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Determination of Primary School Teachers' Mathematical Gender Stereotypes and Examination of Their Reflection on Students*

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Abstract: This study aims to investigate primary school teachers' mathematical gender stereotypes and to discover whether these stereotypes, if any, are reflected on students. The study was designed as a multiphase mixed methods study. Accordingly, in the quantitative and qualitative stages of the study, different sample groups including both fourth-grade teachers and fourth-grade students in Ankara were studied. Teachers' Gender Stereotype Scale toward Mathematics, observation form, Students' Gender Stereotype Questionnaire and Mathematics Achievement Test were sequentially used to collect data. The data were analyzed by Mann Whithey U test and content analysis. Results demonstrate that in comparision to the teacher who has neutral gender related beliefs toward mathematics, the teacher with strong traditional mathematical gender stereotypes favouring their male students. However, results show that students do not internalise their teachers' mathematical gender stereotypes, and, Hense, there is reflection of teachers' gender stereotypes on students' mathematical achievements. By carrying out longitudinal studies, it should be followed at which educational level students begin to acquire such gendered perspectives, which academic fields and professions they choose, and thus the effects of teacher characteristics on students should be revealed more comprehensively.

Keywords: Equity in mathematics education, gender stereotypes in mathematics, Mathematics achievement

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Introduction

The starting point of this study is the fact of male domination in mathematics. Even though Carl Friedrich Gauss regarded mathematics as the queen of the sciences and assigned it a female characteristic, many people agree that the female nature and mathematical thought are incompatible (Koblitz, 2002). However, in Turkey at least, there are no statistically significant differences in the mathematical achievement of boys and girls at primary (Ergun, 2003; Kulunk-Akyurt, 2019; Sari & Ekici, 2018), and secondary school (Akhan, 2015; Ayvaz, 2013; Yilmaz, 2015; Yucel & Koc, 2011) levels. The examination determines student competence to attain higher education, named Higher Education Institution Examination (YKS) 2018 that boys are just slightly more likely to secure the top grades. Still, the differences are small and not viewed as significant. In stark contrast to these results, students' choice to study in mathematics-related fields remains highly gendered in Turkey. For example, the number of male students entering mathematics-related fields in Turkey is much higher than females. Male enrolment to Information and Communication Technologies departments is almost four times more than female students.

Similarly, male students prefer Engineering, Manufacturing and Construction departments, approximately two and a half times more than females. When it comes to the fields of Arts and Humanities, the picture changes and female domination can be seen clearly (OSYM, 2018). This gender disparity in specific fields can be seen in more men than women working in mathematics-related occupations.

Some researchers have emphasized biological differences in mathematical ability between women and men to explain gender differences in mathematics and mathematics-related occupations (Baron-Cohen et al., 2005; Chapman et al., 2006), while others believe that studies examining the effects of biological differences between women and men on mathematical ability provide contradictory and insufficient results (Ceci et al., 2009). According to Caplan and Caplan (2005), no significant gender differences in mathematical ability have ever been proven. When such differences are found, they are based on factors related to individual experiences. Suppose biological differences in mathematical ability do not necessarily force women out of mathematics and fields closely related to mathematics. In that case, some researchers have instead, focused on the question of what kind of experiences do young women have that cause them to leave mathematics in classroom settings (Keller, 2007).

As Philipp (2007) states, to understand students' experiences within the classroom, it is important to understand teachers as a central factor. Therefore, researchers have focused on teachers' traditional gender stereotypes in mathematics related to the belief that males are more capable and successful in mathematics (Beilock et al., 2010), how these gender stereotypes influence their interactions with students in mathematics classrooms and affect their students' mathematical achievement, and whether these stereotypes are passed on to students. Studies have shown that teachers stereotype mathematics as a masculine domain (Keller, 2001), consider boys to be more capable than girls (Kurtz-Costes et al., 2008), believe that boys have more developmental

resources in mathematics than girls, attribute girls' failure to low ability rather than lack of effort than boys, rate mathematics as a more difficult subject for girls than for boys (Tiedemann, 2000), and believe that girls need more explanations than boys (Chionidou-Moskofoglou & Chatzivasiliadou-Lekka, 2008). Keller (2001) asserts that teachers' mathematical gender stereotypes affect teacher-student interaction. Studies have explored that when teachers who maintain mathematical gender stereotypes ask a question, they often select boys over girls to answer questions posed (Mittelberg et al., 2011), therefore, boys are provided more opportunities to receive feedbacks than girls (Chionidou-Moskofoglou & Chatzivasiliadou-Lekka, 2008). In addition, teachers can transfer mathematical gender stereotypes to students through their classroom interaction (Keller, 2001). Keller and Dauenhimer (2003) found that teachers and students stereotype mathematics as a male domain and teachers' stereotypes significantly affect their students' stereotypes, mathematical achievement, self-efficacy and interest.

Due to the importance of mathematics as a selection criterion for further education steps and the most prestigious occupations (Keller & Dauenheimer, 2003; Martinot & Désert, 2007; Roman, 2004), teachers' mathematical gender stereotypes and their influences on mathematics classrooms and students have been studied as a starting point of maintaining gender equality, especially in western cultures. However, it is well known that sexist behaviours and attitudes are prevalent among teachers in Turkey (Esen, 2015; Sayilan, 2012). These sexist behaviours and attitudes show a wide range of variety. Some of them are the intervention of looks and turn out, accusation and pressure of friendships with the opposite sex, not giving girls the opportunity to respod and ignoring their questions during classroom discussions, sortation of course content, order of seating, and organization of tasks regarding students' gender (Tan, 2008). Nevertheless, there is no evidence of Turkish teachers' mathematical gender stereotypes and their reflection on teacher-student interactions in mathematics classrooms and students. Therefore, this study focuses on teachers' mathematical gender stereotypes to explore their stereotypes' reflections on teacher-student interaction in mathematics classrooms and students.

To achieve this aim, the following broader research questions are addressed:

1. How do teacher-student interactions in the classrooms of teachers who hold traditional and neutral gender related beliefs about mathematics?
2. Do teachers' mathematical gender stereotypes influence students' gender beliefs about mathematics?
3. Do teachers' mathematical gender stereotypes influence students' mathematics achievement by gender?

Method

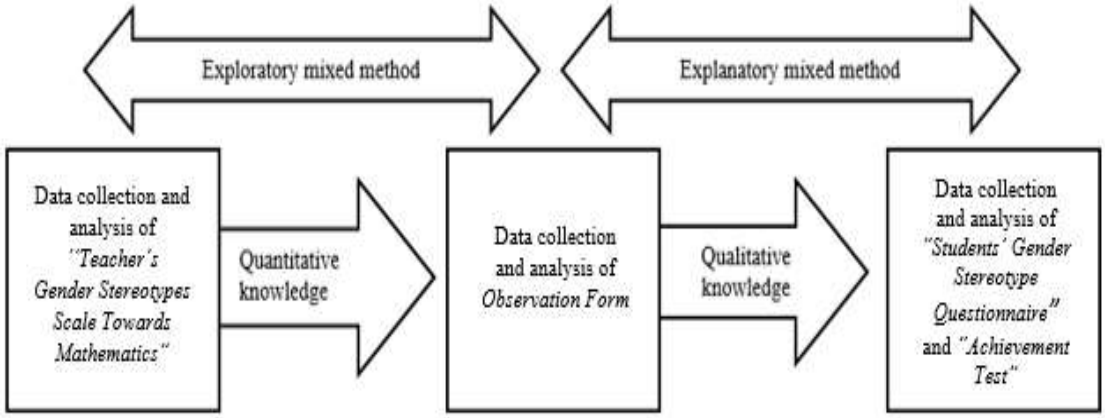
Research Design

Multiphase mixed methods study design (Creswell, 2017) is used in this study. As it is shown in Figure 1, both explanatory and explanatory mixed method research designs

are utilised utilized together in the research. Data is gathered through a serail of phases. A survey is conducted and then classroom observations are used. Later, a questionnaire and an achievement test are applied to students. For the first, in the quantitative phase, teachers' gender stereotype in mathematics is determined. Later, in the follow-up, qualitative phase, teachers' classroom practices are addressed. Then, again in the quantitative phase, these teachers' students' mathematics achievement and stereotypes in mathematics are investigated.

Figure 1.

Multistages Feature of the Research



Participants

In this study, different sampling strategies are utilized. Firstly, Teachers' Gender Stereotype Scale towards Mathematics is administered to 393 4th grade primary school teachers (299 females and 94 males) in 60 schools from each central county of Ankara, Turkey to reveal teachers' mathematical gender stereotypes and determine the further participant group of teachers. Secondly, one teacher having the strongest traditional mathematical gender stereotype beliefs (Ms. Nevin –nickname-) and one teacher having the most gender-neutral beliefs about mathematics (Ms. Nilgun –nickname-) are chosen as cases for the qualitative phase of the study based on their scores on Teachers' Gender Stereotypes Scale Towards Mathematics. Thirdly, students of these two teachers (30 females and 16 males) are participated in the study to take a mathematical achievement test and gender stereotype questionnaire to find out their mathematics scores and stereotypical beliefs about mathematics. Finally, from each classroom, 6 students (gender x achievement) are determined regarding their gender and achievement level to make student-teacher interaction observation.

Data Collection and Procedure

Teachers' gender stereotype scale towards mathematics

The Teachers' Gender Stereotype Scale Towards Mathematics developed by the first Nurlu (2017) was used to determine teachers' gender stereotypes in mathematics. The scale has two different forms and 34 items in total. Total score which can be taken from the scale is 170. Girls Form is constituted by items showing the superiority of girls to boys in mathematics, such as "Girls are more successful than boys in predicting how to solve mathematical problems". On the other hand, Boys Form has items that show the superiority of boys to girls, as "Boys understand mathematical problems more easily than girls do". Items of each form are produced based on the literature and exploratory and confirmatory factor analysis are established. The Cronbach Alpha value of Boys Form is found as .884, and of Girls Form is calculated as .91.

The Scale is administered to 393 forth grade teachers in 60 primary schools. Firstly, the schools are determined randomly. Then, with official permission of the Ministry of National Education, 4th grade teachers are met one by one to explain the research's aim and request their consent. Teachers willing to participate in the study but do not have enough time to fill the scale during the day are given the researcher's phone number to send photos on some applications.

Observation form

The researchers develop an observation form by utilizing Teacher-Child Dyadic Interaction System observation instrument (Brophy & Good, 1970). The observation form focuses on three areas in the teacher-student interaction: teacher-initiated interactions, student-initiated interactions and feedbacks given by teachers.

A sample of analysis of each code is given below:

Teacher initiated interactions

Teacher initiated interactions are related to the direct questions asked to a particular student. These questions are also examined in terms of Bloom's cognitive domain taxonomy. In this study, the first three steps (knowledge, comprehension and application) of Bloom's cognitive domain taxonomy are considered low order questions. The last three steps (analysis, synthesis and evaluation) are high order questions. An example is given below:

> So, second place value after comma? Emre (most achieving male), raise your head. My dear Emre, second place value after comma? Ok, do you remember? Which place value is it?

This teacher-initiated interaction was coded as a low order question asked to a male student.

Student-initiated interactions

Student-initiated interactions are investigated under two codes: public and private interactions. Public interactions involve some contacts with teachers initiated by students that everyone hears in the classroom such as calling out an answer or asking a question. An example of student initiated public interaction is given below:

The question of "*Is there anything smaller than mm?*" was asked by a female student in the classroom. This example was coded as a female student-initiated public interaction because the question is asked by a girl and loudly that everyone in the classroom can hear it. Private interactions involve individual contacts with the teacher-initiated by students, such as showing an answer they have written down in their notebooks.

Feedbacks

Teacher feedback is explored with the codes evaluating the answer (correct, that's right or wrong, etc.), giving no response, rephrasing the question or giving a hint, asking for the correct answer, praising the correct answer, and criticising (you would know that if you had been paying attention, etc.). Below are some examples of teacher feedback:

> Yes, it is pretty good (Fatma).

This feedback given by the teachers was coded as praising the right answer of a female student.

Observations take almost 10 hours for each classroom and are carried out until reaching the saturation point to ensure credibility. These took place between 5-19 December 2016 in Ms. Nevin's classroom, and on 21 March-13 April 2017 in Ms. Nilgun's classroom. During observations, the researcher takes an appropriate row that does not block students from seeing their teachers or the blackboard and does not interfere in their classes.

In the beginning of the study, it was planned that a video camera would record observations. However, some obstacles such as not being able to convince school administration, teachers and parents, convincing school administration, teachers, and parents are confronted. Thus, observational data are based on the taped recordings and the researcher's notes.

Mathematical achievement test and Students' gender stereotype questionnaire

In this study, the Mathematical Achievement Test developed for 4th grade students based on the 2009 mathematics program by Fidan (2013) is used to determine students' mathematical achievement. The test was developed for numbers with the highest number of learning outcomes among four learning areas (numbers, geometry, measurement, data) in the primary school mathematics curriculum. The test consists of 24 items. The KR-20 reliability coefficient is 0.95; the mean difficulty is 0.59 and the discriminant value is 0.65.

Comparing the renewed 2015 and 2009 mathematics curriculum, we find that there is no significant difference in the learning area of numbers in which the test was developed. In addition, interviews with teachers showed that this program change was not reflected on their students. Teachers stated that their students are subject to the 2009 program at the application of the study (2016-2017 academic year). Thus this test was preferred because it is suitable for 4th grade students. Its validity and reliability studies have been carried out and it can be applied under the supervision of the researchers.

Students' Gender Stereotype Questionnaire developed by Steele (2003) examines the gender of students' drawings provided in response to two stories of which characters are children. One of them is really good at math, and the other is good at literature. The stories do not give any information or reference about the gender of the characters.

The stories, originally in English, are translated into Turkish by the researchers. Then, they are examined by an instructor who is an expert in literacy and Turkish education and fluent in English language. After required corrections were made, the opinions of 3 other experts in Primary Education, Turkish Education and Mathematics Education were taken and a final version of the questionnaire was reached.

Data of these two instruments are gathered together from students and data collection process takes one and a half periods. It asked teachers to determine an appropriate date to apply the test and the questionnaire. Data are obtained on 1-5 May 2017. Firstly, the test is given to the students. After ensuring that all students have completed the test, students will be shown the blank page and asked to open it. The short stories on the questionnaire are read aloud one at a time and students are asked to draw the characters from the stories on the page. Because the characters students draw are the focus of the research, students are asked to give their drawings a name. Therefore, the determination of characters' gender becomes easier.

Data Analysis

Teachers' gender stereotype scale towards mathematics

Data gathered from the scale is analyzed with SPSS and descriptive statistics. The five-point Likert scale is coded as strongly disagree=1, disagree=2, little bit agree=3, agree=4 and strongly agree=5, thus responses can be directly scored.

Observational data

Observational data is analyzed by utilizing basic content analysis technique. By this technique "many words of the text are classified into much fewer categories" (Drisko & Maschi, 2016, p. 22). Observational data are transcribed in detail on a Microsoft Word document. These transcriptions are read several times to determine which events recorded during the observations needed to be placed under which code or category. To provide transferability, observational data are described in detail and observation notes are given. Direct quotations are chosen. Observational findings are demonstrated

through frequency tables. Also, to provide validation, the data are cross verified with data gained through, achievement test, and the students' gender stereotype questionnaire. In addition, to ensure confirmability, 30% of all the observational data are coded by two independent researchers. Using Hubermann's formula (1994), inter-coder reliability is calculated and it is found that they have shown 88% similarity. To provide dependability, an external researcher evaluates whether the data support the findings, interpretation and conclusion.

Mathematics achievement test and Students' gender stereotype questionnaire

Mann Whitney-U test is carried out to explore whether there is a significant mathematical achievement difference between girls and boys. SPSS is used for the analysis of to analyse the quantitative data collected by means ofusing Mathematical Achievement Test and Students' Gender Stereotype Questionnaire. Data from the test and questionnaire are coded for the preparation to decrease the risk of errors. The achievement score is generated by coding the correct answer 1, and the wrong answer 0.

The questionnaire is based on a students' drawings. These drawings are coded by separating into three categories. Students who draw a girl in the literacy story and a boy in the mathematics story have traditional mathematical gender stereotypes. Students drawing a boy in the literacy story and a girl in the mathematics story are considered to have non-traditional gender stereotypes. Students who draw the same gender for both stories are considered as having gender neutral beliefs about mathematics. Data gathered from the questionnaire are entered into the SPSS and descriptive statistics procedures are utilized.

Ethical Considerations

Participants' rights and values are considered throughout the research project. Firstly, it is applied to Ankara Directorate of National Education to evaluate the potential risks and benefits of the research, and any permission was obtained to carry out the study in primary schools in Ankara province. This permission is regarded as a prerequisite to ask teachers for their voluntary participation. All participants have informed the aim of the research and details how data gathered from them are used. For example, participants are told that their names or any identifying information are not mentioned in the study, but when it is needed, pseudonyms are used. Also, it is said that raw data are held in encrypted files in the researchers' private computers.

Students participating in the study are asked to fill mathematical achievement test and gender stereotype questionnaire without their name and tin the mathematical achievement test and gender stereotype questionnaire without their name. Additionally, participants are provided with the researchers' phone numbers and they are told that they can get in contact with. They are told that they can contact the researchers if they find themselves feelingeel uncomfortable about anything they have divulged or any

behaviour displayed during the study. They are informed that test results are not shared with their teachers or parents. It is also emphasized that all participants have a right to withdraw from the study at any time.

Findings

Teachers' Gender Stereotype Scale Towards Mathematics Findings

To determine teachers' gender stereotype in mathematics, the *Teachers' Gender Stereotype Scale towards Mathematics* is administered. Results of the scale are illustrated in Table 1.

Table 1.

Summary of Descriptive Statistics for Teachers' Gender Stereotypes towards Mathematics

	N	Minimum	Maximum	M	*Sd*
Boys Form	393	29	77	52,82	10,04
Girls Form	393	28	75	46,57	7,34

As shown in Table 1, participant teachers have mathematical gender stereotypes in both traditional and non-traditional ways.

The maximum score of the Scale's Boys Form that teachers got is 77, but the teacher with the highest score does not accept the participation. Ms. Nevin's score is 74 and she accepts the participation. Therefore, she is regarded as the teacher who demonstrates the strongest traditional gender stereotype in mathematics.

The minimum score of the total scale is evaluated because Boys Form shows the degree of perceived masculinity of mathematics but not gives any information of stereotypical belief about mathematics as a female domain. For instance, a participant having the lowest score from Boys Form could have a neutral belief or even non-traditional gender stereotypes. To make it clear, both Girls and Boys Forms are evaluated to reveal the teacher with most neutral belief toward mathematics. The minimum score in total of the Scale that teachers got is 57, however the teacher with the lowest score is not willing to participate in the study. Ms. Nilgun's score is 68 and she accepts the participation. Therefore, she is regarded as the teacher who has the most neutral gender related beliefs in mathematics.

Observation Findings

Reflections of Ms. Nevin and Ms. Nilgun's beliefs about mathematical gender stereotypes on teacher-student interactions in mathematics classrooms are explored.

Teacher initiated interactions

It is aimed to explore how the numbers and quality of teachers' questions are shaped regarding students' genders and academic achievement levels. Interactions by Ms. Nevin are presented in Table 2.

As it is seen in Table 2, Ms. Nevin asks more questions to male students than females at high and medium achievement levels. However, it is not the same for the lower achievers. At the low achievement level, the female student takes more questions than the male. When considering the characteristics of the questions, male students at high and medium achievement take more questions at both high and low order levels. Even though the female student with low achievement takes more questions at the remembering step, the same number of high order questions are asked to both the female and male student.

Table 2.

Frequency Values of Interactions Initiated by Ms. Nevin

	Questions	High achievers		Medium achievers		Low achievers	
		Female	Male	Female	Male	Female	Male
High Order Questions	Evaluating	0	0	0	0	0	0
	Synthesising	1	2	1	0	1	0
	Analysing	4	5	0	2	3	4
Low Order Questions	Applying	2	12	3	7	5	3
	Understanding	0	0	0	0	0	0
	Remembering	6	2	1	3	6	2
	Total	13	21	5	12	15	9

It is seen that male students have a priority in terms of interactions initiated by Ms. Nevin. For example, to the whole classroom, Ms. Nevin asked the analyzing question of "How old is a person born when the Turkish Grand National Assembly (TBMM) was founded?". Some students bring their notebooks to show the answer, but the most achieving male student has not finished the answer yet. Ms. Nevin says the following words:

> Yusuf, my son, why do not you bring? No, I am waiting for Yusuf. Hang on a minute, do not bring, please. I am waiting for Yusuf. First, Yusuf brings, then we can continue. Come on Yusuf.

Additionally, it is observed that Ms. Nevin frequently warns male students to engage with the lesson.

> Sait, have you solved it?

Sait, you are up in the clouds

Only one time, she warns same achievement level female student with these words:

Bilge, Bilge has never brought (notebook)

Moreover, involving a discipline problem also becomes a learning opportunity for males in Ms. Nevin's mathematics classes. For example, the boy with low achievement engages in some minor disruptive behaviour and talks to the deskmate (Furkan).

Furkan, stand up. What are those in your hands? Throw them. We are dying here to teach something; you are engaging different things. Multiply 12 with 5 in a short way. Sait, you multiply (He does not answer). Because, you talked. Sait, find the half what I say? Multiply with 10. Sait?

Interactions initiated by Ms. Nilgun are presented in Table 3.

Table 3.

Frequency Values of Interactions Initiated by Ms. Nilgun

	Questions	High achievers		Medium Achievers		Low achievers	
		Female	Male	Female	Male	Female	Male
High Order Questions	Evaluating	0	0	0	0	0	0
	Synthesising	1	1	2	1	2	0
	Analysing	0	0	0	0	0	0
Low Order Questions	Applying	2	1	3	3	0	2
	Understanding	4	3	3	5	5	5
	Remembering	1	4	4	3	10	6
	Total	8	9	12	12	17	13

It is seen in Table 3, that the number of questions asked in Ms. Nilgun's mathematics classes does not significantly differentiate regarding the gender of students. However, students' number of questions rises from students with higher achievers to the lower ones. When examining the characteristics of the questions, even it is possible to say that there is a balanced distribution, it is seen that lower achievers take more remembering level questions. It is observed that Ms. Nilgun asks more questions to students with low achievementstudents with low achievement questions.

Ms. Nilgun treats students similarly regardless of their genders. For example, when she realizes her students are distracted, she encourages all of them to concentrate. Her behaviours toward the male student with high achievement and to the female student with low achievement are as follows:

Second place value after comma? Emre (most achieving male), raise your head. My dear Emre, second place value after comma? Do you remember? Which place value is it? Tenths, ok what was 7 here?

> 2 whole ⅓ plus 3 whole ⅓. We need to add the wholes and write as a whole. 2 plus 3 makes 5. By adding numerators, we write on the top of the number, 1 plus 1, yes my dear Sule (low achieving female), look at here. What does make 1 plus 1? 2.

Additionally, regardless of students' gender or achievement level, Ms. Nilgun insists on students' learning when they feel unconfident or leave the question unanswered. The following dialogue shows how she insists that the boy with medium achievement learns.

> - I am too bad.
>
> - You are not bad, you will learn. There is nothing like I am too bad. Come to the blackboard, keep calm.

It is observed that she displays similar treatment to the girl with low achievement:

> - Sule, how many centimetres was in a meter?
>
> - …
>
> - Come to the blackboard (teacher holds a meter).

According to classroom observations, the number and characteristics of interactions initiated by teachers are differentiated regarding students' gender, based on teachers' mathematical gender stereotypes. It is seen that the teacher with strong gender related beliefs toward mathematics generally asks more question to male students. Additionally, in the teacher's mathematics classes, male students often ask high order questions. It is a possibility to think that the expectation of males' superiority in mathematics ability cause them to take more questions. Moreover, in interactions initiated by the teacher, where male students are the focus of the classes, they are encouraged to join the lessons. They are expected to have higher-order thinking abilities and their learning is prioritized as important. On the other hand, it is observed that the number and characteristics of the questions that the teacher having neutral mathematical gender stereotypes asked, are distributed evenly with regards to the gender of students. According to observation results, the teacher invites her students to join the lesson and insists on learning regardless of their genders.

Feedbacks

It aims to examine how the frequency and characteristics of feedback given by teachers are shaped regarding gender. Feedbacks given by Ms. Nevin are presented in Table 4.

Even though there are no clear differences between male and female students' right answers praise, it is observed that male students get more praise and encouragement to learn the right answers. As shown in Table 4, when Ms. Nevin evaluates her students' answers, it is seen that her feedbacks to female students is twice that of male students. However, Ms. Nevin ignores the correct answers of female students by half more times than male students and does not provide feedback. Additionally, when female students give a wrong answer or leave the question unanswered, they are criticised criticized more than male students. On the other hand, wrong answers and unanswered questions of male studentmale students' wrong answers and unanswered questions are directed to find the right answer by providing a clue more than female students.

Table 4.

Frequency Values of Feedbacks Given by Ms. Nevin

	Female Students				Male Students			
	High	Medium	Low	Total	High	Medium	Low	Total
Evaluating the answer	15	2	4	21	3	6	1	10
Not giving feedback to wrong answer	0	2	3	5	2	2	0	4
Not giving feedback to unanswered question	0	0	2	2	2	0	2	4
Not giving feedback to right answer	7	2	2	11	1	5	0	6
Criticising to wrong answer	0	0	1	1	0	1	0	1
Criticising to unanswered question	1	1	1	3	0	0	0	0
Providing a clue for a wrong answer	1	0	0	1	2	2	3	7
Providing a clue for an unanswered question	0	0	1	1	7	0	4	11
Inquiring the right answer	3	0	0	3	1	2	1	4
Praising the right answer	7	2	1	10	10	1	0	11

Ms. Nevin provided more effective feedbacks for her male students in mathematics classes. If her male students cannot answer, even the answer is related with another course, she gives prior knowledge to encourage her students in finding the right answer.

> We are making a relation between two different subjects. We know War of Independence. Was not Turkish Grand National Assembly (TBMM) founded before War of Independence? Ataturk embarked Samsun. 19th May 1919. Then he came to Ankara. Of course, he would make these meetings to officialize, he would make the Independence War officially. No one fights if there is nothing official. I mean it must be depended on somewhere. This must be an institution. He founded the TBMM. When did he found it? On your national holiday. You are always in a trouble on these dates.

On the other hand, it was observed that Ms. Nevin directed her female students to find unanswered questions only once. However, the explanation she provided to a female student also comprised of little criticism. For example, she teaches how to multiply with 50 in a short way. When a female student with low achievement does not answer, her reaction follows:

> Bilge, you have 4 apples. If I ask you to give me half of them, how many will you give? What is the half of 4?

After the explanation, the student finds the answer, however Ms. Nevin's following words shows that she actually criticizes the student:

> Did you get it, Bilge? Bilge, you are not focused. You have never been concentrated. This is not a thing you cannot get. Force your brain, little bit force your brain.

Male students do not receive this kind of. In fact, Ms. Nevin does not criticize her male students. Only once did, she criticizes a male student with medium achievement when he does not answer. However, the criticism comprises of glorifies his intelligence:

> Don't you know multiplication table? Yesterday, what did we do, Mert? We put the ice into water, then measured it. I become like an ice, too. You are a smart boy; you should understand what I mean.

On the other hand, female students are critised for their wrong answers:

> My dear, why do you subtract from it? Children, people do not become younger after ten years, become older. You will not subtract. Bilge, do you become older or younger after ten years. What are you going to be? You will become older. The world donot turn back.

Additionally, it is observed that Ms. Nevin's praises towards male students is more comprehensive and descriptive than towards female when they make close estimations, follow the lesson or keep the notebook orderly:

> Well done Yusuf, bravo. Can you come please, bring your notebook? Look at here, how beautiful his writing. Yusuf, come to the blackboard, solve the problem.

However, her praises towards female students is quite superficial:

> Yes, Ayse, well done

According to observations, feedbacks given by Ms. Nevin are shown in Table 5.

As demonstrated in Table 5, Ms. Nilgun's feedbacks do not significantly differentiate based on the gender of students. It is observed that her feedbacks are quite similar regardless of the gender of students. Similar feedbacks are given for students from both genders even with different achievement levels. For example, a clue for a wrong answer provided by Ms. Nevin for a female student with low achievement follows:

> - My dear Sule, how can I measure the width of the row?
>
> - With chalk.
>
> - With what? With centimetre, millimetre, meter or kilometre?

Table 5.

Frequency Values of Feedbacks Given by Ms. Nilgun

	Female Students				Male Students			
	High	Medium	Low	Total	High	Medium	Low	Total
Evaluating the answer	8	8	9	25	5	8	9	22
Not giving feedback to wrong answer	0	0	0	0	0	0	0	0
Not giving feedback to unanswered question	0	0	0	0	1	0	0	1
Not giving feedback to right answer	0	4	0	4	1	2	0	3
Criticising to wrong answer	0	0	1	1	0	0	0	0
Criticising to unanswered question	0	0	3	3	1	0	1	2
Providing a clue for a wrong answer	0	2	4	6	1	0	3	4
Providing a clue for an unanswered question	0	0	3	3	3	1	1	5
Inquiring the right answer	1	1	3	5	0	4	4	8
Praising the right answer	0	0	4	4	0	0	0	0

Similar feedback is given for a male student with medium achievement to help him find the right answer:

- My dear Arda, 60 centimetres, convert it to the millimetre.

- I divide to 10.

- Divide? 1 centimetre becomes 10 millimetres. Does it increase or decrease? Our number is increased, right? If each space is 10, 10, 20, 30, 40, should I need to count like that? How can we calculate?

Ms. Nilgun criticizes her students in a similar way when they cannot answer the questions. For example, she calls her high achievement male student to the blackboard and asks the following question:

- Ok, 1, what is the place value of 1, Emre?

- …

- On the whole part my dear, what is the place value of that 3? When you think about that 3, which place value? Emre, you are super, if this is difficult for you (!). I am saying 231, what is the place value of 1?

A similar situation happened with a female student with low achievement:

- Ok, I will measure length of the eraser. Which unit of measurement should I use, Sule?

- ...

- Ok, quit to play with that note book.

Even Ms. Nilgun gives very similar feedbacks to her students regardless of their genders, she often praises her low achievement female student by using that kind of expressions:

- Well done you, well done.

It seems like there is an agreement in the class to motivate and encourage the low achievement female student. It is observed that for the right answer given by the female student with low achievement, her classmates applaud without any encouragher classmates applaud without any encouragement for the right answer given by the female student with low achievement. It is possible to consider that an another factor rather than gender of the student can be effective to this situation.

Classroom observational results reveal that the teachers' quality and quantity of feedback are shaped based on their perceptions about mathematical gender stereotypes.

Student initiated interactions

Student initiated interactions in Ms. Nevin's classroom are presented in Table 6.

Table 6.

Frequency Values of Interactions Initiated by Ms. Nevin's Students

		High Achievement		Medium Achievement		Low Achievement	
		Female	Male	Female	Male	Female	Male
Academic Interactions	Public interactions	24	5	0	5	0	0
	Personal interactions	9	3	3	3	1	1
	Total	33	8	3	8	1	1

As shown in Table 6, in Ms. Nevin's classroom, the female student with high achievement initiates more academic interviews. It is also observed that the male student of medium achievement is more active than the girl in the same achievement level, however students with low achievement have less academic interactions and this does not differentiate based on genders of these students.

In the Ms. Nevin's mathematics classrooms, students initiate interactions by commenting on the difficultyof a problem, predicting or excitedly saying the answer of a problem, or running to the blackboard to solve the problem without permission. Additionally, bringing their notebook to the teacher to show their answer is regarded as personal interaction. The female student with high achievement is observed as the student who initiates most for both interactions, personal or public.

Student initiated interactions in Ms. Nilgun's' classroom is presented in Table 7.

Table 7.

Frequency Values of Interactions Initiated by Ms. Nilgun's Students

		High Achievement		Medium Achievement		Low Achievement	
		Female	Male	Female	Male	Female	Male
Academic Interactions	Public interactions	0	0	0	3	1	0
	Personal interactions	0	0	0	0	0	1
	Total	0	0	0	3	1	1

As can be seen from Table 7, students in Ms. Nilgun's classroom generally do not tend to initiate interactions. It is observed that the male student in the medium achievement level initiates interaction.

According to classroom observations, Ms. Nilgun's students initiate public, academic interactions for reasoning about problems, evaluating others answers, and asking questions that are not in the scope of the curriculum such as "*Is there anything smaller than mm?*". It is observed that students bring their notebooks to their teachers to show their answers as the personal interactions initiated by students.

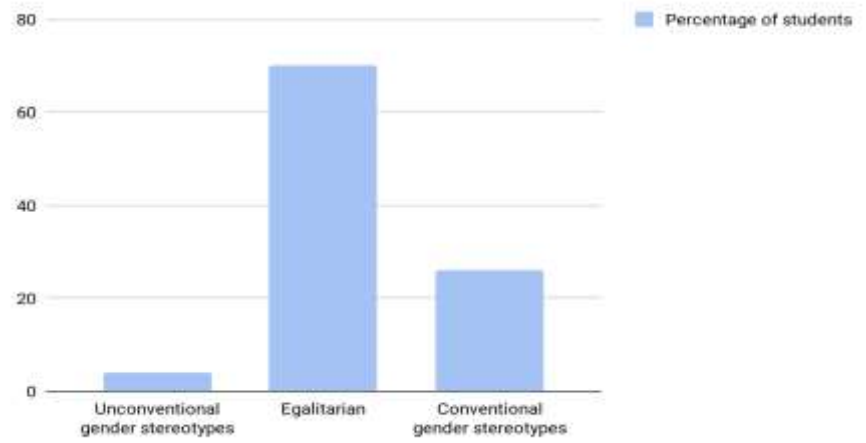
Students' Gender Stereotype Questionnaire Findings

To reveal how teachers' mathematical gender stereotypes shape their students' gendered beliefs about mathematics, Gender Stereotype Questionnaire (Steele 2003) is applied to students.

The results of Gender Stereotype Questionnaire applied to Ms. Nevin's students are shown in Figure 2.

Figure 2.

Summary of the Descriptive Statistics of the Students' Gender Stereotype Questionnaire

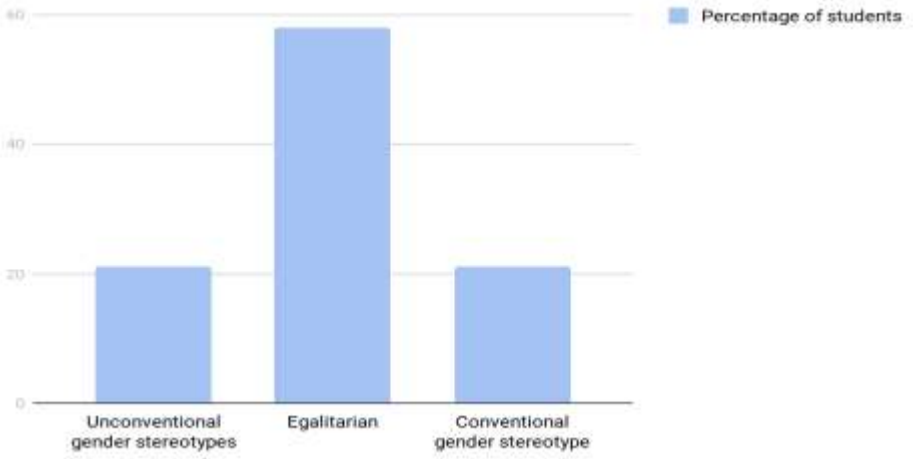


Results of the Gender Stereotype Questionnaire applied to Ms. Nilgun's students are presented in Figure 3.

This figure shows that 4% of Ms. Nevin's students have unconventional gender stereotypes. On the other hand, 26% of them have conventional gender stereotype. When investigating drawings of students who have neutral beliefs, it is seen that almost all of them draw their own gender for both mathematically and literally talented child. 70% of them do not have gendered beliefs toward mathematics.

Figure 3.

Summary of the Descriptive Statistics of the Gender Stereotype Questionnaire



As shown in Figure 3, 21% of Ms. Nilgun's students have unconventional gender stereotypes. Students who have conventional gender stereotypes are 21% of them. 58%

of the students have neutral gender-related beliefs toward mathematics. When considering these students' drawings, it is seen that almost all of them draw their gender for the character of both stories.

The results gained from Students' Gender Stereotype Questionnaire that applied to students to explore students gender-related beliefs toward mathematics reveal that most of the students have egalitarian beliefs toward mathematics in both classrooms that the study was conducted.

Mathematics Achievement

In this study, the Mathematics Achievement test is used to determine students' achievements and gender differences in mathematics achievement.

In Ms. Nevin's classroom, it is seen that female students' achievement mean is 16.06; male students' mean is 11.66. To explore whether there is a significant difference between male and female students' mathematics achievement, Mann Whitney U Test is run.

Table 8.

U-Test Results of Students' Mathematics Achievement Scores Regarding to Gender in Nevin Teacher's Classroom

Gender	N	Mean Rank	Sum of Ranks	U	P
Female	15	16,07	241,00	59,00	,130
Male	12	11,42	137,00		

According to Table 8, Ms. Nevin's female students are more successful than male classmates. However, it is seen that this difference between female and male students' achievements is not statistically significant, $U=59.00$, $p > .05$.

In Ms. Nilgun's classroom, it is seen that the mean value of female students' achievement is 18.40, male students' achievement 18.50. Mann Whitney U Test is run to determine if there are gender differences in students' mathematics achievement.

As shown in Table 9, the mathematics achievement of Ms. Nilgun's male students is higher than female ones. However, this difference in students' mathematics achievement is not statistically significant, $U=29.00$, $p>.05$.

Table 9.

U-Test Results of Students' Mathematics Achievement Scores Regarding to Gender in Nilgun Teacher's Classroom

Gender	N	Mean Rank	Sum of Ranks	U	P
Female	15	10.07	1511.00	29.00	.920
Male	4	9.75	39.00		

Mathematics Achievement Test results reveal minor gender differences in mathematics achievement in both classrooms. In Ms. Nevin's classroom, female students have higher achievement than boys while in Nilgun's classroom, male students are more successful. Nevertheless, it is found that these differences are not statistically significant.

Discussion and Conclussion

This mixed-method design study aimed to investigate primary school teachers' mathematical gender stereotypes and discover their reflections on these gender stereotypes of their students. Education is a critical tool to provide gender equality. Democratic structures and processes should be created in schools and education should be constructed to actualize gender equality (Kalayci & Hayirsever, 2014). However, the present study finds that teachers have mathematical gender stereotypes. Results show that teachers' interactions with students and feedback are all differentiated by extending their mathematical gender stereotypes. However, this does not reflect the students' adoption of these stereotypes and mathematics achievement.

Teachers play a vital role in transferring gender stereotypes to new generations (Beilock, et al., 2010; Gunderson et al., 2012; Myhill & Jones, 2006, Tan, 2008) in various ways. One of these ways is the gendered attitudes teachers display during teacher-student interaction in classrooms (Duffy et al., 2001; Jones & Wheatley, 1990). This study shows that teachers' gendered or egalitarian beliefs toward mathematics shape the nature of teacher-student interactions in the classroom. In the class of the teacher who has mathematical gender stereotypes, male students are the focus of the lesson and often encouraged to engage in the lesson, their learning is a priority and discipline problems return to them as learning opportunities. In parallel, regarding this result, researchers suggest that the interactions of teachers having gender stereotypes about mathematics are focused on male students and that the questions asked, feedbacks (Chionidou-Moskofoglou & Chatzivasiliadou-Lekka, 2008) and disciplinary warnings provided are directed towards male students (Mittelberg et al., 2011).

In addition, it is observed that the teacher with mathematical geder stereotypes gives more effective and frequent feedback to their male students. Male students' answers were evaluated more accurately, and preliminary information about the questions male

students could not answer was provided in more detail. It is seen that even the teacher is criticizing their male students, she emphasizes male students' intelligence and praise them with more comprehensive and powerful messages. Similarly, Becker (1981) states that teachers usually prefer male students when it comes to interactions such as the right to answer, ask open and challenging questions, insist on learning, give praise and criticism, encourage, help individually, and joke in mathematics class. According to Sadker, Sadker, and Klein (1991), male students attract their teachers' attention more than females, receiving more praise and critical feedback. Dweck, Davidson, Nelson, and Emma (1978), state that male students' correct answers, on the other hand female students' harmonious behaviours are usually praised by their teachers. It is claimed that this situation reinforces the behavior of being '*good*' in female students and increases the perception of '*I am smart*' in males (Golombok & Fivush, 1994). In this regard, it would be appropriate to mention the self-fulfilling prophecy. For example, social persuasion, which is defined as verbally persuading the individual that he has the necessary skills, is known as one of the sources of self-efficacy (Bandura, 1997, p. 110). It is possible to think that the mathematical self-efficacy of male students who have created a perception of being intelligent by praising their academic achievements will increase. Moreover, it can be assumed that students whose success is praised will also have a positive attitude towards the course. Considering the positive effects of affective variables such as self-efficacy and attitude on mathematics achievement (Yildirim, 2011; Yucel & Koc, 2011), it can be said that teachers who have mathematical gender stereotypes construct a mechanism that confirms their beliefs through their feedback.

Besides, results of the study reveal that higher order questions are mostly asked to male students by the teacher who have mathematical gender stereotypes. Considering that teachers believe that male students are genetically superior

in mathematics (Mittelberg et al., 2011), that they think that mathematics is a more difficult domain for female students than for males at the same achievement level, that they estimate that male students have more developmental sources in mathematics (Tiedemann, 2002), that they have more interest and self-efficacy (Keller, 2001), it is obvious that they ask higher order questions for male students.

Researchers suggest that even though female students are willing to answer questions as many times as males, they can take fewer questions in the classroom of teachers who have mathematical gender stereotypes. Moreover, it is also mentioned that in these teachers' classrooms, male students are more active as an initiator of teacher-student interactions (Mittelberg et al., 2011). However, in this study, it is found that there is no difference in the number and quality of interactions initiated by students of the teacher who has gender stereotypes about mathematics and the teacher with neutral gender related beliefs toward mathematics. Considering that the exposed gender stereotypes have a negative effect on the participation of the classroom activities (Swinton et al., 2011), it is surprising that female students are actively an initiator of teacher-student interaction in the classroom of the teacher with strong mathematical gender stereotypes.

It is well known that teachers can transfer their gender stereotypes to students through teaching-learning activities (Keller, 2001). This study finds that academic interactions and feedbacks provided by the teacher with strong mathematical gender stereotypes have a feature in support of male students. Nevertheless, female students are the initiators of at least the same amount of interaction as their male friends, regardless of their teacher's mathematical gender stereotypes, points out that the students do not adopt these stereotypes. It is determined that most of the students do not have mathematical gender stereotypes in both classrooms. However, this opinion is in contrast with the results of some research finding that students even in kindergarten are aware of gender stereotypes (Blakemore, 2003; McKown & Weinstein, 2003; Ruble et al., 2006; Yagan Guder & Guler Yildiz, 2016). Therefore, it is hard to think that 4th grade students participating in the study, are not, as yet, aware of gender stereotypes. Additionally, it is revealed that students from 1st grade believe that boys are better at mathematics than girls (Lummis & Stevenson, 1990). There is the existence of gender stereotype among 4th and 3rd graders (Muzzatti & Agnoli, 2007).

On the other hand, researchers mention in-group favouritism bias as a frequently confronted phenomenon in the age group that the study applied (Martinot & Desert, 2007; Rowley et al., 2007). They argue that 10 years old students' awareness of mathematical gender stereotypes are quite clear, but the situation becomes uncertain when it comes to themselves (Martinot et al., 2012). Steele (2003) finds out that female students in the primary school draw a male when asked to draw an adult mathematician and a female when asked to draw a child mathematician. Thus, students are aware of these stereotypes but tend to evaluate their group systematically as better than the other group or groups. This behaviour, which is defined as in-group favouritism bias (Hewstone et al., 2002), may be the reason of the participant students' egalitarian view of mathematical gender stereotypes. Because, when the drawings of the students having egalitarian beliefs toward mathematics are examined, it is seen that they depict the characters in both stories in their own gender. Similarly, Martinot and Desert (2007), in their study conducted with 4th grade students, reveal that female students evaluate girls and male students considered boys as better in mathematics. In this case, it can be concluded that students may be aware of traditional mathematics gender stereotypes but do not internalize these stereotypes by making a positive discrimination towards the group they are in.

It is determined that in both classrooms, the study conducted, students' mathematical achievement does not significantly differentiate regarding with gender. Reviewing the studies that examine gender differences in mathematics achievement, it is seen that some of them found male students (Schwery et al., 2016; Van de Gaer et al., 2008) and some of them found female students more successful (Felson & Trudeau, 1991). In fact, as parallel to this study's results, some studies concluded that mathematics achievement does not differ according to gender (Akhan & Bindak, 2017; Devine et al., 2012; Hyde et al., 2008; Hyde et al., 2009). It is possible to suppose that the date of the research, the age of the participants, and the culture in which the research is carried out have an impact on the results. The results of meta-analysis studies indicate that gender

differences in mathematics achievement from past to present are less visible (Li et al., 2017; Linberg et al., 2010). In addition, it is seen that girls' mathematical achievement decreases from primary school towards the high school and college ages (Hyde et al., 2008; Leahey & Guo, 2001).

Moreover, the study conducted with Trends in International Mathematics and Science Study (TIMSS) data reveals that the relationship between mathematics achievement and gender significantly differs from one culture to the another (Penner, 2008). All these results indicate that the reason for the lower mathematics performance of female students compared to that of male students depends on the cultural gender stereotypes to which they are exposed and on the internalisation and adoption of these stereotypes day after day. Likewise, researchers indicate that the gender stereotypes play a determining role on their achievement by effecting their affective characteristics such as self-efficacy, attitude and interest (Casad et al., 2017). However, this study reveals that most of the students do not adopt mathematical gender stereotypes. Therefore, it is possible to assume that affective factors having an impact on mathematics achievements are not harmed with a sexist perspective. In this regard, it is seen that students' mathematical achievement does not differ regarding gender.

Although the literature suggests that teachers' mathematical gender stereotypes play a crucial role in mathematics achievement by differentiating their expectations of success for girls and boys (Gunderson et al., 2012), impacting their instructional processes (Keller, 2001; Mittelberg et al, 2011), and leading students to adopt these stereotypes (Doyle & Voyer, 2016; Gunderson et al., 2012; Zhao et al., 2016), the results of this study show that the female teacher with mathematical gender stereotypes does not transmit these stereotypes to her students and is not a determining factor in her students' mathematical achievement. Researchers suggest that the gender identity defined as the subjective sense of being a woman or a man (Dokmen, 2017) is affected by the mathematical gender stereotypes of the students. In other words, the students with low sense of gender identity have weak mathematical gender stereotypes and they are affected less than others from these stereotypes (Kiefer & Sekaquaptawa, 2007; Schmader, 2002). This study shows that the students being exposed to mathematical gender stereotypes and the students being in an egalitarian classroom environment have a similar result for both mathematical gender stereotypes and mathematical achievement scores regarding gender. This result could be related to the possible lower gender identity of students.

On the other hand, although teachers are known to play an important role in constructing mathematical gender stereotypes and conveying them to the next generations, it should be underlined that they are not alone. It would be appropriate to mention the parental factor. Researchers suggest that parental beliefs determine children's academic performance, motivation, and perceptions of competence in lessons (Tomasetto et al., 2011). The mathematical gender stereotypes that families have are important for the attitude, belief, and success children develop regarding mathematics (Denner et al., 2016; Tomasetto et al., 2015). Moreover, researchers indicate that performance of female students deteriorates under mathematical gender stereotypes,

however, a mothers' rejection of these stereotypes decreases girls' vulnerability to stereotype threat (Tomasetto et al., 2011). The mathematical gender stereotypes that parents have affect their children's mathematical success and professional expectations. Wilder (2013) suggests that there is a strong relationship between parents' expectation of success for their children and their interventions in children's academic development, and these interventions increase children's academic achievements. Besides, some additional courses and private tuitions that parents with high expectation of success for their children provided, it is not surprising that children who are aware of these expectations. However, they are exposed to a gendered attitude in the classroom, may behave very differently from these stereotypes. Indeed, in the research, parents may be a reason for female students in the teachers' classroom with strong mathematical gender stereotypes, to intensely engage in teacher-student interaction and be as successful as male students.

In addition, it should be noted that this study is limited to 4th grade primary school teachers and their students. It is found that there is not a reflection of teachers' gender stereotypes on 4th grade students. It should be determined that by feeding from what kind of sources, students might have adopted gender equality in mathematics and these sources should be supported. It should be revealed that through these which kind of affective and sociological factors, students do not internalize mathematical gender stereotypes, at least in this age group, even though they are exposed to these stereotypes. By carrying out longitudinal studies, it should be followed at which educational level students begin to acquire such gendered perspectives, which academic fields and professions they choose. Thus, the effects of teacher characteristics on students should be revealed more comprehensively. In addition, it is possible to consider that the data collection tools may cause this result. Therefore, more extended period ethnographic studies should be organized to examine whether students have mathematical gender stereotypes or not. Also, participants are limited with two teachers and their students. The study can be conducted with a larger group.

Ethics Committee Approval: This study is derived from the doctoral dissertation completed by the first author under the supervision of the second author at Gazi University, Institute of Educational Sciences in 2018. Ethical committees were established at universities in 2020. Therefore, ethics committee approval was not received for the study.

Informed Consent: An informed consent was obtained from all participants prior to their inclusion in the study.

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