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Examining The Views Of Classroom Teachers On Mathematics Teaching: A Phenomenological Study*

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Abstract: As the ability to gain behaviors related to mathematics forms the basis for applying mathematics, the role of mathematics is gradually increasing. It is known that gaining these behaviors continues from pre-school education to all levels of higher education, thus the increase in the importance of mathematics increases the importance of mathematics teaching. With the foundation of the mathematics laid in elementary school, there are tasks for classroom teachers to make students truly love mathematics and help them understand it. For this reason, in this study, it is aimed to determine classroom teachers' views on teaching mathematics. This study, in which phenomenological pattern is used, has been realized with the participation of classroom teachers working in the schools affiliated to Erzurum province center. The data of the study which was carried out with a total of five teachers were collected with semi-structured interviews and were analyzed descriptively. Each of the interviewed teachers stated that they felt math anxiety at some stage of their education life and that it was teacher-based. In addition, classroom teachers, who have emphasized that primary school students should learn in a concrete way and mostly by doing and experiencing, have mentioned that these possibilities are inadequate in village schools. They also pointed out that the family support is lacking and that the curriculum is noteworthy for students and families living in the city center, but that this is rarely achieved in village schools. The classroom teachers, who indicated that the mathematics courses they had attended during their undergraduate education were appropriate in theory but insufficient for implementation, have suggested that mathematics instruction courses should be more productive.

Keywords: Classroom teachers, teaching mathematics, phenomenology

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INTRODUCTION

While mathematics is seen as a door opener of a good life and a good career by people (Stafslien, 2001), it is also thought to be an auxiliary element to understand the life and the world and to produce ideas about them (Ernest, 2013). The aim of reform studies made on mathematics education today is to create a system that can help students to learn by understanding mathematics (Franke and Kazemi, 2001; Smith, 2000). Therefore, every breakthrough created reveals a phenomenon that increases the functionality of mathematics and that the students are also involved in the process. However, although mathematics has such a crucial function, it is not liked by most of the students and is seen as a boring and abstract course (Aksu, 1985).

It is being stated in the current mathematics curriculum that there is now a need for people who are able to use knowledge to solve problems, apply it to different disciplines, make assumptions and generalizations, think analytically, can model the problems encountered using mathematical reasoning and can connect models with verbal and mathematical expressions and this openly presents the aims of the mathematics (Ministry of National Education, 2018). Despite the fact that there are many goals and requirements of mathematics, it is also true that most of the students have problems in learning mathematics. This fact is confirmed by the data obtained from the 6th International Science and Mathematics Research (TIMSS), which was last carried out in 2015. In this study where 49 countries participated for the 4th grade and 39 countries participated for the 8th grade, the achievements of the students in mathematics and science courses were evaluated. Looking at the results, Turkey is in the last quarter among these countries in terms of mathematical success. Many studies have been conducted in our country to investigate the cause of this failure. Some of the research indicated that the activities of the students in mathematics classes consisted of just listening and memorizing the information the teachers told them about during the lessons against the blackboard (Aydın, Sarıer and Uysal, 2012; Özenç and Arslanhan, 2010). In addition, it has been shown that the most important factor affecting the student attitude is the teacher's view of the course in many studies aimed at the classroom teachers for the primary school period in which the foundations of mathematics were laid (Hare, 1999; Peker, 2006).

According to Bloom (1979), 42% of the achievements shown until the age of 18 are explained by achievements in primary school. Learning experiences in primary school serve as prerequisites for subsequent learning. Therefore, the place and importance of the primary education level in the education system is an indisputable reality. It is known that the attitudes, behaviors, and beliefs of teachers towards mathematics are also effective in the students' achievements of mathematics, as well as having studying habits and the attitude towards mathematics course at both primary and secondary level. (Peker, Mirasyedioğlu and Yalın, 2003). Yenilmez and Özbey (2006) emphasize that anxiety, which is created by the thoughts such that mathematics is difficult, that he/she cannot succeed mathematics, plays an important role in many students' negative attitudes towards math. Peker (2006) stated that teachers could control this anxiety if they are aware of the mathematical anxieties their students have. Hare (1999), on the other hand, tells that a person's view of mathematics is directly related to how he or she learned mathematics.

It will be easier to recognize the importance of the role of the teacher in mathematics education, if we take into account that the teacher factor plays the leading role in the factors that play an active role in a learning environment and facilitate or complicate the learning process (Turanlı, Karakaş Türker and Keçeli, 2008). For this reason, there are serious tasks for the classroom teachers who set the foundations of mathematics. The aim of this study is to determine what the opinions of classroom teachers are about mathematics teaching.

METHOD

Research Design

This study adopted phenomenology research design, which is a qualitative research approach. The aim was to reveal individuals' experiences related to a phenomenon, perceptions and the meanings they have loaded on them that is studied with a sample of fewer individuals. Interview and observation methods were used as data collection tools and the aim was to reveal generalizable results. Data sources in phenomenology research are the individuals or groups who are experiencing the phenomenon that the researcher focuses on, and who can reflect or reveal this phenomenon (Yıldırım and Şimşek, 2016). Therefore, in this study, the teachers who are currently active in the course of lecturing have been selected. For this reason, in this study, the opinions of the classroom teachers about mathematics teaching were attempted to be determined by semi-structured interviews using phenomenology research design.

Participants

The research group of this study is composed of five classroom teachers. Four of the classroom teachers participating in the study are male and one is female. In addition, the teachers whose statements are mentioned in the study are coded by taking their initials, and their names are not included in the ethical rules (e.g. SB for Sibel Bilgili).

Data Collection Tools

Semi-structured interview form was used as a data collection tool in the research. The content of the interview form was issued in accordance with the subheadings in the findings section of the study. The studies conducted by Peker (2006), Dursun and Dede (2004) were used to prepare the interview questions. These interview questions were examined by two faculty members and their validity and reliability were tried to be provided in this way. In addition, a pilot study was conducted with a classroom teacher candidate to ensure the validity and reliability of the interview questions in terms of intelligibility. The interviews were conducted to determine the opinions of classroom teachers about teaching mathematics. In the interviews, permission was taken from the teachers to record the interview, and interviews were recorded with the voice recorder. Interview notes were transcribed on the same day. The interviews lasted 10-15 minutes.

Analysis of Data

Descriptive analysis was used in the analysis of the data obtained from the interviews conducted to determine the opinions of the classroom teachers on teaching mathematics. In the descriptive analysis, the data are summarized and interpreted according to the themes which are set out by the pre-determined research questions or achieved as a result of observation and interview. The categories created for analysis in this study were inspired by the works of Hoşşirin - Elmas (2010) and Peker (2006). The data obtained from the interviews made were trancribed within the same day, and then the category and code list for these data was created. Data are classified under these categories and is brought into a meaningful state for the reader. In order to increase the reliability of the study, the codes determined were examined by a specialist and it was observed that the percentages of concordance were close to each other. In addition, the reliability of the study was provided by making quotations from the data obtained from the interviews.

FINDINGS

In this section, the findings of data obtained from semi-structured interviews with classroom teachers were presented.

Table 1: Category, Code, and Frequency Table of Classroom Teachers

Categories	Codes	f
The look at mathematics in student life	Frightening	3
	Difficult	1
	Tasteful	1
Adaptation of mathematics to everyday life	Possible	4
	Difficult	1
Undergraduate math courses	Theoretical	3
	Useful	2
Those that are felt when telling math	Boring	2
	Pleasant	2
	Ordinary	1

In examination of category, code and frequency table of the classroom teachers, it was observed that the classroom teachers answered to all questions and the answers were used for creation of category and code.

Opinions of Teachers About Their Mathematical Perspectives in their Student Life

The answers given by the teachers whose opinions were received on mathematics during their elementary school, junior high school, high school and university education were coded as "frightening, difficult, and tasteful".

B.H.'s statement of seeing mathematics as a frightening lesson throughout all student life is as follows:

> *My classroom teacher in elementary school was not a teacher, but was an Agriculturist. He would attach much importance to mathematics as he thought it was important and would constantly give homework. I fear from mathematics since then. Because it was an important class and I could not do it. It was the same in the secondary school. Once a teacher helped me and I almost liked it, but that teacher left the school. And the new coming one forced us too much. I even did a class repetition because of mathematics. I should not talk about high school. I do not know how I could pass the class. I became aware of the situation, when I was in the university. I had to learn the lesson that I was going to teach, but I was still afraid. I neither liked mathematicians nor mathematics.*

Teachers' Opinions on the Adaptability of Mathematics to Daily Life

The answers given by the teachers on the question of whether mathematics topics could be related to daily life were coded as "possible, difficult".

The excerpt of T.T. expressing that mathematics can be related with daily life, are as follows:

> *…In fact, mathematics is in relation with real life and we should teach it with real examples. Otherwise, students cannot understand it. It's a village school. If I do not mention cows or chickens a student cannot understand the meaning of mathematics in real life? I always give examples from real life. I am talking about Fenerbahçe and Galatasaray. I teach addition by asking the number of goals in total. I teach subtraction by asking which team had more goals in total. . I think it should be like that. Already, mathematics is the language of nature. It is available in daily life.*

Opinions on the Applicability of the Courses of Teachers Acquired during Undergraduate Education

The answers given by the teachers whose opinions were received about the applicability of mathematics courses taken during their undergraduate education in teaching life are coded as "theoretical, useful".

The excerpt of Ö.G. who expresses that the courses he took were theoretical and were not so useful in practice is as follows:

> *Those days, we were students and we thought that we should pass the courses. When I became teacher, I saw that those courses were necessary for me. But we only memorized those courses. Teaching cannot be learned by just explaining the course once a semester on the blackboard. My courses were theoretical and we just memorized them. But real life is different, you need to practice. Yes, of course, it's working but we should be more involved. Maybe training is more practiced nowadays. I am a teacher for 23 years. Maybe now they're teaching how the process will be. That's how it should be.*

Opinions about feelings while Teaching Mathematics

The answers given by the teachers whose opinions their feelings for teaching mathematics about what they felt while teaching the mathematics course was coded as "boring, pleasant, ordinary".

The excerpts of A.H. expressing that he does not feel anything different from other courses while he is teaching mathematics and it is ordinary is as follows:

> *I always liked math. Now, I think, I make my students like it, too. But for my feelings during teaching, do I feel something different from other lessons? No. It is almost the same. I feel the same things as other classes. It is normal. When I say it is an ordinary class, but it is an important class as well. I feel the same pleasure and joy for other classes as well. I do not feel something special for math.*

Teachers' Opinions and Recommendations

The opinions and recommendations of the five classroom teachers A.H., B.H., Ö.G., S.O., T.T. who attended the interviews are as follows:

> *"The curriculum we use is suitable for students who live in the city center, but it is unrealistic for students here at the village school. A curriculum that covers everyone, unfortunately, does not exist. Students want to learn by doing and living, but conditions are not suitable for this, sorry but the entire math is not running with the animals in the barn. So I think, the curriculum should cover the general and material support should extend to everywhere"*
>
> *"In fact, there is not much to say. It is good in general. I do not reflect the negativities in my student life on my students personally. I want them to develop a positive attitude toward mathematics."*
>
> *"So now, there's nothing much to say. If a student likes the teacher, nothing else matters. If the teacher is good, then the course is good. So, everything starts with us. Students do repetitions every day. He/she studies for 5 minutes every day, and that is enough for him/her. But of course, family support is also necessary. That is what we do not have. Because the family thinks everything is okay when the student goes to school. However, that's not how it works. Cooperation with the family is important ... "*
>
> *"I want to talk about the importance of undergraduate courses. Personally, I think I am very good at teaching mathematics with the education I got from my tutor in undergraduate. We learned how to teach. And for here, for our students, a good curriculum is necessary. It is no go if it changes constantly. It should settle down. In fact, in any way, we need to teach our children*

through living and doing. And I always ask myself. If my child has a teacher like me, will I be happy? We need to say yes to this... "

"Now, I am a teacher for 19 years. I'm almost experienced. I can tell that the teacher is not the only criterion for a good math alone. The student's intelligence and ability are certainly important, environment matters, family matters. We do not have family and teacher cooperation here. You can not even set up a WhatsApp group because parents have no smartphones or do not understand the internet. The student is not uncomfortable financially with regards to materials. Get it done, it does not. We cannot always get from our pockets. So there should be material support suitable to the curriculum. And also a curriculum suitable for surrounding conditions. The child over here never saw the sea, the problem about the sea never interests him/her, too. But when it is talked about snow, shovel, stove, then he/she engages in the question himself/herself immediately. Have I made myself clear?."

In evaluation of the answers given by classroom teachers, it was observed that concrete materials should be used for teaching mathematics. Moreover, the curriculum should be changed in a way to address everyone by relating mathematics with real life and parent-teacher association board meetings should be performed more often.

DISCUSSION AND CONCLUSION

In the interviews, the classroom teachers were asked about their views on mathematics in elementary school, junior high school, high school and university, and it was stated that the mathematics course is mostly frightening in the student life, and also that it is fundamentally based on the teacher and the meaning attributed to the course. These results are in line with the results of metaphor perceptions on the mathematics concept of classroom teacher candidates in Güveli, İpek, Atasoy and Güveli's (2011) study.

When the opinions of classroom teachers on whether mathematics can be related to everyday life are considered, all of the teachers stated that it is required to be related though just barely and that this is necessary for the student profile which is within concrete operations period. They also pointed out that relating mathematics to everyday life is important for drawing attention to the course and making the course intelligible. This approach has been seen to be in line with the achievements in the Ministry of Education Mathematics Instructional Program (2018).

The answers given by classroom teachers on the reflections of the mathematics courses they have taken during their undergraduate education to their current teaching life is similar to the opinion of classroom teacher candidates that the link between theory and practice in undergraduate courses should be strengthened which was obtained by Şahin-Taşkın and Hacıömeroğlu (2010) in their study.

The answers given by classroom teachers whose opinions were received on what they felt when they were teaching mathematics are in line with the attitudes and beliefs of elementary school teachers towards mathematics teaching found in the study of Ren and Smith (2018). Moreover, according to the results of the study, it was stated that the attitudes of the teachers towards the course differed according to the gender and it was also reflected in the students the same way. Also in this study, according to the feedback from the classroom teachers, if the teacher had a positive view on the mathematics course, he/she stated that he/she even increased the number of course hours, but the teacher, who expressed that he/she found it boring, told that it also lasted long for him/her especially in some subjects.

Opinions and recommendations for teaching mathematics were taken from the classroom teachers and the findings were collected on three main elements: the program, communication with

the family and undergraduate courses. These results are parallel to the results of Akyüz, Pala (2010), Şahin-Taşkın and Hacıömeroğlu (2010) and Duru and Korkmaz' (2010) studies.

Recommendations

Considering that the most important element in the implementation of the existing teaching program in Turkey is the teacher, it is recommended that either the curriculum, or the school-family cooperations, or the undergraduate courses taken at the university should be made useful for the teacher and more detailed studies on these three basic subjects should be conducted.

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Conference Paper

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Opinions of High School Students About the Writing Technique Applied in the Mathematics*

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Abstract: The writing technique emerges as one of the techniques used to develop metacognitive knowledge and behaviour with the ability to think aloud on paper. The purpose of this study is to reveal the views of high school students about the writing exercises used in mathematics lessons and to examine their perspective to develop metacognitive behaviours. Qualitative research methods were used in the research. The participants of the work constitute a total of 64 students who attended 9th and 10th grade in a high school located in a province of Yozgat in the second semester of the 2015-2016 academic year. Different writing activities were applied to mathematics courses for 6 weeks. These activities are based on writing activities that develop metacognitive behaviours unlike traditional writing in mathematics lessons. In addition, the students kept the math log throughout the process. At the end of 6 weeks, the students were asked to evaluate the process. The findings show that students are generally satisfied with the writing technique applied, that these activities improve students' affective, cognitive and metacognitive aspects, but that some students are reluctant to write in the journal.

Keywords: metacognition, writing, high school students.

INTRODUCTION

One of the aims of our curriculum is to develop behaviour, such as the ability to know what students know and can do. It also aims to improve behaviours such as determining the way students will follow in case they are encountered, checking themselves and asking themselves questions while they are working on a subject, evaluating themselves and leaving at the end of the process, and to raise awareness in these issues. These behaviours are defined by the concept of metacognition. Metacognition, in the shortest sense, means that one is aware of his own processes of thinking and

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can control these processes (Brown, 1978, Flavell, 1979, Wellman, 1985, Beauford, 1996, Huitt, 1997, Hacker and Dunlosky, 2003, Jager, Reezigt, 2005, Transporter: Özsoy, 2007). MEB Mathematics Curriculum (2018) emphasizes that in the Learning Objective section of the Mathematics course, "She/he will develop metacognitive knowledge and skills, will manage her/his own learning processes consciously". Indeed, as metacognitive knowledge and skills develop, it is inevitable that learners become more conscious of learning and one step closer to teaching learning.

Various methods can be used to improve metacognition. One of them is writing that is one of the ways of communicating which is among the skills of the 21st century. Writing is also expressed on the paper as voice thinking. When students write, they think more closely about what they know, what they can do, what they are doing, and synthesize all of them to form meaningful sentences. This contributes to the development of both cognitive and metacognitive skills.

When students are given the opportunity to reflect their work through writing, metacognitive behaviours are allowed to make sense of the correct understanding (Rice, 2004).

Different types of writing can be used depending on the purpose of education and the subject. It is used for expressive writing, transactional writing, poetic writing, journal writing, expository writing, impromptu writing prompt, writing prompts are the most common types of writing in the summer (Emig, 1977, Ishii, 2003, Lynch, 2003, Miller, 1992, Shield and Galbraith, 1998, Uğurel and Moralı, 2009). Expressive writing is a kind of writing in which feelings and thoughts are conveyed intimately. Transactional writing is intended to reveal something, to reveal something, and to write personal information in a serious atmosphere without being exposed. Poetic writing is a writing made by embellishing the subject on a subject and adding literary and aesthetic qualities. Journal writing is a type of writing that allows students to observe what they have done during the course and reflect their feelings and thoughts at the end of the day. Expository writing aims to inform about a subject and describe a concept. An impromptu writing prompt is a writing that starts with the teacher's instructions on a subject and gives the students freedom. In writing prompt, the frame to write is more limited. There is no definite distinction between these types of writing, and they can sometimes go into each other's fields. In addition, some writing activities can provide some of the features of these writing types more than once.

In mathematics education, the use of writing is becoming more widespread. Because writing which used in mathematics is a technique that increases the success of problem solving learning. Because writing in mathematics requires that students organize, classify and reflect their thoughts, and all of these are useful processes for making sense of mathematics, writing in mathematics supports learning (Burns, 2004). Metacognitive behaviours emerge when students write about problem solving processes (Pugalee, 2001). Thus, both metacognitive behaviours develop and mathematical understanding and learning levels are increasing. In this study, it was aimed to examine the opinions of the students about the writing technique used in high school mathematics course to develop metacognitive behaviours.

METHOD

The researcher-teacher model, which is one of the qualitative research methods, was used in this study which aims to reveal the views of high school students about the writing studies used in mathematics lesson and to examine the points of view in order to develop metacognitive behaviours. This model aims at identifying and solving a specific problem in the field of education (Cohen, Manion and Morrison, 2007).

Study Group

The working group constitutes a total of 64 students in 9th and 10th grade in a high school located in a province of Yozgat in the second semester of 2015-2016 education year. One branch (20 people) in the 9th grade and two branches (21 and 23 people in the 10th grade) participated. The reason why the study is applied to these branches is that the researcher-teacher is the mathematics teacher of these classes. In short, convenience sampling method was used. On the other hand, classes 9 and 10 are important because they are the first two stages of the transition to the high school.

Writing Activities

Firstly, writing activities were prepared by using the writing applications used in mathematics to develop metacognitive behaviours (Özsoy, 2007; Pilten, 2008; Demircioğlu, 2008). These activities, which were prepared taking the curriculum into consideration, were also finalized by taking expert opinions. Expository writing, impromptu writing prompt, writing prompt, expressive writing and journal writing were used. During the first weeks, activities were organized with more encouragement and direction, while in the following weeks the activities were reduced, leading to more freelance writing. The reason for this is to direct metacognitive behaviours such as how and why they are doing rather than focusing on cognitive behaviours, such as "I multiplied, I divided,...", when they write down what they think about the problem-solving process.

In the three branches where the researcher entered the lessons as a teacher, the writing activities related to the topic were applied for 6 weeks. These activities were usually carried out in the last math lessons of the week. The student activity papers were collected and reviewed weekly by the investigative teacher and written back on the papers and distributed back to the students the following week. These feedbacks are small notes that are written on the edges of the papers, “You should explain it in more detail, You went right, You wrote that you have identified the escape between the triangles, but you have not actually identified them, You must write how you understand the truth, This time your estimates are more consistent,…”. These notes will enable learners to be informed about their own situation and to guide them to metacognitive behaviours. In addition, each activity paper was scanned by the teacher and transferred to the computer environment. At this point both the researcher was able to follow the process and she could observe the changes in the participants.

A transparent file was affixed inside the back of the students' notebooks and students were asked to review the feedback given to the activity sheets by their teachers and to save the activity sheets in this file. Students are also asked to keep a math journal. After each mathematics lesson, when students go home, they are asked to write about these topics, such as what they worked on that day, what they understood and did not understand, what they attracted most, and where they got squeezed. In this way, students have to make a retrospective evaluation after a certain period of time.

Collection of the Data and Analysis of Data

At the end of six weeks students were asked to observe the events collected in their files and to evaluate the process in accordance with the instruction given in Figure 1.

Figure 1: Instruction for students to make assessments at the end of the process

Dear students, as you know, we have done activities related to the topics we have been working on every week for 6 weeks, one event per week. Also, if you go home after every math lesson you are asked to write "math lesson diary". In order to evaluate these studies, you are asked to write your opinions so that they contain the answers to the following questions. Please describe your feelings and thoughts in detail.

1) Do you think that you have given the necessary attention and attention to the work done and are actively participating?

2) How do you find your own performance and progress in the process?

3) What might be the purpose of these studies?

4) Did these studies bring you something, what did it gain you?

5) Would you like to continue such studies?

6) What kind of changes do you want to make in these studies?

The purpose of these questions is to guide the students about the topics which they will focus on, when they are evaluating. In other words, these questions are not intended to be answered in the form of questions and answers, but to make sure that the students are within a certain frame of content in terms of content. As a matter of fact, considering students' writing, it is seen that instead of responding individually to the questions, the students generally evaluate the process, they write about the contribution of the study in general and the feelings and thoughts about the study.

This assessment took about one hour (40 minutes) as it was done in mathematics lesson. Then, these assessments written by the students were collected. The data were analyzed by content analysis. First, each student was given a number. Then the collected papers were transferred into the computer environment by leaving branches. Each article has been examined separately. Later, similar expressions were gathered together and positive and negative opinion categories were formed. In addition, categorizations have been exemplified by making quotations from evaluations of students. Creswell (2013) mentioned the importance of long-term participation and detailed descriptions for validity in qualitative studies. This was an increasing factor in the validity of the study as there was a long association with the study group in this study. In addition, descriptions were made by making quotations from student papers. For the reliability of the study, the categorizations were made while the expert opinions were utilized and the process was reflected in a transparent manner with careful examination.

FINDINGS

In this study, in the high school mathematics lesson, the evaluations of the learner about the writing technique used to develop metacognitive behaviours are examined. At the end of the process, the students evaluated the process as a whole when accompanied by the guidance questions given in the guide. According to these evaluations, opinions are mainly divided into two parts, positive opinions and negative ones, and subcategories are formed for these opinions and the frequencies belonging to these categories are given in Table 1. On the whole, it has been seen that students evaluate the applications made and the reflections of these applications on themselves. Because some students have expressed a few different opinions, they are also written under different categories. In addition, while Table 1 was generated, opinions were given separately for the classes. The reason for this is to determine whether variables such as grade and branch are influencing these views.

Table 1: Categories from student views

Opinions			9-A	10-A	10-B	Total	%
Positive	Affective	I would like these activities to continue.	14	14	11	39	60.9
	Metacognitive	Activities and journals were effective on the repetition and reinforcement of the subject.	7	5	8	20	31.2
	Metacognitive	It helped me to recognize myself.	8	0	1	9	14
		It helped to self-assessment.	1	3	0	4	6.2
		I became aware of my mistakes.	1	2	2	5	7.8
	Metacognitive – Cognitive	I made progress in solving problems by explaining and expressing myself.	6	4	2	12	18.7
	Cognitive	My approach to questioning and problem-solving performance improved.	3	0	7	10	15.6
	Metacognitive	When solving a question, I learned to go with certain steps and ask myself some questions. (problem solving steps and metacognitive steps)	4	0	8	12	18.7
		It provided a better understanding of the lesson or the subject.	3	3	7	13	20.3
	Metacognitive – Cognitive	I improved in mathematics, my performance improved, my grades rose.	6	2	9	17	26.6
	Metacognitive	I have developed in thinking and reasoning.	0	2	4	6	9.4
	Affective	My interest, my love, my desire in mathematics and solving questions increased, and my self-confidence developed.	6	2	6	14	21.9
	Affective	The math lesson was more enjoyable.	1	2	1	4	6.2
		Other positive developments.	3	4	5	12	18.7
Negative		I find the activities tiring or boring, I do not like to write explanations, when I cannot do it, I feel blue.	4	2	1	7	10.9
		I don't want to write a journal.	4	2	2	8	12.5

As seen in Table 1, students often expressed a positive opinion of the applications they had made. The majority of the students (60.9%) stated that they wanted these activities to continue. It can be interpreted that these students liked and enjoyed the activities carried out throughout the process, that the activities contributed to the emotional contribution. Indeed, researcher-teacher observations support this. Students have actively participated in the activities carried out throughout the process. They have done all the activities in the classroom and in the house completely.

Examples from student views in category "I would like these activities to continue.":

"We must continue to do activities. I don't want any changes to work, I want it to continue in the same way"

"I hope that this work will continue in this way well."

In addition, 31.2% of the students who participated in the study indicated that the applications were contributing to the repeat of the courses and to the consolidation of the subjects. This is a cognitive contribution. This is interpreted as the fact that the students think that they are going through the process, to repeat the topics, and therefore contribute to the problem-solving skills of the subject.

Examples from student views in category "Activities and journals were effective on the repetition and reinforcement of the subject.":

"I think our activities are very useful. Because we repeat the issues. For example, we write about what we do in our classes every day, even this is being repetition."

"The journal helped us repeat."

They stated that when students go home and write about the topics that are being done that day, they have to re-examine them. This is not the only goal of the printed journals, but the contribution of the journals has been emphasized by many students. When solving the questions in the activities, it can also affect the permanence of the information by means of writing through which the students think more and occupy their minds in a long and intensive way.

Frequency was higher in other categories, "*I improved in mathematics, my performance improved, my grades rose.*" (% 26.6), "*My interest, my love, my desire in mathematics and solving questions increased, and my self-confidence developed.*" (% 21.9) and *"It provided a better understanding of the lesson or the subject.*" (% 20.3). Note that these categories actually support each other. Providing a good understanding of the lesson and the subject is the metacognitive contribution of the activities. When the course is better understood, this will improve performance and cognitive development will have a visible function. The increase in performance and the improvement in grades will increase the self-confidence of the student and contribute to the motivation, the affective development by increasing the interest in the lesson.

Examples from student views in category "I improved in mathematics, my performance improved, my grades rose.":

"Because I gave the necessary care in the studies, it make the exam easier for me. I had forgotten how to do the problem in the middle of the exam. At the moment, the activities came to my mind and because I wrote the subject to my journal the day of the day, I remembered the subject directly. It gave me 20 points in the exam."

"Thanks to these studies I passed the math exam. I felt on top of the world."

Some of the students stated that the activities and the journals held were positive effects on the written examination notes and that they increased the success in mathematics. These effects may be due to the contributions of the practices made to the permanence and consolidation of the lessons. It may also be due to the fact that writing efficacy increases awareness of learning.

Examples from student views in category "My interest, my love, my desire in mathematics and solving questions increased, and my self-confidence developed.":

"I didn't understand much from mathematics. But some of these activities made me love mathematics a little bit, and helped me to solve the examples."

"I would like to say sincerely; I think I developed myself about mathematics. In the past, I couldn't solve any questions, but I could solve the equation! Can you believe it? I did mathematics activity. Something strange is to solve mathematics. I'm very happy and proud, I have confidence in myself when I solve math."

It is understood that the writing activities made from the expressions of the students contributed positively to the motivations, comments, love, in short, the affective areas of the lesson as it contributed to the students going one step forward in mathematics.

Examples from student views in category "It provided a better understanding of the lesson or the subject.":

"In our activities, I saw that mathematics is not difficult, it can be done when understood These activities proved to me that mathematics is not difficult. The activities were useful to us to understand the issues. It's nice to write a letter."

"These studies help us better understand our subjects."

They stated that they were beginning to understand the issues better and that they were beginning to think that mathematics was an understandable, constructable lesson. It seems to be

supported by the fact that writing in these responses of students has developed metacognitive thinking and thus opens the door to more meaningful learning.

Examples from student views in category "It helped me to recognize myself.":

"I know that these studies are to recognize ourselves."

"In these studies I learned to recognize myself. Maybe I didn't know myself before in math class."

Some students thought that the purpose of these events was to "get to know themselves". The reason for such thinking is that the activities are designed to develop metacognitive behaviours, and the end result may be to make them aware of their knowledge of the job they are doing. This "awareness" may have contributed to their learning by learning new things about themselves and thus to their self-identification.

Examples from student views in category "It helped to self-assessment.":

"I believe that these works will be of great benefit to us. In these six weeks, we had to evaluate ourselves. Are we enough for our questions, and what we can't do?"

"We have evaluated ourselves."

It seems that the parts of the activity to improve the evaluation component of metacognition are useful. Students expressed the view that the activities have contributed to their thinking about what they can and what cannot do.

Examples from student views in category "I became aware of my mistakes.":

"I noticed my mistakes in the activities we did in the process. Wherever I have done wrong, I tried to solve the question again and try to be careful in other activities."

"Most importantly, I think it's helpful to see our mistakes. Our mistakes ... It is nice, isn't it? I think it's the most important thing to know where a person is wrong, to know where the problem is, to correct our problem."

Some of the students stated that they have been trying to correct them by noticing the mistakes in the activities and the feedbacks of the activities and they have questioned themselves in this matter. The reason for students to be aware of their mistakes when doing activities is that they can think more intensely while writing and can watch themselves and their work together with it. At the end of the activities or by looking at the feedback, they may be accustomed to evaluate themselves and what they do in the process of expressing their mistakes.

Examples from student views in category "I made progress in solving problems by explaining and expressing myself.":

"In order for a person to express himself / herself, he / she should focus on some things and do some activities. The activities that our teacher has made us like this have enabled us to express ourselves."

"I noticed in the activities that I was writing very short things in the first week, short answers like yes-no. Then I realized that I was starting to write more clearly and correctly."

The focusing which student mentioned has been tried to be achieved through writing in this work. Thus, through writing, students' concentration on the subject may have started to better express themselves by arranging and organizing their ideas better. Similarly, this student also stated that he has developed in time to express himself by writing, explaining and solving the questions.

Examples from student views in category "My approach to questioning and problem-solving performance improved.":

"At first I couldn't solve it very well. But later, I saw that I could solve the questions. I think I developed myself."

"Has there been any improvement? Of course. For example, I can read more carefully and understand better. These studies helped me to better understand the question, to solve the question, to love."

It is understood that thanks to the applications made, the students gain the habit of reading more carefully, understand the importance of understanding, interpreting and analyzing the question. It is also evident that on this issue they have indicated that they have developed appropriate solutions to find the solution and reach a solution in a correct way.

Examples from student views in category "When solving a question, I learned to go with certain steps and ask myself some questions.":

"The best way to solve the question is to go step by step. I've learned to write step by step not directly in this work."

"To think that I can solve the question before we solve the question, to read the question a few times to understand it, to solve ourselves after solving the question has really developed me very much. At least I can think of what I can do if I can't. So my performance has improved considerably."

Since students are usually used to solve the questions immediately before study, they found strange to think slowly by considering certain steps, thinking that they can compare the subject with their own knowledge, asking them questions to inquire, writing every thought, constantly checking and evaluating at the beginning of the study. However, as we have seen, some students have expressed that they are used to this situation over time and see the benefits of solving it in this way.

Examples from student views in category "I have developed in thinking and reasoning.":

"These studies have given me a lot of things like logic execution."

"Our reasoning is improved and our ability to solve questions more quickly is developing."

In the previous categories, some of the students expressed that they do not know how to start or ask questions in advance, but the activities that have been carried out have made progress in this respect. Similarly, the expressions in the category "Developing in thinking and reasoning" can mean that students learn how to think with a math problem and learn how to act with logic, thanks to applied activities slowly. While students are used to quickly matching out information and formulas from memorized machine-like before, the reasoning processes may be improved when they are asked to progress step by step according to certain strategies.

Example from student views in category "The math lesson was more enjoyable.":

"This year, the math lesson goes well, it's fun, it's not boring, it's fun. It's fun for me. This year we did very good activities, we also kept a math journal."

Since the activities that have been held have changed the course of mathematics from the traditional atmosphere, there has been a change for the students, which is found more colorful, interesting and enjoyable by some students.

Example from student views in category "Other positive developments.":

"If other teachers do it this way, we can come to better points. The teachers gather papers and see who does not understand what. He repeats the matter and does the same activity again. In this way, everyone can express clearly that they do not understand."

This student mentioned the possible contributions of strengthening the communication between the student and the teacher. According to him, if a student write that he doesn't understand on the activity papers, or if the teacher knows that the student doesn't understand from student's paper, the teacher can work to resolve this problem. In this way, the subject is understood by the whole class. In the expressions of this student, there is an indication that students write and

express feelings and thoughts and difficulties in a more comfortable way without hesitation. Writing really contributes to the mathematical communication in the math class.

Example from student views in category "Other positive developments.":

"Our activities and our journals gave us a lot of things. In the journals, we wrote our feelings and thoughts that we could not say in the lesson. In short, what we did in math class that day, what we have experienced in that lesson we wrote them."

This student also emphasizes that writing provides a more comfortable environment to explain feelings and thoughts. In the normal course of study, some students may hesitate to express their feelings and thoughts, and to express the points they do not understand. Indeed, writing provides an alternative environment for expressing such situations. Since the number of negative opinions is very small, there are not many subcategories. As negative opinion (12.5%) they do not want to write a journal by stating that they get lazy to a journal writing. The reason for this may be that the students have not encountered such an application before and that they are not accustomed to this situation. In addition, the journal writing application may be perceived as a homework by some students and may be reluctant to students as it is in all compulsory operations.

Example from student views in category "Negative opinions.":

"I paid attention to all, but sometimes I was a little bored. Because I like to solve the questions, but it's bothering me to explain them again."

Since this student is not accustomed to solving the problems by explaining the questions and he has worked result-oriented rather than process until now, he found boring to write his thoughts with long explanation. The student may be considering this as an unnecessary process. As a matter of fact, the expression "to explain again" suggests the idea that the student does not write what he thinks simultaneously while solving the questions, but writes an explanation after solving it. If he is doing this, he might be find unnecessary this study and warnings.

Example from student views in category "Negative opinions.":

"It's hard for me to leave the TV in the evenings and write a diary. So I write a bit and then I quit."

This student stated that a journal writing was an extra work done at home in the evening and that he got lazy and the television audience was more enthusiastic.

DISCUSSION

From the findings, it is seen that the students are generally satisfied with the applied writing technique. It has been stated by some students that writing activities provided improving metacognition enable them to solve problems better. Indeed, it is known that the development of metacognitive behaviours increases the problem solving success (Özsoy, 2007). A key way for pupils to improve their problem-solving skills and encourage mathematical righteousness is to improve their metacognitive awareness (Rice, 2004). It is understood that in this study, the development of metacognitive behaviours as well as the development of problem solving and mathematics understanding areas.

Some students have expressed that the writing activities will contribute to mathematical communication in the classroom by allowing them to share their feelings and thoughts more easily. Some students have stated that the writing activities increased their interest and love to math and developed their own confidence. Atasoy, Baki and Atasoy (2005) also reached that the use of writing in the course process contributed to the mathematical communication of the class, the motivation of the students, their self-confidence and interest in the course.

Students also stated that they are developing in metacognitive skills such as self-awareness, monitoring and evaluation skills. This result is parallel to the study of Çolak, Bulut and Argün (2005).

In summary, the students stated that these activities have cognitive gains such as learning the lesson, understanding the subject, approaching the questions, as well as affective gains such as increasing the interest and love of the lesson and developing self-confidence. Similar results were obtained with the study conducted by Sağırlı (2010) with university students.

Although the negative opinion is little, most of them seem to complain about journals. When the really written journals were examined, it was seen that most of the students were getting tired and shortened the journals. This result is inconsistent with the findings of Jurdak and Zein (1998) that journal writing is useful both cognitively and emotionally. In this context, journal writing is not recommended for high school students in future studies. Instead, techniques involving technological devices that can attract more attention to students can be used.

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Conference Paper

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The Investigation of Algorithmic Thinking Skills of 5th and 6th Graders According to Different Variables *

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Abstract: Besides algorithmic thinking is a basic mathematical skill that places on the center of processes which has great importance today, such as problem solving, programming and coding, it is seen that studies related to algorithmic thinking in the literature are very limited. In this context, this study aims to investigate the algorithmic thinking skills of secondary school students according to different variables. This is a case study and the study group consists of 138 students in total studying at 5th and 6th grades of different public middle schools in the Ordu, Turkey. Roughly, fifty-four and forty-five percent of the study group consist of female and male students, fifty and forty-nine percent of them are of fifth and sixth graders respectively. Criteria sampling method of objective sampling methods was used in determining the study group and *Algorithmic Thinking Test* developed by the authors was administered to the students in the study group. The study found out a positive but low correlation between students' algorithmic thinking skills and mathematics achievements. There were also significant differences between algorithmic thinking skills of the students by gender and grade level. The differences were in favor of females and 6th grade students, respectively. At the end of the study, some recommendations were presented according to the obtained results and for relevant studies that can be carried out about the subject in the future.

Keywords: algorithmic thinking skill, gender, grade level, middle school student.

INTRODUCTION

Informally, computational thinking describes the mental activity in formulating a problem to admit a computational solution. The solution can be carried out by a human or machine, or more generally, by combinations of humans and machines (Wing, 2006). Although the idea of teaching computational thinking was first brought forward by Seymour Papert (1980), debates on teaching

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this concept became widespread following Wing's (2006) view that computational thinking should be taught to every student as a fundamental area, just like reading, writing, and arithmetic. ISTE (2015) indicates that computational thinking skill is an expression of creative thinking, algorithmic thinking, critical thinking, problem solving, cooperative learning and communication skills and underlines that it cannot be described independently of these skills.

Being an important component of computational thinking skill, algorithmic thinking is defined by Brown (2015) as the ability to understand, implement, assess and design algorithms to solve a range of problems. As for Futschek (2006), it is an ability that is necessary at any stage of problem-solving process whereas Olsen (2000) indicates that this ability is one of the most important abilities that students should develop in education environments. Nevertheless, the studies carried out on algorithmic thinking are fairly limited, Thus, the present study aims to investigate the algorithmic thinking skills of middle school students according to the gender, grade level and mathematics achievement variables. Research questions of the study are as follows.

- How are the students' algorithmic thinking skills generally?
- Is there any significant mean difference between male and female students' algorithmic thinking skills?
- Is there any significant mean difference between 5^{th} and 6^{th} graders' algorithmic thinking skills?
- Is there meaningful relationship between the students' algorithmic thinking skills and mathematics achievements?

METHOD

In this study, relational survey model was used. Survey studies aim to describe specific characteristics of a group (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2009) or determine the degree of change and / or degree between two or more variables (Karasar, 2005). This method was suitable for this study, since the variables of gender, grade level and mathematics achievement affecting a specific mathematical skill as algorithmic thinking were investigated and reported.

Sample

The sample consists of a total of 138 students in 5^{th} and 6^{th} grade levels of different state middle schools in Ordu. Criteria sampling method of objective sampling methods was used for determining the study group (Patton, 1990). For determining the schools that would take part in the study, the TEOG (Transition from Primary to Secondary Education) exam results carried out in 2017 were taken into account, in line with the consensus of mathematics teachers and school principals across the province. In this regard, the students studying at schools that ranked in the middle group according to success rating participated in the study. From these students who have been attending 5th and 6th grades and also volunteer for the study were selected. The demographic information of these students is as follows.

Table 1: Demographic characteristics of the students in the study group

	Gender		Grade Level		Mathematics Achievement	
	Girls	Boys	5	6	<50	>=50
N	75	63	70	68	22	116
%	54.34	45.65	50.72	49.27	15.94	84.05

Data Collection Tools

Algorithmic Thinking Test (ATT) developed by the researchers and consisting of 12 open ended questions was used as data collection tool in the study. The theoretical structure of Burton (2010) was used for developing the questions in the test. Accordingly, the test consists of four sub-dimensions: Algorithmic Tasks, Tracing Tasks, Logic Tasks and Analysis Tasks. Besides, online data sources were utilized in the determination of the questions in ATT.

Process

This study consists of two parts; pilot and main study. The pilot study was conducted with 59 students attending fifth (28 students) and sixth (31) grade levels in total who are in one of the schools determined according to the criteria of the study. In this process, it was observed that some students had difficulty in understanding some of the questions in the ATT, so these questions were rewritten taking into account the results of the observations. According to the results of the pilot study, ATT item difficulty and discriminatory indices were calculated and then 4 problems were removed from the test because of the discrimination values were below 0.20. The last version of the ATT consists of 8 questions in total, having 3, 2, 2 and 1 questions for each dimension respectively. The average strength of the test was calculated as 0.44. Accordingly, it can be said that the difficulties of the questions in the test are moderate. The indices of discrimination and difficulty of the items in ATT calculated at the end of the pilot study are presented in Table 2.

Table 2: Item indices belong to ATT

ATT Items	Discrimination indices	Difficulty indices
I1	.54	.53
I2	.52	.61
I3	.56	.59
I4	.34	.49
I5	.49	.45
I6	.51	.54
I7	.54	.62
I8	.43	.64

Apart from the pilot study, the opinions of two lecturers who were experts in the field of *mathematics education* and *computer & instructional technology education* were used for the validity of ATT.

The main study was conducted with 138 students in sample group. When administering ATT, permission has been obtained from course teachers and school principals. One of the researchers of this study carried out all the application processes (pilot and main study) in schools and made all student and environment controls by himself. In the implementation of the questions, the students were given one course-hour for 8 open ended questions in total and no additional time has been given to the students. Finally, the Spearman Brown coefficient for internal consistency was calculated as 0.75 for the reliability of the test.

Analysis

In the evaluation of the students' data obtained from ATT, the correct answers were coded as 1, and the incorrect ones as 0, an ATT score was obtained for each student. These scores were interpreted by expressing percentage and frequency values for ATT. Besides independent groups t-

test was used for determining the differences between sub-groups according to the gender and grade levels. Pearson correlation analysis techniqu was used for determining the relationship between algorithmic thinking skills and mathematics achievements of students. The first semester school scores for fifth grade students, and the three-semester scores for sixth grade students were used for determining the students' mathematics achievements with the help of school administrators.

FINDINGS

General Findings Obtained from ATT

Findings obtained from ATT are given in Table 3.

Table 3: Findings Obtained from ATT

	Number of Questions	N	$\bar{X}$	ss
Total	8	138	**0.43**	.24

According to Table 3, it can be said that the students in the study group had 43% of the achievement averages for using algorithmic thinking skills. So, it can be said that the students use subject skills below average level.

General Findings Obtained from ATT According to Gender and Grade Level Variables

Independent samples t-test for determining the differences between the groups according to gender and grade level variables are given in Table 4.

Table 4: Findings According to Gender and Grade Level

		N	$\bar{X}$	ss	sd	t	*p*
Gender	Girls	75	4.06	2.02	135.308	3.99	.000**
	Boys	63	2.84	1.57			
Grade Level	5^{th}	70	2.51	1.40	124.342	-7.161	.000**
	6^{th}	68	4.52	1.86			

*P**<.01*

According to Table 4, it's seen that there are significant differences between boys and girls ($t_{135.308}$ = 3.99, p<.05) in favor of girls, and there are significant differences between fifth and sixth grade students ($t_{124.342}$ = -7.161, p<.05) in favor of sixth grade students.

General Findings Obtained from ATT According to Mathematics Achievement Variable

The results of the correlation analysis carried out for the analysis of the relationship between mathematics achievement and algorithmic thinking skills are given in Table 5.

Table 5: The Correlation Analysis Results Between Mathematics Achievement and Algorithmic Thinking Skill Variables

		Algorithmic Thinking	Mathematics Achievement
Algorithmic Thinking	Pearson Correlation	1	.298
	Sig. (2-tailed)		.000
	N	138	138
Mathematics Achievement	Pearson Correlation	.298	1
	Sig. (2-tailed)	.000	
	N	138	138

**Correlation is significant at the 0.01 level (2-tailed).

According to Table 5, there is a positive but low level of correlation between students' algorithmic thinking skills and mathematics achievements. So, it can be said that as the mathematical achievements of the students increases, the algorithmic thinking skills increase too.

DISCUSSION, CONCLUSION AND SUGGESTIONS

In this study, the algorithmic thinking skills of 5th and 6th grade students were examined and the results show that students are not able to use these skills effectively. Besides, it has been observed that students are more successful in using a given algorithm and monitoring it, compared to developing, using, or determining the effectiveness of an algorithm that is appropriate for given situation. These results are similar to some research (Gülbahar, Kalelioğlu & Doğan 2015; Korkmaz, Çakır, Özden, Oluk & Sarıoğlu, 2015) results in the literature. Bilge Kunduz activity (Bebras International Challenge on Informatics and Computational Thinking), which has been organized in different countries since 2004, was organized as a pilot in 2014 for the first time in Turkey. The sample of this comprehensive research was 13.784 students that were attending 5th and 6th grade levels of their schools and the results show that most of the students in this research could make just easy level questions in the activity and only 33% of the students could make advanced questions. Furthermore, the study of Korkmaz et al. (2015) investigates the computational thinking perceptions of secondary students, and it was seen that Algorithmic Thinking is one of the sub-factors of computational thinking which the students had the lowest average. So, the results of the current study can be said to be parallel with these studies' results and according to this observation, it can be said that the students in our country are not very successful in the computational and algorithmic thinking processes generally. According to these results, it is thought that algorithmic thinking skills of students need to be improved in our country. With the development of this skill, it is thought that students will develop computational thinking and programming skills in this context. Because algorithmic thinking is one of the sub-dimensions of computational thinking and programming (ISTE, 2015; Gökoğlu, 2017). Also Kalelioğlu, Gülbahar & Kukul (2016, p.593) study which define computational thinking as a problem solving process and put *algorithmic thinking* as the third step of this process as *generate, select and plan solutions* of subject problems can be shown to support this discussion. So, it can be said for a student whose algorithmic thinking skill is poor/high will probably poor/high computational thinking skill too.

One of the other results obtained from this study is that female students use algorithmic thinking skills more effectively than male students. When we look at the studies conducted in the literature, there are studies which have different results including gender variable. Although there

are studies (Oluk, 2017, Atmatzidou & Demetriadis, 2016, Orton, Weintrop, Beheshti, Horn, Jona, & Wilensky, 2016; Gülbahar, Kalelioğlu & Doğan, 2015) having similar results with this study, there are also studies (Korkmaz et al., 2015; Bilge Kunduz, 2016, as cited in Oluk, 2017) that have results in the opposite direction. According to the report of Bilge Kunduz study (2016), it is seen that male students' scores are higher than female students (cited in Oluk, 2017) while Korkmaz and others (2015) point out that the students' computational thinking skills are not differentiated by gender. So, different results of related studies can be interpreted that gender is not a determinant for algorithmic thinking ability for all the situations. Nevertheless, the results obtained from this study can be explained by the students' characteristics in the sample group, as Atmatzidou and Demetriadis (2016) points out that there were certain differences identified for students' computational thinking skills related to factors as student' cognitive developmental levels and their ages. So, the results of this study according to gender variable, can be interpreted with related to these factors. Besides, it can be said that there is a need to conduct different related studies with larger samples for getting more reliable data on the subject. The data obtained from these studies will be more effective in interpreting the gender variable in relation to the algorithmic thinking skill of the students.

According to the grade level variable, this study shows that sixth grade students have meaningfully higher scores for using algorithmic thinking skills than fifth graders. The studies conducted on different age groups (Korkmaz et all., 2015; Oluk, 2017; Atmatzidou & Demetriadis, 2016) in the literature generally report that computational/algorithmic thinking levels decrease as the grade level increases. Korkmaz et al. (2015) examined university students' algorithmic thinking skills and they found that senior students had the lowest scores for subject skill. Oluk (2007) examined algorithmic thinking skills of middle school and high school students in his study and he found that the students had the highest level of skill in 4th grade. Skill levels were reported as fourth, sixth, eighth and tenth grades from high to low respectively. The lowest level was found at twelfth grade students between the sample group. Atmatzidou & Demetriadis (2016) has examined the students' algorithmic thinking skills in the age range of 15-18, and they found that students in the young age group have achieved a higher average than the older age group of students. So it's seen that for university, high school and middle school graders, related studies have all similar results as subject skill decreases as grade level increases. But at this point, it's important to look at the study results which have similar samples with this study. When the study of Gülbahar, Kalelioğlu & Doğan (2015) is examined which is a comprehensive study and has similar age group students, it is seen that the results were similar and sixth graders use subject skills more effectively than fifth graders. Likewise, different studies in the literature emphasizing specific age groups for the subject skill. Touretzky, Marghitu, Ludi, & Bernstein (2013) points out for children aged 10–17 to have especially on deep and abstract understanding of programming concepts and Grover (2011) report positive results on the development of computational thinking skills regarding elder children (Junior and High School students). So, it can be said that age group is a significant factor for computational/algorithmic thinking skills to be gained by students and it's more easy for elder children have subject skills than older ones. Besides, when the sixth grade is considered it's taught for this level to be a critical age for students to have computational/algorithmic thinking skills. So, with these considerations, it's suggested for related studies to be planned according to this age level for the students. Also, this study is limited with only fifth and sixth graders, related studies can be conducted on seventh and eighth grade students to see grade level differences for middle school term more clearly.

Another result of this study is there was a positive but low level of correlation between students' algorithmic thinking skills and mathematics achievements. This result is parallel with (Barcelos & Silveira, 2012; Oluk, 2017; Liu & Wang, 2010; Weintrop, Beheshti, Horn, Orton, Jona, Trouille, & Wilensky, 2016) conducted on this subject. Except these studies Wing (2008) suggests that computational thinking generally sharing the same routes with mathematical thinking for problem solving processes. Wing (2010) argues that computational thinking problems have a structure that overlaps with logical thinking and problem solving processes include mathematical/logical thinking. Besides Calao, Leon, Correa, & Robles (2015) found in their study that, mathematics course has contributed to the development of the students' understanding of the mathematical processes through the curriculum study which was added to improve computational thinking skills. So, it can be said that with improving students' computational and algorithmic thinking skills, we also improve their mathematical thinking skills like problem solving, reasoning, making connections between different situations and finding the best solutions for problems.

Futschek (2006) defines algorithmic thinking as a special problem-solving skill that involves different abilities and Futschek & Moschitz (2010) defines the essence of this skill as abstract and logical thinking, creativity and problem-solving skills. Hubalovsky, Milkova, and Prazak (2010) said that developing algorithmic thinking skills also improves logical thinking skills in individuals. So, it can be said that one of the most important earnings that can be achieved for students is algorithmic thinking skill for not only in the field of information technology but also in all other fields (Oluk, 2017). One of the targeted qualifications for developing countries in primary and secondary education is algorithmic thinking (Zsakó & Szlávi, 2012), and the development of algorithmic thinking is crucial for students (Ioannou & Angeli, 2016). So, it is suggested for teachers to plan and carry out special activities that improve algorithmic thinking skills of students. These activities should be implemented especially on early ages and mainly for sixth grade students. Because of the fact that it's easier to develop subject skill in early ages, and this skill has strong relationships with mathematical skills, it is suggested that *Mathematics* and *Information Technologies and Software* courses are designed and carried out in relation to each other for especially early ages of students. So, the curriculums of these courses may include activities that support each other. Besides it is suggested for the teachers of these courses should be in constant communication and cooperation with each other in schools.

Besides there are studies on computational thinking in the literature, it is seen that the studies carried out on algorithmic thinking are very limited and most of the existing studies including algorithmic thinking skill examine this skill in the context of computational thinking skill. So there is a need to plan and carry out studies which include algorithmic thinking skill independent from other concepts or skills. This study is limited with 138 students from fifth and sixth graders and ATT developed by the researchers. So, the studies that will be carried out are suggested to have a larger and different age group of students and contain different data collection tools which have different cognitive components and theoretical frameworks. With suggested researches and implementations in schools, it's taught that algorithmic thinking and its related factors can be understood by researchers and students more deeply and this situation contributes to the development of subject skills of all age group of students.

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Investigation of Pre-service Elementary Mathematics Teachers' Beliefs about Mathematics Teaching Self-Efficacy and the Nature of Mathematics, Teaching and Learning *

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Abstract: The present study aims to find out pre-service elementary mathematics teachers' beliefs about mathematics teaching self-efficacy and mathematics, teaching and learning and to investigate their beliefs in terms of gender and years of study. The study was carried out based on quantitative research methods. In this regard, relational survey model was employed in the study. The study group consists of 198 pre-service mathematics teachers studying at 2nd, 3rd and 4th grades of Primary Mathematics Teacher Education Program at a public university in the 2017-2018 academic year as well as the pre-service teachers graduated in the previous year from the same program. For data collection, "The Mathematics Teaching Self-Efficacy Scale (MTSES)" developed by Enochs, Smith and Huinker (2000), adapted to Turkish by Hacıömeroğlu and Şahin-Taşkın (2010) and the "Mathematics Related Beliefs Scale (MRBS)" developed by Kayan, Haser and Işıksal-Bostan (2013) were used. As a result of the research, it was found that the teacher candidates differ in their beliefs about mathematics teaching proficiency beliefs and nature of mathematics, mathematics teaching and mathematics learning about grade level variable but not by gender variable.

Keywords: self-efficacy beliefs, mathematics-related beliefs, preservice teacher.

INTRODUCTION

Although there is not a single definition accepted by everyone, there is a consensus in the literature about the importance of beliefs (Aguirre & Speer, 2000; Handal, 2003). Some researchers believe that beliefs are what individuals regard as right about the world and define them as

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structures that affect behavior (Beswick, 2011; Philipp, 2007). Teacher's self-efficacy belief is defined as the belief in the ability of teachers to influence student performance (Dellinger, Bobett, Olivier & Ellet, 2008; Woolfolk-Hoy & Burke-Spero, 2005).

Teachers' beliefs are shaped by their previous educational experiences before they come to university and the experiences they gained during teacher education at the university (Handal, 2003; Philipp, 2007). This means that preservice teachers have beliefs about mathematics which they have learned from their previous education and are structured by the teachers they have met (Ball, 1988) before starting the teacher education program. The beliefs about mathematics can be defined as the decisions that people have about the nature, learning and teaching of mathematics and their decisions shaped by their experiences (Raymond, 1997).

Ensuring teacher candidates to develop beliefs as will help them to become competent teachers is among the most important goals of teacher education (Green, 1971). Some of the preservice teachers' beliefs about mathematics are shaped outside the classroom environment because of their lack of classroom and school experiences during their undergraduate education (Haser, 2006). Determination of the beliefs of preservice teachers is important because they will affect their future teaching in the first years of their teaching (Lester & Garofalo, 1987). In addition, determining the effects of the vocational courses of teacher education programs on their beliefs about mathematics and to determine the differences in students' beliefs about mathematics in subject processes will contribute to the professional development of the teachers (Dede & Karakuş, 2014).

Preservice elementary mathematics teachers' self-efficacy beliefs about teaching mathematics and also beliefs about the nature of, teaching and learning mathematics seem to be highly important in their professional development. When the research conducted with pre-service teachers are examined, it can be seen that the self-efficacy beliefs about mathematics teaching and student beliefs about mathematics teaching, teaching and learning are examined separately. In this study, it is considered that the study contributes to the literature in this sense since these variables are examined separately in relation to each other. In addition, this study examines and compares not only the self-efficacy beliefs of preservice teachers who are studying at university, but also the self-efficacy beliefs of preservice teachers who have just graduated. In this context, the present study aims to find out pre-service elementary mathematics teachers' beliefs about mathematics teaching self-efficacy and beliefs about mathematics, teaching and learning and to investigate their beliefs in terms of gender and grade. Within the scope of this aim, the following questions were sought:

1. What is the level of preservice elementary mathematics teachers' self-efficacy beliefs about mathematics teaching?
2. What is the level of preservice elementary mathematics teachers' self-efficacy beliefs about the nature of, teaching and learning mathematics?
3. Is there a meaningful difference between the preservice elementary mathematics teachers' self-efficacy beliefs about teaching mathematics and beliefs about the nature of, teaching and learning mathematics according to grade variable?
4. Is there a meaningful difference between preservice elementary mathematics teachers' self-efficacy beliefs about teaching mathematics and beliefs about the nature of, teaching and learning mathematics according to gender variable?
5. What is the relationship between the preservice elementary mathematics teachers' self-efficacy beliefs about mathematics teaching and self-efficacy beliefs about the nature of, teaching and learning mathematics?

METHOD

This study, which aims to examine the relationship between the preservice elementary mathematics teachers' self-efficacy beliefs about mathematics teaching and also self-efficacy beliefs about the nature of, teaching and learning mathematics, is designed in the relational survey model. The relational survey model is a research model that aims to determine the presence and/or degree of change between two and more variables. There are two types of relational survey models. These are comparative relational survey and correlative relational survey (Karasar, 2014). The comparative type of relational survey model was used to examine preservice elementary mathematics teachers' self-efficacy beliefs about mathematics teaching and also self-efficacy beliefs about the nature of, teaching and learning mathematics according to grade and gender variable. Besides, a correlational type of relational survey model was used to reveal whether there exists a relationship in beliefs about mathematics teaching and beliefs about the nature of, teaching and learning mathematics.

Study Group

The study group consists of 198 pre-service mathematics teachers studying at 2nd, 3rd and 4th grades of Primary Mathematics Teacher Education Program at a public university in the 2017-2018 academic year as well as the pre-service teachers who graduated from the same program in the previous year. The distribution of the number of preservice teachers according to grade and gender variables is given in Table 1.

Table 1: Distribution of preservice teachers according to independent variables

Independent variables		f	%
Grade	Grade 2	48	24.2
	Grade 3	60	30.3
	Grade 4	63	31.8
	Graduated	27	13.6
Gender	Female	144	72.7
	Male	54	27.3

Data Collection Tools

For data collection, "The Mathematics Teaching Self-Efficacy Scale (MTSES)" developed by Enochs, Smith and Huinker (2000) adapted to Turkish by Hacıömeroğlu and Şahin-Taşkın (2010) and the "Mathematics Related Beliefs Scale (MRBS)" developed by Kayan, Haser and Işıksal-Bostan (2013) were used. The pre-service mathematics teachers' beliefs about mathematics teaching self-efficacy were investigated under the sub-dimensions of 'Personal Self-Efficacy (PSE)', 'Efficacy Beliefs about Teacher's Role in Effective Teaching (EBaTRiET)' and 'Teaching Performance (TP)' whereas the beliefs about Mathematics Teaching and Learning were handled separately under the dimensions of 'Constructivist Beliefs (CB)' and 'Traditional Beliefs (TB)'. In these 5-point Likert-type scales, positive statements are scored as "Strongly Disagree (1 point)," "Disagree (2 points)," "Neither Agree nor Disagree (3 points)," "Agree (4 points)," and "Strongly Agree (5 points)" while the negative statements are scored reversely. In evaluating the responses given to both scales, the group interval coefficient value was calculated by dividing the difference between the largest value and the smallest value in the measurement results sequence by the group number (Kan, 2009). As a result of the implementation of the scales, the Cronbach alfa coefficient of the scales were calculated as α=.783 for MTSES and α=.800 for MRBS therefore, the scales were evaluated as reliable.

Data Analysis

Independent Samples t-test was used in order to find out how the beliefs of pre-service teachers change according to gender while one-way Anova test was used to find out how their beliefs change according to their years of study. Furthermore, the Pearson correlation coefficient was calculated in order to discover the relationship between mathematics teaching self-efficacy beliefs and the beliefs about mathematics, teaching and learning. The data were analyzed at .05 significance level.

FINDINGS

Findings Related to Mathematics Teaching Self-Efficacy

The descriptive statistics of the preservice mathematics teachers' responses about the MTSES are as follows. Table 2 presents the points scored by preservice elementary mathematics teachers from the subscales of MTSES.

Table 2: Descriptive Statistics about the MTSES

		N	$\overline{X}$	ss
MTSES	**PSE**	198	3.97	.46
	EBaTRiET		3.99	.38
	TP		4.05	.40

According to Table 2 preservice elementary mathematics teachers scores are $\overline{X}$=3.97, ss= .46 on the PSE subscale, $\overline{X}$=3.99, ss= .38 on the EBaTRiET subscale and $\overline{X}$=4.05, ss= .40 on the TP subscale and they are all in the "agree" level.

Table 3 presents the points scored by preservice elementary mathematics teachers from the subscales of MTSES according to grade.

Table 3: Statistics on the Sub-Dimensions of the MTSES

PSE	Grade	N	$\overline{X}$	ss
	2nd grade	48	3.934	.479
	3rd grade	60	3.878	.438
	4th grade	63	3.939	.426
	Graduated	27	4.345	3.974
EBaTRiET	2nd grade	48	4.023	.275
	3rd grade	60	3.995	.404
	4th grade	63	3.959	.400
	Graduated	27	4.042	.424
TP	2nd grade	48	3.963	.326
	3rd grade	60	3.950	.413
	4th grade	63	4.079	.411
	Graduated	27	4.343	.361

Table 3 shows that the highest score of all sub-dimensions of the MTSES obtained by the graduated preservice elementary teachers and these scores are at the level of "completely agree". On the other hand, other preservice teachers' scores are at the level of "agree" in three subscales of MTSES.

Table 4 compares preservice elementary mathematics teachers' self-efficacy levels according to grade variable. Accordingly, no grade-based statistically significant difference is observed between the points scored by pre-service elementary mathematics teachers on the EBaTRiET subscale ($p>.05$)

of MTSES. There are, however, a statistically significant difference in terms of the points scored on the PSE subscale and the TP subscale (p<.05) of MTSES.

Table 4: One-way ANOVA Results According to Grade

	Source of Variance	Sum of Squares	df	Average of Squares	F	p	Significant Difference
PSE	Between Groups	4.439	3	1.480	7.566	.000	2nd grade-Graduated 3rd grade-Graduated 4th grade-Graduated
	Within Groups	37.935	194	.196			
	Total	42.374	197				
EBaTRiET	Between Groups	.180	3	.060	.418	.740	
	Within Groups	27.856	194	.144			
	Total	28.039	197				
TP	Between Groups	3.324	3	1.108	7.419	.000	2nd grade-Graduated 3rd grade-Graduated 4th grade-Graduated
	Within Groups	28.970	194	.149			
	Total	32.294	197				

The results of the independent groups t-test conducted to determine whether the pre-service teachers' beliefs on mathematics teaching differ according to gender variable are given in Table 5.

Table 5: Independent Sample t-test Results of Mathematics Teaching Self-Efficacy Beliefs According to Gender Variable

	Gender	N	$\overline{X}$	ss	t	p
PSE	Female	144	3.991	.47	.849	.397
	Male	54	3.929	.44		
EBaTRiET	Female	144	4.003	.33	.356	.722
	Male	54	3.981	.49		
TP	Female	144	4.034	.39	-.752	.453
	Male	54	4.083	.43		

Table 5 shows that there is not a significant difference in pre-service mathematics teachers' beliefs on *PSE subscale (t(196)=.849, p>.05), EBaTRiET subscale* (t(196)=.356, p>.05) and *TP subscale* (t(196)=-.752, p>.05) of *the MTSES.*

Findings Related to Beliefs about the Nature of, Teaching and Learning Mathematics

Descriptive statistics of the responses regarding the items in the MRBS are given below.

Table 6: Descriptive Statistics on Beliefs about the Nature of, Teaching and Learning Mathematics

CB	Grade Level	N	$\overline{X}$	ss
	2nd grade	48	4.114	.338
	3rd grade	60	4.081	.359
	4th grade	63	4.365	.342
	Graduated	27	4.544	.287
	Total	198	4.242	.377
TB	2nd grade	48	3.184	.711
	3rd grade	60	3.283	.617
	4th grade	63	3.185	.705
	Graduated	27	3.290	.561
	Total	198	3.229	.659

When Table 6 is examined, it is understood that pre-service teachers' CB and TB correspond to the “strongly agree” ($\overline{X}$= 4.242, ss=.287); and “neither agree nor disagree” ($\overline{X}$=3.229, ss=.659) ranges respectively.

The results of the one-way analysis to determine whether there is a meaningful difference between the pre-service teachers’ beliefs about the nature of, teaching and learning Mathematics according to the grade level is given below.

Table 7: One-way ANOVA Results on Beliefs about Nature of, Teaching and Learning Mathematics According to Grade Level

	Source of Variance	Sum of Squares	df	Mean Square	F	p	Significant Difference
CB	Between Groups	5.746	3	1.915	16.587	.000	2^{nd} grade-4^{th} grade ; 2^{nd} grade - Graduated 3^{rd} grade -4^{th} grade ; 3^{rd} grade - Graduated $4t^{h}$ grade - Graduated
	Between Groups	22.399	194	.115			
	Total	28.145	197				
TB	Between Groups	.496	3	.165	.376	.770	
	Within Groups	85.291	194	.440			
	Total	85.787	197				

When Table 7 is examined, it can be said that pre-service teachers’ CB differ in terms of grade (F(3-197) =16.587; p< .05) and there is significant differences between the 2^{nd}, 3^{rd}, 4^{th} grades and graduated pre-service teachers’ average scores related to *CB* and there is not a significant difference between the pre-service teachers’ average scores related to the *TB.*

The results of the independent sample t-test to determine whether pre-service teachers’ mathematics teaching self-efficacy beliefs differ according to the gender variable are given in the following table.

Table 8: Independent Sample t-Test Results on Beliefs about Preservice Mathematics Teachers’ Beliefs about the Nature of, Teaching and Learning Mathematics According to Gender Variable

Gender	N	$\overline{X}$	ss	t	p
Female	144	4.263	.337	1.234	.219
Male	54	4.188	.468		
Female	144	3.235	.660	.208	.835
Male	54	3.213	.665		

It is understood from Table 8 that pre-service teachers’ scores related to both constructivist (t(196)=1.234, p>.05) and traditional (t(196)=.208, p>.835) learning-teachings do not differ significantly according to the gender variable.

Table 9: The Relationship between Pre-Service Teachers' Mathematics Teaching Self-Efficacy Beliefs and Beliefs about Nature of, Teaching and Learning Mathematics

		CB	TB
PSE	Pearson Correlation	0.48	0.58
	Sig. (2-tailed)	4.98	.420
EBaTRiET	Pearson Correlation	-.143*	.009
	Sig. (2-tailed)	0.48	.900
TP	Pearson Correlation	.22	.034
	Sig. (2-tailed)	.757	.636

As can be seen in Table 9, the Pearson's product-moment correlation coefficient analysis was carried out to examine the relationship between the sub-factor of EBaTRiET from the "MTBESS" and the subfactor of CB from the "MRBS" produced the value of ($r= -.143$; $p<.01$). It shows that a very weak negative significant relationship was found between the efficacy beliefs about teacher's role in effective teaching and constructivist beliefs. It means that efficacy beliefs about teacher's role in effective teaching decrease as the constructivist beliefs increase. Considering the determination coefficient ($r^2=.02$), %2 of the total variation of the efficacy beliefs about teacher's role in effective teaching can be interpreted to be related to the constructivist beliefs.

DISCUSSION AND CONCLUSION

When the answers of the mathematics teacher candidates' sub-factors of Mathematics Teaching Proficiency Beliefs Scale were examined, it was determined that the answers in all sub-dimensions are in "agree" level. This suggests that teacher candidates' beliefs about mathematics teaching are positive and high. On the other hand, preservice mathematics teachers' mathematics teaching proficiency beliefs were found to be meaningful when they were examined in terms of grade variable. It is thought that this difference in the dimensions of 'Personal Competence' and 'Teaching Performance' for graduate students may be due to the experiences they have in real classrooms. The results show that the experience gained in the real classroom environment has a positive impact on the beliefs about the level of personal competence and thus the applicants have the opportunity to find out the theoretical knowledge they have acquired during their training. For this reason, it is proposed to make arrangements to ensure that prospective teachers remain active for longer in the course of teacher application. On the other hand, it has been determined that prospective teachers do not differ according to their genders for mathematics teaching proficiency beliefs. This finding overlaps with the findings of Hacıömeroğlu and Şahin-Taşkın (2010).

It is known that the lesson experience in teacher training programs partially alters the beliefs of prospective teachers (Ambrose, 2004; Gill, Ashton & Algina, 2004; Joram & Gabriele, 1998). Eryılmaz Çevirgen (2016) stated that there are no significant differences in the constructivist beliefs of the mathematics teacher candidates in different grades and there are significant differences in the traditional beliefs. In this study, it was determined that there is a significant difference in the constructivist beliefs of mathematics teacher candidates in favor of graduates between graduates and all other grades, in favor of final grades between intermediate classes and final grades. When it's considered that beliefs are motivated by experience (Raymond, 1997), it is understood that teaching practice courses in the fourth grade of teacher training programs and teaching experiences in real classes give the students the opportunity to gain experience in their beliefs they are beginning to develop and significantly affect constructivist beliefs about mathematics. It is recommended that

arrangements should be made to increase the time of the teaching practice courses and also to provide more opportunities for teacher candidates to teach in real classroom settings. In terms of gender, there is no significant difference between the average scores of the 3rd, 4th grades and graduated teacher candidates on the constructivist and traditional beliefs factors. This finding is consistent with the findings of Ayvaz and Dündar (2014) that used the same scale. On the other hand, Kayan, Haser and Işıksal-Bostan (2013) stated that there is a meaningful difference in beliefs of elementary mathematics teacher candidates about their mathematics in favor of female teachers according to gender variables, but this difference is not practically meaningful. It can be said that the results obtained from these studies stress to similar points with this study because of no difference in terms of gender.

In this study, a very weak negative significant relationship was found between the efficacy beliefs about teacher's role in effective teaching and constructivist beliefs. However, a significant relationship could not be found between the sub-factors of Mathematics Teaching Efficacy Beliefs scale and the traditional belief factor of the Beliefs about Mathematics, Teaching and Learning Scale. As there could not be encountered any study regarding the relationship between beliefs about Mathematics Teaching Self-Efficacy and Mathematics, Teaching and Learning, these results were expected to contribute the mathematics education literature.

This study was conducted with a limited number of preservice mathematics teachers studying at a state university. It is possible to reach more general information about this subject through the larger study groups from different universities. Also in this study, preservice mathematics teachers' beliefs about mathematics teaching and beliefs about the nature of, teaching and learning mathematics were analyzed quantitatively. Future studies using both quantitative and qualitative methods will contribute to literature to understand preservice elementary mathematics teachers' beliefs.

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