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Comparison of Gifted Students and Anatolian High School Students' Perspectives on Errors in Mathematics Lesson

ABSTRACT

In this study, it is aimed to compare the perspectives of gifted students and students studying at Anatolian High School towards errors in mathematics lessons. The research was conducted with 30 students, including 15 gifted students studying in the project program at the Science and Art Center in Niğde, and 15 high school students studying at Anatolian High School during the 2020-2021 academic year. A semi-structured interview form consisting of 6 questions was used as a data collection tool. Content analysis was used in the analysis of the obtained data. In the interviews, the students were asked questions that would enable them to determine how often they made errors in the mathematics lesson, their fear of making errors, the expression of their errors by others, and their perspectives on the discussion of errors. Based on the findings, it is seen that Anatolian High School students avoid, fear and make errors more than gifted students in mathematics lessons. The Anatolian High School students were more likely to leave the questions unsolved or blank not to make errors, they make errors more frequently, they are more emotionally affected by the errors they make. It can be said that Anatolian High School students are more afraid of making errors in mathematics lessons. All of the gifted students and the majority of Anatolian High School students see the errors "instructive".

Keywords: Error, gifted students, mathematics education, high school students

Introduction

Errors made by students in mathematics lessons are quite common. Errors play a more fundamental role in the growth of a discipline than is thought (Kuhn, 1970; Lakatos, 1976). Errors are a common phenomenon in mathematics education worldwide (Boaler, 2016; Heinze, 2018; Santagata, 2005). Mathematical errors, on the other hand, arise as a result of generalizing students' productions for problems in an incorrect way when they encounter new topics (Önal & Aydın, 2018). Error is one of the most frequently studied topics by mathematics education researchers. Errors are mostly more informative than correct answers in terms of learning (Lannin et al., 2007; Rushton, 2018). Errors create opportunities for students to evaluate how well they grasp mathematical concepts, and to provide feedback in order to develop and awaken students' ideas (Gardner & Wood, 2009; Metcalfe, 2017).

If students see errors as failures and avoid them, their brains will miss out on opportunities for improvement.

Therefore, teachers should see errors as an opportunity for students' brain development and learning. Thus, students will not see the error as a failure and will be able to benefit from the tutorial part. In the study by Parviainen and Eriksson (2006), negative and positive knowledge have been compared.

In this study, correct knowledge shaped by belief is positive knowledge; the knowledge that is not learned and thrown into the background is defined as negative knowledge. Additionally, research has been shown that individuals' knowing what they should not do or what they do not know emerges with the use of positive and negative knowledge together. In the definition given in the study of Gartmeier et al. (2008), individuals' knowing what to avoid and knowing what they do not know is defined as only negative knowledge. Furthermore, Bickhard (2004) expresses negative knowledge as being able to use error in learning. Errors in providing negative knowledge should be considered as potential opportunities (Lakatos, 1976; Kline, 1980). Studies have shown that errors and difficulties are the best opportunity for the development of the brain

(Boaler, 2016; Moser et al., 2011; Tall, 1990). Such studies on the brain and errors are quite important for teachers and parents (Boaler, 2016). Additionally, other studies aim to reveal errors in a concept (Billi et al., 2020; Movshovitz-Hadar et al., 1987; Radatz, 1979; Şimşek, 2018; White, 2005). Students encountering new problems and making misgeneralizations during their production constitute mathematical errors. Besides, errors occur due to many reasons such as a momentary slip of the pencil, carelessness, misinterpretation of texts and symbols, understanding about the learned target, mathematical concept and subject, lack of knowledge and inability to control the answer given by experience, lack of awareness. (Burns, 2007; Hansen, 2014; Ryan & Williams, 2007). New knowledge in students is formed by using previous knowledge. Borasi (1988) states in his study that errors are a starting point in the process of enabling individuals to learn. Errors are generally more informative than 'correct' answers in terms of learning. Errors provide opportunities to give feedback to awaken and develop students' ideas, and to evaluate how well mathematical concepts are grasped by students (Heinze, 2018; Ingram et al., 2015; Santagata, 2005).

Teachers are encouraged to choose errors as a starting point in teaching a subject. The reason is for that students do not acquire common misconceptions about the subject to be taught (Ingram et al., 2015). Santagata (2005) recommends that teachers and students should attach importance to errors and see them as learning achievements rather than as learning failures. If students see errors as failures and avoid them, both their brains will not develop and they will miss opportunities for improvement. For this reason, teachers should consider errors as an opportunity for students' brain development and learning new knowledge. To this end, studies that result in errors should be made to students by teachers.

Heemsoth and Heinze (2018) state that errors can be a powerful tool that can be used to diagnose learning difficulties and direct correction. Studies dealing with this function of errors emphasize the importance of inadequacy in terms of increasing awareness of difficulties in learning mathematics and individual differences and correcting errors by constantly explaining the same issues (Mathan & Koedinger, 2018; Wijaya et al., 2019). Errors are an opportunity to learn. If teachers do not take advantage of these opportunities, the error becomes permanent (Berman, 2006; Ryan & Williams, 2007). Teachers should take into account various variables when determining the cause of the error. Errors should not be thought as just learner-centered. Many variables play role in the environment where errors occur (Cockburn, 2005; Hansen, 2014; Ryan & Williams, 2007).

Errors are significant in terms of instructive quality in mathematics education. It is of crucial that the errors are used by the teachers as an instructive element in the lessons. Some teachers, realizing the importance of errors, see errors as a sign of students' need to restructure their knowledge (Santagata, 2005). Rach et al. (2013) emphasized that teachers should consider errors in their lessons as learning opportunities. In the study, it was determined that the fear of making errors in the students of the teachers who support the errors as an opportunity to learn in their lessons decreased. Borasi (1989) states that individuals realize their errors when they encounter error-based activities, their questioning skills develop and they gain new ideas. Experimental studies to determine this situation are found in the literature. Heinze and Reiss (2007) pointed out in their quasi-experimental study that error-based activities applied to seventh grade students achieved a much better level of reasoning and proof performance in the applied group.

Understanding the knowledge needed for teaching mathematics is a prominent domain in terms of teaching and learning mathematics (Peng & Luo, 2009). For learning and teaching in schools, especially in mathematics classes, errors are crucial for the learning process (Rach et al., 2013). In the process of mathematics education, it is significant to examine the students' perspectives on errors, their knowledge, awareness and perceptions about errors, while teachers' perspectives on errors and their orientation in this direction are important. Regarding that students are classified according to their success and they receive different education in this direction, it might be a matter of curiosity whether there are similarities or differences between the perspectives of gifted and non-gifted students. Even, the gifted students can be expected to see the errors as the opportunity for learning process. Being giftedness may be related to the error perception. Here, the study conducted can give results to see the error perception of gifted students and non-gifted Anatolian high school students. In the literature it is easy to see the studies conducted with non gifted students. However, gifted students' perceptions and perspectives about the errors in mathematics has not researched yet. That is why this study can give an entry idea about the gifted students' perception and perspectives by comparing them with non gifted Anatolian High School students.

There are many studies contributing to the literature on errors and learning from errors in mathematics education (Bilgili et.al., 2020; Oflaz & Polat, 2022; Önal & Aydın, 2018 Özkaya & Konyalıoğlu, 2019). However, there are no studies on gifted students' perceptions of and perspectives on errors in mathematics learning. However, the

perceptions and perspectives of gifted students about errors in mathematics have not been investigated yet. Therefore, by making a comparison, it is possible to have an idea about gifted students' perspectives on errors in mathematics. It is thought that this comparison of errors can also bring a suggestion to the literature on why and why both student groups show similarities and differences. When the literature is examined, by considering that any error study involving gifted students in mathematics education is confronted and that the ideas of the students in both groups may have an impact on the literature and the teaching plans of the teachers, it is aimed to compare the perspectives of the students studying at Anatolian High School and the gifted students about the errors in the mathematics lesson. In addition, in this research, "What are the differences and similarities in the perspectives of students studying at Anatolian High School and gifted students towards errors in mathematics?" search for an answer to the question.

Purpose of the Study

The purpose of the study is to compare the perspectives of gifted students and students studying at Anatolian High School towards errors in mathematics lessons. The research question is;

- "What are the differences and similarities in the perspectives of students studying at Anatolian High School and gifted students towards errors in mathematics?"

Method

Research Model

The phenomenology design, one of the qualitative research methods, was used in the study. The phenomenology study is based on the examination of phenomena that are known but not in-depth knowledge (Yıldırım & Şimşek, 2013). The aim in phenomenology is to reveal the opinions and thoughts of the participants to reach the underlying meanings of the phenomenon to be investigated (Oiler, 1982). The data collection tool in phenomenological studies is mostly face-to-face interviews with participants (Christensen et al., 2011; Creswell, 2007). The steps used in the analysis of phenomenological studies; to record in the minutes, to reveal the meaning of the explanation, to form the meanings; clusters of themes, detailed description, fundamental structure (Colaizzi, 1978).

In this study, reveal how the errors made in the mathematics lesson were perceived by the Gifted students and Anatolian High School students. A semi-structured interview form was used as a data collection tool. While

analysing the data, recording the minutes of Colaizzi (1978) for the analysis of phenomenological studies revealing the meaning of the explanation, forming the meanings; clusters of themes, detailed definition steps were followed. The thoughts of the Gifted Students and Anatolian High School Students towards the errors was determined as phenomenology study (Yıldırım & Şimşek, 2013) because of the examination of the students' opinions about the errors in order to reach students' thoughts about the errors made in the mathematics course, which is observed to be noticed in the literature but it is understood that the opinions of the individuals are not examined in depth (Oiler, 1982), using the semi-structured interview form as a data collection tool (Christensen et al., 2011; Creswell, 2007) and following the steps that Colaizzi (1978) put forward for the analysis of phenomenology studies.

Study Group of the Research

The sample of the research consists of 30 students who are studying in a city in Central Anatolia, who comply with the study criteria, volunteer to participate in the research and have parental permission. The study was carried out with a total of 30 students, 15 high school students studying in the project programme at the Science and Art Centre in the same city in the 2020-2021 academic year, and 15 high school students studying at an Anatolian High School in the same city who were not identified as gifted individuals who had previously taken the Science and Art Centre exam. The criterion sampling method, one of the purposeful sampling methods, was used as a sampling method. The basic understanding in this sampling method is to study all situations that meet a set of predetermined criteria. The criteria or criteria mentioned here can be created by the researcher or a pre-prepared criterion can be used (Yıldırım & Şimşek, 2005). The main criterion determined by the researcher in determining the participants is that the students included in the sample are diagnosed as gifted and non-special gifted individuals.

Data Collection Tool

A semi-structured interview form consisting of 8 questions was used as a data collection tool. After the necessary literature review was done, the questions were prepared by the researchers. Prepared interview The questions were analysed by three faculty members, two of whom are experts in the field of gifted education and one in the field of measurement and evaluation. With the suggestion of one of the faculty members, the first two questions were changed. While the question of "How do you act when you make an error in math class?" was converted in to the form of "How often do you make errors while solving questions in math class? How do you realize your errors? Can you give

examples from your experience?", the question of "Is there any question that you left unsolved or blank in order not to make errors in your mathematics lesson? Can you explain with an example?" was presented as a suggestion by the same faculty member. Additionally, "What is the reason for leaving the questions blank in order not to make errors in the math lesson?" was suggested by one of the experts. After the relevant changes were made, the final version of the semi-structured interview form was obtained. The interview questions are presented in the appendix. Each question was asked separately to the students. Fourth question was asked separately as three question. That's why there are eleven questions in the results findings section.

The ethical process in the study was as follows:

- Ethics committee approval was obtained from Kırşehir Ahi Evran University Social Sciences and Humanities Scientific Research and Publication Ethics Committee (Date: 03.02.2022, Number: 2021/6)
- Informed consent has been obtained from the participants and their parents.

Data Analysis

Content analysis was used in the analysis of the obtained data. Due to the pandemic, students were contacted via remote interview tools. In the interviews with the students, questions were asked to determine how often they made errors in mathematics lessons, what they did when they were afraid of making errors, what they did when they were afraid of making errors, how their errors were expressed by others (teachers, friends, etc.), and their perspectives on the discussion of errors.

Content analysis was used in the analysis of transcribed data. Since the data was transferred to prose, the record was taken on the minutes. The answers received from the students were read one by one by the researchers. Therefore, the step of recording Colaizzi (1978) to the minutes has been fulfilled. The answers given by the students to each question were read by the researchers and the expressions related to the concepts in the questions were determined. The meanings of the explanations were tried to be revealed by removing the unnecessary explanations (Colaizzi, 1978). Similar statements were noted. For the expressions noted by the researchers, codes were created with keywords and thus the meanings were formed (Colaizzi, 1978). The categories for the questions were created by using the expressions in the question statements. The resulting codes and categories are presented as a concept map. Categories, codes, frequencies showing the number of participants for

the code and category are specified in the concept map. Following the concept map, examples are given. Necessary explanations are provided by associating the sample expressions with the category and code (Colaizzi, 1978).

Validity and Reliability

The validity of this research has been tried to be ensured by the detailed reporting of the data obtained from the interviews. One of the ways to ensure validity in qualitative studies is to report the data in detail (Yıldırım & Şimşek, 2016). In order to ensure internal validity, a conceptual framework was created by reviewing the relevant literature during the preparation of interview questions. In this way, while descriptive analysis was made on the data obtained, it was tried to provide a scope to include the relevant concepts. Regarding the research process in order to ensure external validity in the research; the subjects of determining the participants, interview environment, conducting the interviews, conveying the participant's views one-to-one and data analysis were explained in detail. Personal information of the students was kept confidential in the presentation of the findings. In this qualitative research, expert opinion was sought in order to ensure the internal validity, credibility and consistency of the interview form. The reliability and validity of the prepared interview questions were also determined using the formula developed by Miles and Huberman (1994). The percentage of agreement between the experts was realized at the rate of 90%, and the validity and reliability of the interview questions were tried to be ensured.

Comparisons made by the researchers were checked for consistency. The reliability of the research was determined by determining the number of consensus and disagreement in the comparisons. Miles and Huberman's (1994) $\text{Reliability} = \frac{\text{consensus}}{\text{consensus} + \text{disagreement}}$ formula was used. According to Miles and Huberman (1994), the consensus among coders is expected to be at least 80%. A consensus (reliability) of 90% was achieved in this study.

Results

The findings obtained from the interviews with gifted students and Anatolian High School students are presented through diagrams. In the given diagrams, the answers on the right (green) belong to the gifted students, and the answers on the left (orange) belong to the Anatolian High School students.

Gifted Students and Anatolian High School Students' Opinions on Making Errors

The codes for the students' answers to the question of "Is there any question that you leave unsolved or blank in order not to make errors in the math lesson?" are presented in Figure 1.

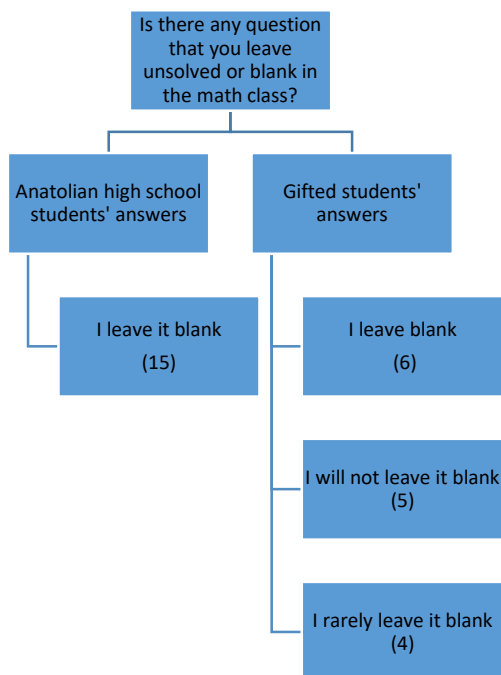
In Figure 1, it is seen that the answers of the gifted students consist of 3 different categories, and the answers of the Anatolian High School students consist of 1 category. While 6 of the gifted students were answering as "I leave it blank", 5 of them "I do not leave it blank" and 4 "I rarely leave it blank.", all of the Anatolian High School students answered as "I leave it blank."

In the interview, G1 said, "No, it never happens because I am not afraid of making errors. I think that I will definitely learn the result of my error in every test and every exam. He can get out by doing the right thing in another way. The questions I left blank are only questions that I could not generate ideas for, that I did not know at all, and that I did not see such a question in my life ", and G5 said "I try to do all of them. I can't leave it blank " and G9 " No, I try to do all of them ." found in the statement.

Also, A2 " Yes, sir .", A6 "Yes, there can be several." and A10 replied " Of course it does ".

Figure 1.

Codes Related to "Making Errors" Category



Opinions of Gifted Students and Anatolian High School Students on Leaving the Questions Blank in order not to Make Errors

The codes for the answers of the students, who stated that they left the questions blank in order not to make errors, to the question that "What is the reason for leaving the questions blank in order not to make errors in the math lesson?" are presented in Figure 2.

As seen in Figure 2, it is seen that the answers of the gifted students consist of 3 different categories, and the answers of the Anatolian High School students consist of 5 different categories. On the process of listing the reasons for leaving blanks in the mathematics lesson, while 6 of the gifted students were stating as "Preventing making errors, 1 of whom "In the case of have not learnt the topic" and 2 of whom "Because I am not sure", 5 of the Anatolian High School students answering as "Because the wrong answers take the correct answers", 2 of whom answering as "To solve it later", 1 of whom answering as "Because I could not solve the question", 2 of whom answering as "For not giving wrong answers" and 1 of whom answered "Because I was depressed".

G4 of the students said that "Leaving blank takes less correct answers, that's why. In order not to take risks", G8 "If I am not sure at all, of course I leave it blank" and G7 found in the statement. "If I have not learnt the subject of the question, I leave it blank." In addition, A13 replied as "I sometimes leave it blank in order not to reduce my motivation for questions that I have difficulty or think I cannot do", and A14 "So when I make an error, I cannot correct that error again, so when I leave it blank, at least I do not take the risk of that error. When I make an error, something will go away, but when I leave it blank, nothing will go away from me" and A6 "That's why I'm doing it to return to them later.

Figure 2. 1

Codes Related to the Category of "Reasons for Leaving Questions Blank"

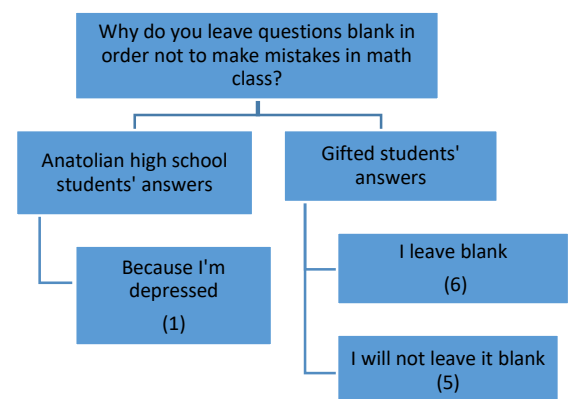
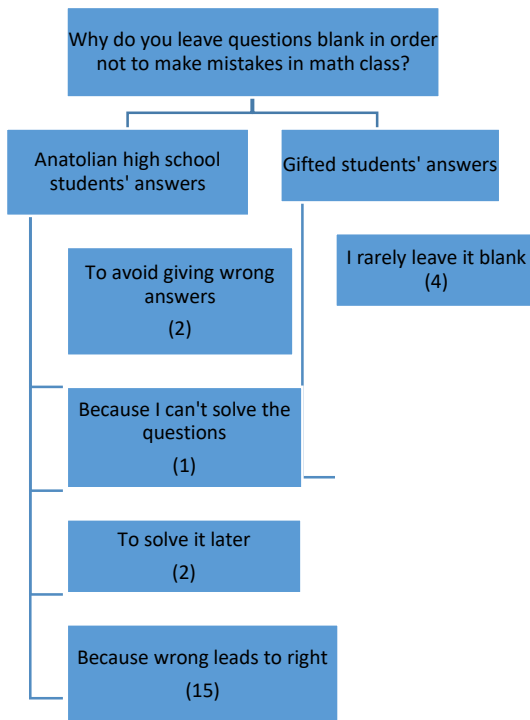


Figure 2. 2

Codes Related to the Category of "Reasons for Leaving Questions Blank"



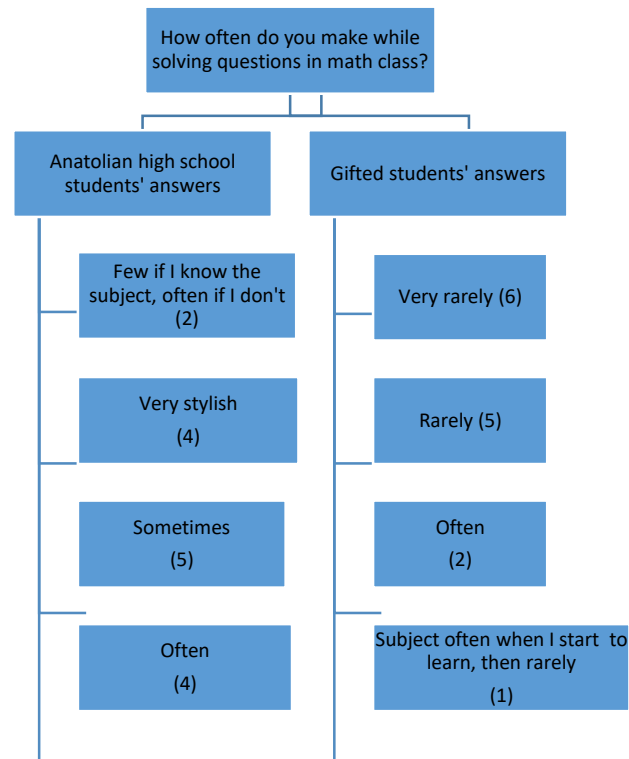
Opinions of Gifted Students and Anatolian High School Students on the Frequency of Making Errors

The codes for students' answers to the question that "How often do you make errors while solving questions in math class?" are presented in Figure 3. In Figure 3, it is seen that the answers of the gifted students consist of 4 different categories, and the answers of the Anatolian High School students consist of 5 different categories. When the students were asked about the frequency of making errors in mathematics lessons, 3 of the gifted students said "Very rarely", 9 "Rarely", 2 "Frequently" and 1 "Frequently at the beginning of the subject, it decreases over time." gave the answer. In addition, 4 of the Anatolian High School students stated "Often", 5 "Sometimes", 4 "Very often", and 2 "If I know the subject little, if I don't know very often" found. In the interview, G7 said, "My teacher, I leave it blank mostly because I couldn't solve it, not to avoid making errors, because when I solve it, I act by thinking that I have solved it correctly. Therefore, there is no question that I left blank in order not to make an error. I rarely make errors.", G10 "Rarely." and G2 "My teacher, I often make errors at the math is not good at all, my teacher." and A7 stated as "I make errors very often." and G2 "My teacher, I often make errors at the beginning of the subject, but it decreases over time." gave the answer. In addition to this, A4 of the students said "I am doing quite less errors right now because I am studying as I am preparing for the exam", and

A3 stated that "I often make errors while solving questions because my math is not good at all, my teacher." and A7 stated as "I make errors very often."

Figure 3.

Codes Related to the Category of "Frequency of Error"



Opinions of Gifted Students and Anatolian High School Students on How They Feel When They Make Error

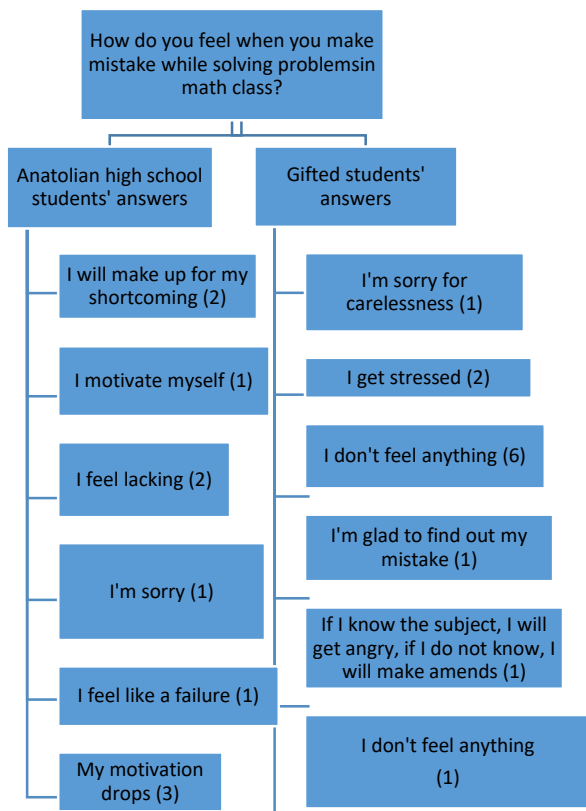
The codes for students' answers to the question of "How do you feel when you make an error while solving questions in the math lesson?" are given in Figure 4. In Figure 4, it is seen that the answers of the gifted students consist of 6 different categories, and the answers of the Anatolian High School students are again 6 different categories. When the students were asked how they felt when they made an error, 1 of the gifted students said, "I feel sad rather than carelessness", 2 of them "I get stressed", 6 of them "I don't feel anything", 1 of them "I am glad to learn about my error.", 1 of them "If I know the subject, I will get angry, if I do not know, I will make amends." and 1 of them gave answer as "I am ashamed of myself.". In addition, 3 of the Anatolian High School students said that "My motivation drops", 1 of them "I feel unsuccessful", 7 of them "I feel sad", 1 of them "I motivate myself" and 2 of them expressed their opinion as stating "I make up for what I lack."

During the interview, among students G3 replied as "I think I need to work harder", G5 "Frankly, I get very upset when

I'm careless. Because being careless about the questions I've worked so hard for makes me feel bad. But I don't get upset at all when I don't know or know my error, I learn in a different way just because it's like this. If there are two ways, I even learn two ways. I don't just learn the easy way to me." and G1 said, "If I know the subject, I will get angry, if I do not know, I will make up for it." In addition to this, A8 "I'm bored ", A11 "I mean, my teacher, the score goes away, even in the university exam, you know 40 questions in mathematics. People feel up set ." and A6 found in the statement that " I try to make up for what I lack ."

Figure 4.

Codes Related to the Category of "Feelings When Errors are Made"



Opinions of Gifted Students and Anatolian High School Students on Fear of Making Errors

The codes for students' answers to the question that "How much do you fear making errors in math class?" are given in Figure 5. In Figure 5, it is seen that both the answers of the gifted students and the answers of the Anatolian High School students consist of 3 different categories. In the interview, While 10 of the gifted students giving their answers as "I'm not afraid", 1 of them "I'm afraid." and 4 of them "Sometimes I get scared.", 3 of the Anatolian High School students expressed their opinions as "I am not afraid.", G8 "Making errors does not scare me ." and G12 " Maybe it will scare me if I make a lot of errors, but

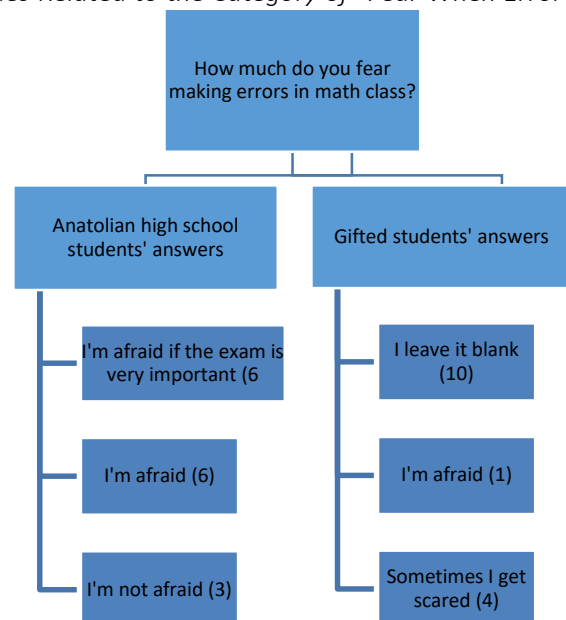
usually I am not afraid because I don't make many errors .". From Anatolian High School students A7 found in the statement that "If the exam is important, of course I am afraid .", A2 said " I am afraid, teacher because I do not want to fail ." and A10 stated that "I am not afraid, I choose to try harder instead ." afraid.", 6 of them "I am afraid." and 6 of them "I'm afraid if the exam is very important.".

The codes for students' answers to the question that "How much do you fear making errors in math class?" are given in Figure 5. In Figure 5, it is seen that both the answers of the gifted students and the answers of the Anatolian High School students consist of 3 different categories. In the interview, While 10 of the gifted students giving their answers as "I'm not afraid", 1 of them "I'm afraid." and 4 of them "Sometimes I get scared.", 3 of the Anatolian High School students expressed their opinions as "I am not afraid.", 6 of them "I am afraid." and 6 of them "I'm afraid if the exam is very important.".

In the interview, among the students G5 gave the answer as " No, it doesn't scare. Making errors makes me more ambitious.", G8 "Making errors does not scare me ." and G12 " Maybe it will scare me if I make a lot of errors, but usually I am not afraid because I don't make many errors .". From Anatolian High School students A7 found in the statement that "If the exam is important, of course I am afraid .", A2 said " I am afraid, teacher because I do not want to fail ." and A10 stated that "I am not afraid, I choose to try harder instead ."

Figure 5.

Codes Related to the Category of "Fear When Error Made"



Opinions of Gifted Students and Anatolian High School Students on What They Do When They Are Afraid of Making an Error

The codes for the answers given to the question of "What do you do when you are afraid of making errors in math class?" are given in Figure 6. In Figure 6, it is seen that the answers of the gifted students consist of 5 different categories, and the answers of the Anatolian High School students consist of 8 different categories. In the interview, 2 of the gifted students said "I leave it blank", 3 of them "I take a break", 2 of them "I think that I need to study more", 5 of them "I try different methods." and 3 of them expressed their opinion as "I increase my attention level". In addition, 4 of the Anatolian High School students gave answer as "I try not to make errors", 2 of them "I will make up for the part where I was wrong", 1 of them "I will skip that question", 1 of them "I don't know", 1 of them "Lesson from error" I remove it.", 1 "I do not reflect on my behaviour", 2 of them "I go over my errors." and 1 of them "I increase my attention level."

During the interview, students G2 "Maybe I will read the question once again.", G9 "When I am afraid of making an error, I leave the question blank ." and G10 "I will solve the question once again ." A8, from Anatolian High School students, said that "I will try harder. I try to calm down.", A2 stated that "I work on the topics of the questions I made errors ." and A14 expressed opinion as "I learn from my error."

Opinions of Gifted Students and Anatolian High School Students on Whether Making Errors Is Instructive

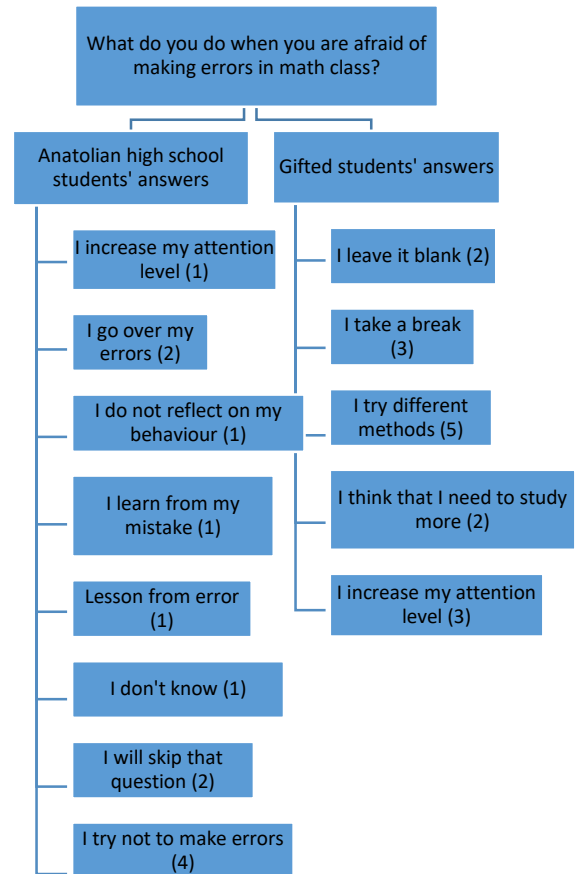
The codes for students' answers to the question of "What do you think about the instructivity of the errors you made in the math lesson for you?" are given in Figure 7.

In Figure 7, it is seen that the answers of the gifted students consist of 1 category and the answers of the Anatolian High School students consist of 2 different categories. In the interview, all of the gifted students found making errors instructive, 14 of the Anatolian High School students stated that they found it instructive, and 1 of them did not find it instructive.

One of the students G7 said, "I definitely think it is instructive because the errors we make show us the part of the subject that we do not understand. Here we take it to the teachers and they show us the correct. That's why they actually teach us the correct, just like in all other lessons. ",

Figure 6.

Codes Regarding What to Do in Case of Fear When Error Made



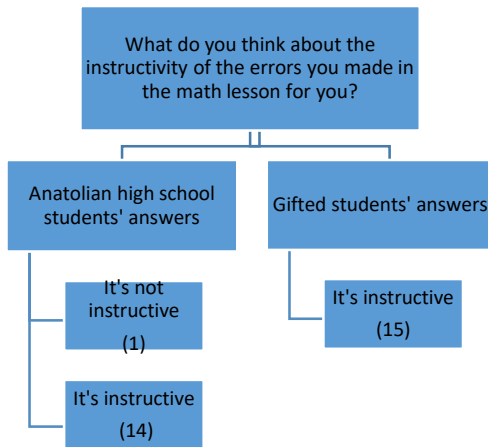
G2 stated "When I make an error, when I correct that error, I do not repeat the same error again. So it stays clearer in my mind." and G8 expressed opinion as "If I made an error in that question before solving the other questions and if I really found the correct answer, it allows me to solve the other questions correctly using that method". Also, about the instructivity of making errors A5 expressed that "So I don't do it again about that question about similar questions ... In fact, making errors and making errors are both good things, but it is not good if it is done too much. At least we can see our errors and learn a lesson." and A14 expressed opinion as "It is definitely instr productive, teacher, we learn the truth after making errors."

Opinions of Gifted Students and Anatolian High School Students on Expressing Their Teachers' Errors

The codes for students' answers to the question of "How do you respond to your teacher expressing your errors when you get a question wrong in the math class?" are presented in Figure 8.

Figure 7.

Codes Related to the Category of "Instructivity of Error"



In Figure 8, it is seen that the answers of the gifted students consist of 7 different categories, and the answers of the Anatolian High School students consist of 8 different categories. In the interview, 9 of the gifted students "I find it normal", 1 of them "It raises awareness", 1 of them "I like it", 1 of them "I find it positive." I benefit from the teacher's experience." 1 of them "I don't like it." and 1 of them expressed opinion as "I get mad at myself.". In addition, 1 of the Anatolian High School students was found in the statement that "This is what I want", 1 of them "It is very valuable", 3 of them "Good, important, good", 4 of them "helpful", 1 of them "I am hurt and ambitious.", 1 of them "Motivates.", 1 of them "I am happy." and 3 of them stated that "I find it normal."

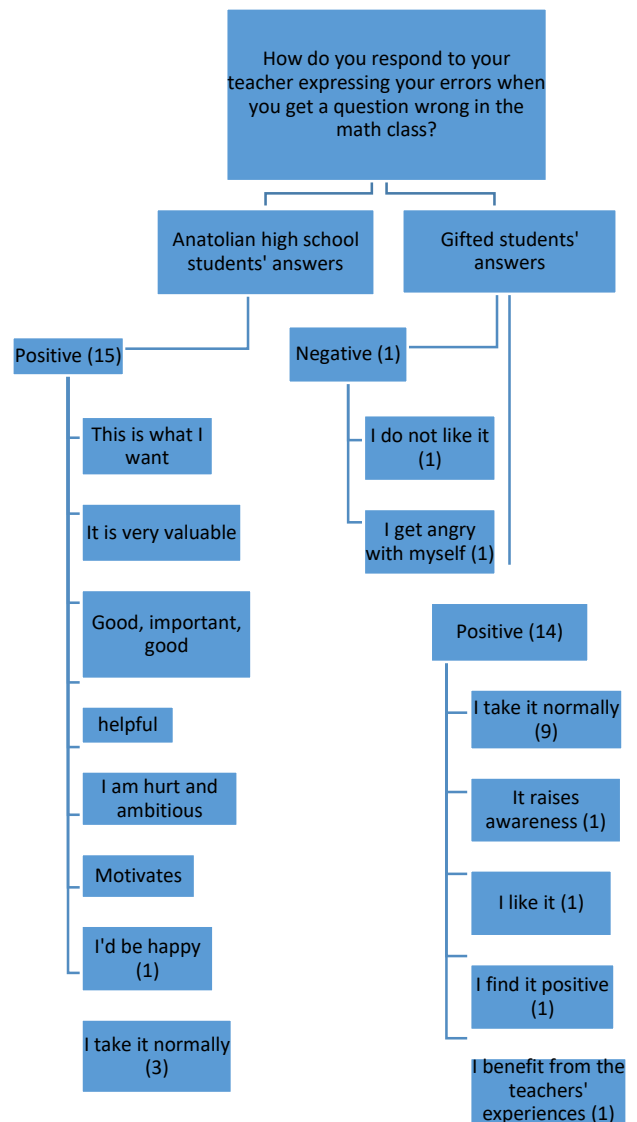
While gifted students G14 "Isn't this the way it should be?", G1 "It is very instructive for my teacher to express my error. It shows me over and over again that I'm usually careless ." and G13, " I don't like it, teacher .", A9 who is from Anatolian High School students expressed opinion as " Helps .", A10 stated that " So...it's a good thing because when I make an error, I want to learn the truth. I understand when my teacher tells me." and A12 said "I feel happy when my teacher tells me about my error, I think my teacher cares about me."

Opinions of Gifted Students and Anatolian High School Students on Expressing Their Friends' Errors

The codes for students' answers to the question that "How do you respond to your friends expressing your errors when you get a question wrong in math class?" are presented in Figure 9.

Figure 8.

Codes Related to the Category of "Teacher's Expression of Error"

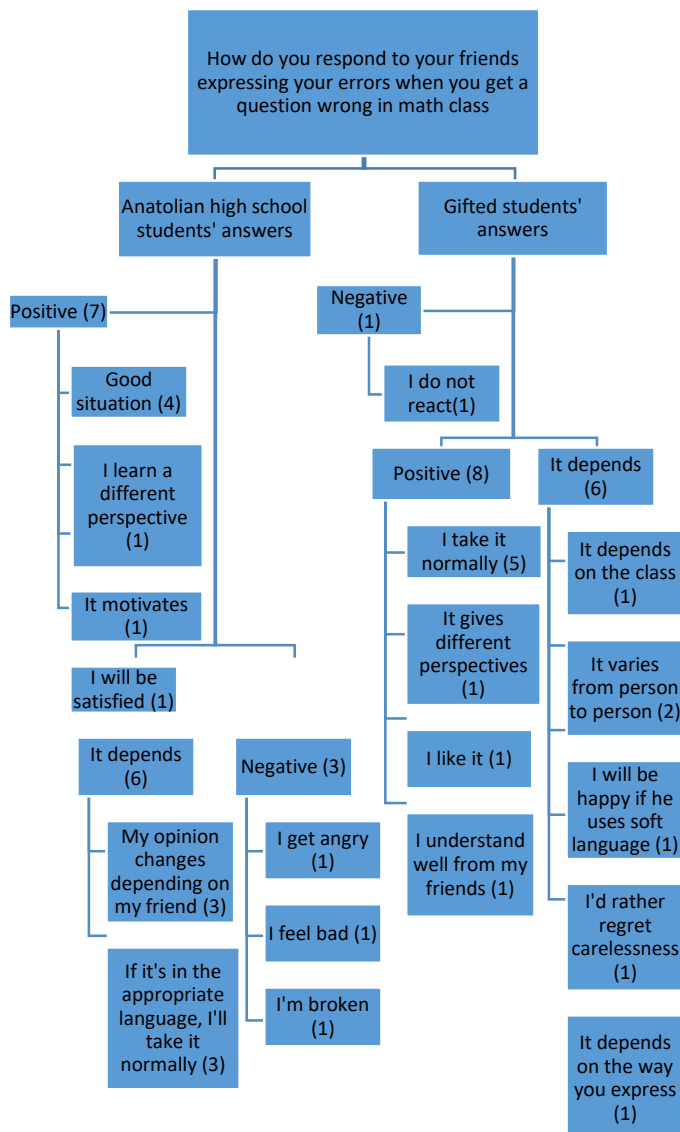


In Figure 9, it is seen that the answers of the gifted students consist of 10 different categories, and the answers of the Anatolian High School students consist of 9 different categories. In the interview, 5 of the gifted students were "Normal", 1 of them "Gives different perspectives", 1 of them "I understand well from my friends", 1 of them "I am happy if I learn new information.", 1 of them "Depends on the class I'm in.", 1 of them "I get upset rather than carelessness.", 2 of them "It depends on the person.", 1 of them "I will be happy if he uses soft language.", 1 of them "Depending on the way of expression changes." and 1 of them expressed opinion as "I don't react.". In addition, 4 of the Anatolian High School students said "It's a good situation", 1 of them "I learn a different point of view", 1 of them "Motivates", 1 of them "I am satisfied", 3 of them "My opinion according to my friend". changes.", 3 of them "If it

is in the appropriate language, I will accept it normally.”, 1 of them “I get angry.”, “I feel bad.” and 1 of them expressed as “I break.” While one of the gifted students, G4 giving answer a “Everything I did in the old class was making fun of everyone. That’s why I was bad. The current class is good so there is no problem. “, G10 “I don’t like him either. If he did it himself, let him fix it himself, I don’t need someone else to come and fix his error.” and G12 “I don’t react at all.” A 10 from Anatolian High School students said, “I welcome it naturally, my teacher. Where I make errors, they can make it right and correct me. I’d be happy with that. In the same way, I can do this too.”, A6 stated “I welcome it, my teacher, so it is something that can happen to everyone, I see it as normal.” and A3 expressed opinion as “I would feel bad in such a situation.”

Figure 9.

Codes Related to the Category of “Friends’ Expressing Errors”



Gifted Students and Anatolian High School Students' Opinions on What They Do When They See Their Friends' Errors

The codes for students' answers to the question of “What do you do when you see your friends' errors in math class?” are presented in Figure 10.

In Figure 10, it is seen that the answers of the gifted students consist of 7 different categories, while the answers of the Anatolian High School students consist of 6 different categories. In the interview, about the reaction given when they see the error of their friends in the mathematics lesson 2 of the gifted students gave answer as “I express their error”, 7 of them “I will help”, 1 of them “I warn”, 2 of them “Express with an empathetic and soft language I would say it.”, 2 “It varies from person to person.”, 1 “I say it when alone.” and 1 is “I don't react.”. In addition, 2 of the Anatolian High School students expressed views as “I convey the information I know”, 5 of them “I will tell without being offensive”, 1 of them “I will tell when I am alone”, 4 of them “I will help”, 1 of them “I will inform the teacher” and 2 of them “I wouldn't say it's wrong.”.

While one of the gifted students G9 gave answer as “I can explain if they want . Of course, if he wants to.”, G7 “I mean, if we are actively teaching at that moment, I don't say much because the teacher will solve the problem in a minute or two.

If we are in recess or something, I often say that the solution to this problem was like this .” and G15 “I do not prefer to tell my friend's error in the classroom environment. I say it when I find him alone. I don't want your pride hurt .”, A5 replied that “I try to help as much as I can, if I thought that I would help what I understood as well as help.

They replied that “I try to help as much as I can, if I thought that I would help what I understood as well as help. I try to be supportive as much as I can.”, A1 stated “I usually try not to offend them. I'm showing you the way, so if you solve it like this, you will reach the result like this, so without hurting .” and A11 expressed opinion as “I don't often tell my friends about my error.”

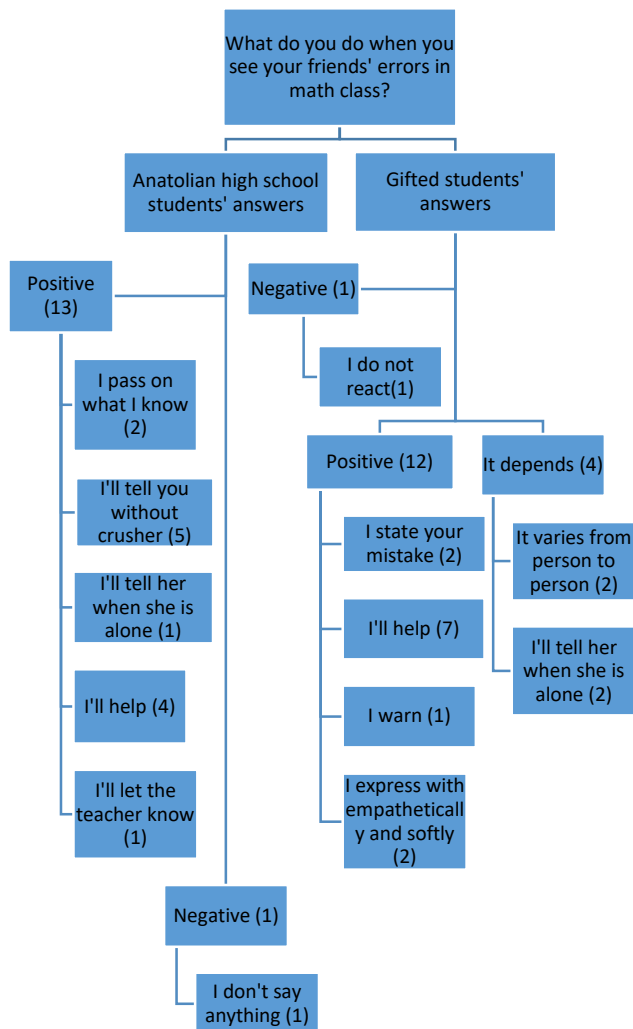
Gifted Students and Anatolian High School Students' Opinions on Discussion on Errors

The codes for students' answers to the question of “How is your perspective on discussing?” are as follow.

The answers of the gifted students consist of 4 different categories, while the answers of the Anatolian High School students consist of 2 different categories. In the interview, while 2 of the gifted students said “It should definitely be

Figure 10.

Codes Related to the Category of "Friends' Reaction to Error"



discussed", 1 of them "must be discussed", 1 of them "I am undecided." and 1 of them "Not required.", 14 of the Anatolian High School students answered as "It should be discussed on the situation."

While G5 who is among from gifted students, stating that "I can say it's my favourite thing, I like to discuss the errors I made the most. For example, I turned out to be wrong, I don't like comparing my error with my friend, I like to proceed by thinking why we did this. Maybe I'll change my working style. I can change my reading style, decoding technique. For example, in high school entrance exam, for example, last year, some people start from science and some people from mathematics. I compared the number of wrong answered questions. I was doing it starting from science. My friend had more unanswered questions. He said that he could not read any more mathematics questions, when he started from mathematics and compared to mathematics, although he did not have a

science education, compared to mathematics .", G9 "I think errors can be discussed because, as I said, each person has a different point of view and solving errors from different perspectives can be discussed ." and G8 "I don't think it's necessary to discuss errors .", A8 replied, " So, normal, normal .", A9 " This is a very good thing, actually.. It increases our determination to work with each other." and A1 expressed opinion as "I think bugs are something we should discuss."

Discussion

Although the teaching of mathematics operations and activities at an early age, mathematics is a science for abstract thinking as a mental system (Umay, 1996). The abstractness of mathematics is one of the sources of error in mathematics. Inaccurate and incomplete knowledge learned in the primary education creates a problem for students when transitioning to secondary education. It also causes a decrease in the success rate. Teachers have a great role in preventing the problems that may arise in the education chain. If teachers consider errors as a powerful tool that reveals students' "learning difficulties" (Borasi, 1987), they can also reveal students' thoughts about mathematics (Ingram et al., 2015). Including errors in the teaching process by taking into account provides great benefits in terms of mathematics education.

In the research, When the students were asked the question of "Is there any question that you leave unsolved or blank not to make errors in mathematics lesson?", all of the Anatolian High School students remarked that they left it blank, while 6 of the gifted students said "I leave it blank" and 5 of them "I do not leave it blank" and 4 "I rarely leave it blank." gave the answer. Furthermore, when the students who indicated that they left the questions blank in order not to make errors were asked the question of "What is the reason for leaving the questions blank in order not to make errors in the mathematics lesson?", the majority of the gifted students gave the answer "Preventing the error", while the majority of the Anatolian High School students said "Because it takes the wrong truth". Based on the findings, the Anatolian High School students were more likely to leave the questions unsolved or blank not to make errors. It is thought that some of the anxiety and prejudices of the students caused the students to leave the questions

blank in order not to make errors. Identifying the prejudices of students in terms of education is important in building new knowledge on existing knowledge (Bransford et al., 2000). Additionally, it can be said that the parents, as models, express that people are afraid of mathematics and that mathematics is difficult (Thomas, 1998), which causes

students to leave some questions unsolved or blank not to make errors. In addition, Keklikçi and Yılmaz (2013) stated that the stress created by the exams students take in order to pass to higher education institutions and the results of these exams triggers the fear of mathematics.

In the interviews, when the question of "How often do you make errors while solving questions in the mathematics lesson?" was asked to students, the majority of gifted students answered "Very rarely" and "Rarely", while the majority of Anatolian High School students answered "Often", "Sometimes" and "Very often". In the scope of the findings, Anatolian High School students make errors more frequently. Ingram et al., (2015) emphasized that errors and misconceptions are important for both students and teachers in learning mathematics in the literature. It is thought that students' learning from their errors and turning to the benefits of making errors in learning mathematics will positively affect their success. In addition, many researchers stated that errors also develop higher-order thinking skills (Dweck, 2012; Moser et al., 2011; Melis 2004). Soncini et al., (2021) also stated that teaching strategies related to error have a positive impact on students' thinking differently. Moreover, Janet (2017) emphasized that instead of preventing errors in learning, encouraging students will contribute positively to examining questions and solutions.

In the interviews, when the question of "How do you feel when you make an error while solving questions in the mathematics lesson?" was asked to the students, 6 of the gifted students said "I don't feel anything.", 2 of them said "I get stressed." 1 of them "I feel sad rather than carelessness", 1 of them "I will be glad to learn about my error", 1 of them "I will get angry if I know the subject, if I do not know, I will make up for it." and 1 of them gave answer as "I am ashamed of myself.". Additionally, 7 of the Anatolian High School students answered as "I feel sad", 3 of them "I lose my motivation", 2 of them "I make up for my deficiency", 1 of them "I feel unsuccessful", 1 of them "I feel incomplete." and 1 of them stated "I motivate myself". It is observed that Anatolian High School students are more emotionally affected by the errors they make. Şahin (2004) emphasized that although math anxiety is a multidimensional anxiety, it is intertwined with the concepts of fear, tension, uneasiness and anxiety.

Furthermore, Ufuktepe (2009) expressed the fear of mathematics as people's tension in solving mathematical problems they encounter in real life, interruption of thinking process, stress or fear in operations with figures or numbers. Civelek et al. (2001) stated that this fear is an important factor affecting the development and emergence of human mathematical abilities. Considering

the fears in students from this point of view, teachers have great duties in the occurring of students' mathematical abilities.

In the interviews with the students, when the question of "How much does it frighten you to make an error in the mathematics lesson?" was asked, the majority of gifted students stated that they were not afraid, while the majority of Anatolian high school students stated that they were afraid. In addition, when the students were asked the question of "What do you do when you are afraid of making errors in math class?", it was seen that the answers of the students in both groups varied greatly. Based on the findings, it can be said that Anatolian High School students are more afraid of making errors in mathematics lessons. Some of the students stay away from mathematical activities for fear of making errors. In studies on mathematics anxiety and fear, it was stated that with the increase in students' negative experiences about mathematics, their positive attitudes towards mathematics decreased. Although the role of the teacher and the school in the formation of this change is great, it will not be possible to increase the success of mathematics unless this negative attitude is eliminated (Altun, 2001). It is emphasized that one of the most important reasons behind the failure of students in mathematics lessons is the negative attitude towards the lesson (Altun, 2001; Çiftçi, 2010; Dursun & Bindak, 2011; Yenihayat, 2007; Şentürk, 2010). In some studies, it has been determined that developing a positive attitude towards mathematics is seen as one of the rules that must be followed in order for mathematics teaching to reach its goal (Altun, 2001; Arı et al., 2010; Koca, 2011; Mirasyedioğlu & Peker, 2008; Şentürk, 2010; Yenilmez & Özabacı, 2003).

In the interviews, when the students were asked the question of "What do you think about the instructiveness of the errors you made in the mathematics lesson for you?", all of the gifted students and the majority of Anatolian High School students are found in the statement of "instructive." In parallel with these statements of the students, it has been stated in many researches in the field of mathematics that errors are a guide for efficient teaching for teachers and for students in terms of instruction. (Borasi, 1987; Brown & Callahan, 1985; Dede & Peker, 2007; Fisher & Lipson, 1986; Yıldız et al., 2015).

In addition, during the interviews, when the students were asked the question of "How do you respond to your friends expressing your errors when you get a question wrong in the math lesson?", the answers were received from gifted students and Anatolian High School students in the form of positive, negative and it could change according to the

situation. The answers of the majority of the students in both groups were positive and varied according to the situation. These statements reveal that students allow their friends to express their errors. If individuals are provided with the opportunity to identify errors, and they are supported in the subject that the error made, an improvement in the level of conceptual knowledge can be seen (Borasi, 1986; Özkaya, 2015). Besides, Janet (2017) stated that encouraging instead of preventing errors in learning would contribute positively to students' questions and solution.

During the interviews, the students were asked the question of, "What do you do when you see the errors of your friends in the math class?". The majority of both Anatolian High School students and gifted students positively answered this question. Borasi (1994) thought that in order for learning to be meaningful, it is necessary to interpret the thinking processes during the detection and verification of errors, which supports students' views. It is thought that students' questioning each other's answers will also benefit students. Konyalıoğlu, Kaplan, Selvitopu et al., (2011) emphasized that someone who can correctly question the error internalizes that concept. Moreover, errors play a key role in understanding the correct solution (Ginat, 2003).

During the interviews, the students were asked the question of, "What do you do when you see the errors of your friends in the math class?". The majority of both Anatolian High School students and gifted students positively answered this question. Borasi (1994) thought that in order for learning to be meaningful, it is necessary to interpret the thinking processes during the detection and verification of errors, which supports students' views. It is thought that students' questioning each other's answers will also benefit students. Konyalıoğlu, Kaplan, Selvitopu et al., (2011) emphasized that someone who can correctly question the error internalizes that concept. Moreover, errors play a key role in understanding the (1989) stated that the knowledge learned through errors gained permanence, and the interest and curiosity in this knowledge was much higher. In addition, in studies on learning from errors, it was observed that students began to question questions more and approached the given question-solutions with a critical perspective (Booth, Begolli & McCann, 2016). These statements reveal the discussing the errors in mathematics education.

Conclusion and Recommendations

Based on the findings, the Anatolian High School students were more likely to leave the questions unsolved or blank not to make errors. In the scope of the findings, Anatolian High School students make errors more frequently. It is observed that Anatolian High School students are more emotionally affected by the errors they make. It can be said that Anatolian High School students are more afraid of making errors in mathematics lessons. All of the gifted students and the majority of Anatolian High School students see the errors "instructive". Each group of the students respond positively to their teachers' expressing their errors. The answers of the majority of the students to the responding to friends' answers in both groups were positive and varied according to the situation. These statements reveal that students allow their friends to express their errors. Each group of students agree with the idea that errors should be discussed in the class.

In the study, it was seen that students' avoidance of making errors prevented them from gaining some knowledge that they could learn in mathematics. In this context, it is thought that it would be appropriate for teachers to encourage students not to be afraid of making errors, based on the idea that if students see errors as failures and avoid them, their brains will not develop and they will miss development opportunities. Thus, it is thought that students' perspectives on errors will change in a positive way. The lack of sufficient research on this subject in the literature suggests that the subject should be examined among teacher candidates, students and teachers. If the study is conducted with more student participation, it can become more effective. And also, it is thought that it would be beneficial to include seminars on the importance of errors in mathematics education for teachers through in-service training.

Ethics Committee Approval: Ethics committee approval was obtained from Kırşehir Ahi Evran University Social and Humanitarian Ethics Committee (Tarih: 03.02.2022, Sayı: 2021/6)

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References

- Altun, M. (2001). *Teaching mathematics in the second stage of primary education*. Alfa.
- Arı, K., Savaş, E. & Konca, Ş. (2010). Examining the causes of mathematics anxiety among 7th grade primary school students. *Journal of Ahmet Kelesoglu Education Faculty*, 29(1), 211-230.
- Berman, W. (2006). When will they ever learn? Learning and teaching from mistakes in the clinical context. *Clinical Law Review*, 13, 115-141. <https://ssrn.com/abstract=874070>
- Bickhard, M. H. (2004). The social ontology of persons. In J. I. M. Carpendale & U. Muller (Eds.), *Social interaction and the development of knowledge*, (111-132). Psychology Press.
- Bilgili, S., Özkaya, M., Çiltaş, A. & Konyalıoğlu, A. C. (2020). Examining middle school mathematics teachers' error approaches to modeling. *Journal of Social Sciences of Mus Alparslan University*, 8(3), 871-882. <https://doi.org/10.18506/anemon.637049>
- Booth, J. L., Begolli, K. N. & McCann, N. (2016). The effect of worked examples on student learning and error anticipation in Algebra. In M. B. Wood, E. E. Turner, M. Civil & J. A. Eli (Eds.), *Psychology of Mathematics & Education of North America* (pp. 551-556). Tucson, University of Arizona.
- Borasi, R. (1987). Exploring matematics through the analysis of errors. *For the Learning of Mathematics*, 7(3), 2-8.
- Borasi, R. (1988). *Towards a reconceptualization of the role of errors in education: The need for new metaphors*. Annual Meeting of the American Educational Research Association, New Orleans, LA.
- Borasi, R. (1989, March). *Students' constructive uses of mathematical errors: A taxonomy*. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA, USA.
- Borasi, R. (1994). Capitalizing on errors as "Springboards for inquiry": A teaching experiment. *Journal for Research in Mathematics Education*, 25(2), 166-208. <https://doi.org/10.2307/749507>
- Borasi, R. (1996). *Reconceiving mathematics instruction: A focus on errors*. Ablex Publishing.
- Bransford, J. D., Brown, A. L. & Cocking, R. R. (2000). *How people learn*. National Academy Press.
- Brown, S. I. & Callahan, L. (Eds) (1985). Using Errors as Springboards for the Learning of Mathematics [Special Issue]. *Focus on Learning Problems in Mathematics*, 7(3-4).
- Burns, M. (2007). *About Teaching Mathematics: A K-8 Resource* (3rd ed.). Math Solutions.
- Christensen, L. B., Johnson, B. & Turner, L. A. (2011). *Measuring variables and sampling. Research Methods, Design, and Analysis*. Boston, Pearson.
- Cockburn, A. D. (2005). *Teaching mathematics within sight*. Falmer Press.
- Colaizzi, P.F. (1978). Psychological research as the phenomenologist views it. In Valle RS, King M (Eds.) *Existential phenomenological alternatives for psychology*. Oxford University Press, New York.
- Civelek, Ş., Meder, M. & Tüzen, H. (2001). Problems encountered in teaching mathematics. http://www.matder.org.tr/index.php?option=com_content&view=article&catid=8:matematik-kosesi-makaleleri&id=62:matematik-ogretiminde-karsilasilanaksakliklar-&Itemid=38
- Creswell, J. W. (2007). *Quantitative, qualitative and mixed methods approach research design* (SB Demir, Trans. Ed). Anı.
- Çiftçi, Ş. (2010). *Problems of mathematics education in rural areas: an evaluation study from the perspective of teachers and students*. (Thesis Centre. No: 266403). [Unpublished master's thesis, Osmangazi University-Eskişehir]. Council of Higher Education National.
- Dede, Y. & Peker, M. (2007). Students' errors and misunderstandings regarding algebra: predictive skills and solution suggestions of prospective mathematics teachers. *Elementary Education Online*, 6(1), 35-49.
- Dweck, C.S. (2012). Teaching Mathematics for a Growth. In Personal Communication. *Mindset workshop*, Stanford, CA.
- Dursun, Ş. & Bindak, R. (2011). Investigation of mathematics anxiety of primary school second stage students. *Cumhuriyet University Journal of Social Sciences*, 35(1), 18-21.
- Fisher, K. M. & Lipson J. I. (1986). Twenty questions about student errors. *Journal of Research Science Teaching*, 23(9), 783-803. <https://doi.org/10.1002/tea.3660230904>
- Gardner, D. & Wood, R. (2009). Errors, feedback, learning and performance. *The Australasian Journal of Organisational Psychology*. 2(1),30-43. <https://doi.org/10.1375/ajop.2.1.30>
- Gartmeier, M., Bauer, J., Gruber, H. & Heid, H. (2008). Negative knowledge: Understanding professional learning and expertise. *Vocations and Learn*, 1(2), 87- 103. <https://doi.org/10.1007/s12186-008-9006-1>
- Ginat, D. (2003, February). *The Greedy Trap And Learning From Mistakes*, Proc of the 34th ACM Computer Science Education Symposium - SIGCSE, Nevada, 11-15. <https://doi.org/10.1145/792548.611920>
- Hansen, A. (2014). *Children's errors in mathematics*. Learning Matters Publishing.
- Heemsoth, T. & Heinze, A. (2016). Secondary school students learning from reflections on the rationale behind self-made errors: a field experiment. *The Journal of Experimental Education*, 84(1), 98-118. <https://doi.org/10.1080/00220973.2014.963215>
- Heinze, A. & Reiss, K. (2007). Mistake-handling activities in the mathematics classroom: effects of an in-service teacher training on students' performance in geometry. In J.-H. Woo, H.-C. Lew, K.-S. Park & D.-Y. Seo (Eds.), *Proceedings of the 31st Conference of the International Group for the Psychology of Mathematics Education* (Vol. 3, 9-16). Seoul: PME.
- Ingram, J., Pitt, A. & Baldry, F. (2015). Handling errors as they arise in whole class interactions. *Research in Mathematics Education*, 17(3), 183-197. <http://dx.doi.org/10.1080/14794802.2015.1098562>
- Keklikçi, H. & Yılmaz, Z. (2013). Determining the relationship between primary school students' levels of fear of mathematics and their views on mathematics teachers. *Journal of Education and Teaching Research*, 2(3), 198-204.

- Kline, M. (1980). *Mathematics: The loss of certainty*. Oxford University Press.
- Koca, S. (2011). *Investigation of the differences in mathematics achievement, attitudes and anxieties of 8th grade primary school students according to their learning styles* [Unpublished master's thesis, Afyon Kocatepe University-Afyonkarahisar]. Council of Higher Education National Thesis Centre. No: 296359
- Konyalıoğlu, A., Kaplan, A., Selvitopu, H., Işık, A. & Tortumlu, N. (2011). Some determinations on conceptual learning of the concept of derivative. *Kazım Karabekir Faculty of Education Journal*, 22, 317-328.
- Kuhn, T. S. (1970). *Criticism and the growth of knowledge: Proceedings of the International Colloquium in the Philosophy of Science*, London. Cambridge University Press.
- Lakatos, I. (1976). Falsification and the methodology of scientific research programmes. In *Can theories be refuted?* (pp. 205–259). Springer.
- Lannin, J. K., Barker, D. D. & Townsend, B. E. (2007). How students view the general nature of their errors. *Educational Studies in Mathematics*, 66(1), 43-59. <https://doi.org/10.1007/s10649-006-9067-8>
- Mathan, S. A., & Koedinger, K. R. (2018). Fostering the intelligent novice: Learning from errors with metacognitive tutoring. In *Computers as Metacognitive Tools for Enhancing Learning* (pp. 257-265). Routledge.
- Miles, M. B. & Huberman A. M. (1994). *Qualitative data analysis: An expanded source book*. (2nd Edition). Sage Publications.
- Melis, E. (2004). *Erroneous examples as a source of learning in mathematics*. CELDA, 311–318. <https://pdfs.semanticscholar.org/17be/73f009cf0df2a4523f099fbf0db42180679a.pdf>
- Metcalfe, J. (2017). Learning from errors. *Annual Review of Psychology*, 68, 465-489. <https://doi.org/10.1146/annurev-psych-010416-044022>
- Mirasyedioğlu, Ş. & Peker, M. (2008). Pre-service elementary school teachers' learning styles and attitudes towards mathematics. *Eurasia Journal of Mathematics, Science & Technology Education*, 4(1), 21-26. <https://doi.org/10.12973/ejmste/75302>
- Moser, J. S., Schroder, H. S., Heeter, C., Moran, T. P. & Lee, Y. H. (2011). Mind your errors: Evidence for a neural mechanism linking growth mind-set to adaptive post error adjustments. *Psychological Science*, 22(12), 1484-1489. <https://doi.org/10.1177/0956797611419520>
- Movshovitz-Hadar, N., Zaslavsky, O. & Inbar, S. (1987). An empirical classification model for errors in highschool mathematics. *Journal for research in mathematics Education*, 18(1), 3-14. <https://doi.org/10.2307/749532>
- Oflaz, G., & Polat, K. (2022). Error analysis of eighth grade students' non-routine problem solutions. *Mehmet Akif Ersoy University Journal of Education Faculty*, 62, 1-41.
- Oiler, C. (1982). The phenomenological approach in nursing research. *Nursing Research*, 31(3), 178-181. <https://doi.org/10.1097/00006199-198205000-00013>
- Önal, H. & Aydın, O. (2018). Misconceptions and error examples in primary school mathematics lesson, *Journal of Educational Theory and Practice*, 4(2), 1-9. <https://dergipark.org.tr/tr/pub/ekuat/issue/38280/442698>
- Özkaya, M., & Konyalıoğlu, A. C. (2019). Error-based activities in the development of subject matter knowledge of secondary school mathematics teachers: Addition with fractions. *Journal of Bayburt Education Faculty*, 14(27), 23-52.
- Özkaya, M. (2015). *Investigating the effects of error-based activities on the professional development of mathematics teachers* [Unpublished doctoral dissertation] (No: 418259). Atatürk University, Erzurum.
- Parviainen, J. & Eriksson, M. (2006). Negative knowledge, expertise and organisations. *International Journal of Management Concepts and Philosophy*, 2(2), 140-153. <https://doi.org/10.1504/ijmcp.2006.010265>
- Peng, A. & Luo, Z. (2009). A framework for examining mathematics teacher knowledge as used in error analysis. *For the Learning of Mathematics*, 29(3), 22-25.
- Rach, S., Ufer, S. & Heinze, A. (2013). Learning from errors: effects of teacher straining on students' attitudes towards and their individual use of errors, *PNA*, 8(1), 21-30.
- Radatz, H. (1979). Error analysis in mathematics education. *Journal of Research in Mathematics Education*, 10(3), 163-172. <https://doi.org/10.5951/jresmetheduc.10.3.0163>
- Rushton, S. J. (2018). Teaching and learning mathematics through error analysis. *Fields Mathematics Education Journal*, 3(1), 1-12. <https://doi.org/10.1186/s40928-018-0009-y>
- Ryan, J. & Williams, J. (2007). *Children's mathematics 4–15: learning from errors and misconceptions*. Open University Press.
- Santagata, R. (2005). Practices and beliefs in mistake-handling activities: A video study of Italian and US mathematics lessons. *Teaching and Teacher Education*, 21(5), 491–508. <https://doi.org/10.1016/j.tate.2005.03.004>
- Şimşek, B. (2018). Examining the mistakes made by 7th grade secondary school students on algebraic expressions and the reasons for these mistakes [Master's thesis]. (No: 497271). Atatürk University, Erzurum.
- Tall, D. (1990). Misguided discovery. *Mathematics Teaching*, 132, 27–29.
- Thomas, R. (1998). *A Comparison Between Male and Female Mathematics Anxiety at Community College*. [Unpublished Master Thesis Central Connecticut University-Connecticut].
- Soncini, A., Matteucci, M. C., & Butera, F. (2021). Error handling in the classroom: an experimental study of teachers' strategies to foster positive error climate. *European Journal of Psychology of Education*, 36(3), 719-738. <https://doi.org/10.1007/s10212-020-00494-1>
- Şahin, F. Y. (2004). Mathematics fear levels of secondary school and university students. *Educational Sciences: Theory & Practice*, 3(5), 57-74.

- Şentürk, B. (2010). *The relationship between the general success, mathematics success, attitudes towards mathematics and mathematics anxiety of 5th grade primary school students* (Thesis No: 258064). [Unpublished master's thesis, Afyon Kocatepe University]. YÖK Thesis Center.
- Ubuz B. (1999). Student errors in general mathematics (calculus). *Mathematics World*, 5, 9-11.
- Umay, A. (1996). Mathematics education and measurement. *Hacettepe University, Journal of Education* 12(21), 145-149.
- Ufuktepe, U. (2009). Mathematics and fear. *Mathematics, Logic and Philosophy*, 7.
- White, A. L. (2005). Active mathematics in classrooms: Finding out why children make mistakes—and then doing something to help them. *Square One*, 15(4), 15-19.
- Wijaya, A., Retnawati, H., Setyaningrum, W., & Aoyama, K. (2019). Diagnosing Students' Learning Difficulties in the Eyes of Indonesian Mathematics Teachers. *Journal on Mathematics Education*, 10(3), 357-364. <https://doi.org/10.22342/jme.10.3.7798.357-364>
- Yenihayat, S. A. (2007). *Evaluation of the relationship between primary school students' mathematics anxiety and teachers' attitudes* (Thesis Centre. No: 241872). [Unpublished master's thesis, Yeditepe University-İstanbul]. Council of Higher Education National.
- Yenilmez, K. & Özabacı, N. Ş. (2003). A study on the relationship between attitudes towards mathematics and mathematics anxiety levels of boarding teacher training school students. *Pamukkale University Journal of Education*, 14(2), 132-146.
- Yıldırım, A. & Şimşek, H. (2013). *Qualitative research methods in social sciences*. Seçkin Publishing.
- Yıldız, P., Çiftçi, Ş. K., Ş. Akar, Ş. & Sezer, E. (2015). Mistakes made by 7th grade secondary school students in the process of interpreting algebraic expressions and variables, *Hacettepe University Institute of Educational Sciences Journal of Educational Research*, 1(1).

AAppendix

The interview questions are as follows:

1. Is there any question that you leave unsolved or blank in order not to make errors in your math lesson? Can you explain with an example?
2. How often do you make errors while solving questions in math class? How do you realize your errors? Can you give examples from your experience?
3. How do you feel when you make an error while solving questions in the math class? How much does making an error scare you? What do you do when you are afraid of making errors? Can you give an example from your experience?
4. What do you think about the instructiveness of your errors? Can you explain?
5. How do you respond to your teacher expressing your errors when you get a question wrong in the math class? What do your teacher's statements mean to you?
6. How would you respond to your friends expressing your errors in math class? What do your friends' statements mean to you?
7. How do you act when you see your friends' errors in math class? What is your perspective on discussing errors?