has been empirically corroborated and repeatedly demonstrated (Brügger, Kaiser & Roczen, 2011; Davis, Green & Reed, 2009; Geiger, Dombois & Funke, 2018; Milfont, 2009; Oerke & Bogner, 2011; Roczen, Kaiser, Bogner & Wilson, 2014). Besides the media, schools provide one of the first external, non-familiar instance known to influence and develop attitude. In relation to our context, this is the initial occasion in which environmental issues are introduced in a formal setting; both entire classes and individual lessons have been shown to have a lasting positive effect on environmental concern (Arcury & Christianson, 1993; Chanda, 1999; Theodori & Luloff, 2002; Zhou, 2013; Zsóka et al. 2013). Therefore, it is compelling to investigate pro-environmental attitude particularly in students as they are a valuable target group. As attitudes and personalities are known to form at a young age, they can already be measured in this age group, opening up the possibility to explore possible predispositions to being environmentally conscious.

Numerous studies have observed a negative relationship between age and pro-ecological attitude (Honnold, 1984; Hsu & Roth, 1996; Johnson & Schwadel, 2018; Zhang, 1993, but see Domingues and Gonçalves, 2020). Several explanations suggest that young people show less commitment to common value systems, do not feel bound to the current social order, and can accept massive disruptions of social order (Buttel, 1979; Diamantopoulos, Schlegelmilch, Sinkovics, & Bohlen, 2003; Davis, 1940; Theodori & Luloff, 2002; Van Liere & Dunlap, 1980). Thus, it seems reasonable that they are more likely to be idealists in terms of finding overarching environmental solutions and changing the way society should treat the environment. To apply this suggestion, we hypothesize that pro-environmental attitude decreases as age increases.

Convincing evidence has demonstrated other demographics that are responsible for a predilection to support the environment. A plethora of studies have illustrated gender as an influence; women have more positive attitudes towards sustainability, renewability and environmental concern (Blocker & Eckberg, 1997; Domingues & Gonçalves, 2020; McCright, 2010; Seebauer et al., 2017; Theodori & Luloff, 2002; Xiao & McCright, 2015; Zelezny et al., 2000). This could potentially be explained by personality traits, especially related to altruistic features such as agreeableness, and that they feel socially responsible and value the needs of others (Dietz et al., 2002; Luchs & Mooradian, 2012; Zelezny, Chua & Aldrich, 2000). Based on these findings, we hypothesize that females show a higher pro-environmental attitude than males.

Without prior knowledge about the impact and relevance of ecological problems, it may be difficult to comprehend the importance of having a pro-environmental attitude. Knowledge about the current circumstances has been shown to be a strong predictor for engaging in pro-environmental behavior (Hines et al., 1987; Lee et al. 2015). As such, a background in science and the level of completed education plays a role in environmental attitude (Lyons & Breakwell,1994; Domingues and Gonçalves; 2020). The German education system is complex and consists of distinct types of schooling which offer a variety of diplomas. This provides us with the means to investigate similarly aged students with different education levels. Our study focuses on two school types: Gymnasium and Gesamtschule. As the Gymnasium tends to have more higher-level classes, we assume that scientific knowledge is related to not only the quality of education and educational level but also to the access of specific environmental knowledge. It then seems reasonable that a higher educational level is related with more knowledge in disciplines relevant to develop an understanding of environmental aspects. Therefore, we hypothesize that Gymnasium students have a higher pro-environmental attitude than Gesamtschule students.

Finally, the Fridays For Future (FFF) movement is an international climate strike that began in August 2018 and was initiated by the Swedish youth activist Greta Thunberg. The central goal is to protest the way politicians deal with the climate crisis and raise awareness that humankind is responsible for damaging the environment. Today, the movement receives international attention and has amassed a colossal number of participants. Even in several German cities, there are series of weekly school strikes in which students skip classes to participate in FFF climate strikes. Joining this movement and actively participating can be seen as exhibiting pro-environmental behavior. As there is a strong relationship between pro-environmental behavior and pro-environmental attitude, we hypothesize that students who participated in the FFF movement show a higher pro-environmental attitude than students who did not participate.

Purpose of the research

Here, we explore possible proclivities to being pro-environmental in high school students by using a well-established questionnaire accompanied by demographic information to measure pro-environmental attitude and behavior. Based on previous literature, we hypothesize that age, gender, education level and active participation in the Fridays For Future Movement all play a role towards having a pro-environmental attitude. Knowledge about individual differences in

these factors may be a critical prerequisite to develop promising interventions and promote conservation behavior in the future (Steg & Vlek, 2009).

METHOD

Data was collected from students participating in the project "Biology up close" which takes place within an external laboratory for high school classes in Ostwestfalen-Lippe, Germany (Wegner & Strehlke, 2015). The project offers multiple workshops on topics such as marine biology, bionics, photosynthesis and enzymatic reactions and served in this study solely for data collection. To measure environmental attitude, a German translation of the revised "New Ecological Paradigm Scale" (NEP) from Schleyer-Lindenmann, Ittner, Dauvier and Piolat (2018) was used. The original scale is widely used to analyze general environmental attitude and consists of 15 items such as "We are approaching the limit of the number of people the earth can support" and "Humans have the right to modify the natural environment to suit their needs" (Dunlap, Van Liere, Mertig & Jones, 2000; Cruz & Manata, 2020). Each item was recorded on a 6-point Likert Scale ranging from (1) "I strongly disagree" to (6) "I strongly agree". Odd-numbered items were verbalized to suggest agreement with a pro-ecological attitude and even-numbered items were worded for agreement to indicate a less pro-ecological attitude. Afterwards, even-numbered items were reorganized to designate a pro-ecological attitude. General environmental attitude was calculated as the average score from the 15 NEP items since it is recommended by the authors of the NEP score to treat the scale as a single, unidimensional score if reasonable dimensions do not emerge. This was the case for our sample in both an explanatory and confirmatory factor analysis, whereas the internal consistency for the global score is appropriate and hence suitable for analysis in this study ($\alpha = .705$).

Furthermore, students were asked if they participated in the FFF movement to measure pro-environmental behavior. Finally, we recorded school type, gender and age. The questionnaire was completed by students before the workshops to avoid potential bias caused by the workshop topic, as this may have had a situational influence on environmental attitude. Questionnaires were anonymous and confidential. Data processing, analysis, and presentation were conducted using R v.4.0.2 (R Core Team, 2020).

RESULTS

Participants

A total of N=221 students (n=120 female, n=88 male, n=8 other, mean age = 15.69, age range = 12-20) answered the questionnaire. One participant was excluded as they only answered the two first items. In our sample, n=148 students attended Gymnasium and n=70 students the Gesamtschule. 3 subjects did not answer the school-item. Furthermore, n=53 students were involved in the "Fridays for Future" movement, n=166 were not and 3 participants did not answer the question.

Findings

Age and pro-environmental attitude

Overall, students tended to have a pro-environmental attitude (NEP global score mean = 4.23). To examine the relationship between age and NEP-score, we conducted a linear regression analysis, revealing that age is a significant predictor for NEP-score ($\beta = -0.086$, $t = -2.83$, $p < .005$, see Figure 1a). With each year that a person gets older, their NEP-score decreases by approximately 0.08 points. This variable also predicted a significant proportion of NEP-score variance in our regression model ($F(1, 168) = 7.997$, $p < 0.005$, $R^2 = 0.046$). As younger students scored higher values, they appear to have a higher pro-environmental attitude than older students.

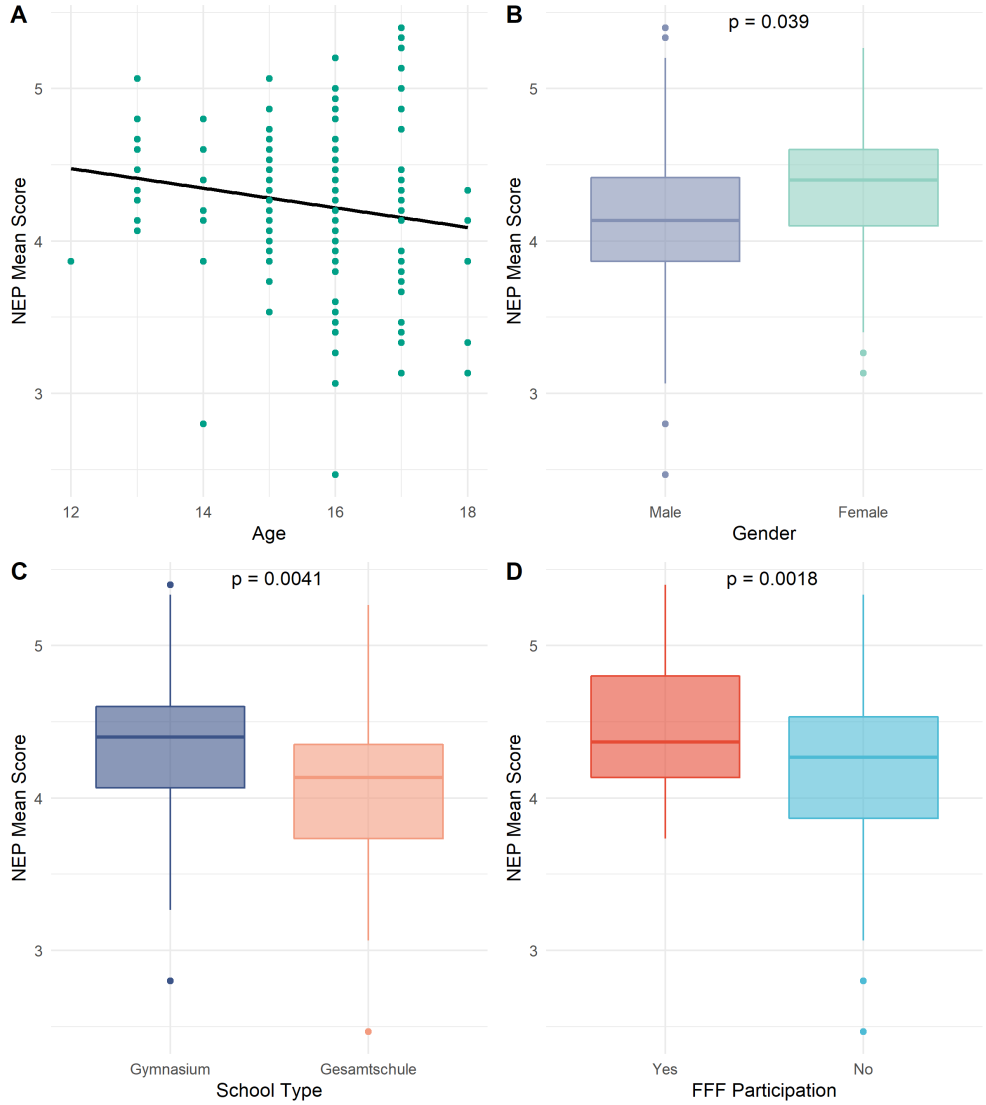

Figure 1. NEP score differences depending on Age, Gender, School Type and FFF Participation.

Gender and pro-environmental attitude

We also explored potential gender differences, concluding that women had a significantly higher average agreement to the questionnaire items than men (M = 4.30, SD = 0.42; M = 4.13, SD = 0.60, respectively, unpaired t-test, t(122.45) = -2.10, p = .037, see Figure 1b).

School type and pro-environmental attitude

We investigated differences in pro-environmental attitude based on school type. We found that Gymnasium students agreed significantly more than Gesamtschule students (M = 4.33, SD = 0.46; M = 4.03, SD = 0.56, respectively, t-test, t(180) = 3.84, p < .001, see Figure 1c). In addition, we examined differences between students participating in the FFF movement, observing that students that participated answered with higher agreement than students that did not (M = 4.46, SD = 0.43; M = 4.17, SD = 0.51, respectively, unpaired t-test, t(181) = 3.27, p = .001, see Figure 1d).

Interaction effects

As all predictors were significant, we inspected the dataset for between-factor interactions in a subsequent, exploratory step. We found a small but insignificant interaction effect between FFF participation and gender (two-way ANOVA, F(1,168) = 3.76, p = .054, $\eta p^2 = 0.02$): For students who participated in FFF, male students scored higher than female students (M = 4.58, SD = 0.50; M = 4.43, SD = 0.39, respectively, see Figure 2). However, for the group of students who have not participated, female students scored higher than male students (M = 4.27, SD = 0.42; M = 4.05, SD = 0.58, respectively, see Figure 2).

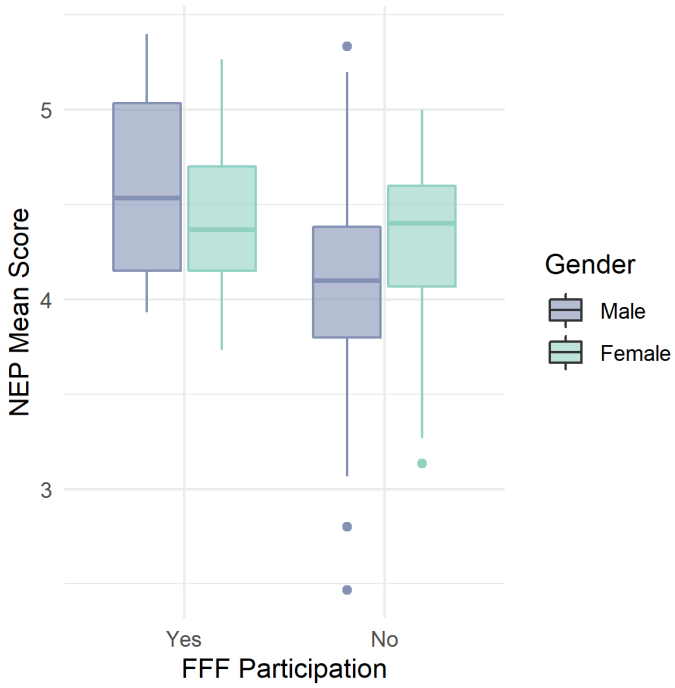

Figure 2. Interaction effects for FFF Participation and gender

DISCUSSION

The aim of this study was to investigate possible socio-demographic factors that could be considered a predisposition to having a certain environmental attitude. As attitudes and personalities form early on in life, it is of great interest to investigate how students reflect upon the relationship humanity has with the environment. Introducing programs for newer generations may in fact be the only effective way to straightforwardly address the global challenges that society faces. Our results suggest that factors such as age, gender, school type and FFF participation influence pro-environmental attitude and behavior.

Younger students showed a stronger pro-environmental attitude than older students, which has been supported by previous research (Honnold, 1984; Hsu & Roth, 1996; Johnson & Schwadel, 2018; Zhang, 1993). However, other studies have found no relationship between age and environmental attitude or even found an opposite relationship (Levine and Strube, 2012; Domingues and Gonçalves, 2020). This may potentially be due to age; there might be a threshold around puberty in which students become conscious of environmental problems and then are able to form strong opinions about them. One should also note that the participants in our study represent a narrow age range of school children, and that it is possible for other ideals or priorities to influence older age ranges. Albeit, we collected a sizable age range of students, between 12-20 years old, which we find represents biological, psychological, cognitive and personality changes at different stages.

We found that female students had a more pro-environmental attitude than male students and suggest that this is due to gender-based personality traits such as agreeableness, the extent of being “other-orientated” and a feeling of social responsibility (Blocker & Eckberg, 1997; Dietz et al. 2002; McCright, 2010; Xiao & McCright, 2015). This draws practical implications in the context of school. It is crucial that teachers equally influence female and male students in terms of environmental education (Liefländer & Bogner, 2014). Teachers should be aware that they need to sufficiently impart environmental knowledge and highlight the importance of pro-environmental thinking, especially to male students. This could be achieved by talking about several everyday items that all students use, such as talking about microplastic in cosmetics, artificial grass pitches, clothing, tyre wear particles, etc. emphasizing that all genders are affected by ecological wellbeing and should act pro-ecologically.

Gymnasium students were more pro-environmental than those attending Gesamtschule. Comparative testing shows that already in 9th grade, Gymnasium students are more competent in biology than those in the Gesamtschule (proportion of those within the top two competency levels is 39.4% and 5.1%, respectively; Hans Anand Pant et al., 2013). A weaker competency level in the Gesamtschule may correlate with teaching additional environmental topics in less depth, as the teacher might have to focus more on content for all students to catch up (e.g. studying the food web of an ecosystem to understand predator-prey interactions but not discussing the influence of humankind). Furthermore, Gymnasium students might be able to link content from different subjects with more ease, thus reflecting on the topic from alternative perspectives (e.g. political restrictions as part of social studies, agricultural problems resulting from climate change in geography, decreasing ecological diversity in biology). We suggest that further research should explicitly investigate the influence of studying environmental topics in

certain classes and the extent to which they are linked between classes. Schools should be advised that they can influence environment-friendly behavior in students if they offer environmental lessons or out-of-school environmental related projects.

We found that students participating in the FFF movement had higher NEP-scores, suggesting that they have a pro-environmental attitude. FFF participation can be seen as an indicator of pro-environmental behavior. Recently, people have been curious about the effect of the FFF movement and critical opinions suggest that students only participate to skip classes. Although we cannot fully reject such statements, investigating motives to participate was not our main focus and was not incorporated into our study design. Therefore, our results should be interpreted with caution as students may have ulterior motives to participate in FFF. Nonetheless, we suggest that our findings should motivate schools and other institutions to organize and promote opportunities for students to participate in pro-environmental programs and projects. There is a good chance that increasing student pro-environmental attitude can influence the public as well, leading to even bigger changes.

Although insignificant, we found a slight Gender x FFF interaction effect. Males participating in FFF showed higher pro-environmental attitudes than females, but among those not participating in FFF, females showed higher pro-environmental attitudes than males. This effect could be explained by the fact that more female students participated in FFF. It is possible that only male students with a high level of pro-environmental attitude participate. Wahlström et al. (2019) assume that the role of female leaders in the FFF movement might have a particularly strong effect on female students leading them participate even those with a "lower" pro-environmental attitude. We find this result noteworthy as it could have potential theoretical relevance as a promising and pivotal subject of further research.

Finally, the act of measuring environmental attitude is a multifaceted concept. It must be noted that there is a large discrepancy about the factorial structure and interpretation of using the NEP as our primary method; researchers often use different dimensions in their application of the NEP, resulting in a difficulty to form generalizations (Amburgey & Thoman, 2012). Although there is a consensus that the scale subdimensions are correlated, it is still debated as to which and how many subdimensions there are (Amburgey & Thoman, 2012). The authors of the NEP recommend to treat the scale as a single, unidimensional score if reasonable dimensions do not emerge (which was the case for our sample in both an exploratory and confirmatory factor analysis) and if the internal consistency for the global score is appropriate ($\alpha = .705$, this study). Since we are primarily interested in the global extent to which a person embodies pro-environmental attitude, we averaged all 15 items to determine pro-environmental attitude. However, we find that it would be thought-provoking to explore other ways of measuring pro-environmental attitude and behavior, possibly by gathering qualitative data by means of interviews or observations.

CONCLUSION AND SUGGESTIONS

To combat the demise of the planet, becoming environmentally aware is our only prevention method. There is an enormous potential to reach students using appropriate methods in schools to point out the pertinence of ecological responsibility and awareness. Although everyone

benefits from environmental programs, some adjustments could be made (Liefländer & Bogner, 2014). Our results alone indicate possible predispositions that could be used to help tailor individualized projects aimed at different genders, age ranges and educational level. Environmental issues could be well-addressed as a project week in school. Tackling the subject from multiple angles could reach students with different interests and allow them to individually work on topics adapted to their cognitive level. Environmental courses should be taught early on as young minds are open and flexible; forming an initial, strong pro-environmental attitude results in students that are much more likely to engage and possibly develop effective pro-environmental engagement activities. This leads to the possibility for society-wide programs to be enacted that maximize pro-environmental attitudes and ultimately, change the way we interact with the environment. As climate change is one of today's most challenging problems, it is crucial to investigate all possible influential factors and design pragmatic educational interventions to change students' attitude for good because – to put it in the words of Greta Thunberg – "our house is on fire".

DATA AVAILABILITY

Code and documentation are available as a PDF file written in Rmarkdown (File S1). Raw data and scripts for the analysis of the NEP Data are available via Github (https://github.com/vlitzke/NEP_Analysis).

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THE IMPACT OF DEMOGRAPHICS ON THE SELF-EFFICACY, TECHNOLOGY USE, AND PROFESSIONAL DEVELOPMENT EXPERIENCE FOR HIGH SCHOOL SCIENCE TEACHERS

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ABSTRACT

Several studies have been done to identify the impacts of educators' demographic factors on their use of technology in the classroom. The objective of this study was to identify the possible impacts of teacher demographics and self-efficacy, the use of technological tools in the classroom, and/or their professional development experience. The demographic factors included scientific discipline, gender, age, class length, class size, years of teaching and the school environment. In this study, the participants of a random sample of full-time high school science educators across 46 states were surveyed. Teachers' emails were gathered online from public high schools' websites. All the data was obtained through an online, closed-ended survey via the Qualtrics website. We did send a survey to 3000 science educators and 104 completed it. Data was analyzed quantitatively through SPSS Software. Findings showed that there are no significant relationships between science educators' demographic factors and self-efficacy, tool use, or professional development for the variety of technology tools given in this study. Although our research considered all possible demographic factors about self-efficacy, the use of technology tools in the classroom, and/or their professional development experience, no significant relationship between these variables was found. To continue to examine demographics' impacts on educator self-efficacy levels with technology, future research needs to involve class observations and interviews of educators using technology while teaching. Observational studies would better assess educator efficacy levels and the extent to which teachers are involved with different types of professional development and how demographics affect those levels.

Keywords: demographic factors, science educators, technology tools, regression analysis.

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INTRODUCTION AND LITERATURE REVIEW

In the following section, the literature relating demographic factors with educator professional development and self-efficacy using technology tools in the classroom is discussed. This section seeks to recognize what kind of demographic factors might have been pursued in prior studies and what factors may need to be considered further.

Gender

A few studies have focused on the connection between gender and self-efficacy in technology tool use. Hong and Koh (2002) found that female teachers had more anxiety when it came to hardware use; while Bang and Luft (2013) found that male teachers used PowerPoint more frequently than female teachers did. However, when it came to comparing teachers' self-efficacy of technology tool use with their gender, Bang and Luft (2013) found no differences. In contrast, Bebetsos and Antoniou (2009) found men had higher self- efficacy towards using technology than women. A study by Hong and Koh (2002) revealed that overall, male teachers and female teachers had similar anxiety levels. The research generally indicates there is a difference in gender when it comes to aspects of technology use in the classroom. We were curious if gender differences in self-efficacy and use of technology might be mediated by professional development. One issue that researchers are facing today is that more research may be needed for this gender demographic, given that gender is no longer considered binary- Male or Female exclusively. We need a future study to look more closely at different non-binary gender categories, but that would also compare teacher self-efficacy levels and current professional development with technology tools in the classroom.

Teaching Experience

It is crucial to also examine teachers' experiences with integration technology and teachers' experiences with professional development in using technology tools. Overall, less-experienced teachers used technology more than more experienced teachers. Isman, Yaratan, and Caner (2007) revealed that the educators who have been teaching less than ten years used technology more than those who had been teaching for 11 years or more. Willams and Kingham (2003) found that experienced teachers are not integrating technology consistently. Even though some professional development is being provided, it was not enough to fully equip veteran teachers to incorporate technology tools into their classrooms at their full abilities. Previous studies have been essential to study the relationship between both a teachers' years of experience as well as the training they have received, which is something that researchers could continue to study. It was our interest to determine if the amount of professional development increases use or self-efficacy of technology use in teachers with more experience.

School Setting and States

There are many specific difficulties that school systems must overcome in connection to technology professional development. For educators to develop methods for technology to be implicitly combined into the curriculum so that it impacts student learning, they must first

become competent with the new technology to the point where they are no longer merely trying to master the hardware or software. Few studies considered school setting as a demographic variable in their research with technology tool integration. Pierson & Borthwick (2010) recognized that many teachers remember a time when a specific type of new technology was revealed at their school, only to be thrown out when new technology was introduced. The technology tools were too complicated or were never fully adopted. In other cases, teachers may spend personal time in their classrooms or at home trying to learn how to use and integrate new technologies, only to find that they failed or felt inadequate when it came time to teach. Events like this cause problem for professional development creators, leaving them wondering how to encourage and efficiently assist teachers in integrating today's high-tech classroom tools (Pierson & Borthwick, 2010). While true, it appears as if very few educators or professionals are making strides to increase their useful knowledge about technology use and classroom integration.

Lu & Overbaugh (2009) examined if school setting (urban, suburban, and rural) affected teachers' perceptions of their environments and the effects it had on their technology integration. Time and access were the biggest factors that affected teacher's integration of technology, specifically for urban and rural schools. Suburban schools were better able to efficiently integrate technology into their classrooms. Urban schools did not provide training in the specific technology tools for teacher use. Even though all school administrators were encouraging the use of technologies, rural schools lacked technology resources. Lu and Overbaugh (2009) recognized that professional development was not provided enough for the schools that required efficient use of technology sources. Overall, school setting does impact teacher use of technology. Additionally, state education policies differed regarding professional development for teacher integration of technology. Prior research we conducted led us to question whether, in addition to the factors above, school setting, class period length, class size, teacher discipline area, or level of teacher education, might also impact technology use or teacher efficacy in science classrooms. In our previous study, we had a small sample size, but saw interesting data trends that might have multiple explanations if we had a larger sample size to work with (Aljuzayri, Pleasants, & Horvitz, 2017).

Based on the literature review, we noted that certain demographic factors had been addressed in previous studies, such as school type, school experience, and gender. All these demographics must be addressed as having a role in our research and can be investigated as part of the relationship between teachers' demographic factors and science teachers' self- efficacy, use of technology tools in the classroom, and/or their professional development experience.

Purpose of the Study

The goal of this study was to recognize the relationships between teachers' demographic factors and science teachers' self- efficacy, use of technology tools in the classroom, and/or their professional development experience. Demographic influences included: science discipline, gender, age, class duration, class size, years of teaching, and school setting (urban, rural, suburban, online/virtual, or other).

Research Question

What, if any, are the relationships between teachers' demographic factors (gender, age, science discipline, class duration, class size, education level, years of teaching, and school setting) and their' self-efficacy, use of technology tools in the classroom, and/or their professional development experience with a variety of technology tools (course management systems, student wireless or digital devices, social networking/media, class response systems, hardware, software, and mass media)?

Significance of the Study

This research is intended to help science teachers by providing them with a research-based view on how demographics can affect teacher self-efficacy and professional development in their technology use. This study examines teachers at the high school level at schools around the United States, rather than at one specific school or location. This can help faculty and administrators who educate teachers be more aware of how they can increase teacher self-efficacy and improve professional development. Additionally, this study provides a large sample that can help determine the extent to which demographic information predicted the dependent variable. The findings in this study can be used as a basis for qualitative research.

METHOD

Participants and Research Design

Participants for this research were a random sample of full-time high school science educators in the United States from 46 states (excluding Alabama, Kentucky, New York, and Pennsylvania). A survey that inquired about technology use in classrooms, and correlated efficacy was sent to 3000 instructor emails, but only 2456 science educators were reached via those emails. The emails were sent via the Qualtrics program. A total of 134 educators began the survey, but only 104 finished it. This non-experimental quantitative research was designed to use a correlational and descriptive survey to investigate the connection between science teachers' self-efficacy in using technology tools in the classroom and the professional development educators have had in technology use.

The inclusionary characteristics used: any current high school science instructors could have been chosen randomly to receive the email if: a) they taught in any one of the 50 United States, b) if they taught science at the high school level, c) if the school or district they taught in had an active website, d) if educator email addresses were available through the school or district website. Any teacher enrolled in the study was asked to participate by filling out the questionnaire. Exclusionary characteristics: a) teachers outside the 50 American states, b) Teachers at the secondary or elementary school level, c) teachers who did not teach science, d) If a participant did not complete the survey in its entirety, e) surveys where participants did not spend adequate time on the survey.

Survey Development

A new survey was developed, covering all fields of modern teaching technology, self-efficacy, and professional development. Our survey included demographic questions such as school environment, level of education, discipline of science, and teaching years, gender, age, and period of class. From previous studies, we used a similar model such as Yidana's (2007) Technology Integration Survey and the framework he used to shape his statements on the 5 Likert-type scales. There were questions in our survey about our how often teachers used these technology instruments, as well as how many hours they had for those instruments in professional development. Seven different technology platforms addressed the questions we asked: Course Management Systems, Wireless or Digital Devices for Students, Social Networking, Class Response Systems, and Hardware for Teachers, Software, and Mass Media. While I used Pan and Franklin (2011) survey model for the question about how often teachers use specific tools that were included in my survey, we adjusted the frequency options (never, less than once a month, 1-3 times a month, weekly, daily). Likewise, we did review surveys that only discussed professional development technology tools or self-efficacy when utilizing technology tools. A review of statements written for education and teaching for self-efficacy was conducted by reviewing the "Technology Education Teaching Efficacy Belief Instrument" written by Kelani (2009). We utilized some of the material by rewording and adapting the material for my needs.

The survey had two parts: the first part covered demographic information such as age, gender, science discipline, level of education, the state teachers teach in, class periods, class size, school setting, and years of teaching experience. The second part of the survey comprised a variety of 5-point Likert scale style questions inquiring about the use of course management systems, learner wireless or digital devices, social networking/media, class response systems, instructor hardware, software, and their professional development and self-efficacy related to these tools. For every item, high school science instructors were asked to imply the degree to which they agree or disagree with each statement (Strongly Disagree, Disagree, Uncertain, Agree, Strongly Agree). The measure of the 5-point Likert-scale was recognizing under three categories: low-self-efficacy in the point range of (1.0-1.80 to 1.81-2.60), moderate self-efficacy in the point range of (2.61 – 3.40), and high self-efficacy in the point range of (3.41-4.20 and 4.21-5.00) (Pimentel, 2010).

Validity is the term used to describe whether a concept has been properly demonstrated in the content. A committee comprised of one research graduate and four associated faculty members evaluated the survey for preliminary validation and changes were made to the discussion. One of the committee faculty members was an expert in teaching technology, and face-validated the revised survey.

The survey was re-created on the Qualtrics platform and sent to a convenience sample of educators as a pilot study that was conducted two months prior to the research study. The purpose of this pilot study was to prove the validity of our research. The survey was also sent to friends and relatives (all teachers) of the research committee for comment and validation. A second committee member also provided face-validation given his expertise in teacher professional development. Once all comments were received, a final version of the survey was

completed. The Cronbach alpha coefficient was used to test the internal coherence of the instruments for this research in order to infer the coherence and accuracy of the responses (Heale & Twycross, 2015). Cronbach's alpha standards are noted as: 0.90 to 1.0 excellent, 0.80 to 0.89 good, 0.70 to 0.79 acceptable, 0.60 to 0.69 questionable, 0.50 to 0.59 poor, and below 0.50 unacceptable (Glassman, Prosch, & Shao, 2015).By utilizing the answers from the convenience sample of educators (n=36) for an initial reliability estimate, we coded all the replies throughout SPSS and ran a Cronbach's Alpha (=0.724). This number implied that the investigation was of acceptable reliability of the research.

Data Collection

High school educators from 46 States were the participants in this study. Included an educator from Connecticut, West Virginia, Wyoming, New Hampshire, Maryland, Florida, Missouri, Washington, New Jersey, Maine, Georgia, Kansas, Mississippi, North Dakota and Hawaii. In total, two teachers from the following states were involved: Louisiana, Vermont, South Carolina, Oklahoma, Virginia, Arizona, Tennessee, Michigan, Indiana, Idaho, Massachusetts, South Dakota, Delaware, California and Oregon. A total three teachers from Minnesota, Nevada, Rhonda Island, Nebraska, Arkansas, Taxes, Alaska and Montana were involved. Four teachers from the states of Ohio, Wisconsin, NC, Colorado and Illinois participated in the study. Five teachers from the state of Iowa took part, and six from New Mexico.

The researcher collected from Wikipedia the list of high schools by a state, which gave the name of all public, private, and charter high schools in the United States. These schools were grouped by county and the counties were alphabetically ordered. All the lists were copied and pasted directly from Wikipedia by the investigator and then inserted into Microsoft Word documents. The list was stripped of the bullet points and headings and then counted. Each state has been provided with its own Word document. The list was stripped of the bullet points and headings and then counted. Each state has been provided with its own Word document. A random number generator (https:/www.random.org, 2018) was used to pick schools from each state. The survey, which could be performed on any computer or device with Internet access anywhere in the world, took participants 15 minutes or less to complete. At any moment, teachers who did not want to participate in the research might quit the survey.

Data Analysis

In order to answer the research question for this research, Statistical Package for Social Scientists (SPSS) version 24.0 was used for data analysis to respond to the research question for this study. We used the Cronbach alpha with the final sample size (n = 104) to determine the reliability of the multi-scale Likert survey. Multiple regression is a statistical method for analyzing the relation between a dependent variable and several independent variables. The main objective of multiple regression analysis is to use independent variables with known values to predict the value of the single dependent value. We used multiple regression analysis to find the relationship between the dependent variable (science teachers' self- efficacy, use of technology tools in the classroom, and their professional development experience) and the independent variables (demographic factors). Reliability analysis was conducted with the sample size (104). So, first, we confirmed all assumptions of multiple linear regressions: There

is a linear relationship between the outcome variable and the independent variables. There is no multicollinearity, so the independent variables are not highly correlated with each other. This assumption was tested using variance inflation factor (VIF < 3). VIF is the reciprocity of the tolerance value; small VIF values indicate little correlation between variables under ideal VIF<3 conditions, but that's fine if it's less than 10 (Hair, Anderson, Tatham, & Black,1995). Homoscedasticity was also met, so that the variance of error terms is similar across the values of the independent variables (Appendix A).

RESULTS

Firstly, the results showed the demographic information of participants Females had the highest participation of the 104 respondents, with 64 participating in the survey. We had only one non-binary individual respond (Table 1). Regarding age, the highest percent of the sample was 46 or older (36.5%). The second largest age group was between 26 and 35 years (33.7), followed by 26% of teachers between 36 and 45 years. The lowest percent of the sample were under 25 years (3.8%). Most respondents had a Master's degree (66.3%). Just over a quarter of the sample had a Bachelor's degree (27.9%), while only 3.8% held a PhD (Table 1). The highest percent of the sample teach Biology (36.5%), closely followed by Chemistry (31.7%). Physics (17.3%) and Earth Science (5.8%) had much less representation. Engineers represented only 1% of the sample (Table 1). The largest percent of the sample (36.5%) teach in Suburban schools, followed by Rural (30.8%) and Urban (29.8%). Only one teacher taught at an Online/Virtual school (Table 1).

Most of the teachers in this study had 21 to 30 students per class (57.7%). Another 24% had a class size of 11 to 20 students, and 12.5% of teachers had 31 to 35 students. The least frequent class sizes were on either end of the spectrum, with 4.8% of teachers having 36 or more students, and only one respondent had one to ten students per class (Table 1).

Most teachers reported that their class periods were up to 90 minutes long (89.4%), while only 9.6% of the total sample had classes that last 90 to 120 minutes (Table 1).For teaching experience, the highest percent of the sample had 4 to 10 years of experience (36.5%). Teachers with 11 to 20 years and those with 20 or more years of experience represented the same percent of the sample (26%). Teachers with one to three years experience were only 11.5% of the sample (Table 1).

Table 1. *Frequency and Percent Distribution of Gender, Age, level of Education, discipline, type of school, typically class size, typically a class period, total teaching experience*

Demographic	Frequency	Percent
Gender		
Female	64	61.5
Male	39	37.5
Non-Binary	1	1.0
Total	104	100.0
Age		
Under 25 years	4	3.8
26-35 years	35	33.7
36-45 years	27	26.0

46 and Up	38	36.5
Total	104	100.0
Level of Education		
Bachelors	29	27.9
Masters	69	66.3
PhD	4	3.8
Other	2	1.9
Total	104	100.0
Discipline		
Biology	38	36.5
Chemistry	33	31.7
Physics	18	17.3
Earth science	8	7.7
Engineering	1	1.0
Other	6	5.8
Total	104	100
Type of School		
Urban	31	29.8
Suburban	38	36.5
Rural	32	30.8
Online/Virtual	1	1.0
Other	2	1.9
Total	104	100
Typical Class Size		
1-10	1	1.0
11-20	25	24.0
21-30	60	57.7
31-35	13	12.5
36 and Up	5	4.8
Total	104	100.0
Typical Class Period		
Up to 90 mins	93	89.4
90-120 mins	10	9.6
120-180 mins	1	1.0
Total	104	100.0
Total Teaching Experience		
1-3 years	12	11.5
4-10 years	38	36.5
11-20 years	27	26.0
20+ years	27	26.0
Total	104	100.0

Secondly, a summary of the outcomes of the multiple regression examinations is indicated in. (table 2 below). For each model, only one of the technology tools was inserted as a dependent variable, and the demographic factors were inserted as independent variables (Predictors): gender, age, education, experience, subject, class periods, class size and school setting. Table 2 below shows that there is no significant regression, since all (F-ANOVA) had p- value > 0.05 across all regression models. These results indicate a convergence between means among all

demographic groups in their self- efficacy, use of technology tools in the classroom, or professional development experience in each technology tool.

Table 2. *Summary Results of Multiple Regression Tests*

Model	Dependent variables	R	R^2	F	P-value
Model 1	Course Management Systems	0.287	0.082	1.067	0.393
Model 2	Student Wireless or Digital Devices	0.215	0.046	0.574	0.797
Model 3	Social Networking/Media	0.321	0.103	1.363	0.223
Model 4	Class Response Systems	0.286	0.082	1.055	0.401
Model 5	Instructor Hardware	0.310	0.096	1.267	0.270
Model 6	Software	0.223	0.050	0.621	0.758
Model 7	Mass Media	0.272	0.074	0.848	0.481

Note. Dependent Variable: For each model, there is one D.V (technology tool).
Predictors: (Constant), Gender, Age, Education, Experience, subject, class periods, class size and school setting.

Discussion, Conclusion and Recommendations

Bebetsos and Antoniou (2009) found that males were more likely to use technology than females. Previous study by Hong and Koh (2002) also found that teachers as a whole had similar levels of anxiety. Nevertheless, our study which recently found that there are no significant difference between the use of technology and gender in teacher self-efficacy.

Overall, we found that there are no significant differences between educators' demographic factors (gender, age, science discipline, class duration, class size, education level, years of teaching, and school setting) and science teachers' self-efficacy, use of technology tools in the classroom, and/or their professional development experience with the seven technology tools. Even with the study considering all possible demographic factors in relationship to self-efficacy, use of technology tools in the classroom, and/or their professional development experience, no significant relationships between these variables were found. However, the results of this study should not be overly generalized because the sample size of this study became too limited once the large group was subdivided into demographic categories. In order to better determine whether demographics affect effectiveness, the use of tools or professional development, a larger sample size may be required.

We noted that previous studies suggest that certain demographic characteristics are effective, but that our study's demographic data had no effect in this study. Possibly Science teachers are more knowledgeable about the technology itself and its implementation to achieve educational goals compared to other disciplines.

The findings supported by the study conducted by McConnell (2011) who reported that teaching experience did not have a significant relationship to the level of technology integration in K-12 classrooms. Isman et al. (2007) have also found no major differences in the use of technology in classrooms, between genders of teachers. Also, another study by Joseph and Buehl (2009) found there were no also significant gender differences in teacher self-efficacy for technology use. Since there were no significant differences between teachers' demographic factors, so it will be better for future study to be replicated in two to four years to see again if demographics have an influence on efficacy, tool use, or PD a larger sample size might be needed, as our sample size developed limited once the group was subdivided into demographic categories. Surveying on a state-by-state basis might be more representative in the United States, since it does not have a federal educational system.

A limitation at the forefront of this study is it used self-reported data, obtained via email (a technological tool in itself), and so there were no observations or interviews to see exactly how, and how well, the teachers use these tools in the classroom. Another limitation is that the only high school list, which was used to identify teachers to distribute the survey to, came from Wikipedia. Any other updated source(s) of statewide high schools from all school types (private, public, and charter, urban, rural, and suburban) couldn't be located. Some of the schools listed on Wikipedia were no longer operating, or there may have been others that were not updated on the page. Also, we were first trying to send emails to the 2000 high school science teachers, not all went through. Some bounced, were invalid, or were deducted. This led to a decreased sample size for us to pull from. Going forward for future studies, adding more of a wide-range and a larger variety of questions that touch on more different varieties of technology types as well as going further into demographics in specificity might yield more conclusive results. That would mean a focus of more micro-niches such as young, female teachers, under age 25 teaching Earth Science. That would help as long as the survey would have more participants and the data could be analyzed and aggregated for analyzing the data by these micro-niches.

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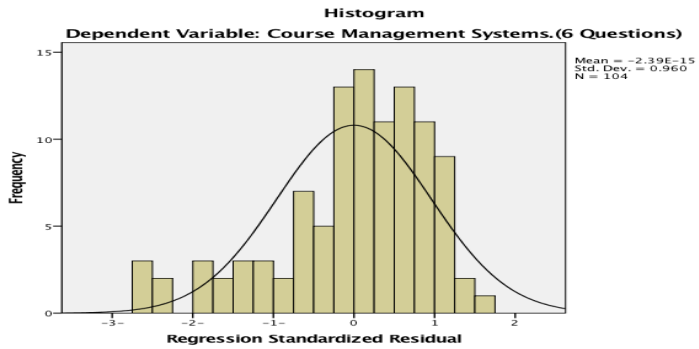
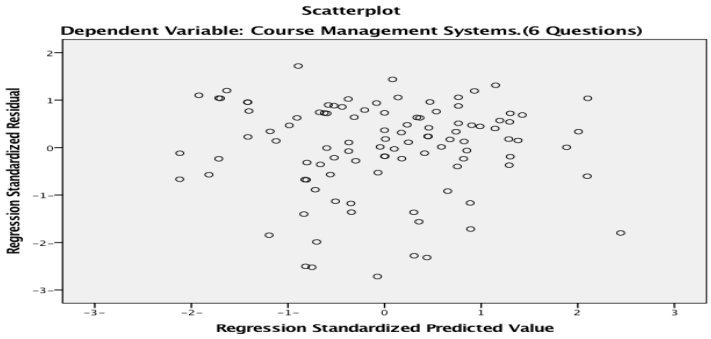
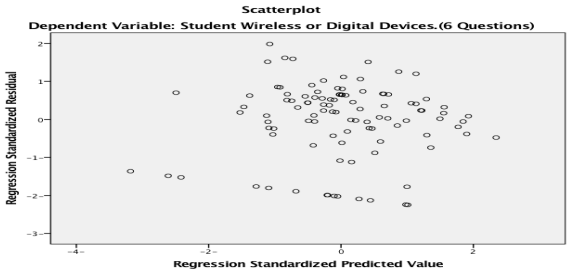
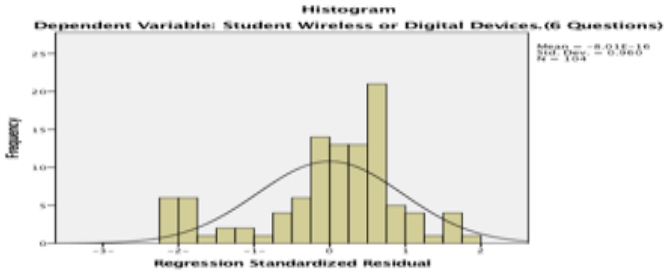
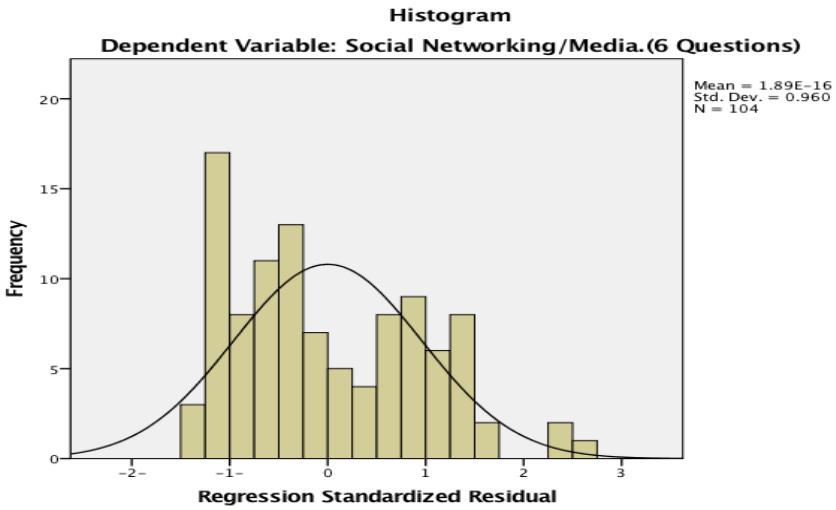
APPENDIX A Scatterplots and Histograms of Regression Standardized Residual

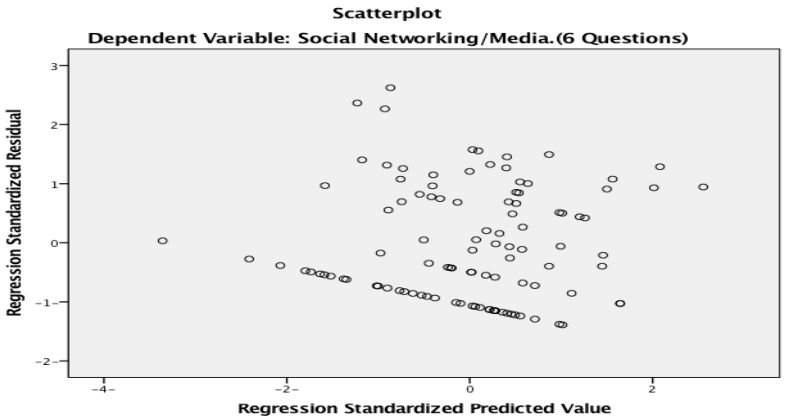


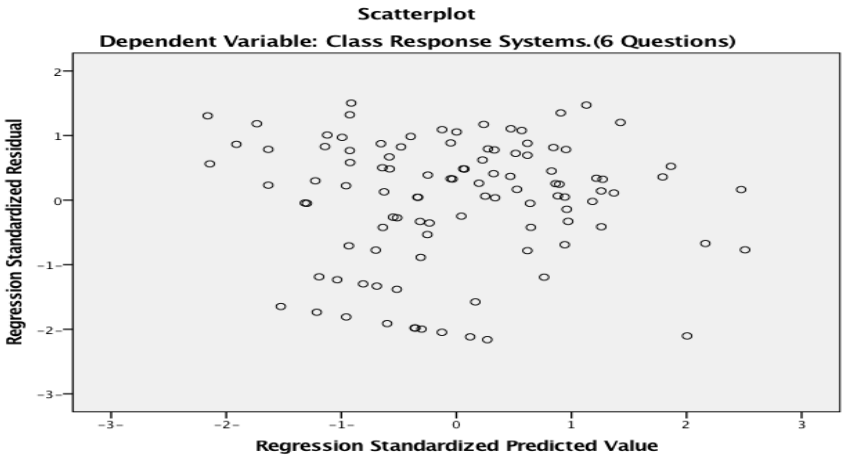


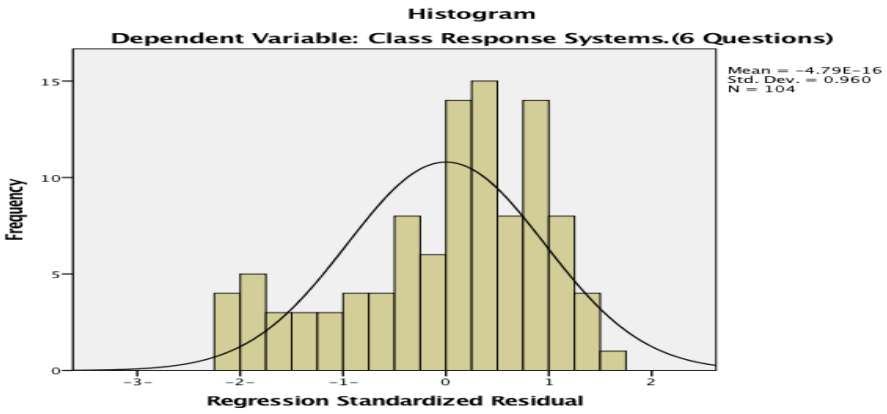





Histogram
Dependent Variable: Social Networking/Media.(6 Questions)
Mean = 1.89E-16
Std. Dev. = 0.960
N = 104
Frequency
Regression Standardized Residual


Scatterplot
Dependent Variable: Social Networking/Media.(6 Questions)
Regression Standardized Residual
Regression Standardized Predicted Value


Scatterplot
Dependent Variable: Class Response Systems.(6 Questions)
Regression Standardized Residual
Regression Standardized Predicted Value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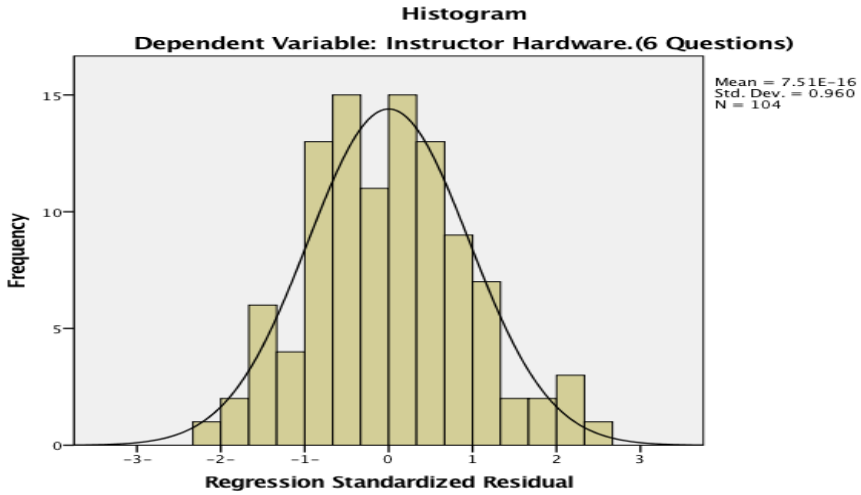
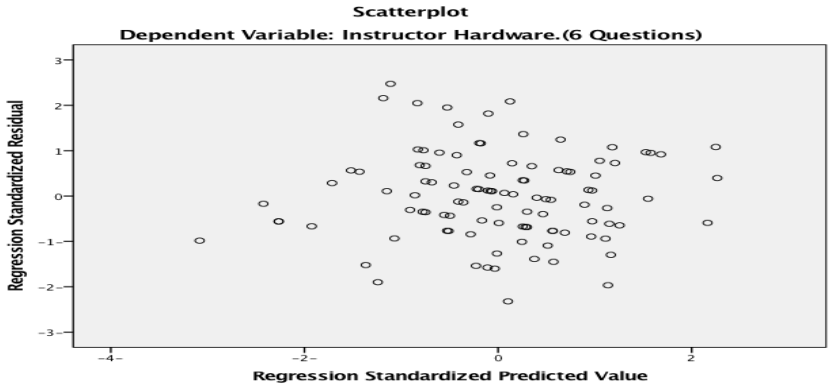
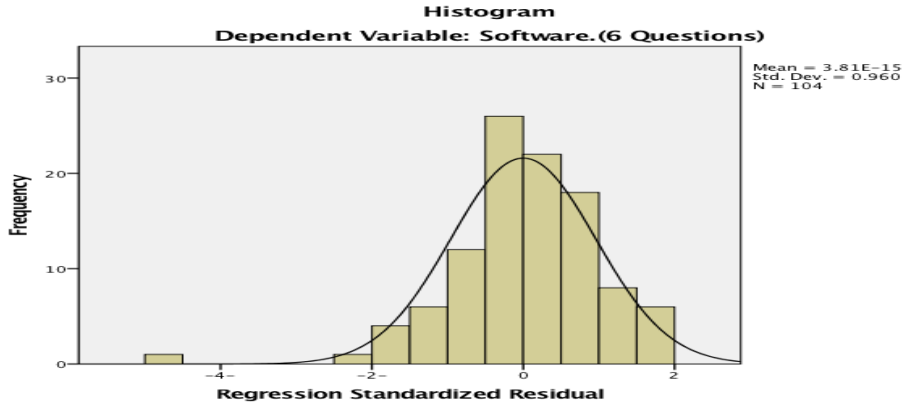
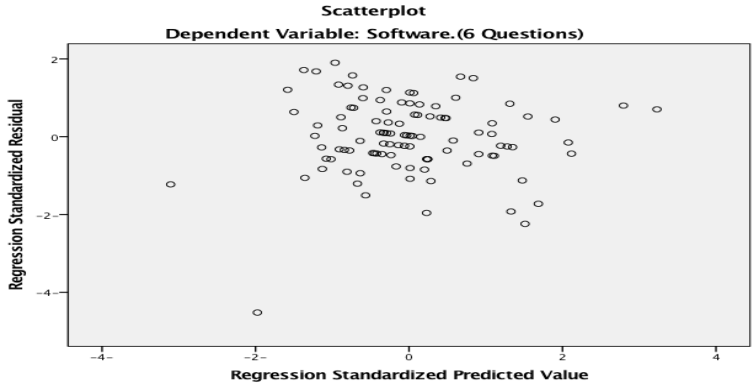
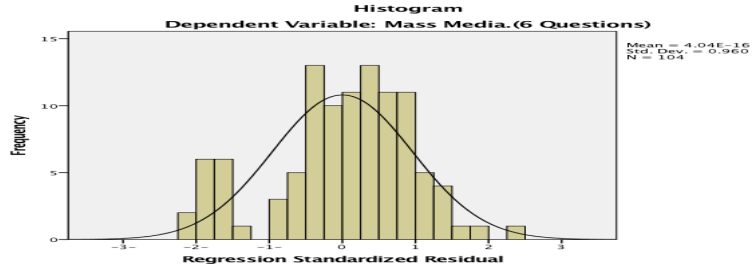
Frequency
Regression Standardized Residual

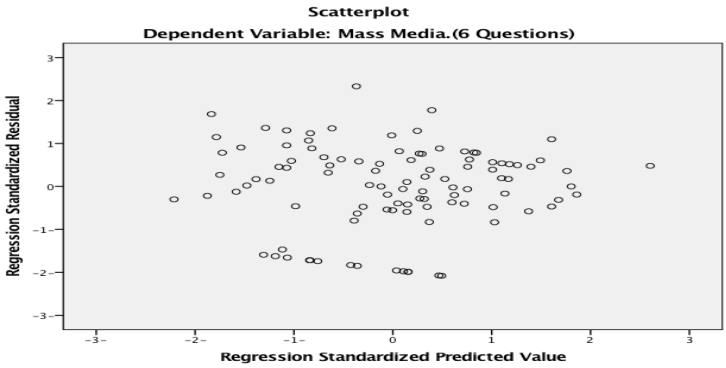

Histogram
Dependent Variable: Instructor Hardware.(6 Questions)
Mean = 7.51E-16
Std. Dev. = 0.960
N = 104
Frequency
Regression Standardized Residual


Scatterplot
Dependent Variable: Instructor Hardware.(6 Questions)
Regression Standardized Residual
Regression Standardized Predicted Value


Histogram
Dependent Variable: Software.(6 Questions)
Mean = 3.81E-15
Std. Dev. = 0.960
N = 104
Frequency
Regression Standardized Residual


Scatterplot
Dependent Variable: Software.(6 Questions)
Regression Standardized Residual
Regression Standardized Predicted Value


Histogram
Dependent Variable: Mass Media.(6 Questions)
Mean = 4.04E-16
Std. Dev. = 0.960
N = 104
Frequency
Regression Standardized Residual


Scatterplot
Dependent Variable: Mass Media.(6 Questions)
Regression Standardized Residual
Regression Standardized Predicted Value
3
2
1
0
−1
−2
−3

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Analysis of High School Entrance Exam (LGS) Questions in Terms of PISA Scientific Literacy*

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ABSTRACT

The Ministry of National Education (MEB) abolished the Transition Examination from Primary Education to Secondary Education (TEOG) in 2017 and replaced it with the High School Entrance Examination (LGS). In this study, it is aimed to analyze the content of LGS questions applied to students in the last four years and to evaluate them in terms of PISA science literacy dimensions. In this context, the study in question is suitable for the qualitative research paradigm. Content analysis was used in data analysis. When the contents of the questions in the LGS, the questions related to content knowledge and scientific explanation of events are examined in 2017-2018 and 2019-2020, the questions related to the local (national) context are analyzed in 2019-2020 and 2020-2021, questions related to physical systems content area are encountered more in 2017-2018 and 2018-2019 years. However, it was seen that the questions examined by years were mostly at a medium level in terms of cognitive level. Finally, with the change in the exam in the Turkish Education System, it is aimed to increase the success of an exam that measures various skills at the international level, and what can be improved measures for this are explained in the suggestions section.

Keywords: PISA, High School Entrance Exam (LGS), Science Literacy, Document Analysis

* This study is an extended version of the study presented at the International Conference on Science and Education (IConSE) held on November 06-09, 2021 in Antalya, Turkey.

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Tuna, S. & Seckin Kapucu, M. (2022). Analysis of high school entrance exam (LGS) questions in terms of PISA scientific literacy. *Journal of STEAM Education, 5*(1), 31-54.

INTRODUCTION

With the technological developments in the world, it is important to raise individuals with various skills, to integrate the information they have learned into daily life, to be able to use it and to be literate against the events happening around them. In this respect, it will be possible for countries to raise individuals with 21st century skills who can keep up with the space age with the changes they will make in their education systems (Okumus & Yetkil, 2020). In Turkey, it has become more and more important for students to transfer the education they receive at school to daily life. In this respect, the Ministry of National Education (MEB) makes frequent changes in Turkish education system and tries to ensure that our students are individuals who can follow the developments as global citizens and have the skills required by their age. It is aimed that students become scientifically literate individuals by developing various exams conducted throughout the country, especially in the curriculum used in schools. In this context, it is seen that the LGS exam has been applied instead of the TEOG exam for the last 4 years in Turkey. LGS is a central examination conducted by the Ministry to place eighth grade students in higher education institutions (MEB, 2018b). These changes are very important as they also include skills that are addressed at the global level.

In 2021, it is more important for students to be people with various competencies rather than knowing knowledge. When we look at the education systems of developing countries, it can be said that the reports of the Program of International Student Assessment (PISA), which is held at the international level, are effective on the basis of the changes they have made within themselves and that they are trying to reach a certain standard globally (Iseri, 2019). PISA is an international exam organized by the Organization of Economic Cooperation and Development (OECD) every three years since 2000, which provides information about the course of the education systems of the participating countries by collecting students' reading skills, science and mathematics literacy with various additional data, and makes it possible to compare countries with each other in this sense. In this exam, open-ended, closed-ended and multiple-choice questions are asked to children aged 15 using a computer-based assessment system. This exam, which has been evaluating students in an innovative field since 2012, can also collect data on students' motivations, opinions about themselves, learning styles, school environments and families, apart from subject areas. Turkey participated in PISA exams for the first time in 2003 and continues to participate. PISA is an important international test in terms of showing the gaps in their education systems to countries and also allowing them to see their own place within the countries participating in the exam (Gurlen et al., 2019). The effect of this exam on the education policies of the participating countries should not be ignored. When we look at the content of the PISA exam, it is seen that one of the basic areas is accepted as the weighted area in each exam period. In this context, the weighted area in PISA 2006 and PISA 2015 studies was determined as science literacy.

Science Literacy

Science literacy can be expressed as the use of science-related subjects in daily life. A science literate individual understands the nature of science, the processes of science, the research processes of scientists, basic science concepts, principles, laws and theories, and uses scientific process skills. The individual with this skill has an idea about science and technology within a

certain logical framework (Karakoc Alatli, 2020). Science literacy is defined by the American Association for the Advancement of Science (AAAS) as knowing nature closely, understanding scientific concepts and principles, having scientific thinking skills, and using this knowledge for the benefit of society (Ustun et al., 2020). Today, one of the most important aims of education in schools is to enable students to transfer the information they learned at school to daily life and to bring scientific solutions and interpretations to the problems they encounter. In this context, raising scientifically literate individuals is important for individuals and the country. According to OECD (2016), science literacy should be evaluated in four dimensions: knowledge type, competencies, contexts and attitudes (Karakoc Alatli, 2020).

The first of the science literacy dimensions, “knowledge type” consists of “content knowledge”, “process knowledge” and “epistemic knowledge” as sub-dimensions. “Content knowledge” means knowledge of theories, explanatory ideas, information and facts (OECD, 2016). On the other hand, "process knowledge" includes the concepts and processing processes required for scientific inquiry, which form the basis of the collection, analysis and interpretation of scientific data. Process knowledge is needed both to conduct scientific research and to criticize the evidence used to support claims (OECD, 2019a). “Epistemic knowledge” refers to an understanding of the nature of knowledge, the nature and origin of science, and reflects students' capacity to think and engage in rational discourses, as scientists do (OECD, 2016). The difference between process knowledge and epistemic knowledge can be expressed as follows: While process knowledge is needed to explain what is meant by the control variable, epistemic knowledge is needed to explain why the use of control variables is important in the creation of scientific knowledge (OECD, 2019a).

Another science literacy dimension, the “competence dimension” consists of three sub-dimensions like "explaining events scientifically", "designing and evaluating a scientific inquiry method", "interpreting data and findings scientifically". Within the scope of "explaining events scientifically" competence, students are expected to have skills such as remembering and applying scientific knowledge, defining explanatory models and representations, making appropriate predictions and verifying these predictions, proposing explanatory hypotheses, understanding the implications of scientific knowledge for society (OECD, 2019a). Within the scope of "designing and evaluating a scientific inquiry method", some skills are expected from students such as distinguishing questions that can be researched scientifically, suggesting and evaluating methods for researching scientific questions, and expressing how data reliability is ensured (OECD, 2019a). In the competence of "interpreting data and findings scientifically", skills such as analyzing data, interpreting and drawing appropriate conclusions, creating findings, analyzing arguments based on scientific findings and opinions, evaluating scientific arguments and findings from different sources (for example, newspapers, internet, magazines, etc.) are expected from students (OECD, 2019a).

The “context dimension” is another PISA science literacy dimension. In this study, it was examined in three sub-dimensions as “personal”, “local/national” and “global”. Each sub-dimension is further detailed as "health and disease", "natural resources", "environment", "risks", "limitations of science and technology".

In this study, apart from the scope of science literacy, the questions in LGS were also examined in terms of cognitive level. Cognitive level was analyzed as “low”, “medium” and “high”. “Low” depth of knowledge here; contains items that require the student to carry out a one-step procedure, such as remembering a single fact, term, principle or concept, or finding a single point of knowledge from a graph or table. If it is "medium" knowledge depth; points to items that require the student to use and apply conceptual knowledge to describe or explain the phenomenon, choose appropriate procedures involving two or more steps, organize/view data, or interpret and use simple datasets and graphs. Finally, “high” depth of knowledge requires students to analyze complex information or data, synthesize or evaluate evidence, justify claims, reasons (considering various sources), or develop a plan to deal with a problem (OECD, 2016).

In this study, out of the scope of science literacy, the questions in LGS were also examined according to the content areas of science. The questions examined were classified by three content areas: "physical systems", "systems related to living things", "earth and space systems", according to the content area of the subjects in the Science course. In physical systems, content related to the structure of matter, its properties, chemical changes, motion and force, matter and energy interactions are included, while in systems related to living things, issues related to cells, organisms, universe and ecosystems are included. In the earth and space systems, there are contents related to the earth and space (OECD, 2019a).

Looking at the literature, it is seen that there are various studies on the PISA exam. With this exam, students' math and science literacy and reading skills are measured and reported together with various variables, giving researchers a rich material in terms of presenting many research topics. Therefore, studies on the subject have spread to a wide range. Some of the studies have focused on the interpretation of the PISA exam on behalf of Turkey. When we look at our situation in the PISA exam on behalf of Turkey, the results are not encouraging (Sezer, 2018).

It is seen that various countries set the PISA exam reports as criteria for the changes they made in their education policies (Iseri, 2019). In a study conducted by Gurlen et al. (2019), the opinions of experts on PISA and International Mathematics and Science Study (TIMSS) exams and how these exams affect education policies were examined. As a result of the research, experts stated that there is a parallelism between the content of international exams and our curriculum. However, they also stated that exam results are not the only criteria that can be used to interpret our education system. In addition, it has been revealed that experts have differences of opinion on the impact of the said exams on education policies. In another study, the factors affecting the changes in the curricula were examined. In the light of the results obtained, it has been understood that one of the factors affecting the curriculum is 21st century skills (Aksoy & Taskin, 2019). The basis of these changes is questioning, critical thinking and problem solving skills. With the development of these skills, the goal of raising individuals who are science literate will also be realized.

However, some of the studies included the opinions of teachers and students in order to improve the results. In the study of Bozdogan and Yildirim (2020), the opinions of science teachers on student success in international exams were examined. The teachers involved in the study in question stated that they had heard of PISA and TIMSS exams before and that Turkey's average success rate in these exams was unfortunately very low. The reason for this is the frequent

changes in the education programs in Turkey. In another similar study, through interviews with science teachers, what can be done to increase our success in the field of science in the PISA exam was investigated. According to the teachers involved in the study, people from parents to students and even teachers should be informed about such international exams. Another striking result is that teachers say that the question styles in the exams held in Turkey are different from the questions in the PISA exam (Cumaoglu et al., 2020). In another study that brings a different perspective to the subject, the opinions of the students who took the PISA 2015 exam were examined. In this context, students said that some of the open-ended and test question types they saw in the PISA exam were similar to the questions they encountered in the school exams, but they added that they had never encountered some question types (Simsek et al., 2018).

Some of the studies have compared the PISA results of different countries and tried to determine what causes the differences between the PISA results between countries. In the study conducted by Aytekin and Tertemiz (2018), the PISA exam results and education systems of Turkey and South Korea were compared, and as a result, although there is not much difference in the education systems of the two countries, it has been seen that the results of the PISA exam have been in favor of South Korea over the years. It was stated that the economic development program implemented by South Korea had a great impact on the emergence of such a result. On the other hand, when the PISA results of Turkey and Germany made until 2015 are examined, the factors affecting the success of these countries are examined. As a result, Germany's development in the skills in the PISA exam is much better than Turkey. It has been understood that socioeconomic levels and school types have a great impact on this (Weissbach, 2018). In another study comparing the results of PISA 2012 problem solving skills of different countries, it is seen that South Korea and Japan, which have a holistic education approach, are at the top of the list in questions measuring higher-order thinking skills. It was concluded that the fact that Turkey and Hungary remained at the lower levels was due to the differences in education practices in these countries (Ileriturk et al., 2017).

As a result, at this point where the PISA exam is important for many countries in the global sense, the literature studies in Turkey have also contributed by addressing the issue from different perspectives and shed light on the precautions that can be taken to the relevant authorities and the places that need to be improved in our training program.

Considering their relationship with this study, it is possible to come across various studies conducted within the scope of science course or science literacy in the literature. One of the studies that can be mentioned in this context belongs to Kızılay (2019). In the study, the science course questions in the Transition from Primary Education to Secondary Education (TEOG) exam held in 2015 were evaluated within the scope of PISA exam questions by consulting the opinions of experts. As a result, it has been stated that TEOG questions are based on knowledge and memorization, while PISA questions generally lead students to make comments. Therefore, it has been suggested that the questions in the national exams should be designed in a way that encourages students to comment and based on scientific process skills. In another similar study, it was aimed to compare 8th grade science teachers' written exam questions and TEOG science questions according to PISA 2015 cognitive steps (Sezer, 2018). According to the results of the research, it was determined that the TEOG questions were at a lower level than the PISA

questions. In this respect, it can be said that similar results were obtained with other studies in the literature.

In the research conducted by Cakir (2019), it was aimed to examine the science questions asked in the TEOG and LGS exams according to the two-dimensional structure of the Renewed Bloom Taxonomy (YBT) of the sample science questions shared within the scope of PISA. As a result, it has been determined that the questions in the TEOG exam are included in the understanding step of conceptual knowledge, but there are very few questions that require high-level cognitive skills. However, it was stated that LGS and PISA exam questions were similar in terms of measuring both low-level and high-level cognitive skills.

In this study, it is aimed to examine the questions in the content of the central exam (LGS) related to secondary education institutions that will take students with the exam applied for the first time in the 2017-2018 academic year, within the scope of the science literacy dimensions measured by the international PISA exam questions. Since the two exams in question are applied to close age groups (LGS≈14; PISA=15), it was deemed appropriate to compare them. In this context, it is important that the content of the two exams will be compared in the light of the questions asked in the LGS, which has been announced as the new exam system by the Ministry of National Education and has been applied for 4 years, as it will contribute to educators, researchers and program development studies. In the literature review, it was seen that comparisons were made in this way, but no study was found on the questions published by the Ministry of National Education and on the PISA science literacy dimensions.

In this study, PISA exam questions are the main theme of the study, both because of the importance of the dimensions of science literacy measured by the PISA exam, and because countries see this exam as a criterion while shaping their education policies. Success of students in such an important exam is only possible if they receive an appropriate education focused on the development of these skills and enriched in this sense. Of course, it is very important that the assessment and evaluation tools that we subject students serve the same purpose.

Purpose of the research

The Ministry of National Education (MEB) abolished the Transition examination from Primary Education to Secondary Education (TEOG) in 2017 and replaced it with the High School Entrance Examination (LGS). The reason for this change made by the MEB in the examination system is the low levels of science literacy, mathematical literacy and reading skills in the international PISA examinations for Turkey. From this point of view, in the new exam system, questions parallel to the questions asked in the PISA exam are tried to be asked to the students and thus, it is aimed to increase the success level in the PISA exams. For the first time in the 2017-2018 academic year, MEB applied LGS with the change it made in the exam system, and this practice continues. The parallelism of the two exams (LGS and PISA) in question, and what can be done to increase the success of students in this sense, are encountered in a few studies in the literature based on teacher opinions. However, no study has been found in which the relationship between the content of the questions in the published LGS and the dimensions of science literacy that the PISA exam tries to measure are investigated in detail. Therefore, in this study, it is aimed to analyze the content of LGS questions applied to students in the last four

years and to evaluate them in terms of PISA science literacy dimensions. For this purpose, "which PISA science literacy dimensions include the contents of the questions that appeared in the LGS, published by the Ministry of National Education in the last four years, in the 2017-2018, 2018-2019, 2019-2020, 2020-2021 academic years?" is sought in the context of the following questions.

1. Which types of knowledge can be included in the content of the questions that appeared in the LGS, published by the Ministry of National Education in the last four years, from the PISA science literacy dimensions?

2. Which competencies in PISA science literacy dimensions include the contents of the questions that appeared in the LGS published by the Ministry of National Education in the last four years?

3. Which contexts of the PISA science literacy dimensions include the contents of the questions that appeared in the LGS published by the Ministry of National Education in the last four years?

4. At which cognitive level is the content of the questions that appeared in the LGS published by the Ministry of National Education in the last four years, within the framework of PISA science literacy?

5. Which content areas in the PISA exam cover the contents of the questions that appeared in the LGS published by the Ministry of National Education in the last four years?

METHOD

Research Design

Qualitative research emerges as a research conducted to reveal perceptions and events in a natural environment in a realistic and holistic way (Yildirim & Simsek, 2016). Qualitative data collection methods such as observation, interview and document analysis are used in qualitative research. The data of this study were collected through document analysis, one of the data collection tools frequently used in qualitative research. Document analysis is a systematic procedure for reviewing or evaluating documents in both print and electronic media. Like other analytical methods in qualitative research, document analysis requires examining data to develop empirical knowledge and make sense of it (Corbin & Strauss, 2008). With this method, it is possible to make detailed interpretations by examining the data on the subject.

Documents Examined in the Research

The documents examined in the study are the 80 Science course questions asked in the High School Entrance Exam (LGS) applied in the academic years of 2017-2018, 2018-2019, 2019-2020 and 2020-2021 on the official website of the Ministry of National Education. (MEB, 2018c, 2019b, 2020, 2021).

Data Collection Tool Development Process

In this study, a document review form prepared by the researchers was used as a data collection tool. With the form, it is aimed to evaluate the published Science course questions according to the PISA science literacy evaluation dimensions. In this respect, the questions were evaluated in detail in terms of 3 dimensions, which are "type of knowledge", "competence", "context", which are among the PISA science literacy dimensions, and also under five dimensions in total, namely "cognitive level" and "content area".

One of the PISA science literacy dimensions is the knowledge type dimension and it was examined in terms of "content knowledge", "process knowledge" and "epistemic knowledge" sub-dimensions. Another science literacy dimension is the competence dimension and it was analyzed in three sub-dimensions: "explaining events scientifically", "designing and evaluating a scientific inquiry method", "interpreting the data and findings scientifically". The "context dimension", which is another of the dimensions of science literacy, was examined under 3 sub-dimensions as “personal”, “local/national” and “global”. Each sub-dimension is further detailed as "health and disease", "natural resources", "environment", "risks", "limitations of science and technology".

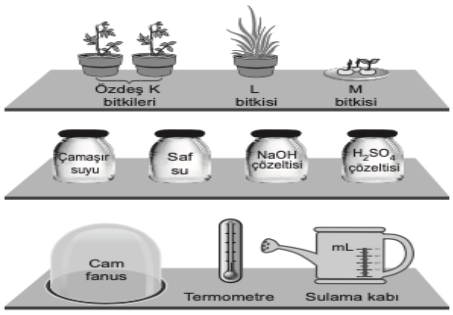
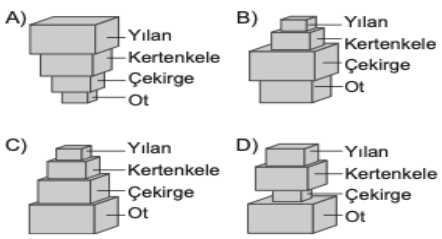
In the data collection tool, another dimension other than the science literacy dimensions is the "cognitive level" theme. This main theme was analyzed by dividing it into three sub-dimensions as low, medium and high. The last dimension is the "content area" and the questions to be evaluated here are classified according to three content areas: "physical systems", "systems related to living things", "earth and space systems". The document review form developed in this study is included in Appendix-1.

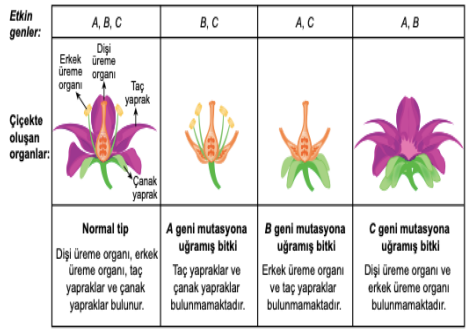
Analysis of Data

The document analysis process proposed by Corbin and Strauss (2008) was used in data analysis. In the analysis process of the data, the steps of review (surface examination), reading (detailed examination) and interpretation were followed.

The analysis of the data was carried out with the document review form prepared by the researchers. The questions that appeared in LGS in the last four years were examined by considering the PISA science literacy assessment dimensions (knowledge type, competence, context), cognitive level and content area criteria. Due to the scope of the study, detailed analyzes of the science course questions in the last four years were made and the analysis of a question that came out in each exam period was shared as an example in order to show which category they were placed in (Table 1).

Table 1. Sample analysis of a question that came out in each exam period

Question Number	Question Content	Year	Correct Answer	Knowledge type	Competence	Context	Cognitive Level	Content Area
Q17	**17.** Bir deney yapılarak asit yağmurunun bitkiler üzerindeki etkisi gözlenmek isteniyor.  Bu deneyde şekildeki bitki ve malzemelerden uygun olanlar seçilerek iki düzenek hazırlanıyor. Seçilen sıvılar bitkilere sulama kabıyla yağmur gibi üstten verilerek gözlem sonuçları karşılaştırılıyor. **Buna göre, düzeneklerde aşağıdakilerin hangisinde verilen bitki ve malzemeler kullanılmıştır?** A) L bitkisi ve özdeş K bitkileri, çamaşır suyu, eş değer miktarda H_2SO_4 ve NaOH'ten oluşan karışım, cam fanus B) K bitkisi, M bitkisi, NaOH çözeltisi, saf su C) Özdeş K bitkileri, H_2SO_4 çözeltisi, saf su D) L bitkisi, M bitkisi, eş değer miktarda H_2SO_4 ve NaOH'ten oluşan karışım, termometre, cam fanus	2017 - 2018	C	Process knowledge	Designing and evaluating a scientific inquiry method	Global / Risks	Medium	Physical systems
Q1	**1.** Karasal bir ekosistemdeki besin zinciri şekildeki gibidir. Ot → Çekirge → Kertenkele → Yılan Bu besin zincirindeki canlıların yaşadıkları ortamdaki birey sayıları farklı boyutlardaki tahta bloklar ile eşleştirilecektir. Bu blokların boyutları birey sayısını temsil etmektedir. Büyük olan bloklar birey sayısının çok, küçük olanlar ise birey sayısının az olduğunu göstermektedir.  **Buna göre, bu besin zincirindeki canlıların birey sayılarını temsil eden tahta blokların dizilimi aşağıdakilerin hangisindeki gibi olmalıdır?**  	2018 - 2019	C	Content knowledge	Explaining events scientifically	Global / Environment	Low	Systems related to living things

Q6	**6.** Bitkilerde çiçek organlarının (çanak yaprak, taç yaprak, erkek üreme organı, dişi üreme organı) oluşumunda *A*, *B* ve *C* genleri etkilidir. Tabloda *A*, *B* ve *C* genlerinin etkin (işlevsel) olduklarında oluşan çiçek organları verilmiştir.  **Tablodaki verilere göre aşağıdakilerden hangisi doğrudur?** A) *A* geninin işlevsiz olduğu çiçekte, çiçek organlarının tümünün normal gelişim göstermesi beklenir. B) *B* geninin işlevsiz olduğu çiçekte, üremeden sorumlu hiçbir organın gelişmediği görülür. C) *C* geninin işlevsiz olduğu çiçeğin, eşeyli üremeyi gerçekleştirmesi beklenir. D) Çiçekte bir organın oluşumu üzerinde birden fazla gen etkili olabilir.	2019 - 2020	D	Content knowledge	Interpreting the data and findings scientifically	Global / Environment	High	Systems related to living things
Q9	**9.** Yerkürenin doğal dengesini korumak amacıyla 2002 yılında yapılan bir dünya zirvesinde kabul edilen ilkelerden biri "Tehlikeyi Önleme İlkesi"dir. Bu ilkeyle, doğal dengeyi korumak için söz konusu sorun ortaya çıkmadan önlem alınması amaçlanmıştır. **Buna göre aşağıda verilenlerden hangisi "Tehlikeyi Önleme İlkesi" kapsamında yapılan bir uygulama değildir?** A) Akarsulara evsel atıkların karışmasının önlenmesi B) Atmosfere karbondioksit veren enerji kaynaklarının kullanımının artırılması C) Plastik ve cam gibi malzemelerin geri dönüşümünün sağlanması D) Orman varlığının korunması için kâğıt kullanımının azaltılması	2019 - 2020	B	Content knowledge	Interpreting the data and findings scientifically	Global / Natural resources	Low	Systems related to living things

When the analysis of one of the exam questions (Q17) that came out in the 2017-2018 academic year as an example is examined; In order to understand the effect of acid rain on plants, the student is expected to design an experimental setup by using various materials. Here, it is in the category of "process knowledge" as a type of knowledge, as it measures the knowledge of procedures that are essential for scientific research. The competence dimension of the question is "designing and evaluating a scientific inquiry method" because here the student is expected to propose a method to scientifically investigate a particular question. The context of the problem is in the category of "global/risks" since acid rain is a global issue and can be considered as a result of climate change. The cognitive level of the question in question is medium because the student is expected to choose appropriate procedures that involve two or more steps using their conceptual knowledge. The content area of the problem can be examined under the title of physical systems because it can be considered as a continuation of the topic of acids and bases.

Looking at the analysis of one of the exam questions (Q1) that came out in the 2018-2019 academic year, as an example, in the question related to the food chain, the student is expected to know that there are producers at the bottom step and that a pyramid-like image will emerge as the number of living things decreases as you go up. From this point of view, the type of knowledge is "content knowledge" since the question directly asks the information about the subject. In the competence dimension, it can be said that it is in the category of "explaining events scientifically" since it is expected from the student to remember and apply the scientific information about the situation. Looking at the context of the problem, the food chain/pyramid can be examined under the title of "global/environment" since it can be considered within the scope of biodiversity. The cognitive level of the question is low because it is expected from the student that the producers should be in the lowest group and to find a triangle-like shape that shows the relationship between living things, and this points to a single truth or principle. Finally, since the content area of the problem is ecosystems and the food chain, it can be clearly expressed as "systems related to living things".

When the analysis of one of the questions (Q6) of the 2019-2020 academic year is examined as an example, the student is expected to understand how the genes that are effective in the formation of the flower in the plant affect in various situations. In this respect, the knowledge type of the problem is “content knowledge”. In the question, the student was asked on a table what effect the various mutations in the genes had on the formation of the flower. In this respect, since the student is expected to analyze the data, interpret it and draw appropriate conclusions, the competence of the question can be said to be "interpreting the data and findings scientifically". Since the subject of biodiversity is addressed in the question, its context is in the category of "global/environmental". In addition, the cognitive level of the question is "high", as the student is expected to analyze and evaluate the data and justify the claims considering various sources. Finally, since the content of the problem is the changes that occur on DNA and genes, the content area is "systems related to living things".

When we look at the analysis of one of the questions (Q9) of the 2020-2021 academic year as an example, in the question (Q9) the student was asked what practices could be included in the principle after the purpose of the "prevention of danger principle" was given, and in this respect, it is expected that an explanatory idea will be given in the question. The knowledge type of the question is “content knowledge”. The competence of the question is in the category of "interpreting the data and findings scientifically", both because the student is expected to analyze and interpret the information given and to draw an appropriate conclusion, and because the student evaluates scientific arguments. In addition, considering the context of the problem, it can be said that the problem is in the context of "global/natural resources" since it questions the sustainable use of resources. The cognitive level of the question is "low", as the student is expected to perform a one-step procedure, that is, to understand the purpose of the danger avoidance principle and evaluate the options. Finally, since the question draws attention to the issue of sustainability, the content area can be discussed under the title of "systems related to living things".

The sample analyzes shared for each year were made separately for a total of 80 questions in the study. Each question in the LGS published by the Ministry of National Education in the last four years was examined in terms of knowledge type, competence, context, cognitive level and

content area, which are among the PISA science literacy dimensions, and the information obtained was transferred to the document analysis review form.

The reliability criterion for qualitative research focuses on identifying and documenting recurring correct and consistent (homogeneous) or inconsistent (heterogeneous) features, such as patterns, themes, worldviews, and other phenomena studied in similar or different human contexts (Labuschagne, 2003). In this study, the criteria put forward by Guba and Lincoln (1982) (credibility, transferability, consistency and confirmability) were taken into account in order to ensure the credibility of the analyzes. In order to ensure credibility in this research, the questions were examined in detail by the researchers and analyzed at different times. In addition, the questions with consensus and disagreement among the researchers were determined and the reliability of the analysis was calculated as .81 (Miles & Huberman, 1994). In order to ensure transferability, the research process has been tried to be explained in detail. To ensure confirmability, the researchers compared the obtained results and questions by reviewing them at different times.

FINDINGS

The contents of the questions that appeared in the LGS published by the Ministry of National Education in the last four years were examined in terms of PISA science literacy dimensions (knowledge types, competence, contexts, cognitive levels and content areas) and the findings were presented.

Findings on Types of Knowledge

The questions that appeared in the LGS published by the Ministry of National Education over the years were examined in terms of content knowledge, process knowledge and epistemic knowledge, which are one of the PISA science literacy dimensions (Table 2).

Table 2. Examination of the content of the questions in LGS in terms of knowledge type dimension

	Types of Knowledge					
	Content knowledg		**Process knowledge**		**Epistemic knowledge**	
Years	**f**	**%**	**f**	**%**	**f**	**%**
2017-2018	15	75	4	20	1	5
2018-2019	12	60	7	35	1	5
2019-2020	15	75	5	25	0	0
2020-2021	14	70	6	30	0	0

As a result of the analyzes, while there were more questions about content knowledge in 2017-2018 and 2019-2020, this rate decreased in other years. However, it can be said that more than 60% of the exam questions every year consists of questions covering content knowledge. While there were more questions in the process knowledge in 2018-2019, this number remained at the lowest level in 2017-2018. As a result, it is seen that the questions asked vary between 20-35%

on a yearly basis in the category of process knowledge. When the questions in 2017-2018 and 2018-2019 were examined, it was determined that the number of questions containing epistemic knowledge was only 1. However, in other years, no questions regarding this type of knowledge were included. For the questions examined in our study, the distribution of epistemic knowledge type questions on years does not exceed 5%.

Findings on Competence

The contents of the questions in the LGS published by the Ministry of National Education over the years were analyzed in terms of scientific explanation of events, designing and evaluating a scientific inquiry methods, and scientific interpretation of data and findings in the competence category of PISA science literacy dimensions, and the results are shown in the table (Table 3).

Table 3. Examination of the content of the questions in LGS according to the competence dimension

	Competence					
	Explaining events scientifically		**Designing and evaluating a scientific inquiry method**		**Interpreting the data and findings scientifically**	
Years	**f**	**%**	**f**	**%**	**f**	**%**
2017-2018	12	60	4	20	4	20
2018-2019	6	30	6	30	8	40
2019-2020	8	40	5	25	7	35
2020-2021	6	30	6	30	8	40

In the sub-dimension of scientifically explaining events, while there were more questions (60%) in 2017-2018, the number of questions decreased in the following years and the percentage distribution of the questions asked varies between 30-40%. In the category of designing and evaluating a scientific inquiry method, the distribution of questions over the years is between 20-30%. Finally, in the sub-dimension of scientifically interpreting the data and findings, it is seen that the distribution varies between 20-40%. It can be stated that the distribution of questions on competence in 2018-2019 and 2020-2021 is the same.

Findings Related to Contexts

The contents of the questions in the LGS published by the Ministry of National Education over the years were examined according to the PISA science literacy dimensions, in terms of personal, local (national) and global contexts (Table 4). Personal, Local/National and Global

context consists of health and disease, natural resources, environment, risks and limitations of science and technology.

Table 4. Examination of the content of the questions in LGS by years according to the context dimension

	Context					
	Personal		**Local/National**		**Global**	
Years	f	%	f	%	f	%
2017-2018	7	35	6	30	7	35
2018-2019	4	21	6	32	9	47
2019-2020	0	0	15	75	5	25
2020-2021	1	5	12	60	7	35

When we look at the distribution of the 80 questions examined in terms of context by years, the questions in 2017-2018 show an equal distribution in the personal and global context, with a ratio of 35%. Looking at the questions in 2018-2019, it is seen that 50% of them have content in the global context. The questions in 2019-2020 do not contain any personal content. However, it can be stated that 75% of the questions were asked in the local/national context for the same year. LGS questions in 2020-2021 are also similar to the previous year in terms of distribution. It can be said that in the exam held in 2020-2021, no questions were asked in a personal context, except for a single question, and there was 60% of the question content in the local/national context.

Findings Related to Cognitive Levels

The contents of the questions that appeared in the LGS published by the Ministry of National Education by years were analyzed according to the PISA science literacy dimensions in terms of low, medium and high cognitive levels (Table 5).

Table 5. Examination of the content of the questions in LGS by years in terms of cognitive levels

	Cognitive Level					
	Low		**Medium**		**High**	
Years	**f**	**%**	**f**	**%**	**f**	**%**
2017-2018	6	30	12	60	2	10
2018-2019	4	20	11	55	5	25
2019-2020	5	25	8	40	7	35
2020-2021	5	25	9	45	6	30

When Table 5 is examined, it is seen that the number of medium-level questions is higher with a distribution ratio of at least 40% compared to years.

Findings Related to Content Areas

The contents of the questions published in LGS published by the Ministry of National Education over the years were examined according to the content areas of physical systems, systems related to living things, and earth and space systems, which are one of the PISA science literacy dimensions (Table 6).

Table 6. Examination of the questions in LGS according to the years in terms of content areas

	Content Area					
	Physical systems		**Systems related to living things**		**Earth and space systems**	
Years	**f**	**%**	**f**	**%**	**f**	**%**
2017-2018	13	65	5	25	2	10
2018-2019	12	60	7	35	1	5
2019-2020	9	45	8	40	3	15
2020-2021	9	45	9	45	2	10

According to the findings obtained over four years, it is seen that more questions are given to the physical systems content area. In the questions in 2020-2021, more emphasis was placed on the content area of systems related to living things. It can be said that the year with the highest number of questions in the field of earth and space systems was 2019-2020, however, the distribution on the basis of years did not exceed 15%.

CONCLUSION AND RECOMMENDATIONS

The contents of the questions in the LGS published by the Ministry of National Education in the last four years were examined in terms of knowledge types, competencies, contexts, cognitive levels and content areas from the PISA science literacy dimensions, and the results are presented below.

When the questions that appeared in the LGS published by the Ministry of National Education by years are analyzed according to the types of knowledge, one of the PISA science literacy dimensions, it is determined that the content knowledge in 2017-2018 and 2019-2020, the process knowledge in 2018-2019, and one question in 2017-2018 and 2018-2019 about epistemic knowledge were encountered more frequently. When we look at the results of the mentioned 80 questions regarding the types of knowledge, it can be said that almost more than half of the exam questions every year consist of questions covering content knowledge.

According to the latest PISA 2018 Turkey Preliminary Evaluation Report, the content knowledge of the questions asked in PISA 2018 varies between 54-66% (MEB, 2019a). When we look at the analyzes made, it can be said that the distribution of the questions asked in four years in the dimension of process knowledge is at a moderate level. According to the PISA 2018 Preliminary Evaluation Report published on behalf of Turkey, the weight of process knowledge on the questions is between 19-31% (MEB, 2019a). In this respect, it can be stated that a great deal of harmony has been achieved in the category of knowledge types in PISA with the changes made in the examination system. However, in the same report, it was stated that the epistemic knowledge distribution of PISA 2018 questions was between 10-22% (MEB, 2019a). For the questions examined in our study, questions of this type of knowledge are almost non-existent. When the general distribution of the questions in the context of knowledge types is examined, a similar situation can be seen in the renewed science curriculum. In this context, in the study conducted by Cansiz and Cansiz (2019), the extent to which the science course curriculum implemented in Turkey reflects the dimensions of science literacy was investigated using the PISA 2015 Science Literacy Evaluation Framework. According to the results of the research, course outcomes do not show a balanced distribution in terms of knowledge type at all levels from the 3rd to the 8th grade. It has been determined that the course outcomes in question are quite inadequate in terms of epistemic knowledge. In this type of knowledge, no acquisitions that will directly enable the development of students were found at the 4th, 5th, 6th and 8th grade levels. Epistemic knowledge is very important because it encompasses an understanding of the nature and origin of science and includes content in which students experience thinking skills as scientists do. Since one of the most important goals in the science curriculum is to raise individuals who are scientifically literate and to enable students to understand scientific research methods, it can be said that more questions should be included both in terms of achievements and in the exams, and as a result, the success achieved in the PISA exams will also increase.

When the contents of the questions in the LGS published by the Ministry of National Education according to the years are examined in terms of the competences sub-dimension, one of the PISA science literacy dimensions, there were more questions in the sub-dimension of explaining events scientifically in 2017-2018, while there were more questions in designing and evaluating a scientific inquiry method and interpreting the data and findings scientifically in 2018-2019 and 2020-2021. According to the results obtained, it is seen that the questions asked at the "explaining events scientifically" competence level are at a medium level in terms of distribution. Looking at the PISA 2018 Turkey Preliminary Evaluation Report, the expected distribution of questions for this level of competence is between 40-50% (MEB, 2019a). At the level of "designing and evaluating a scientific inquiry method", which is another level of competence, it can be said that the distribution of the questions over the years is balanced. According to the PISA 2018 report, the expected rate at this level is exactly 20-30% (MEB, 2019a). It can be said that the distribution of the questions is moderate in the category of "interpreting the data and findings scientifically", which is the last level of competence. Again, if we take the PISA 2018 Preliminary Evaluation report as a reference on behalf of Turkey, we can state that the expected distribution of questions is 30-40% (MEB, 2019a). Kızılay (2019), in her study examining the science questions in the PISA and 2015 TEOG exams in the context of teaching principles, similarly expressed the competence levels expected to be found in the

questions in the PISA 2015 exam. In this state, it can be said that the content of LGS exams organized by the Ministry of National Education in the last four years is at the required level according to PISA science literacy competence.

To analyze the contextual findings of the questions examined, while there were an equal number of questions regarding the personal and global context in 2017-2018, the number of questions regarding the local (national) context in 2019-2020 and 2020-2021 is quite high. Looking at the findings of the same years, it was seen that almost no questions were asked in a personal context. In 2018-2019, questions regarding the global context were more than other years. Considering the general logic of the PISA questions, it is tried to determine how much the students are interested in their family, social environment and global events in addition to their experiences at school. Students are expected to comment on their own life and social environment, the society in which they live and the situations in the world, with questions covering various fields such as health, natural resources, environment, risks arising from disasters, and the limits of science and technology. While evaluating the questions in this section, it is necessary to consider the cultural differences of the countries and the living conditions of the students, so generalizing the results of the study according to all countries may lead to incomplete and erroneous interpretations (Gokdemir, 2020). However, it has been suspected from time to time that it is very difficult to put the questions in the study into the categories mentioned in the context, and that some of the question contents are not suitable for almost any of the categories in question. This situation is not surprising because in the studies that tried to determine how much the science curriculum overlaps with the science literacy dimensions in the literature, it was emphasized that the science lesson outcomes did not contain sufficient context-based outcomes (Cansiz & Cansiz, 2019). It is inevitable that the questions asked in LGS will be weak in terms of context since the achievements in the curriculum are guiding both in the preparation of national-scale exams and in the assessment and evaluation processes used by the teachers in the course.

When the contents of the questions in the LGS published by the Ministry of National Education by years are analyzed according to cognitive levels, one of the PISA science literacy dimensions, it is seen that the number of medium level questions is higher than the years. However, while low-level cognitive questions were given more space in 2017-2018, high-level cognitive questions were included more in the following years. If we look at how the questions asked in LGS are distributed in the cognitive level dimension over four years, it is seen that there are more questions asked at medium level in almost all years. However, it can be said that low and high cognitive level questions are also included in certain proportions. In order for the assessment to be balanced, it is very important that all three cognitive levels are included (OECD, 2016). In this respect, it can be stated that the questions that emerged as a result of the study have the necessary framework. As a matter of fact, Kızılay (2019) stated in her study that 61% of the questions included in the PISA 2015 science evaluation had a medium cognitive content. The remaining distributions of the questions also include other cognitive levels. This situation supports the results of our study on this dimension.

When the contents of the questions published in LGS published by the Ministry of National Education by years are analyzed according to the content areas of PISA science literacy dimensions, physical systems content area is given more place in the questions in 2017-2018

and 2018-2019, while in the questions in 2020-2021, systems related to living things are included in the content area. It was seen that the year with the highest number of questions related to the earth and space systems content area was 2019-2020. In summary, it can be said that the physical systems content area is given more space in all years in the questions in LGS. However, it is another remarkable result that there are very few questions about the earth and space systems. It can be said that this result is similar when we look at the distribution of the achievements in the 8th grade units in the updated Science Curriculum. In total, it is seen that the achievements in seven units are mostly in the field of physical systems content, while the unit with the least achievements is in the field of earth and space systems (MEB, 2018a). At this point, when we look at the PISA 2018 Turkey Preliminary Evaluation Report, the distribution of the questions according to the content areas is stated as 36% for physical systems, 36% for systems related to living things, and 28% for earth and space systems content area (MEB, 2019a). As it can be understood from here, it can be said that the content of the questions is not balanced and distributed as it should be. The problem here is that the distribution of the gains in the curriculum is unbalanced and, as a result, the exam prepared according to this program is negatively affected. Looking at the literature, it can be said that there are studies that reach similar results. In the study conducted by Kasıkci et al. (2015), it was aimed to determine the level of meeting the achievements in the curriculum of the 2nd semester TEOG exam science and technology exam questions applied to the 8th grades in the 2013-2014 academic year. As a result of the study, it was found that the science lesson questions in TEOG did not show a homogeneous distribution according to the achievements in the curriculum. In addition, according to a study cited by Kızılay (2019), it was aimed to examine the science course curriculum within the scope of TEOG and TIMSS exams. As a result, it was revealed that the content validity of TIMSS 2015 and the 8th grade science curriculum in terms of achievements was low. Considering all these, it can be thought that the distribution of the questions in LGS according to the content areas is not at the expected level as reported in the PISA reports, due to the unbalanced distribution of the contents in the curriculum. It should also be stated that the revisions made in the science curriculum are still insufficient in this sense.

PISA exams guide the participating countries to make changes in many issues. In this sense, it is seen that countries can achieve better results with the improvements they have made both in their education systems and in various components of this system (Berberoglu et al., 2019). Since the concept of science literacy is measured in exams like PISA and TIMSS, this concept was included in the revised curriculum and it was aimed that students could adapt what they learned to daily life issues. At this point, the concepts of "informal learning" and "interdisciplinary" were included in the renewed curriculum (Aksoy & Taskin, 2019). As a result, we see that the science literacy results in Turkey's past PISA exams are getting better (PISA, 2018). We can say that this improvement has also emerged as a result of different variables such as the increasing number of female students in schools and the decrease in the difference in success between private and public schools, apart from some adjustments made in the curriculum (Albayrak, 2009).

Education is a holistic process with exams and evaluations for both transferring knowledge and seeing how it takes place in the mind of the student. Therefore, in order for students to be individuals who question and use information, in order to keep up with the globalizing world,

the education they receive in their schools and the written exams they are subjected to or the national exams should be compatible with those held at the international level. Thus, when the achievements in the curricula that form the components of our education system and the assessment and evaluation processes are compatible with each other, the results we get in important exams like PISA will be more positive (Unal, 2019).

It is very important that we have an education system that can meet the needs of the children of the Z generation, as they have different interests and ways of thinking compared to their peers in the past. In this context, the Ministry of National Education has stated that it aims to raise individuals with high-level thinking skills, who can question information, associate what they have learned with daily life, in the curriculum it has published recently. It can be said that the science course has an extremely rich content in terms of covering high-level thinking skills, which we can also call logical reasoning skills, and transferring them to the student, in terms of establishing a relationship with daily life (Sezer, 2018). In this respect, our examination system also gets its share from the changes made in order to meet the needs of the age. With frequent updates, it is aimed that students can keep up with the developments in our age, where access to information and its availability are so important. In this sense, the achievements in the curriculum developed were prepared by adopting the constructivist approach, and thus, it was aimed that the student himself could reach the information by going through the questioning and research processes. In addition, it is extremely important to get correct results that the content of the exams, which can be considered as an output of the teaching in schools, is in the same parallelism.

Although the success of the students in Turkey has increased over the years, the results of the students in terms of high-level thinking skills are still behind the average of many countries and are below the general average in terms of ranking. For high-level thinking skills, a common understanding should be adopted and arrangements should be made according to the content of curricula and books, the activities used by teachers in the classroom, and teacher training programs in universities. Both the teacher and the students will benefit from the content prepared correctly. In this context, it is very important to prepare teacher training programs in universities well and to enable teacher candidates to develop different measurement tools. When teachers use up-to-date measurement and evaluation techniques that will improve students' thinking skills in their lessons, the success in international exams such as PISA, TIMSS, etc. will increase. Teachers who have graduated can be provided with various in-service trainings so that they do not feel inadequate in the preparation of questions and activities based on scientific thinking, which is called the new generation. Finally, in order to improve science literacy, the effect of laboratory applications based on students' scientific process skills and transferring information to daily life should not be ignored. Therefore, it is recommended to create the necessary financial opportunities for schools.

This study is limited to the questions in the LGS published by the Ministry of National Education in the last four years, the type of knowledge, competence, contexts, data analysis form developed by the researchers and document analysis from the PISA science literacy dimensions.

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Appendix-1. Document Review Form

Question	Knowledge Type			Competence			Context																Cognitive Level			Content Area		
							Personal					Local / National					Global												
	Content knowledge	Process knowledge	Epistemic knowledge	Explaining events scientifically	Designing and evaluating a scientific inquiry method	Interpreting the data and findings scientifically	Health and disease	Natural resources	Environment	Risks	Limitations of science and technology	Health and disease	Natural resources	Environment	Risks	Limitations of science and technology	Health and disease	Natural resources	Environment	Risks	Limitations of science and technology	Low	Medium	High	Physical Systems	Systems related to living things	Earth and space systems
1																												
2																												
3																												
4																												
5																												
.																												
.																												
19																												
20																												

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THE EFFECT OF 5E MODEL STEM EDUCATION ON THE SCIENCE ACADEMIC ACHIEVEMENT OF SECONDARY SCHOOL 6TH GRADE STUDENTS

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ABSTRACT

This research was carried out in order to reveal the effect of the 6th grade students' "Systems in Our Body" unit "Support and Movement" on the academic achievement of 6th grade students of the science course, which is explained with 5E model STEM applications. The sample of the research consists of 6th grade students studying in a state secondary school in 2018-2019. Semi-experimental design was used as the research design. The application, which lasted 5 weeks, was evaluated with pretest, posttest and retention test. The "Systems in Our Body Achievement Test" with a reliability coefficient (KR-20) = 0.89, developed by the researcher, was used as a data collection tool. Statistical analyses of the data were made with the help of SPSS package program with independent and dependent sample t-test. According to the results of the t-test analysis, it was observed that the academic achievement of the science course taught with the 5E model STEM education applications was significantly ($p<0.05$) high. There was a significant ($p<0.05$) difference between the retention test and the posttest of the group in which STEM education and science lesson were taught, compared to the group in which science lesson was taught with traditional teaching method. According to the findings obtained at the end of the research, it was concluded that the science course taught with the 5E model STEM education is effective both on academic success and on remembering the learned information, in other words, on the permanence of the information.

Keywords: STEM Education with 5E Model, Science Education, Systems in Our Body.

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INTRODUCTION

Generations come to the world with a great curiosity and desire to explore, and from the moment they are born, they try to satisfy their curiosity with their five senses. The experiences they have in daily life give children the opportunity to realize the environment they live in, get to know them and make sense of the outside world. They always keep their desire to explore alive by mixing each new information with the previous one and arranging their new information. Events such as the swimming patterns of fish in the natural environment or watching a spider weave a web provide opportunities for children to study science (Martin et al., 1998). Cepni (2007) science; He defines it as "the understanding of the universe after the individual has organized and systematized the knowledge with scientific methods". In our age, when science is mentioned, mostly science comes to mind (Çepni, 2008). Science education is a field of education that is astonishing and attractive in the environment in which the individual lives (Gürdal, 1992). Individuals who are needed in education are those who can access information, produce information and use this information. In order to put future generations on solid foundations, it is necessary for each individual to be matured with science education equipment. Considering within this framework, the importance of science courses and science curricula increases (Arslan , 2005). Since students establish a connection between daily life and science lessons, it is one of the lessons that they have difficulty in creating prejudices and transferring knowledge (Durmaz, 2004). The fact that science teaching is purified from traditional methods and plain expressions and directed towards inquiry-based science education will make students' interest in science meaningful (Rocard et al, 2007). In our age, as new discoveries are made, the production of knowledge increases. With increasing production, it is getting harder to dominate the information that increases. With the development and growth of technology, even the most up-to-date methods used now will become out of date over time. Staying up-to-date will be possible by not falling behind the times, approaching problems scientifically, questioning and researching (Başkurt, 2009). STEM education; It is an education model formed by the combination of science, technology, engineering and mathematics disciplines (Çorlu, 2014). It has been seen that STEM education, which has an important place in science education, increases the motivation and interest of students towards the lesson (Yamak et al, 2014). When we look at the success results as a country in Trends in International Mathematics and Science Study (TIMMS), which is one of the international exams, our science course success and science literacy averages fell behind other countries that participated in the exams (https://timss.meb.gov.tr). In the light of these results, studies can be conducted to investigate the effect of STEM education approach on increasing success in science education in our country. In the world, there are trials on what can be done to increase success in science and mathematics courses. Among these trials, it is important to determine the effects of STEM education that has just emerged in the world and to put it into practice in our country's schools.

Purpose of the research

The aim of the study is to examine the effect of 5E Model STEM education applications on the academic achievement of 6th grade students in science course. Purposeful answers were sought for the following questions:

1. Is there a significant difference between the Systems in Our Body Achievement Test (VSUBT) post-test of the experimental group students in the study and the post-test scores of the control group students?
2. Is there a difference between the retention test scores of the experimental group students and the VSUBT retention test scores of the control group students in the study?
3. Is there a significant difference between the pre-test and post-test scores of the experimental group students in the study?
4. Is there a significant difference between the pre-test and retention test scores of the experimental group students in the study?
5. Is there a significant difference between the post-test and retention test scores of the experimental group students in the study?
6. Is there a significant difference between the pre-test and post-test scores of the control group students in the study?
7. Is there a significant difference between the pre-test and retention tests of the control group students in the study?
8. Is there a significant difference between the post-test and retention test scores of the control group students in the study?

METHOD

The design of the study is a quasi-experimental design with pre-test, posttest and retention test, and control group. In the study, the groups were pre-tested before the application, and as a result, an unbiased assignment was made between the classes that were similar to each other as an experiment and a control group. In the experimental group, the science course was taught with 5E model STEM education applications, and in the control group, the traditional method was taught within the framework of the current science curriculum.

Participants

The sample of the study consists of 40 students studying in the 6th grade. The study was conducted in a state secondary school in Selçuk district of Konya province in the 2018-2019 academic year. The pretest mean scores of the experimental and control groups were not included in the research by the researcher, so that some students who changed the equivalence in the classes were not included in the study in order to make a healthy comparison. equalized and the number of students in the groups was equalized as 20. The students who were not included in the study were not informed of this situation and they received the same education as the students included in the study. To see if there was a difference between the groups, t-test analysis was performed for unrelated (independent) samples according to the pretest scores (Table 1). As a result of the analysis, it was determined that there was no difference between the groups in terms of academic achievement according to the pretest score averages (p=.968).

Table 1. Independent Sample t-test results of the Pretest Scores of the Experimental and Control Groups

Group	N	Mean	Ss	Sd	t	p
Control Group	20	12,900	4,102	38	0,041	0,968*
Experimental Group	20	12,950	3,691			

*p>0,05

Care was taken to ensure the equivalence of the experimental and control groups in terms of academic achievement as well as in terms of secondary variables. For this purpose, information about the academic achievement of the groups included in the research was obtained from the science teacher and school administration. All processes of the research were carried out under similar conditions for both groups, and the socioeconomic level, gender, attention was paid to the similarity of characteristics such as class size, the number of participants was kept high in case of possible loss of participants, and care was taken to ensure that the data collection process was carried out impartially in both groups.

Data Collection Tool Development Process

In the study, the "Systems in Our Body Unit Achievement Test" developed by the researcher was used to measure the academic success of the students in the Science course "Support and Movement". The "Systems in Our Body Unit Achievement Test" used within the scope of the research was prepared by considering the 2018 science curriculum achievements of the Ministry of Education. In order to develop this test, first of all, a test consisting of 45 items was prepared by making use of the MEB Achievement Tests and State Scholarship Exams. This test was piloted on 256 students who had taken this course in previous years. The data obtained from this application were analysed with the TAP statistics program. At the end of the analysis, 15 items that would definitely not be included in the test and that could be corrected and included in the test were excluded from the test. In its final form, the academic achievement test consisting of 30 items (KR-20) = 0.89, item discrimination of 0.55 and item difficulty of 0.61 was administered to the students in the trial and control groups as pre-test, posttest and retention test.

Application of this Research

In the experimental and control groups, the teaching of the science course took 5 weeks as per the program. It was done before starting the classes in both groups. In the experimental group, introductory activities and practices were made in accordance with the 5E model STEM education on the subject for 5 weeks. In the control group, the lessons were taught with the classical method during the same period. After the lecture was completed, the posttest and the retention test were administered to both groups 6 weeks after the post-test.

Analysis of Data

Before the analysis of the data, it was checked whether the data had a normal distribution, and it was decided which of the parametric or non-parametric statistical techniques would be used according to the result. Since the number of samples was less than 30, normality test was applied with SPSS package program to test the suitability of the data for normal distribution. For this work, besides the skewness and kurtosis values of the data, the Shapiro-Wilk test was used because the number of samples was less than 30 (Yazıcıoğlu, 2004; Köklü et al., 2006). As a result of the test, as the skewness and kurtosis values of the data were between +1.5 and –1.5, and the p values in the Shapiro-Wilk test were greater than 0.05 (Table 2), it was assumed that the data showed a normal distribution, and parametric tests were used in the statistical analysis of the data. Analyses were made using the SPSS package program, with independent sample t-test for intergroup comparisons and dependent sample t-test for in-group comparisons.

Table 2. Shapiro-Wilk test results of Experimental and Control Groups

Group	Statistic	df	Sig.
Control Pretest	,948	20	,333
Control Posttest	,951	20	,377
Control Retention Test	,934	20	,188
Trial Pretest	,934	20	,182
Trial Posttest	,927	20	,137
Trial Retention Test	,956	20	,470

In addition, the effect size, which is another criterion that shows whether the difference between the groups is significant or not. To be defined simply, the effect size is the size of the difference that a newly used method makes compared to the old one and is calculated in different ways. It is the calculation most commonly developed by Cohen. According to Cohen, a d value less than 0.2 is defined as a weak effect, a medium effect of 0.5, and a strong effect if it is greater than 0.8.

FINDINGS

In this part of the study, the findings are given with the data collected quantitatively in parallel with the sub-problems of the research. Findings of the first sub-problem:

Is there a significant difference between the posttest scores of the experimental group students and the posttest scores of the control group students in the study?

H_0 hypothesis: There is no significant difference between the posttest and academic achievement scores of the control group, in which the science lesson was employed with the traditional teaching method, and the posttest scores of the experimental group, in which the modern teaching method 5E Model STEM education applications and the science lesson were recruited.

In order to test the H_0 hypothesis, data analysis with independent sample t-test and Cohen's d effect size calculation were performed. Analysis results are presented in Table 3.

Table 3. Independent sample t-test and Cohen's d effect size calculation results of posttest mean scores of the experimental and control groups

Group	N	Mean	Ss	Sd	t	p	Effect size
Control Group	20	18,900	6,129	38	-3,600	0,001*	1,14
Experimental Group	20	24,850	4,156				

*p<0,05

When Table 3 is examined, it will be seen that the posttest arithmetic mean is 18.900 in the control group, 24.850 in the experimental group, and the difference between them is significant in favor of the experimental group (t= -3.600; p<0.05). According to the Cohen's d effect size calculation, it is seen that this difference is in the large effect category (cohen's d=1.14>0.8). According to the results, it can be said that the contribution of the 5E model STEM education applications to the academic success of the students is good.

Findings of the second sub-problem:

Is there a difference between the VSUBT retention test scores of the experimental group students and the VSUBT retention test scores of the control group students in the study?

H_0 hypothesis: There is no significant difference between the academic achievement scores of the retention test belonging to the control group in which the science lesson was employed with the traditional teaching method, and the retention test belonging to the contemporary teaching method 5E Model STEM education applications and the science lesson of the experimental group. In order to test the H_0 hypothesis, data analysis with independent sample t-test and Cohen's d effect size calculation were performed. Analysis results are presented in Table 4.

Table 4. Independent sample t-test and Cohen's d effect size calculation results of retention test mean scores of the experimental and control groups

Group	N	Mean	Ss	Sd	t	p	Effect size
Control Group	20	13,750	3,697	38	-6,349	0,000*	2,00
Experimental Group	20	21,800	4,299				

*p<0,05

When Table 4 is examined, it will be seen that the arithmetic mean of the retention test is 13.75 in the control group, 21.80 in the experimental group, and the difference between them is significant in favor of the experimental group (t= -6,349;). According to the Cohen's d effect size calculation, it is seen that this difference is in the large effect category (cohen's d=2.00>0.8). According to the results, it can be said that the 5E Model STEM education applications are good in terms of students' remembering information and retention.

Findings of the third sub-problem:

Is there a significant difference between the pre-test and post-test scores of the experimental group students in the study?

H_0 hypothesis: There is no significant difference between the contemporary teaching method 5E Model STEM education applications and the academic achievement scores of the pretest and posttest scores of the experimental group employed in the science course. In order to test the H0 hypothesis, data analysis with independent sample t-test and Cohen's d effect size calculation were performed. Analysis results are presented in Table 5.

Table 5. The results of dependent sample t-test and Cohen's d effect size calculation of the pre- and post-test mean scores of the experimental group

Test	N	Mean	Ss	Sd	t	p	Effect Size
Pretest	20	12,950	3,691	19	-9,587	0,000*	3,03
Posttest	20	24,850	4,145				

*p<0,05

When Table 5 is examined, it is seen that the Pretest mean score in the experimental group is 12,950, and the retention test mean score is 24,850, and the difference between them is significant in favor of the retention test (t= -9.587; p<0.05). According to the Cohen's d effect size calculation, it is seen that this difference is in the large effect category (cohen's d=3.03>0.8). According to these results, it can be said that the contribution of the 5E model STEM education applications to the academic success of the students is good.

Findings of the fourth sub-problem:

Is there a significant difference between the VSUBT pretest and retention test scores of the experimental group students in the study?

H_0 hypothesis: There is no significant difference between the contemporary teaching method 5E Model STEM education applications and the academic achievement scores of the pretest and retention test scores of the experimental group employed in the science course. In order to test the H0 hypothesis, analysis with dependent sample t-test and Cohen's d effect size calculation were made. The results are presented in Table 6.

Table 6. The results of the dependent sample t-test and Cohen's d effect size calculation of the mean scores of the pretest and retention test of the experimental group

Test	N	Mean	Ss	Sd	t	*p*	Effect Size
Pretest	20	12,950	3,691	19	-6,984	0,000*	2,20
Retention test	20	21,800	4,299				

*p<0.05

When Table 6 is examined, it is seen that the mean score of the Pretest in the experimental group is 12,950, and the mean score of the retention test is 21,800, and the difference between them is significant in favor of the retention test (t= -6,984; p<0.05). According to the Cohen's d effect size calculation, it is seen that this difference is in the large effect category (cohen's d=2.20>0.8). According to these results, it can be said that the contribution of 5E model STEM education applications to the students' level of remembering what they have learned is in a good way.

Findings for the fifth sub-problem:

Is there a significant difference between the VSUBT post-test and retention test scores of the experimental group students in the study?

H_0 hypothesis: There is no significant difference between the modern teaching method 5E Model STEM education applications and the academic achievement scores of the post-test and retention test scores of the experimental group recruited for the science course. In order to test the H_0 hypothesis, analysis with dependent sample t-test and Cohen's d effect size calculation were made. The results are presented in Table 7.

Table 7. Results of dependent sample t-test and Cohen's d effect size calculation of posttest and retention test mean scores of the experimental group

Test	N	Mean	Ss	Sd	t	p	Effect Size
Posttest	20	24,850	4,145	19	2,284	0,028*	0,72
Retention test	20	21,800	4,299				

*p<0.05

When Table 7 is examined, it is seen that the posttest mean score in the experimental group is 24,850 and the retention test mean score is 21,800, and the difference between them is significant in favor of the posttest (t= 2.284; p<0.05). According to the Cohen's d effect size calculation, it is seen that this difference (cohen's d=0.72>0.2, <0.8) is in the medium effect category.

Findings of the Sixth Sub-problem:

Is there a significant difference between the VSUBT pretest and posttest scores of the control group students in the study?

H_0 hypothesis: There is no significant difference between the pretest and posttest scores of the control group, in which the traditional teaching method and the science lesson were employed. In order to test the H0 hypothesis, analysis with dependent sample t-test and Cohen's d effect size calculation were made. The results are presented in Table 8.

Table 8. Results of dependent sample t-test and Cohen's d effect size calculation of pretest and posttest mean scores of the control group

Test	N	Mean	Ss	Sd	t	p	Effect Size
Pretest	20	12,900	4,102	19	-3,638	0,001*	1,15
Posttest	20	18,900	6,129				

*p<0.05

When Table 8 is examined, it is seen that the pretest mean score is 12,900 and the posttest mean score is 18,900 in the control group, and the difference between them is significant in favor of the posttest (t= -3.638; p<0.05). According to the Cohen's d effect size calculation, it is seen that this difference is in the large effect category (cohen's d=1.15>0.8).

According to these results, it is seen that traditional education practices contribute to the academic success of students.

Findings for the seventh sub-problem:

Is there a significant difference between the VSUBT pre-test and retention tests of the control group students in the study?

H_0 hypothesis: there is no significant difference between the pretest and retention test scores of the control group in which the traditional teaching method and science lesson were employed. In order to test the H0 hypothesis, analysis with dependent sample t-test and Cohen's d effect size calculation were made. The results are presented in Table 9.

Table 9. Results of dependent sample t-test and Cohen's d effect size calculation of pretest and retention test mean scores of the control group

Group	N	X̄	Ss	Sd	t	p	Effect Size
Pretest	20	12,900	4,102	19	-0,688	0,527*	0,21
Retention test	20	13,750	3,697				

*p>0.05

When Table 9 is examined, it is seen that the pretest mean score of the control group was 12.900, and the mean score of the retention test was 13.750, and there was no statistical difference between them (t= 0.688; p>0.05). According to the Cohen's d effect size calculation, it can be said that this difference is important in the low-level effect category (cohen's d=0.21>0.2).

Findings for the eighth sub-problem:

Is there a significant difference between the VSUBT posttest and retention test scores of the control group students in the study?

H_0 hypothesis: There is no significant difference between the posttest and retention test scores of the control group in which the traditional teaching method and science lesson were employed. In order to test the H0 hypothesis, analysis with dependent sample t-test and Cohen's d effect size calculation were made. The results are presented in Table 10.

Tablo 10. Results of dependent sample t-test and Cohen's d effect size calculation of posttest and retention test mean scores of the control group

Group	N	Mean	Ss	Sd	t	p	Effect Size
Posttest	20	18,900	6,129	38	3,218	0,003*	1,01
Retention test	20	13,750	3,697				

*p<0.05

When Table 10 is examined, it is seen that the posttest mean score in the control group is 18,900, and the retention test mean score is 13,750, and the difference between them is significant in favor of the posttest (t=3,218; p<0.05). According to the Cohen's d effect size calculation, it can be said that this difference is in the large effect category (cohen's d=1.01>0.8). According to these results, there is a significant difference between the posttest and retention test mean scores against the retention test.

CONCLUSION AND RECOMMENDATIONS

This study was carried out to examine the effect of 5E Model STEM education applications on the academic achievement of 6th grade students. In this section, the results obtained from the findings obtained within the framework of the research are evaluated by comparing them with the results of the literature related to the subject, and the suggestions developed according to the results are given. As a result of the comparison between the groups in the study, the posttest and retention test average scores of the experimental group, who were taught with the contemporary teaching method, 5E Model STEM education applications, were significantly higher than the control group taught with the classical method ($p<0.05$). (Tables 3 and 4). According to this finding, it was concluded that the STEM applications made have a positive effect on the science lesson performance of the students. When the in-group comparisons of the experimental group given in Tables 5, 6 and 7 are examined, it is seen that the mean scores of the pre-test, posttest and retention test are significantly different from each other ($p<0.05$).

According to these results, it can be said that the permanence of the high learning level provided by the STEM application decreases in the future, but the information is not completely forgotten. On the other hand, when the in-group comparisons of the control group given in Tables 8, 9 and 10 are examined, the difference between the mean scores of the pretest and posttest, posttest and retention test is significant ($p<0.05$). the difference was insignificant ($p>0.05$). According to this result, it can be said that the permanence of the learning level obtained with the traditional method disappears in the following periods and what is learned is forgotten. Yıldırım and Altun (2015) worked with 3rd grade science teacher candidates and examined the effect of STEM education and related practices on success. From this point of view, within the scope of the "Science Laboratory Applications" course, activities were implemented in line with the objectives set for the subject of "Energy Conversions and Renewable Energy", and it was aimed to provide the students participating in the study with the ability to solve real-life problems as well as using the processes of engineering design. Within the scope of my research, it has been shown that the experimental group taught with STEM education in the science laboratory significantly increased the success ($p<0.05$) compared to the control group, where the course was taught according to the traditional method.

In a study conducted by Ceylan and Özdilek (2015), the effect of STEM education activities on students' success was examined. The study was conducted with 8th grade students and a quasi-experimental design was used. Science lessons were taught with STEM activities on acid and base prepared according to the 5E model. It has been revealed that activities prepared according to STEM on acid and base have a positive effect on students' success. This result supports the findings of our study. Yamak, Bulut, and Dündar (2014) worked with 20 people formed by 5th grade students in their studies. The activities were held during the summer term and they investigated the effects of three STEM activities on students' attitudes towards science lesson and scientific process skills. Studies have concluded that STEM activities have a positive effect on students' attitudes towards science and science process skills. These results show parallel results with our study.

Ceylan (2014) investigated the effect of STEM education on academic success, creativity and problem solving skills in his study with secondary school students. Students were also asked about their views on STEM education with open-ended questions.

As a result of the research, the average academic achievement score of the group taught with STEM education was found to be significantly higher ($p<0.05$), similar to the results of our study, compared to the group in which the course was taught with the traditional teaching method. It was concluded that the students' views on STEM education, which were determined by open-ended questions, were positive. Pekbay (2017) investigated the effect of STEM activities on more than one variable (problem solving skills, interest in STEM fields, etc.) on secondary school students. At the end of the research. It has been determined that the activities contribute to the students' solving the problems of daily life and increase the students' interest in STEM in a positive way. In a study similar to our study by Yasak (2017); In the Force and Motion unit, it was examined whether explaining the subject of pressure with STEM applications had an effect on students' academic success in science and their attitudes towards science.

As a result of the research, the test score averages of the group in which STEM applications were made were higher than the control group. According to the interviews with the students and the scale analysis, it was reported that the models created during the activity had an effect on increasing the attitudes of the students towards the lesson. In his thesis study, Nağaç (2018) examined the effect of STEM education on academic achievement and problem-solving skills in secondary school students. The lesson was taught with STEM activities in his work in which he employed the matter and heat unit. He determined that the different STEM applications he made did not have a statistically significant effect on the academic success and problem solving skills of the students. However, he stated that the lesson taught with STEM applications increased the students' interest in the lesson, they had fun and the lesson taught in this way would benefit the students. Again, Ergün and Balçın (2019) examined the effect of problem-based STEM applications on the academic achievement of 6th grade students. He used a one-group weak experimental design and 19 students formed his sample. As a result of the applications, it has been seen that STEM activities have an increasing effect on academic achievement.

According to the results obtained from the comparison between the groups at the end of the research; It was observed that the posttest and retention test average scores of the group in which 5E model STEM applications were applied were statistically significantly higher than the average scores of the group taught with the traditional teaching method. According to the in-group comparisons, it was revealed that the learning and remembering levels were high in the experimental group, in which the lessons were taught with the 5E Model STEM applications, and that the students did not completely forget the information they learned. It was determined that the learning level, which was quite high, although not as much as the experimental group, in the group taught with the traditional method, completely disappeared in the following periods, and the students completely forgot the information they learned. According to these results, it can be said that 5E model STEM applications can be used successfully in teaching science courses.

According to the findings of this study, the recommendations of the researchers are given below:

STEM education activities on subjects suitable for the MEB curriculum should be added to the textbooks and implemented.

Science teachers related to STEM education should be supported with in-service training.

STEM education should not only be limited to science courses, but also should be associated with other courses.

Units and topics should be expanded in accordance with the application of STEM education practices.

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INVESTIGATION INTO POPULAR SCIENCE BOOKS AS CHILDREN'S LITERATURE IN TERMS OF SUSTAINABLE ENVIRONMENT AND CLIMATE CHANGE

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ABSTRACT

This study aims to investigate how the subject of 'sustainable environment and climate change' is handled as a popular science subject in children's literature. To this end, among 346 children's books in the 2-12 age group published by TUBITAK, 25 books on the subject of 'climate change and sustainable environment' were determined as the sample of the study with criterion sampling, one of the purposeful sampling methods. Adopting a qualitative study design, the data were analyzed through document analysis. In the analysis, descriptive content analysis was used. Based on the analysis, it has been determined that all of the books include sustainable environment and climate change issues. The findings revealed that the subject of 'sustainable environment and climate change' was handled in the books in line with the developmental characteristics of the target group of children. It has also been determined that the books examined include the causes of climate change and what needs to be done for a sustainable environment. Taken together, the findings of this study have many important implications for educating children on the issues of sustainable development and climate change through popular science books.

Keywords: Children's literature, climate change, sustainable environment, popular science books

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INTRODUCTION

The general average values of the weather conditions of any geographical region are called climate. The change in the average values of weather conditions over long years is also called climate change. Global climate is a system connected to the ice sphere and the life sphere, as well as to the atmosphere, hydrosphere, and stony sphere, which are the layers of the Earth. Climate change can be seen as global and regional climate change and is caused by changes in natural conditions. These changes can be caused by natural means as well as by the human factor. The impact of climate change on humans and the environment has been the subject of research for centuries (Kahraman & Şenol, 2018). International reports on climate change are carefully followed by countries and international environmental organizations (IPCC, 2021). When we look at the studies carried out in this field around the world, "The Stockholm Conference" also known as the United Nations Conference on the Human Environment (UNCHE), attended by 113 countries in 1972 in the city of Stockholm, Switzerland, "Mediterranean Action Program prepared by the United Nations Environment Program (UNEP) in 1974 Plan (MAP)", "The establishment of the World Commission on Environment and Development (WCED) by the UN in 1983 under the chairmanship of Norwegian Prime Minister Brundtland", "The Rio Summit held in the city of Rio de Janeiro in 1992 with the participation of 178 countries", "Japan in 1997" The signing of the Kyoto Protocol at the conference held in the city of Kyoto, in 2000) 10 organization", "Organization of the Council of Europe ministerial committee meeting in 2006", "Sustained by the MB in 2015" Arrangement of the Sustainable Development Program (UNDP)" (Aktaş, 2019) attract attention.

To draw attention to climate change in Turkey, as in different parts of the world, relevant institutions, organizations and universities have been trying to attract the attention of the public by organizing congresses with wide participation. One of the important studies in this field is the "1. Turkey Climate Change Congress – TİKDEK 2007 (TİKDEK, 2007). In the conference, various issues related to climate change that concern Turkey and the world were discussed. Turkey's signing of the "Paris Agreement" (RG, 2022) is also considered an indicator of the state's sensitivity to the issue. Again, the Ministry of National Education's bringing the subject of "Global Warming and Climate Change" to the textbooks (Aktaş, 2019; Ölger, 2019) is considered as an important attitude in terms of raising awareness of the individuals who will create the future. As it is known, the subject of "Climate Change and Global Warming" is included in the learning area of global connections, which is included in the 7th-grade social studies course (MEB, 2022). Studies on global warming and awareness studies continue and various academic studies on the subject (Bozkurt & Cansüngü Koray, 2002; Kınık & Toprak, 2016; Nacaroğlu & Bozdağ, 2020; Ünlü et al. 2011) have been condcuetd. With these studies, it is aimed to raise awareness on issues related to global warming and climate change, and to determine the approaches of academic circles, students, and the public. On the other hand, despite many academic studies in the field, it has been reported that the theoretical foundations

on the subject are weak, the human factor is effective in climate change, climate change is a natural process, people have no effect, etc. (Dönmez & Çelik, 2016; Ünlü et al., 2011).

Changes in one or more of the elements that make up the global climate cause regional climate change, and global changes cause global climate change (Türkeş, 2013). Environmental attitudes of people in the region they live in are very important in terms of regional climate changes. Since people living in some parts of the world behave sensitively to the environment they live in, the impact of climate change is less felt in the region they live in.

After the industrial revolution, rapid developments took place in the field of technology and science in the world, and these developments are continuing rapidly. It is accepted that the foundation of the industrial revolution was laid with the invention of the steam-powered machine in Scotland in 1763 by James Watt. The developments that started with the industrial revolution in the 18th and 19th centuries caused serious population movements and wars in the world as well as in Europe, particularly England (Başer, 2011). After the industrial revolution, mechanization, the life span of people, the time they receive information and access information have accelerated faster than before (Başer, 2011).

With the establishment of industrial zones, organized production increased, and migration from rural areas to industrial cities began for the needed workforce. As a natural result of this migration, the interest in the traditional agriculture and livestock sector has decreased. A rapid population growth emerged from the industrial zones, and consumption increased in parallel with this increase. Rapidly increasing urbanization in Europe in the beginning, then in the countries that were exploited by Europe and in the important industrial regions of the world brought along many problems such as illegal construction, transportation, education, housing, and heating. Both the rapidly increasing population and the necessary production works to meet the needs of this population and, many problems, especially the environmental pollution caused by this population, are closely related to the atmosphere (Başer, 20; Haradhan, 2019; Türkeş, 2013). For this reason, it is thought that the discussions on climate change and a sustainable environment will be among the important agenda items of the world's states in the future.

To meet the needs of the rapidly increasing population, production wheels turn non-stop 24 hours a day, new settlements are built on agricultural lands, and the environment is rapidly polluted as a result of the consumption emotions pumped by the press and media. Due to their nature, people primarily seek solutions to the problems they first encounter; they did their best to meet their basic needs such as heating, shelter, food, and drink, and as a result, they ignored the damage they caused to the environment. In this destruction, the degeneration, insensitivity (Çelik & Küçük, 2020), singular and selfish philosophy of life, and self-centered thinking that emerged with the developing technology have a great effect. It is after a period of one hundred and fifty years that people become aware of climate change. From the industrial revolution to the present, unusual diseases, droughts or excessive precipitation, melting in glaciers, extraordinary changes in living things and plants have attracted the attention of people, and

their causes have begun to be investigated with developing medicine and technology. As a result of the research, the reality of regional and global climate change has been encountered.

It can be deduced that if the earth and its finite resources are continuously used carelessly, it will become difficult to shelter soon. For this reason, keeping the earth as a livable place concerns the entire world. If the necessary precautions are not taken and the necessary regulations are not introduced, the rapidly increasing world population will face major environmental disasters (Akın 2006; Karademiz et al. 2018) in the next century. Realizing this, scientists have increased their studies on climate change and livable environments. Relevant national, regional and international agreements are signed, meetings are held on certain dates, and training is held. Since minimizing climate change and having a sustainable environment is a problem that concerns the whole world, it will be possible to reach a satisfactory result with the work of all nations and states in collaboration. It is considered that international studies such as "Paris Climate Agreement" and "Kyoto Protocol" are important (Genç, 2021; Öztürk & Öztürk, 2019). While the people living in some regions are sensitive to nature, the insensitivity of those living in other regions will prolong and complicate the solution of the problem. Everyone has some responsibilities that they must fulfill. These responsibilities to protect the environment should be taught to children from an early age to increase their awareness of the subject. According to UNESCO, people of all ages all over the world should have quality education and gain knowledge, skills, and values having key roles *for a sustainable future and positive societal transformation* (UNESCO, 2005, p.6). In this context, it is our responsibility to educate children on issues such as sustainable environment and climate change since these issues will have more damaging effects for today's children in the future. Their knowledge and skills and awareness on these issues are directly related to a better future for them and also for the adults. The issue of climate change and a sustainable environment should therefore be taught in schools and should be addressed in social media inappropriate ways for all age levels.

TUBITAK is the institution at the center of scientific research in Turkey and is one of the important institutions that work on climate change and a sustainable environment on behalf of the public. At the same time, it supports this field with its publications and tries to raise awareness of our people on the subject.

The current study aims to draw attention to how children's books deal with the issue of 'climate change and sustainable environment' by investigating how these issues are handled as a popular science topic in children's literature. The obtained results are expected to shed light on the issue in terms of raising children's awareness of climate change and sustainable environment through popular science books. To this end, the following research questions guided the study:

1. Is the sustainable environment and climate change, a popular science subject, included in children's literature?

2. In which age group is the subject of 'sustainable environment and climate change' included in children's books and how it is dealt with?

METHODOLOGY

Research Design

This qualitative study aiming to investigate how the subject of 'sustainable environment and climate change, a popular science subject in children's literature, is handled, was carried out using the document analysis technique. The document analysis technique was used in the current research because it was aimed to reveal an existing situation. The research sample was determined by criterion sampling, one of the purposive sampling methods. Qualitative research has been expressed with different names and definitions such as natural research, interpretive research, and field research due to its characteristics. Observation, interview, focus group interview and document analysis techniques are commonly used to collect data in qualitative research. According to Yıldırım and Şimşek (2018), since the validity of the data and the accuracy of the results are important in qualitative research, the researcher can benefit from more than one research technique depending on the subject and the characteristics of the target audience.

Reviewed Documents

Children's books published by TUBITAK for children between the ages of 2 and 12 constitute the research area of the study, which aims to investigate how 'sustainable environment and climate change, a popular science subject in children's literature, is handled. From the popular books, 25 books on climate change and sustainable environment were taken as samples. The research is limited to the analysis of 25 books on the subject of 'climate change and sustainable environment'.

Data Collection and Analysis

The books published by TUBITAK were examined and it was determined that the subject was included directly or indirectly in 25 books. After the relevant books were obtained, they were read, necessary examinations were made, notes were taken and the places in the books that would answer the problem sentence were determined. Findings of 25 books out of 346 children's books in the 2-12 age group published by TUBITAK are given within the framework of the relevant titles. The data collected in the research were subjected to document analysis, one of the data analysis techniques in qualitative research. For the document analysis, first of all, among the children's books published by TUBITAK for children between the ages of 2 and 12, books dealing with the subject of 'climate change and sustainable environment' were determined and studied in accordance with the purpose of the research. In this study, content analysis technique was used to evaluate the obtained data. In content analysis studies, according to Yıldırım and Şimşek (2018) data is coded and categorized, themes are found, data is

organized and defined according to codes and themes, and the findings are interpreted. However, in the current study for the research aims of the study, descriptive content analysis was used and a thematic analysis was not preferred.

FINDINGS

Findings Regarding the First Sub-Problem

The first sub-problem of the research is 'Is "sustainable environment and climate change', a popular science subject, included in children's literature? In the research, children's books, which are among the publications of TUBITAK Popular Science Books, were examined and it was determined that the subject of 'sustainable environment and climate change was included in 22 books directly or indirectly. The books that directly or indirectly include the subject of "sustainable environment and climate change" and the pages they include are shown in the table below.

Table 1: List of books that directly or indirectly include the subject of Climate Change and Environmental Pollution.

Rank	Book name	Age Group	Page/s
1	Do not throw, use.	3	2, 27
2	Caring for our environment	3	12
3	What if we cope natural disasters?	6	38
4	Weather	6	-
5	Weather Conditions	7	-
6	Natural disasters	7	38
7	Rain forests	7	27
8	Why should I care the world?	7	22
9	Polar bears, Why are the glaciers melting?	7	30
10	Nature, Trees	8	54
11	Ecology	8	52
12	Climate change	8	2, 60, 63
13	Energy	8	60
14	The Kalundborg Gang	8	32
15	Arctic and Antarctic	8	-
16	Is wind power reliable?	12	3
17	Are Biofuels a Threat to Our Food Sources?	12	12, 16, 17,
18	Is Natural Gas a Clean Fossil Fuel?	12	25
19	Human vs. Nature	12	2,4,39
20	Energy Crisis	12	3,5,32
21	Rainforest Food Chains	12	45
22	River Food Chains	12	46

23	Ocean Food Chains	12	25, 41
24	Grassland Food Chains	12	36,43
25	Mountain Food Chains	12	46

Findings Regarding the Second Sub-Problem

The second sub-problem of the research is 'in which age group and how is the subject of sustainable environment and climate change included in TUBITAK children's books. The findings regarding the books examined in the study and published by TUBITAK for children between the ages of 3 and 12 are presented in Table 1.

Table 2: List of books showing how and in which age group the sustainable environment and climate change issue is included

Rank	Book name	Age Group
1	Do not throw, use.	3
2	Caring for our environment	3
3	What if we cope natural disasters?	6
4	Weather	6
5	Weather Conditions	7
6	Natural disasters	7
7	Rain forests	7
8	Why should I care the world?	7
9	Polar bears, Why are the glaciers melting?	7
10	Nature, Trees	8
11	Ecology	8
12	Climate change	8
13	Energy	8
14	The Kalundborg Gang	8
15	Arctic and Antarctic	8
16	Is wind power reliable?	12
17	Are Biofuels a Threat to Our Food Sources?	12
18	Is Natural Gas a Clean Fossil Fuel?	12
19	Human vs. Nature	12
20	Energy Crisis	12
21	Rainforest Food Chains	12
22	River Food Chains	12
23	Ocean Food Chains	12
24	Grassland Food Chains	12
25	Mountain Food Chains	12

Table 2 shows that there is a total of 25 (books, two of which are for the three age groups, two for the six-year-olds, five for the seven-year-olds, six for the eight-year-olds, and ten for the twelve-year-olds.

Findings Related to Sustainable Environment and Climate Change in Three-Year-Old Children's Books

In the book titled 'Don't Throw, Use', the following statements about 'climate change and sustainable environment' are included: "*If we waste less and separate what we can recycle, there will be less environmental pollution and we can live longer in our world, breathe smoke-free air, swim in clean waters, and wander in litter-free forests and mountains*" (Roca, 2010, p. 28). In the book, attention is drawn to waste and environmental pollution caused by wastage. The importance of recycling the ones we consume to prevent environmental pollution was emphasized. The subject is explained in accordance with the developmental levels of children in the three age groups.

In the book 'Caring for Our Environment', attention is drawn to recycling on the subject of 'sustainable environment'. With the headline "**I Protect the Environment by Recycling**", the following statements are included: "*We came back from the attic with a lot of useless things: bottles, old newspapers, and a doll with a broken leg… Let's throw them in the recycling bins for reuse," my mother said*" (Cabrera, 2011, p. 12).

Findings Related to Sustainable Environment and Climate Change in Six-Year-Old Children's Books

In the book named 'Weather', the effects of climate change are mentioned under the title of '**weather in the future'**. It is stated that "*Across the world, air temperatures are slowly rising. This change in our world's climate is known as global warming. In many countries, winters are now warmer, spring comes earlier and summers are drier. Pollution has an impact on our climatic conditions. With winters getting warmer in the Arctic, the ice is melting faster than ever before. This negatively affects animals such as the Polar bear living in the Arctic*" (Chancellor, 2012, p. 28).

In the book named 'What If We Cope with Natural Disasters?', climate change due to global warming is shown as causing natural disasters. It is stated that "*Exhausts increase the greenhouse effect that causes our world to overheat. This increase in temperature also causes climate change on our planet. This is why hurricanes, droughts, and fires are now both more frequent and more destructive*" (Palattı, 2012, p. 24).

Findings Related to Sustainable Environment and Climate Change in Seven-Year-Old Children's Books

The book 'Weather Conditions' provides encyclopedic information about weather conditions and weather events. With the title of '**Global Warming**', information about global warming is given and it is stated that oil, coal, and similar fuels cause global warming. It is mentioned that as a result of global warming, "*the atmosphere warms up because these gases trap the heat of the Sun*" (Clarke, 2013, p. 28).

In the book titled, 'Why Should I Care About the World?' encyclopedic information is given on various topics related to life on earth. Under the title of '***Overheating***', it is pointed out that our planet is getting warmer and information about greenhouse gas is given (Meredith, 2012, p. 8). In the title of '**Climate Change**', information about climate change is given and it is stated that if the climate gets too hot, it will cause droughts and floods, and if it gets too cold, it will cause the destruction of agricultural products (Meredith, 2012, p. 9). Information about recycling is given under the heading '**Use Less, Reuse, Recycle**', and it is stated that more than 60% of household waste can be recycled. Under the title of '**What Are the Leading Threats to the Environment**?', brief information about the environmental problems awaiting our planet is given and what we can do is briefly mentioned (Meredith, 2012, p. 40).

In the book called 'Natural Disasters', encyclopedic information about natural disasters and their causes is given and what can be done against natural disasters is explained. Under the title of '**A Huge Greenhouse: The World**', it is stated that motor vehicles, factories, and power plants are constantly pumping gas into the atmosphere. It is stated that these gases cover the atmosphere like a quilt and cause climate change and our planet to become warmer. What we can do against global warming is pointed out by stating "*We can help our Earth by consuming less energy, throwing our garbage in recycling bins and using less fuel as possible*" (Guire Mc, 2013, p. 38). It is noted that climate change causes the melting of glaciers in the polar regions, and it is pointed out that the animals living in that region are in danger of extinction (Guire Mc, 2013, p. 30).

The book 'Rainforests' provides encyclopedic information about rainforests, the creatures living in them, and the climate of rainforests. Under the title of '**Endangered'**, it is stated that rainforests are being destroyed and may disappear in the next fifty years. Drawing attention to the extinction of many plants and animals with the depletion of rainforests, it is stated that "*This loss will also be disastrous for the climate of the world*" (Ganeri, 2013, p. 27).

In the book titled 'Polar Bear, Why Are the Glaciers Melting?', the polar bear and the glacial region it lives in, the reasons for the melting of the glaciers, and what can be done against this danger are explained. It is emphasized that scientists are worried, that the temperature of the Arctic region is gradually increasing every year and that the glaciers are melting (Wells, 2015, p. 7). In the book, the greenhouse gas and greenhouse effect is defined and the benefit of the greenhouse effect to the earth is emphasized. The damage to the global climate with the level of greenhouse gases above normal is explained by "*if there are too many greenhouse gases in the air, the air can get too hot. This is what is happening now in the Arctic and around the world*" (Wells, 2015, p. 14). The causes of climate change are indicated and information is given about what we can do to prevent it (Wells, 2015, pp. 28-33).

Findings Related to Sustainable Environment and Climate Change in Eight Age Group Children's Books

In the book called 'Trees', encyclopedic information about the tree is given under different titles from seed to adult. Under the section title of "Trees and People", the human-tree relationship has been mentioned in general. In the section where how the tree is used by human beings, the place of the tree in daily life, and the importance of the tree in our life are explained, attention is drawn to the important functions of trees in maintaining the heat balance in the world. After expressing "*But without trees that maintain this balance, too much carbon dioxide builds up in the air, causing less and less heat to escape from the atmosphere. This causes the entire planet to heat up like an oven*" (Howell, 2019, p. 70), the section gives information about what can be done to protect the trees (Howell, 2019, p. 71).

In the book named 'Ecology', ecology is defined and encyclopedic information is given under the main headings on the subjects related to ecology in general. Under the main title of '**Nature's Cycles**', nature's cycles are explained and information about fossil fuels is given. It has been stated that the excessive consumption of fossil fuels for the last 150 years has caused the greenhouse gas effect and triggered global warming (Eason, 2019, p. 18). Climate information is given under the main title of '**Climate and Earth**'. In the section where information about the factors affecting the climate is given, it is stated that the temperature of the world has increased by 50°C in the last fifty years due to human-induced pollution under sub-titles such as "ozone layer, greenhouse effect", and it is stated that this causes global warming (Eason, 2019, p. 27). Under the main heading of '**Ecology**', it is stated that modern production techniques started after the industrial revolution, and accordingly, industrial facilities consume huge amounts of energy and natural resources, and the world population is increasing rapidly. To meet the rapidly increasing needs, it is pointed out that the unconscious destruction of rainforests increases global warming (Eason, 2019, p. 47). In the main title of '**Environmentalism**', information about the environment and environmentalism is given and the principles of environmentalism are discussed. In the section where information about what should be done for a sustainable environment is given, it is pointed out that the biggest duty belongs to humans (Eason, 2019, pp. 57-62).

The book 'Climate Change' provides encyclopedic information on climate and climate change under different headings. Emphasizing that climates are changing in the main title of '**World Climate**', attention is drawn to climate change by expressing "*Climate scientists working at research centers like this station in Antarctica are sure that temperatures are increasing worldwide* (Woodward, 2015, p. 7). Under the heading of '**Controls and Balances**', it is stated that the ever-increasing global temperature will make the world warmer in the coming years and may have serious consequences for all humans (Woodward, 2015, p. 12). Under the title of '**Human Impact**', the human impact on global warming is emphasized. Concerning the cause of the overheating in the last century, it is stated that "*the acceleration in global warming is*

most likely due to our modern lifestyle, which is dependent on energy consumption" (Woodward, 2015, p. 16). With the title '**Burning Forests**', it is pointed out that burning forests triggers global warming (Woodward, 2015, p. 18). In the '**Additional Issues**' heading, information is given about the burning of forests that cause global warming and various factors other than fossil fuels. The heading '**Forecasting Future Climates**' provides predictive information about what kind of problem will be faced in the future if global warming continues in this way and mentioned that "if we do nothing to stop climate change, temperatures may increase by *3*°C or more by 2100, which may cause serious problems" (Woodward, 2015, p. 37). With the title of '**Next Century**', it is emphasized that global warming will continue to increase throughout the 21st century and what kind of dangers await the world in this period. The title of '**Climate Change and Society**' describes the effects of climate change on society (Woodward, 2015, p. 44). Under the title of '**Combating Climate Change**', what has been done and what can be done against global warming has been examined. It is emphasized that developed countries do not want to give up on modern technologies that cause warming in the fight against global warming. It is also highlighted that new and harmless technologies can offer positive opportunities and stated that "*therefore, agreements are being worked on to combat climate change gradually*" (Woodward, 2015, p. 48). Under the title of '**Energy Efficiency**', the importance of efficient use of energy for a sustainable environment is highlighted.

In the book called 'Arctic and Antarctica', encyclopedic information is given under different headings about plants, living things, and people living in the Arctic and Antarctic regions. Under the main title of '**Climate in the Past and Future**', it is emphasized that the world is currently experiencing a rapid warming period and that the effects of this warming will have very dramatic consequences in the polar regions and other parts of the world. In addition, it is emphasized that the level of carbon dioxide in the atmosphere has increased continuously since 1958, and this situation is caused by excessive fuel use, and it is pointed out that excess carbon dioxide released into the atmosphere causes global warming (Taylor, 2015, pp. 66-67).

In the book called 'Energy', encyclopedic information is given on the topics related to energy, types of energy, areas of use of energy, etc. under different headings. Under the title of '**Energy on a Global Scale**', it is stated that the source of the energy we use is fossil fuels. It is pointed out that if energy consumption continues at this rate, oil and natural gas may run out after a certain period, and coal within 200 years. It is emphasized that this increase in the use of fossil fuels also causes global warming (Challoner, 2015, p. 55). In the section titled '**Alternative Energy**', it is stated that such a large consumption of fossil fuels causes global warming, and energy resources will be depleted. By explaining what can be done against the danger of depletion of energy resources in the future, attention is drawn to alternative energy sources. Solar energy, hydroelectric energy, and wave energy are specified as alternative energy sources (Challoner, 2015, p. 57).

In the book called 'Kalundborg Gang', some activities done by the children named Viggo, Victor, Alan, Emil, and Oliver to protect the beach and ducks in Kalundborg, a small port city in the early 1980s were mentioned. The children found a baby duck by the lake and took it under protection. From time to time, the children write letters to the baby duck's family, expressing what they have done for the environment along with the condition of the baby duck and what more needs to be done. After the children's demonstration, the authorities took some decisions to protect the environment. According to this decision, energy use and polluted water will be controlled and used more efficiently (Nam, 2017, p. 23). Thus, the environment will be protected (Nam, 2017, p. 27).

Findings Related to Sustainable Environment and Climate Change in Twelve-Year-Old Children's Books

In the book named 'Wind Energy', encyclopedic information about wind energy is given and attention is drawn to the importance of wind energy for global warming and a sustainable environment. Under the title of '**What is the problem?**', it is emphasized that using fossil fuels pollutes the atmosphere and causes global warming. In response to this situation, it is stated that "*the challenge ahead of us is to find reliable alternative energy sources that do not increase our environmental problems"* (Pipe, 2013a, p. 3). In addition, it is stated in the book that wind energy alone cannot be a solution to all energy needs because the wind does not blow on some days.

In the book named 'Biofuels', encyclopedic information about biofuels is given. Under the title of '**What is the Problem**', it is stated that the energy we use is generally obtained from fossil fuels, but fossil fuels cause global warming. It is emphasized that biofuels can be used as an alternative to fossil fuels. On the other hand, it means that the product to be used to obtain biofuel is the use of the fields that provide us food and the water used to irrigate the fields for biofuel (Pipe, 2013b, p. 3). At the end of the book, information is given about the pros and cons of biofuels and renewable energy sources (Pipe, 2013b, p. 29).

In the book called 'Natural Gas', encyclopedic information is given on the subjects of natural gas, its production, use, contribution to the environment, etc. Regarding the use of natural gas, it is considered that "*Although burning gas causes global warming due to greenhouse gas emissions, it causes much less pollution than burning coal"* (Pipe, 2013c, p. 3). It is emphasized that natural gas emits 45% less carbon dioxide than coal and 30% less carbon dioxide than oil, emphasizing the importance of natural gas in reducing global warming (Pipe, 2013c, p. 7).

In the book called 'Humans vs. Nature', encyclopedic information is given on natural disasters, planning the future, and the effect of humans on nature. Under the title of '**Human's Impact on Nature**', information about harmful gases is given and the concern of fossil fuels is expressed by stating "*Every day, with the burning of fossil fuels used to run power plants, factories, airplanes, and cars, enormous amounts of carbon dioxide (CO_2) and other gases are*

released into the air, which scientists think that this causes global warming" (Mason, 2013, p. 36). In the book, information about global warming is given, and what can be done to reduce it is emphasized.

In the book called 'Energy Crisis', there is encyclopedic information about various subjects under different titles such as energy types, energy sources, and energy crisis. Under the sub-title of '**Problems Related to Fossil Fuels**', the problems caused by fossil fuels are listed and it is emphasized that fossil fuels cause global warming (McLeish, 2013, p. 11). Under the title of '**Global Warning**', global warming caused by fossil fuel use and its effect on our planet is explained and it is stated that "*these effects will have some costs for humans; economies will suffer, global food production will change, and societies will deteriorate*" (McLeish, 2013, p. 29).

In the book 'Rainforest Food Chains', encyclopedic information is provided on the subjects of the rainforest food chain, rainforest habitat, what needs to be done to protect rainforest food chains, etc.

With the title of '**How Are Humans Harming Rainforest Food Chains?**', information about the damage caused by humans to rainforests is given. The importance of rainforests for our world is emphasized and it is pointed out that rainforests are a "carbon sink" and contribute to reducing global warming (Moore, 2013a, p. 35).

In the book 'River Food Chains', encyclopedic information is given on subjects such as the river food chain, river food chains around the world, etc. under the relevant headings. Under the title of '**Climate Change**', it is stated that global warming causes climate change and that many rivers all over the world face the danger of drying up due to climate changes. It is also expressed that the waters of the rivers that are in danger of drought decrease so that the river beds that turn into swamps become the nest of flies, which are the carriers of diseases (Lynette, 2013a, p. 39).

In the book 'Ocean Food Chains', information about subjects such as the ocean food chain, where the ocean food chains are in the world, how the ocean food chains are in different parts of the world, etc. is given under different headings. Under the heading of 2**Losing a Link in the Chain: Southern Ocean Krill**', the impact of global warming on ocean food chains was emphasized by stating that "*the number of krill in the Southern Ocean has decreased by about 80 percent since the 1970s. Many krill in the Southern Ocean depend on algae living in sea ice. Global warming has caused this sea ice to melt. Therefore, the number of algae required to feed the krill has decreased. If krill numbers continue to decline, the entire Southern Ocean food chain will be endangered"* (Moore, 20014b, p. 19). More information is given about the oceans. Global warming threatens many species in the oceans. The rising temperature of the ocean is causing the death of sensitive corals. A study has shown that 95% of corals will disappear by 2050 (Moore, 20014b, p. 33). Corals are a food source for many reef-dwelling

species. The disappearance of corals means that other species will also be endangered. Depending on the climate that changes with global warming, the glaciers melt, the sea rises, the direction and characteristics of the currents change. With the melting of glaciers, the amount of ice that polar bears will rest on while swimming is decreasing. As this situation makes it difficult for polar bears to hunt, their species are endangered (Moore, 20014b, p. 36).

In the book called 'Grassland Food Chains', encyclopedic information about grassland food chains is given under different headings. Under the title of '**Climate Change**', it is stated that the temperature has increased all over the world in the last hundred years, and accordingly the temperature has increased in the meadows. Some bird species will migrate to other areas to find cooler places during their nesting season. On the other hand, it will be more difficult for the grasses that the birds will eat to grow in the meadows (Silverman, 2014, pp. 38-39).

In the book called '**Mountain Food Chains**', encyclopedic information is given on the subjects such as the mountain food chain, the creatures in the mountain food chain, how people harm the mountain food chains, etc. under headings. It is stated that as a result of global warming, the number of Vancouver marmots living in the high mountains of Canada's Vancouver Island has decreased (Lynette, 2014, p. 17). Continuing their lives in cold weather conditions, picas have had to migrate to colder places with global warming. If global warming continues, if they cannot find a cold place to migrate, they will become extinct (Lynette, 2014, p. 33). For a sustainable environment, it is important to teach people about food chains (Lynette, 2014, p. 42). Thus, people will act more consciously towards nature.

CONCLUSION and DISCUSSION

Children are faced with problems of climate change, environmental pollution, and loss of biological diversity (Hedefalk et al., 2015). Therefore, teaching children about environmental issues has become an important issue. Such an education in schools may bring about positive results in terms of environmental protection (Nikolaeva, 2008). Moreover, raising awareness of children on sustainable environment and climate change has a significant role in developing their life-long protective and caring attitudes towards the environment (Barratt-Hacking et al., 2007). Apart from a need for integrating sustainable environment and climate change issues into the school curriculum, it is important to provide resources for children such as books to increase their knowledge on the issues. In line with this, the current research aimed to investigate how the subject of 'sustainable environment and climate change' is handled as a popular science subject in children's literature. To this end, children's books published by TUBITAK for children aged 2-12 were examined, and among these books, those that touch on the subject of "sustainable environment and climate change" were selected for research. In this context, 25 books among 346 books were examined through document analysis.

The findings revealed that the subject of sustainable environment and climate change is handled with different aspects in all of the books examined for seven different age groups. In the study, it was determined that the perception levels of children in different age categories about environmental and climate problems are different (Doğar & Başıbüyük, 2005). For this reason, the same problem takes place with different expressions and visuals in children's books for different age groups. In children's books, "theme, heroes, language and expression, images used, interior and exterior design of books" etc. It is known that the subjects vary according to the age groups of the target audience children (Çiftçi, 2013). The subjects in the books written for younger children are handled with shorter sentences, while for older children, long sentences, numbers, and statistical information are provided. In the images used in preschool children's books, "pictures" instead of "photographs" (Külük, 2013) are preferred. It has been determined that the visuals used in the examined books are suitable for the age and developmental characteristics of the children. The visuals used in the books are also suitable for the age and developmental characteristics of the children. In the books prepared for preschool children, pictures are preferred instead of photographs. In the books prepared for school-age children, it has been determined that photographs are used instead of pictures. Such differences in the books based on the age groups are important to note. The selection of images and length and complexity of the information given is important criteria when presenting the issue to the different age groups through popular science books. Addressing the issue of sustainable environment and climate according to the level of children is evaluated positively (Çiftçi, 2013) in terms of developmental periods of the targeted children age group.

In the books examined, the mistakes made by the states and people for a sustainable environment are emphasized in connection with the subject. It has been determined that there are common mistakes about the environment. As it is known, the issue of global warming, climate change and sustainable environment is an issue that concerns all parties living in the ecosystem (Kaymaz & Tut, 2020). States, institutions and organizations, and citizens have separate duties. It is known that there are internationally accepted attitudes on the subject (Özkaya, 2013). In all of the books, reasons such as the destruction of forests for various reasons, the unconscious use of fertilizers and water for more production, the opening of fertile lands, and pastures to settlement and tourism have been identified as mistakes made on the subject of a sustainable environment. Natural disasters caused by people's wrong attitudes and behaviors also pose another problem for the sustainable environment. Forests that are burned to make agricultural land and cut illegally for commercial purposes cause landslides. The settlements established on the stream bed result are another reason for the environmental disaster after floods. Unconscious and illegal fishing in the seas is another danger for the sustainable environment. Endangered species as a result of overhunting may increase the number of other species and disrupt the life chain, posing a threat to the sustainable environment. It is thought that global warming, climate change, and sustainable environmental education should start in the family from a young age and continue in environmental and educational institutions, and it is important to include the subject in the programs of educational

institutions (Tanriverdi, 2009). The subject is considered an important issue concerning the future of the world that individuals and societies should internalize in their daily lives.

Although the books examined were written for children, what adults and children should do about the sustainable environment are also partially emphasized in the books. It has been determined that the targeted books include suggestions: children should have a picnic in the countryside with their families and friends, plant new trees, not pollute the environment, leave the waste in suitable places, send the used items for recycling, etc. It has been evaluated as a positive situation in the context of sustainable environment and climate change that solutions are presented along with the problems experienced in the environment and climate.

The issue of global climate change is covered in all of the books reviewed. Excessive use of fossil fuels is shown as the main cause of global warming. With the mechanization that started after the industrial revolution, mass production was started in the industry. Continuous and more energy was needed in mass production. Continuity of energy is possible with the use of fossil fuels. Excessive use of fossil fuels also creates a greenhouse effect and causes global warming (Kahraman & Şenol, 2018). The effects of global warming on our world are explained in connection with the subjects in the books. The warming in the poles and the melting of glaciers threaten both the world's water resources, settlements, and agricultural lands for a long time. At the same time, many species living in the Antarctic region are in danger of extinction in the future. Global warming causes floods with more rain in other parts of the world. As a result of floods, agricultural and residential areas are damaged. On the other hand, as a result of global warming, many species living in drought-ridden regions are in danger of extinction. While the books examined tell what children can do against global warming in accordance with their age, the inclusion of what adults can do as well against global warming is considered a positive approach.

Sustainable environment and climate change is a major problem faced by the earth. This problem is also the main source of other problems that are experienced. To solve the problem, people need to be informed and educated on the subject from a young age. Based on the analysis in the current research, TUBITAK children's books can be recommended for out-of-school reading to raise awareness about the sustainable environment and climate change. Moreover, in developing projects for raising the awareness of children on the subject, these popular science books by TUBITAK can be benefitted. Further research can be conducted on different children's books in terms of age and handling of sustainable environment and climate change. It is considered that popular science books published by TUBITAK can have positive influences on raising the awareness of children about the sustainable environment and climate change.

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The Effect of Science Festival on Participants' Attitudes Towards Science

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ABSTRACT

Science festival aims to spread the science culture and communication to wider sections of the society, to provide scientific knowledge to the participants and to comprehend the interaction between science and technology through activities. 30 regional and original events prepared by the units within our university, such as "Adventure of Rose Oil and Rose Water" and "Lavender Perfume" will be realized. The proposed activities include workshops, experimental applications, interactive applications, observation, competitions, collaborative group works, field studies, exhibitions and demonstrations, interviews, and sports activities to attract everyone's attention from 7 to 77. The event aims to present scientific knowledge to the participants within the framework of applied sciences. In addition to regional projects in agriculture, forestry, technology, and aquaculture science, participants at the Science Festival of Isparta University of Applied Sciences as well as activities such as "Reproduction of Medicinal and Aromatic Plants", "Survival and Camping in Nature" and "Arduino" aims to provide. In order to enable the participants to take an active role in the realization of the activities, the activities were diversified in each activity using different types of activities. The scientific attitude scale was used to determine the gains, experiences, and opinions of the participants within the scope of the planned activities. In the study, the level of the science fair participants' attitudes towards science and gender difference in the attitudes of science fair participants towards science, and opinions and suggestions of the participants about the Science Festival are determined. Within the scope of that, the scientific attitude scale and an open-ended question is used. In the scientific attitude scale, there are 40 items structured to explain the nature of science, the way scientists work, and how the participants feel about science. After the survey items, an open-ended question was asked to reflect opinions and suggestions about the Science Festival. Also, a result of this research, it was determined that the attitudes of the participants towards science were high in a positive way, the participants found the organization productive and fun, and they stated that they could experiment, they wanted such organizations to continue by taking precautions during the pandemic process, suggested that more workshops be held at the next science festival.

Keywords: Science Festival, Science Education, Scientific Attitude.

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INTRODUCTION

The purpose of science festivals is to spread the culture and communication of science to wider sections of the society, to convey scientific information to the participants, and to make them comprehend the interaction between science and technology through activities. According to Martin (2009), long-term gains can be achieved in developing positive attitudes towards science with fun, successful and inquiry-oriented science fair practices. Korkmaz (2012) stated that science festivals are accepted as beneficial practices for individuals of all ages. Tezcan and Gülperçin (2008) examined the attitudes of the participants of the science fair and education science festival in İzmir to insects. According to the results of the study, it was determined that the participants' perspectives on nature and insects were positive, willing to relate to nature, aware of nature and insects, but tended to approach cautiously (Tezcan & Gülperçin, 2008). In the research, it was emphasized that the support and dissemination of science fair activities aiming to make people love science and nature are very important, and that new projects to be supported will contribute to the creation of new generations that are more conscious about the environment, nature and insects they are training (Tezcan & Gülperçin, 2008). Şahin (2012), investigated the effect of science festivals on the attitudes of 10th-grade students towards the field of chemistry. According to the results of the research, it was concluded that science festivals have positive effects on the development of high school students' attitudes towards chemistry lessons. In addition, in this study, it was stated that students with low interest in chemistry courses were observed to be more active and interested in the courses taught after they had examined the projects in the science festivals on site and participated in the presentations there (Şahin, 2012). Kızılcık, Cagan, and Yavaş (2018) examined visitor opinions on The Scientific and Technological Research Council of Turkey (TUBITAK) science fairs and the effects of fairs on student attitudes towards physics lessons. As a result of the research, it has been determined that the visitors to the science fair have highly positive opinions about science fairs. In addition, visitors think that such fairs will make a highly positive contribution to students' attitudes towards physics courses (Kızılcık, Çağan, & Yavaş, 2018). Also in this study, no significant difference was found according to the gender variable.

In the literature review, studies with students who participated in the science fair with their projects and took an active role were also found. According to the findings obtained in the research, it was determined that the students who contributed and took part in the science fair with their projects had positive attitudes towards science fairs (Karadeniz & Ata, 2013; Yıldırım & Şensoy, 2016; Urmaz, Dinçer, & Osmanoğlu 2017). In the research, the views of primary school students and workshop leaders of the TÜBİTAK 4007 Science Festival project held in the 2018-2019 academic year in Kastamonu were examined (Gulgun et al., 2019). The sample group of the research consists of 1200 primary and secondary school students who visited the science fair between 10-11 October 2018 and workshop leaders of 50 people who worked at the science fair on the same dates. As a result of the study, it was determined that primary school students and workshop leaders were highly satisfied and expressed their opinions about the repetition of similar projects.

Purpose of the research

When the related literature review was examined, it was determined that the science festivals held had a positive effect on the participants. Within the scope of the Isparta University of Applied Sciences Science Festival held in the Fall Term of 2021, it continued for four days with 30 regional and original workshops. Inconsistent with the results of studies in the literature, in this study it was determined that women participated more in positive items, and women participated less in negative items.

The research questions of the research are listed below;

- What is the level of the science fair participants' attitudes towards science?
- Is there a gender difference in the attitudes of science fair participants towards science?
- What are your opinions and suggestions of the participants about the Science Festival?

METHOD

The survey method (Karasar, 2008) is used to determine the gains, experiences, and opinions of the participants in the science festival.

Research Process

Table 1. Isparta University of Applied Sciences Science Festival Workshop list

No	Workshop Name	No	Workshop Name
1	The Adventure of Rose Oil and Rose Water	16	Life in the Water
2	Raising Insect Awareness	17	Let's Examine Sick Fish
3	Correct Spraying in Agriculture	18	Darts Tournament
4	Reproduction with Tissue Culture	19	The Magical World in the Bell
5	Grafting on Fruit Trees	20	1 drop of water 2 different lives: Aquaponic Production
6	Pruning in Fruit Trees	21	Journey from Flower to Fruit
7	Planting Fruit Saplings	22	Arduino Workshop
8	Lavender Perfume	23	I Solder My Own Circuit
9	Reproduction of Medicinal and Aromatic Plants	24	Let's get to Know the Drone Closely
10	Let's Explore the World of Insects	25	Fire Dance with Colors
11	Survival and Camping in Nature	26	Touching the Future from Tradition
12	Let's Get to Know the Birds	27	Dynamic Art Practices
13	Medicinal and Aromatic Plants	28	Breeding Techniques in Aquarium Fish
14	I Use My Personal Protector: Provide Job Security	29	Learning Raspberry pi Coding
15	Draw Your Own Route	30	Innovation Workshop

Isparta University of Applied Sciences aims to spread the science culture and communication to wider sections of the society, to provide scientific knowledge to the participants and to comprehend the interaction between science and technology through activities. Within the scope of that, 30 regional and original events prepared by the units within our university, such as “Adventure of Rose Oil and Rose Water” and “Lavender Perfume” will be realized (Table 1).

The activities include workshops, experimental applications, interactive applications, observation, competitions, collaborative group works, field studies, exhibitions and demonstrations, interviews and sports activities to attract everyone's attention from 7 to 77. The event aims to present scientific knowledge to the participants within the framework of applied sciences. In addition to regional projects in agriculture, forestry, technology and aquaculture science, participants at the Science Festival of Isparta University of Applied Sciences as well as activities such as “Reproduction of Medicinal and Aromatic Plants”, “Survival and Camping in Nature” and “Arduino” aims to provide. In order to enable the participants to take an active role in the realization of the activities, the activities were diversified in each activity using different types of activities, approximately 2000 people visited the science festival (see Figure 1).

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Figure 1. Isparta University of Applied Sciences Science Festival Workshop Process

When the participants came to the relevant workshop stand, after the academician gave brief information about the subject, showed the educational material to the participants, performed the experiment, and had the participants perform some parts of the experiment. Participants were able to observe the experiment, made partial contributions to the experiments, were informed about the subject. For example, one of the "I Solder My Own Circuit" workshop activity was soldering, after the participants learned about the subject and watched the academician do it, they soldered the two ring wires together.

Science fair activities were carried out after the academicians presented their workshop proposals, the project management reviewed and approved the workshops, and the workshops were corrected during the TUBITAK project writing process, this process lasted for 9 months. Meetings were held with workshop leaders and guides about the science fair workshops, and the presentations of the workshops were supervised by the project management. Science fair workshops were presented to the participants between 20-23 October 2021. In order for the participants to be everyone from 7 to 77, one of the event days is Saturday in order to ensure the participation of the people working in the workplace. In the event calendar, it is aimed to offer diversity by repeating 30 workshops in different numbers on different days, an average of 16 workshops were held in one event day.

Participants

206 people, 118 women and 88 men participated in the survey voluntarily. The %80 of the participants is between the ages of 13-24 (n=165), see Table 2.

Table 2. Demographic characteristics of the participants

Variables		N	Percentage
Age	0-12	17	8.25
	13-24	165	80.10
	25-36	13	6.31
	37-48	9	4.37
	49-	2	0.97
Gender	Female	118	57.28
	Male	88	42.72
Total		206	100

Data Collection Tool and Data Analysis

The scientific attitude scale was developed by Moore and Foy (1997), and its original English form was obtained by e-mail from the researchers who developed the scale and translated into Turkish (Demirbaş & Yağbasan, 2006). In the scientific attitude scale, there are 40 items structured to explain the nature of science, the way scientists work, and how the participants feel about science. The items were created in a five-point Likert type and the degree to which people agree with the items; it was classified as "Strongly Agree", "Agree", "Undecided",

"Disagree" and "Strongly Disagree". In the survey, 20 of the items were determined as positive and 20 of them as negative. In addition, the scale is divided into 6 categories. While 5 of the categories are related to the nature of science and the way scientists work; One category included items about how students felt about science. While creating the categories, a scoring format of 5, 4, 3, 2, 1 for positive items and 1, 2, 3, 4, 5 for negative items were taken into consideration in scoring the answers given by the participants.

Table 3. Creation of survey categories

Scale	Number of items	Category	Numbers of items on the scale
1. AB*	3+3	The Structure of Scientific Laws and Theories	(4,16,34) ;(11,15,35)
2. AB*	3+3	Structure of Science and Approach to Events	(10,19,33) ;(2,7,26)
3. AB*	3+3	Exhibiting Scientific Behavior	(17,18,25) ;(3,5,32)
4. AB*	3+3	Structure and Purpose of Science	(20,21,28) ;(9,24,31)
5. AB*	3+3	The Place and Importance of Science in Society	(12,23,29) ;(6,8,38)
6. AB*	5+5	Willingness to Do Scientific Studies	(1,27,30,36,40) ;(13,14,22,37,39)
Positive items	20	-	-
Negative items	20	-	-
Total	40	-	-

**contains negative meaning*

After the survey items, "What are your opinions and suggestions about the Science Festival?" an open-ended question was asked. Since participation in the survey is voluntary, this optional open-ended question was answered by many people. The words in the answers given to this open-ended question were processed with content analysis, and the themes most frequently mentioned by the participants were transferred as codes. Two academicians who are experts in their fields worked for content analysis. Encoder reliability in the analysis of the data is measured by calculating the percentage of agreement (Miles and Huberman, 1994). The agreement between encoders was calculated as 93%. Also, some one-to-one versions of the expressions used by the participants are presented.

FINDINGS

The survey results of the science festival participants are presented in Table 4. According to the findings, it was determined that the scientific attitudes of the participants were high in a positive way. Positive items of the survey received high scores and negative items of the survey received low scores. In Table 4, the request to reverse the item has not been applied

Table 4. Mean and standard deviation scores or scale items

Question	N	Mean	SD
1. I would enjoy studying science	206	3.88	1.17
2. Anything we need to know can be found out through science*	206	3.12	1.14
3. It is useless to listen to a new idea unless everybody agrees with it*	206	2.04	1.36
4. Scientists are always interested in better explanations of things	206	3.57	1.17
5. If one scientist says an idea is true, all other scientists will believe it*	206	1.64	1.15
6. Only highly trained scientists can understand science*	206	1.78	1.08
7. We can always get answers to our questions by asking a scientist*	206	2.13	1.18
8. Most people are not able to understand science*	206	2.33	1.21
9. Electronics are examples of the really valuable products of science*	206	4.17	0.99
10. Scientists cannot always find the answers to their questions	206	4.33	0.98
11. When scientists have a good explanation, they do not try to make it better*	206	1.77	1.11
12. Most people can understand science	206	3.44	1.13
13. The search for scientific knowledge would be boring*	206	2.52	1.19
14. Scientific work would be too hard for me*	206	2.69	1.21
15. Scientists discover laws which tell us exactly what is going on in nature*	206	3.68	1.12
16. Scientific ideas can be changed	206	4.24	1.07
17. Scientific questions are answered by observing things	206	4.05	1.01
18. Good scientists are willing to change their ideas	206	3.29	1.27
19. Some questions cannot be answered by science	206	3.86	1.16
20. A scientist must have a good imagination to create new ideas	206	4.13	1.05
21. Ideas are the important result of science	206	4.11	1.09
22. I do not want to be a scientist*	206	2.73	1.41
23. People must understand science because it affects their lives	206	3.30	1.16
24. A major purpose of science is to produce new drugs and save lives*	206	3.43	1.25
25. Scientists must report exactly what they observe	206	4.35	0.95
26. If a scientist cannot answer a question, another scientist can*	206	1.60	1.03
27. I would like to work with other scientists to solve scientific problems	206	4.18	1.09
28. Science tries to explain how things happen	206	4.19	0.99
29. Every citizen should understand science	206	2.72	1.26
30. I may not make great discoveries, but working in science would be fun	206	4.11	1.05
31. A major purpose of science is to help people live better*	206	4.02	1.06
32. Scientists should not criticize each other's work*	206	2.30	1.43
33. The senses are one of the most important tools a scientist has.	206	3.88	1.13
34. Scientists believe that nothing is known to be true for sure	206	3.39	1.25
35. Scientific laws have been proven beyond all possible doubt*	206	3.51	1.19
36. I would like to be a scientist	206	3.44	1.36
37. Scientists do not have enough time for their families or for fun*	206	2.85	1.35
38. Scientific work is useful only to scientists*	206	1.63	1.11
39. Scientists have to study too much*	206	3.66	1.22
40. Working in a science laboratory would be fun	206	4.17	1.02

**contains negative meaning*

The answers given by the participants to the survey items and the results of the analysis by gender t-test are presented in Table 5. According to the t-test results according to gender, it was determined that women participated more in positive items, and women participated less in negative items. Therefore, the scientific attitude of women is higher than that of men in a positive way.

Table 5. Scale items t-test results according to gender

Question	Gender	Mean	SD	*F*	*p*
4. Scientists are always interested in better explanations of things	F	3.58	1.015	14.690	0.000
	M	3.56	1.363		
7. We can always get answers to our questions by asking a scientist*	F	2.03	1.045	13.286	0.000
	M	2.25	1.341		
9. Electronics are examples of the really valuable products of science*	F	4.15	0.883	4.600	0.033
	M	4.20	1.126		
11. When scientists have a good explanation, they do not try to make it better*	F	1.67	0.916	12.155	0.001
	M	1.91	1.319		
14. Scientific work would be too hard for me*	F	2.65	1.130	4.971	0.027
	M	2.73	1.313		
15. Scientists discover laws which tell us exactly what is going on in nature*	F	3.77	0.991	11.425	0.001
	M	3.57	1.267		
17. Scientific questions are answered by observing things	F	4.14	0.936	4.037	0.046
	M	3.93	1.091		
24. A major purpose of science is to produce new drugs and save lives*	F	3.34	1.123	11.657	0.001
	M	3.50	1.397		
33. The senses are one of the most important tools a scientist has.	F	4.04	1.016	6.438	0.012
	M	3.67	1.238		

**contains negative meaning*

In the survey, 6 subcategories were created (Demirbaş & Yağbasan, 2006). While creating the categories, a scoring format of 5, 4, 3, 2, 1 for positive items and 1, 2, 3, 4, 5 for negative items was taken into consideration in scoring the answers given by the participants. According to the answers given by the participants to the survey, when the category averages are examined, the highest "Exhibiting Scientific Behavior" and the lowest "Structure and Purpose of Science", see table 6.

Table 6. Categories results of the scale

Category	Mean	Sd
The Structure of Scientific Laws and Theories	3.37	0.451
Structure of Science and Approach to Events	3.87	0.553
Exhibiting Scientific Behavior	3.95	0.611
Structure and Purpose of Science	3.13	0.418
The Place and Importance of Science in Society	3.62	0.520
Willingness to Do Scientific Studies	3.53	0.667

After the survey items, "What are your opinions and suggestions about the Science Festival?" an open-ended question was asked. Since participation in the survey is voluntary, this optional open-ended question was answered by many people. According to the answers given to the open-ended question, the participants found the organization productive (n=123) and fun (n=85), and they stated that they could experiment (n=89), they wanted such organizations to continue by taking precautions during the pandemic process (n=66), suggested that more workshops be held at the next science festival (n=45). In addition, some of the expressions used by the participants are given below.

P12: "It was very nice, the scientists explained all of them one by one and they gave us good information, I had the opportunity to experiment."

P84: "They were very friendly and expert people. His explanations were clear and helpful. Personally, I found the science festival very positive and productive."

P121: "Academics were very successful in teaching and informing. The fact that they answered every question asked, stood on it until they understood the event, and waited patiently in our activities increased my interest in the Science Festival."

P125: "It was enjoyable, could have more workshops"

P180: "All the events held during the pandemic period show the importance our country attaches to science and science learning. Therefore, it is a great honor for me to increase these activities even more."

P186: "It was a nice event. They paid attention to the pandemic. Mask and distance rules were applied. I think it would be good if the event was held in the open air."

CONCLUSION AND RECOMMENDATIONS

The science festival develops positive scientific attitudes such as scientific thinking, observation and awareness in the participants (Bencze & Bowen, 2009; Durmaz, Dinçer & Osmanoğlu, 2017; Finnerty, 2013; Keçeci, 2017; Başar et al., 2018). Isparta University of Applied Sciences Science Festival aims to spread the science culture and communication to wider sections of the society, to provide scientific knowledge to the participants and to comprehend the interaction between science and technology through activities. Isparta University of Applied Sciences Science Festival was held for 4 days with 30 different workshops and a total of 2000 people attended the workshops. In the research, 206 people voluntarily participated in the survey conducted with the participants of the science festival.

In the study, the level of the science fair participants' attitudes towards science and gender difference in the attitudes of science fair participants towards science are determined as sub-problem. As a result of this research, it was determined that the attitudes of the participants towards science were high in a positive way. According to the answers given by the participants to the survey, when the category averages are examined, the highest "Exhibiting Scientific Behavior" and the lowest "Structure and Purpose of Science". Kızılcık et al. (2018) found no significant difference towards science according to the gender variable. But, when the participant answers according to the gender variable were examined in this paper, it was determined that the scientific attitudes of the female participants were higher in the positive direction compared to the male participants.

Moreover, opinions and suggestions of the participants about the Science Festival is determined as sub-problem of the research. According to the answers given to the open-ended question, the participants found the organization productive and fun, and they stated that they could experiment, they wanted such organizations to continue by taking precautions during the pandemic process, suggested that more workshops be held at the next science festival. It has

been determined that the results of the research are compatible with the studies that carried out other science festivals in the literature (Kızılcık, Cagan, & Yavaş 2018; Karadeniz, & Ata, 2013; Yıldırım & Şensoy, 2016; Urmaz, Dinçer, & Osmanoğlu 2017; Gülgün et al., 2019; Akkanat 2020) in terms of the usefulness of science festivals.

Limitations

The vast majority of the participants of this study were between the ages of 13 and 24 (80.1%), no age-related analysis was performed. Again, the group that gives the most answers to the open-ended question is the same age range. Therefore, an analysis and inference could not be made according to the age of the participants in this study, this is the limitation of the study.

Recommendations

When the survey results and open-ended questions applied in the study are evaluated, suggestions for future science festivals are presented below.

- Science festivals are considered productive and fun by the participants and should be carried out by taking measures to increase interest in science.
- The number of workshops in science festivals should be kept as much as possible.
- Participants considered it important to be able to conduct experiments and practices on their own, it is important for the participants to be active in the workshop after information is presented by the trainers at the science festivals.

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