



ADA UNIVERSITY
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MASTER OF ARTS IN TEACHING AND LEARNING

Students' Difficulties in Learning Trigonometry

Ulkar Musayeva

Contact e-mail umusayeva14608@ada.edu.az

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STATEMENT OF AUTHENTICITY

I have read ADA's policy on plagiarism and certify that, to the best of my knowledge, the content of this thesis, entitled (Students' Difficulties in Learning Trigonometry), is all my work and does not contain any unacknowledged work.

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Abstract

The purpose of this qualitative study was to explore the reasons contributing to the high school students' underperformance in trigonometry in the state examination. The research was conducted to analyze the teachers' and students' perspectives regarding this issue. The data for the research was collected in two public schools in Baku through semi-structured interviews with four (4) mathematics teachers, focus group interviews with sixteen (16) students studying in 10th and 11th grades, and non-participant observations. The results of the research show that the reasons for high schoolers underperformance can be divided into two categories: teacher-related and student-related reasons. Among teacher-related reasons teachers' methods, teachers' self-efficacy (i.e., teachers' confidence, teachers,' and students' motivation) are emphasized whereas student-related reasons are shown as students' motivation and their perspectives about the relation of trigonometry to a real life. Apart from the teacher and student-related reasons, the study identifies that the lack of resources for teaching trigonometry also negatively affects the exam results. The findings were interpreted based on Lev Vygotsky's Social Constructivism Theory (1968).

Keywords: students' underperformance, students' difficulties, trigonometry, achievement

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Chapter 1: Introduction

Ojose (2015) stated that mathematics can solve problems across all disciplines. Indeed, with the help of their knowledge in mathematics, students can learn how to pose questions, investigate, create mathematical inquiries, and make sensible decisions, thereby enhancing their critical and logical thinking skills, which are the determining factors in students' academic performance (Chukwuyenum, 2013). Owing to its significant impact on human life, mathematics is a subject that must be a fundamental exam requirement for school graduation and for proceeding to higher education (Gravemeijer, Stephan, & Julie, et al., 2017).

Although the importance of mathematics as a subject cannot be denied, school students still encounter particular difficulties in grasping certain fields of mathematics. To specify, State Examination Center (SEC) of the Republic of Azerbaijan informed that high school students' math results in centralized examinations for the years of 2011-2022 were low, particularly in the trigonometry branch of the subject (State Examination Center, 2011-2022). Thus, since the problem has existed for more than ten years now, there is a need to explore the reasons behind it. Thapa (2016) stated that the outdated teaching methodology in schools for teaching trigonometry might affect students' academic performance. Paudel (2019), in turn, highlighted that a negative attitude of students toward trigonometry could be one of the reasons of poor test results. Being one of the core areas of mathematics, trigonometry is helpful and practical in different other fields as well. For instance, it is used in oceanography to calculate the height of sea levels and can also be applied in satellite systems (Ginsburg, 2016). Furthermore, trigonometry is applicable in aviation, criminology, marine biology, and navigation. This essential branch of math helps students develop their critical thinking skills in various contexts (Achariya, 2015;

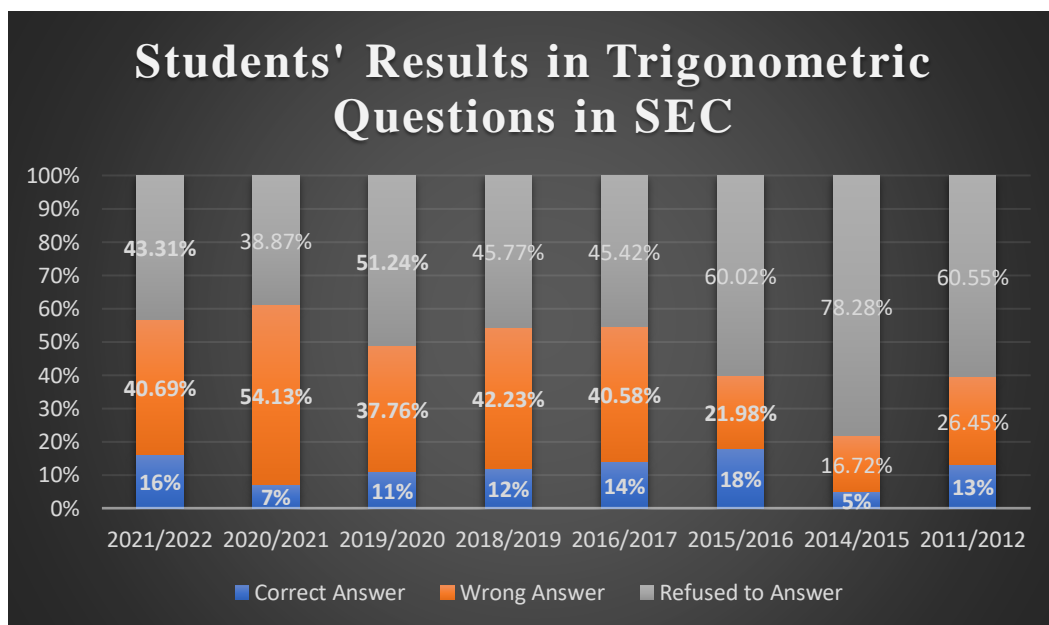
Courtney, 2016). Trigonometry is also crucial for continuing learning in higher education (Prihaswati, Mawarsari & Suprayitno, 2020).

Hence, the current study aimed at examining the underlying reasons for the high school students' poor test results in trigonometry during centralized state examination. The perspectives of the teachers and the students in public schools of Baku were in the focus of the study.

Statement of the Problem

State Examination Centre of the Republic of Azerbaijan analyzed the test results of senior grades students. The analysis was categorized into three parts: the percentage of students who answered trigonometry questions correctly, those who answered incorrectly, and those who refused to answer (State Examination Center, 2011-2022). During the academic years of 2021-2022, only 16% of students answered trigonometry questions correctly, while 40.69% answered incorrectly, and 43.31% left the questions blank (See Figure 1.).

Figure 1. Students' State Exam Center results in trigonometry questions during 2011-2022.



The statistical evidence from SEC displays a significance of the problem and poses the need for researchers to reveal the factors leading to the underperformance of high schoolers in the

centralized examinations. Before starting the study, a qualitative research method by interviewing four mathematics teachers from three different secondary public schools was employed to validate the existence of the problem. Two of the teachers had experience of teaching for more than 20 years, one for more than 13 years, and another one for 4 years. All the interviewed teachers were using the same textbooks approved by the Ministry of Science and Education of Azerbaijan. They also stated that students still are not interested in trigonometry, which adversely affects their performance.

Purpose of the Study

The purpose of this qualitative study was to explore the reasons behind the high school students' underperformance in trigonometry in the state examination in public secondary schools in Baku. To learn this, the teachers' and students' perspectives were examined and analyzed.

Research Question

The study was structured around the key question, which served to achieve research objective:

1. What are the main reasons contributing to students' underperformance in trigonometry?

Definition of Key Terms

Terms used in the study guided readers through the study.

Learning Difficulties – It entails general learning issues with reading, writing, and mathematics as well as subpar academic achievement (Lenhard & Lenhard, 2013).

Underperformance – A collection of actions, results, or attitudes that fall short of the mark is referred to as poor performance (Preckel, Holling, & Vock, 2006).

Significance of the Study

It is a fact that the performance of high school students in trigonometry is low (State Examination Center, 2011-2022); yet the reasons behind this problem are not examined sufficiently, thereby creating the need for conducting research in this direction. Taking the empirical evidence provided by State Examination Centre into account, the current master thesis has a purpose to identify the underlying reasons for the underperformance of high school students in trigonometry questions during centralized examinations. The perspectives of the main stakeholders, i.e., teachers and students, in two public schools in Baku were analyzed to answer the research question.

The findings of this research can help teachers to better understand the students' needs in tackling the problems in trigonometry and guide them through their achievements since trigonometry branch of math is essential also for advancing in higher education (Prihaswati, Mawarsari, & Suprayitno, 2020). Subjects in higher education, such as differential equations, integral calculus, and advanced calculus require adequate knowledge of trigonometry.

Besides, the findings of this research would enable curriculum developers and also it would be significant to consider supplementary materials for teachers.

The study can also suggest ideas for further research, and in the future, more stakeholders and private schools can be included into the sample of the studies to shed more light on the issue.

Chapter 2: Literature Review

As stated in Chapter I, the purpose of this qualitative study was to explore the reasons behind the high school students' underperformance in trigonometry in the state examination in public secondary schools in Baku. The research aimed to explore teachers' and students' perceptions about the existing problem. This review was organized around the following sections: A brief history and importance of trigonometry in real life, Reasons that contribute to difficulties in learning mathematics, Reasons that contribute to learning trigonometry, and a gap in the literature.

Origin and Significance of Trigonometry

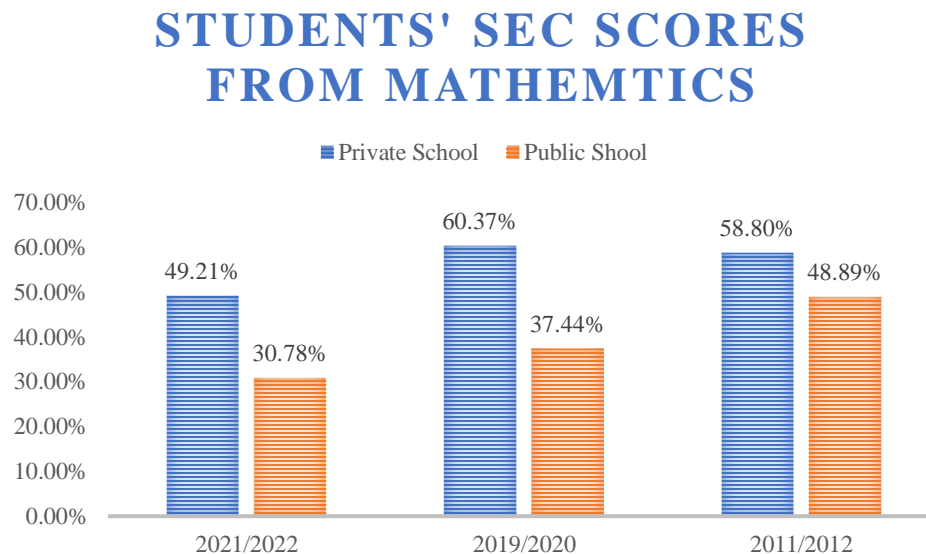
The term "trigonometry" comes from the Greek words – "tri" – three, "gon" – sides, and "metron" – measure. Trigonometry is the study of the relationships among a triangle's sides and angles. Trigonometry was first discovered in Egypt and Babylon (Archibald, 1929). It was first used by astronomers to calculate the distances of planets and stars from Earth. Even today, trigonometry is useful for measuring the height and distance of any objects such as buildings, which makes it applicable to real life (Ginsburg, 2016). In addition, trigonometry can be used in transportation, aviation, marine biology, and criminology. Besides, differential equations, integral calculus, and advanced calculus are the topics taught in higher education institutions which require the knowledge of trigonometry. For this reason, to progress in higher education, one should learn trigonometry in high school (Prihaswati, Mawarsari, & Suprayitno, 2020).

Reasons that Lead to Underperformance in Mathematics

Since the study focused on public schools, State Examination Center Statistics analysis of students' math exam results showed that public school students received lower math scores than

private school students (State Examination Center, 2011-2022). For instance, in 2021-2022, only 30.78% of Baku public school students answered math questions correctly (see *Figure 2*).

Figure 2. *Students State Exam Center scores from math in 2011-2022*



Some studies presented that students' attitude to mathematics is one of the reasons for students' low achievement in mathematics (Mazana, Suero Montero, & Olifage, 2019). The study was conducted to investigate students' attitudes toward learning mathematics in Tanzania. Both quantitative and qualitative data were collected from seventeen (17) primary and secondary schools and six (6) colleges. The results revealed that students had a positive attitude towards mathematics in primary years, nevertheless as they progress through education, the decline in the attitude is observed. Hence, a significant positive correlation was found between students' attitudes and their performance in mathematics. (Mazana, Suero Montero, & Olifage, 2019). As opposed to Mazana et al.'s findings, according to Akhter and Akhter (2018), students are enthusiastic about learning mathematics in higher grades. The quantitative study was conducted using a questionnaire in Pakistan with N = 647 sample of IX and X grade students. Based on the findings, students found mathematics to be interesting and valuable, indicating that they have a

positive attitude toward mathematics. However, their math performance was low due to teachers' inexperience.

Another quantitative study was conducted in North Carolina based on Reading and Math End-Of-Grade tests to identify if there is a link between teachers' self-efficacy and their students' academic performance on. The data was collected through surveys distributed to teachers from eight Pre-K through 8th-grade schools. The results showed that enhanced teacher self-efficacy has the potential to boost the working environment generally and student achievement in math consequently. (Eberle, 2011). Furthermore, according to Suharta and Parwati (2020), teacher self-efficacy, teacher content knowledge, and teacher pedagogic content knowledge are the reasons affecting students' performance in mathematics. Teachers' knowledge of teaching and learning processes is referred to as pedagogical content knowledge (Suharta & Parwati, 2020). The ex post facto design was used for this study. The samples were eight (8) 8th grade mathematics teachers and two hundred sixty-six (266) 8th grade students in Indonesia. The study revealed that there is a positive correlation between teacher content and pedagogic content knowledge and students' mathematics performance; however, there is no significant relationship between teacher self-efficacy and students' mathematics performance. Another study found a positive correlation between teachers' ability to explain mathematics and students' math achievement (Riconscente, 2014). The study was conducted in California, and three hundred twenty-six (326) 9th and 10th grade students were involved as participants. Also, a correlation between teacher's ability to explain content, students' self-efficacy, and interest in mathematics was identified. It means that teacher's competence to explain content affects the student's performance, self-efficacy, and interest in mathematics positively (Riconscente, 2014).

Reasons that Contribute to Underperformance in Trigonometry

Considering the low performance of public-school students in mathematics, the State Examination Center Statistics analysis in Azerbaijan revealed the fact that the main difficulty for students in mathematics is trigonometry branch (State Examination Center, 2011-2022). In the 2021-2022 academic year, for example, only 16% of students were able to correctly answer trigonometric questions in the centralized examination (See *Figure 1* in the Problem Statement section).

Adhikari and Subedi (2021) conducted a mixed method research to scrutinize the main challenges of 10th graders in both the quantitative and qualitative data were gathered through interviews with students, teachers, and math specialists and data from the students' achievement tests. Five of the one hundred fifty-five (155) students were chosen for the interview based on the purposive sampling method; those students scored low in the achievement test. Out of five students, two were from a private school and three from a public school. In total, three (3) mathematics teachers and five (5) students were chosen using convenient sampling method. The questions were designed to identify their main difficulties in learning trigonometry. According to the findings, the use of teacher-centered instruction, as well as a focus on rote memorization rather than conceptual understanding, and a lack of understanding of the trigonometry's importance to their daily lives were articulated as the reasons that influence students' performance in trigonometry (Adhikari & Subedi, 2021). Another quantitative research investigated the relationship between students' trigonometric function achievement and their teachers' content knowledge in this area (Ogbonnaya & Mogari, 2014). The study employed cognitive test for this purpose. To compare test results more effectively and gain a better understanding of the connection between teacher content knowledge and student achievement,

teachers and students took the same test, and it showed a statistically significant relationship between students' trigonometric achievement and teacher content knowledge. As a result, teachers' inadequate understanding of trigonometry contributed to increased confusion among students and learning challenges for them in trigonometry. The study shows that student achievement is positively and significantly correlated with teacher content knowledge in trigonometry (Ogbonnaya & Mogari, 2014). A different study utilized a quasi-experimental approach to explore two hundred eleven (211) senior secondary school students' performance based on inquiry and Polya's problem-solving methods (Ibrahim & Maruta, 2022). According to Polya (1945), there are four techniques to solve the problem successfully: 1) understanding the problem, which means teachers should make sure their students understand the wording and the problem itself; 2) devising a plan, which means finding the best and practical way to solve the problem; 3) carrying out the plan, which emphasizes care and patience; 4) looking back, which emphasizes reflection. The study revealed that learners who were taught by the inquiry and Polya's problem-solving methods behaved and performed better than those who were taught through the lecture method (Ibrahim & Maruta, 2022).

Gap in the Literature

The reviewed literature indicated that the use of teacher-centered instruction, the focus on rote memorization rather than conceptual understanding, and teacher content knowledge are the reasons that influence students learning in trigonometry (Adhikari & Subedi, 2021; Ogbonnaya & Mogari, 2014). There are also other variables, such as teacher self-efficacy, student attitude, and teacher's pedagogic knowledge affecting students' performance in mathematics. These reasons were studied and discussed in the existing literature; however, they were not explored specifically regarding trigonometry. In addition, the research which was conducted to explore

reasons influencing students' difficulties in learning trigonometry referred to the wide array of contexts from the USA, Africa, and Asia. However, the problem was not sufficiently explored in Azerbaijan. Therefore, as a gap, there is a need for additional research considering students' low performance and challenges in learning trigonometry in Azerbaijani schools (State Examination Center, 2011-2022).

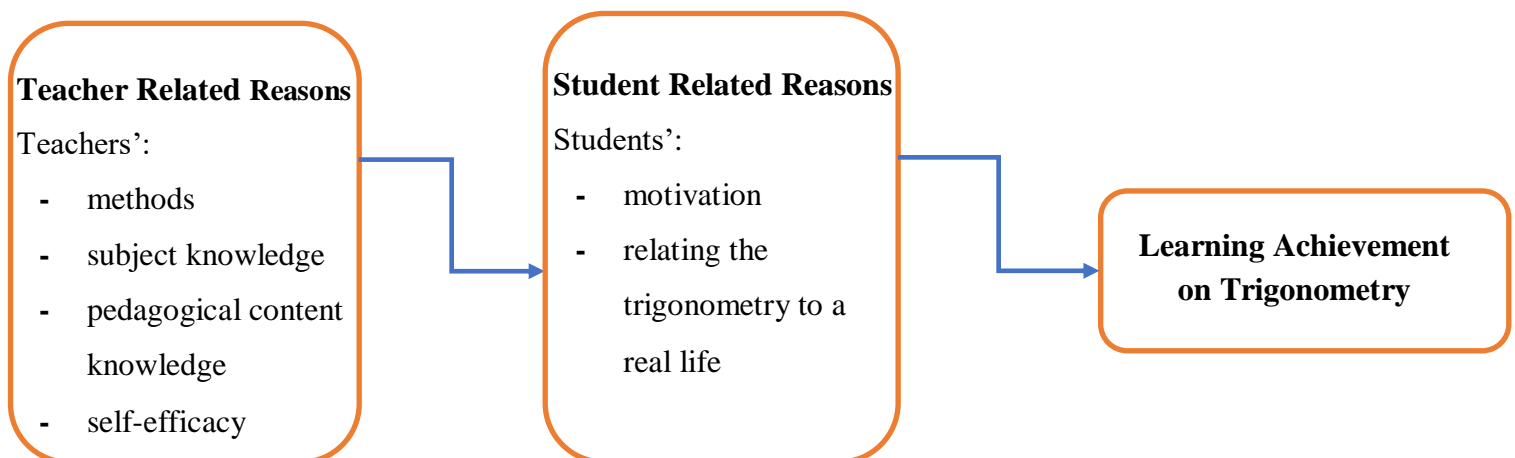
Theoretical Framework

Studies display that inquiry-based teaching method and Polya's problem-solving approach, which require student interaction, and in which teachers only scaffold the students in the learning process lead to better student performance in math (Ibrahim & Maruta, 2022). The Social Constructivism theory established by Lev Vygotsky (1968) also supports the same idea. According to Vygotsky, students can construct their learning when they are supported by their teachers or more capable peers through the Zone of Proximal Development (ZPD). Furthermore, the studies show that scaffolding aids learners to be competitive and smart (Bruner, 1960, 1966).

Considering the importance of social interaction and teachers' support in the learning process, the current study refers to Vygotsky's theory to better identify how high school students acquire new knowledge, more specifically, trigonometry.

Conceptual Framework

The conceptual framework has been developed based on the reviewed literature.



Chapter 3: Research Design and Methodology

The purpose of this qualitative study was to explore the reasons behind the high school students' underperformance in trigonometry in the state examination in public secondary schools in Baku. The research aimed to explore teachers' and students' perceptions regarding the existing problem. Based on the study purpose, the following research question guided the study:

1. What are the main reasons contributing to students' underperformance in trigonometry?

This chapter was organized around the following sections: research design and methods, target population, sampling, data collection process, the trustworthiness of the study, data analysis, ethical considerations, and the research process timeline.

Research Design and Methods

Creswell (2014) states that the choice of research design should depend on the study's purpose or objective for responding to the research question in the studied problem. For this study, an exploratory qualitative research design was chosen because the purpose was to explore the reasons behind the high school students' underperformance in trigonometry in the state examination through teachers' and students' perceptions of the difficulties in learning process in public secondary schools in Baku.

Qualitative research helped to conduct more in-depth investigation, on the grounds that it reflects real-world circumstances, people's lives, views, and perspectives (Yin, 2011). The goal of this design was not to offer complete and comprehensive solutions to the existing problem. Rather the aim was to delve deeper into the research topic and questions (Creswell, 2013).

Since this study did not test any theories and would not provide any mathematical description of variations (Creswell, 2013), the quantitative research method was not selected. In

this case, data-collection instruments, such as surveys and experiments were not used among participants.

Target Population

Creswell (2014) maintains that if the data are collected from the selected participants, the target population needs to be clearly specified. The targeted population in our case was 10th and 11th grade mathematics teachers and students since the purpose of this study was to explore the reasons behind the high school students' underperformance in trigonometry in the state examination (See *Figure 1* in the Problem Statement section), and teachers' and students' perceptions of the difficulties in learning trigonometry. Considering the low performances of students in trigonometry in centralized examination, there was a need to interview students and learn about their experiences and real stories (Seidman, 2013) which were relevant in exploring the answers to the research question of this study.

Another target population was teachers because reviewed literature revealed that teacher self-efficacy, teacher content knowledge, and methods are the reasons that affect students' learning (Mazana, Suero, Montero, & Olifage, 2019; Ogbonnaya & Mogari, 2014; Partida, 2022). In this case, there was a need to observe and interview teachers, which helped to study actual behavior and gather firsthand open-ended information (Creswell, 2014).

Sampling (for more information, See *Table 1* after Student Selection Section)

Convenient and purposeful sampling strategies suited best for this study (Merriam & Tisdell, 2016). Purposeful sampling assisted me in gaining a deeper understanding of the problem and having more adequate insight into the central phenomenon in the study (Creswell, 2007). Four (4) teachers and sixteen (16) students were chosen purposefully, and the schools were selected through convenient sampling.

School Selection (See *Table 1 below* Student Selection Section)

The participants were selected from two out of three hundred twelve (312) public schools in Baku (Bakı Şəhər Üzrə Təhsil İdarəsinin Tabeliyində Olan Ümumtəhsil Müəssisələri, n.d.). The school names were coded as School A and School B. I purposefully chose public schools because in the State Examination Center Statistics (2011-2022) analysis of students' exam results in mathematics from various regions of the country, the highest results in this subject are primarily from private schools in Baku for all years. When looking at the list of schools with high Math results, public schools in Baku were only displayed in it in 2011-2012, 2019-2020, and 2021-2022 (See *Figure 2* in the Literature Review section). However, when comparing the same years with those of private schools, the results of public schools are lower than private schools. In 2020-2021, for example, the percentage of Baku public schools students answering math questions correctly is 30.78%, while the indicator for private schools is 49.21%. In 2019-2020, the percentage of correct answers to mathematics questions in public schools is 37.44%, while it is 60.37% in private schools. In 2011-2012, the percentage of correct answers to mathematics questions in public schools of Baku is 48.89%, while it was 58.80% in private schools (State Examination Center Statistics, 2011-2022).

When it comes to the selection process, two of the schools were selected through convenient sampling.

Teacher Selection (See *Table 1 below* Student Selection Section)

As Battaglia (2008) states, purposeful sampling is the carefully planned selection of participants based on their own qualities. Accordingly, for this research, purposeful sampling was used to select teachers as my purpose was to choose experienced mathematics teachers who were teaching upper secondary levels (10th, and 11th) for more than 15-20 years. Another reason I

selected 10th, and 11th grade teachers was that when I was collecting preliminary data for the problem identification, teachers who were not teaching in upper secondary were hesitating and unsure about the information they provided. I selected two teachers from each school (*Table 1*). When the principals from each school provided the list of teachers, I randomly selected two experienced teachers from each, hence, the overall sample size for teachers was four.: Teacher 1, Teacher 2 from School A and Teacher 3, Teacher 4 from School B.

Student Selection (See *Table 1* below)

Purposeful sampling technique was also employed in the selection of student participants. Based on the selection of teachers, students were also chosen from those teachers' classes. This selection enabled me to get in-depth and rich information in the data collection process (Creswell, 2007). In total, there were sixteen students from 10th and 11th grades.

Table 1. *Participant Selection*

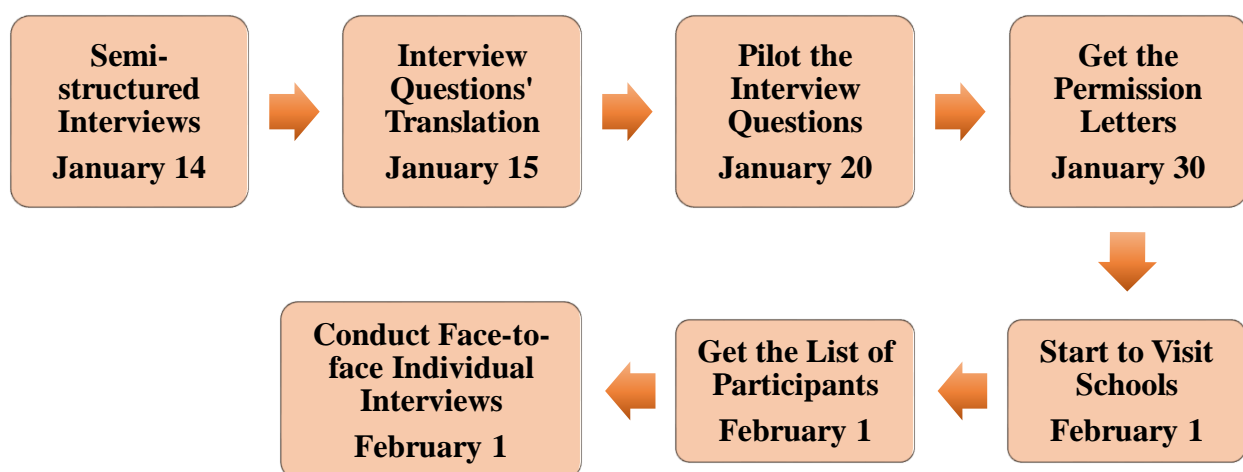
Participants	The Number of Participants from School A	The Number of Participants from School B
Teachers	2	2
Students	8	8
Total Number of Participants	20	

Data Collection Process

The data collection process took place at the end of January 2023, as our second semester started. Firstly, invitation letters were sent to two different public schools to inform them about the purpose of the study and the significance of their participation in this research. After receiving official permission, I conducted school visits to get the list of teachers and students at the beginning of February. The classroom observations were conducted with the same teachers. Later, I conducted individual face-to-face interviews with teachers (See *Figure 3*) and focus group interviews with the interviewed teachers' students. In addition, for the participants' convenience, the informed consent form was written in Azerbaijani, and it was introduced to each participant (teacher and students' parents because they are under 18 years old).

The interview questions were piloted with a small group of teachers and students who did not participate in the study. The goal was to determine whether the included questions were understandable or not. To confirm the validity of the interview questions, my supervisor also reviewed them beforehand.

Figure 3. *Data Collection Process (Interview)*



Sources of Data

To explore the reasons contributing to students' underperformance in trigonometry, the data were collected by interviewing teachers and students and observing their lessons in public secondary schools of Baku. According to Harding (2013), interviews assist a researcher to understand the experiences of participants more thoroughly, which is why they were chosen as a source of data for this study. Furthermore, non-participant observations with observation forms helped me to gather firsthand information, which was useful to observe actual behavior (Creswell, 2014).

Semi-Structured Interviews

According to Creswell (2012), conducting interviews as a method for gathering qualitative data gives researchers the chance to record interviewees' voices and pose open-ended questions to one or more individuals. Semi-structured individual interviews with teachers were utilized for this study to investigate teachers' (participants') thoughts and beliefs about the topic. Following that, the researcher transcribed interviews to analyze the interviewees' responses.

Focus Group Interviews

Due to the time restriction, the focus group interviews were used to collect the data from students of 10th and 11th grades. According to Creswell (2014), this type of interview, which is conducted among six to eight participants in one group, helps the researcher collect shared understanding from various students. Thus, I conducted focus group interviews with eight students from each school.

Observations

Listening to people's voices, noticing their feelings and emotions, and paying attention to their methods, techniques, and behavior throughout the procedure are all examples of

observation (Frieden & Sbarbaro, 2007). The literature review revealed that one of the reasons that contribute to student's underperformance was teachers' content knowledge, methodology, and technique; thus, making it necessary for me to observe teachers' classes using non-participant observation, which allowed me to take notes and observe the whole class (Creswell, 2014). In the following stage, to better understand how teachers and students view the challenges of learning trigonometry, I intersected observational notes with interview data.

Trustworthiness of the Study

Trustworthiness is essential in qualitative research to indicate that findings are significant enough to pay more attention to (Creswell, 2014). Triangulation allowed me to demonstrate the reliability of the research findings. The triangulation method used in this research study, which included interviewing respondents and validating the evidence provided by different teachers and students, as well as classroom observations is supported by Creswell (2014). To learn the participants' perspectives and experiences, I collected data from a variety of participants through the interview process. Member checking was also used to validate the collected data. The interviews were initially recorded and were later transcribed. The interviewees received the transcripts of the interviews to review and add any information they deem pertinent (Birt et al., 2016).

Data Analysis

Based on my research question, thematic analysis was used as a way of finding out about people's viewpoints, experiences, and opinions (Merriam & Tisdell, 2016). Three steps directed this data analysis: reading and rereading, taking notes, and interview transcription. For transcribing the interviews and familiarizing oneself with the data, primary notes must be taken

(Lewis, 2015), which aided the researcher in deepening comprehension of the perspectives of the teachers and students during the thematic analysis.

To analyze the data, the researcher started first to examine the data – by listening to interview recordings and transcribing them. Furthermore, transcripts were carefully read a few times because, as Creswell (2014) states, it is necessary for researchers to be involved in the data analysis process. The researcher got a general overview of the information and reflected on the overall meaning of the data. Then, the researcher continued to identify codes and themes using coding techniques, grouped them into categories, and then labeled the categories. When analyzing observations, it was identified that the intersection of observational notes with interview data by using non-participant observation included consistent points.

Ethical Consideration

As Creswell (2014) claims, every stage of the research process should include ethical considerations. For this reason, all the participants were informed that their participation was voluntary, and they were free to stop and withdraw from the interview any time. In addition, all teachers and students were provided with a consent form reflecting the detailed information about the research. Interviewees' information was kept private, and participants' names and schools were coded to ensure their confidentiality.

Study Limitations

The research was not without limitations. The small sample size and lack of literature in post-Soviet countries were the main limitations of the study. As the researcher focused on only two schools, it limited the scope of the research. Also, the schools which were located only in Baku were chosen for the study, which does not allow the generalization of the findings to the whole country. In addition, while reviewing the literature, no research study was found in post-

Soviet context. Reviewing the literature from the other post-Soviet countries with geographical, political, cultural, and contextual commonalities with Azerbaijan could have contributed to the knowledge about the students' underperformance in trigonometry.

Chapter 4: Findings

The purpose of this qualitative study was to explore the reasons behind the high school students' underperformance in trigonometry in the state examination in public secondary schools in Baku. The research aimed to explore teachers' and students' perceptions about the existing problem. Based on the study purpose, the following research question guided the study:

1. What are the main reasons contributing to students' underperformance in trigonometry?

To answer the research question, semi-structured interviews with four mathematics teachers, focus group discussions with a total of sixteen students (eight students from school A and eight students from school B), and non-participant observations were conducted in two public secondary schools in Baku. As it is mentioned in Chapter 3, the selected schools were coded as School A and School B.

Table 2. *The number of participants and their background/experience*

Participant	School	Experience/Background	Number of Participants
Teacher 1	School A	17 years	4
Teacher 2	School A	20 years	
Teacher 3	School B	30 years	
Teacher 4	School B	31 years	
8 Students	School A and School B	10 th grade	

8 Students	School A and School B	11 th grade	16
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In this chapter, the findings from the collected data are reported in the following major findings section. In this section, there are three themes and several sub-themes: teacher-related reasons, student-related reasons and beyond the control of teacher and student related reasons which are included in the major findings section.

Major Findings

Theme 1: Teacher-related Reasons

The collected data from semi-structured interviews with teachers, focus group discussions with students, and non-participant observations revealed some main reasons related to the teachers.

Subtheme 1: Teachers' Methods

Based on the collected data, almost all the interviewed teachers and students reported that when they start the trigonometry lessons teachers explain the topic, and provide some examples, then students come to the board or solve the tasks from the SEC test bank in their seats. One of the mathematics teachers from school A shared the approaches she is using:

“Ən çox önəm verdiyim keçilən mövzunu şagirdlər əzbərləməsinlər. Ona görə də düsturların hamısının çıxarışlarını lövhədə izah edirəm. Nümunələr göstərildikdən sonra şagirdləri ya lövhəyə çağırıram, ya da yerlərində edirlər. Qrup işləri vaxt məhdudiyyətinə görə olmur.” [One of the most important things for me is I do not want the students to memorize the concepts without understanding them. Therefore, I explain all the formulas on the board. After the examples are shown, either I call students to the

board, or they solve the tasks in their seats. Due to the time constraints, we do not have group work activities during the lesson.]

A teacher from school B described her teaching approach as follow:

“Triqonometriyani izah edərkən çalışıram çıxarışlarını da göstərməyə çalışıram. Bəzən qrup işlərimiz olur, lakin sırf triqonometriya dərslərində qrup işləri etməmişik, şagirdləri lövhəyə bir -bir çağırmağa daha çox üstünlük verirəm.” [I try to explain students trigonometry concepts with the help of the detailed formula description. Sometimes we have group work activities, but we did not have group activities in trigonometry classes, I prefer to call the students to the whiteboard one by one.]

In addition, the collected data from non-participant observations confirmed that the teachers were using only a teacher-centered teaching approach. Based on the all observed classes in schools A and B, the teachers were using teacher-centered approaches. The teachers were the dominant ones, and they were only explaining the lesson without using any concept-checking questions. After explaining the lesson, students were solving tasks individually. Based on the observations in schools A and B, the teachers were starting the lesson either by explaining the new concept and solving tasks on the board or assigning tasks individually, or directly were starting the lesson by assigning tasks from textbooks and SEC test bank on the board or individually. One student from school A described a trigonometry lesson:

“Əvvəlcə dərsə üçbucaqlar və bucaqlarla başladıq. Məsələn, $\sin\alpha$, $\cos\alpha$, və $\tan\alpha$. Daha sonra çevrədəki rüblər. Müəllimin dərsi izah etməsindən sonra da test toplusundan ən çətin tapşırıqları yermizdə tək işləyirik.” [We have started the topic with triangles and angles, such as $\sin\alpha$, $\cos\alpha$, and $\tan\alpha$. Then quadrants in the circle. After the teacher's explanation, we started to solve individually the hardest tasks from the SEC test bank.]

Besides, all the students mentioned how they would like to see the lesson process. They all stated that they would consider all students' weaknesses, and they would create lessons not only for strong students but also for those who have some difficulties. In addition, all the students' responses were almost the same for the interview question about the teacher's method for student engagement.

During those responses, one of the students described the trigonometry lesson as follows:

“Sinifdə zəif və ya dərsi tam başa düşməyən uşaqlar nəyisə soruşmur və müəllimə də bununla maraqlanmır. Artıq digər mövzuya keçdikdə uşaq heç nə başa düşmür. Çünki trigonometriyada bir şeyi başa düşmürsən artıq zəncir qırılır.” [When the students do not understand something, they do not ask anything from the teacher, and the teacher is not interested in them either. Therefore, when we move to the next topic, they do not understand anything. When you do not comprehend something, the chain is breaking, and you do not understand others.]

Likewise, non-participant observation data revealed that when students did not participate in the lesson, teachers from both schools did not attempt to engage them in the lesson process. Teachers were only explaining the lesson to a specific three or four students who were sitting in front of teachers. They were not engaging other students in the lesson, especially those who were weak students and were sitting at the last desks.

Moreover, based on the focus group interviews with the students, all of them described how they would teach the trigonometry topic. Almost all reported that they would teach the topic with various techniques, strategies, and approaches. Students stated that academic explanation is not always understandable. They would explain trigonometry in an easy way. They would also teach the topic in a fun way and incorporate games.

Besides, they touched on the activities and their effectiveness during the lesson. Students mentioned that they like to work and discuss trigonometry with their classmates. It allows them to quickly understand which parts of the teacher's explanation they could not comprehend. However, they reported that they had fewer group work activities and those activities were not effective. Instead of working on only one small problem from a trigonometry topic, they preferred to solve the example individually. They stated that when they had group work, only a few students were working, and others were sitting without any help. Instead of groups, they reported that it would be better to have pair work. Another student from school A shared the thoughts:

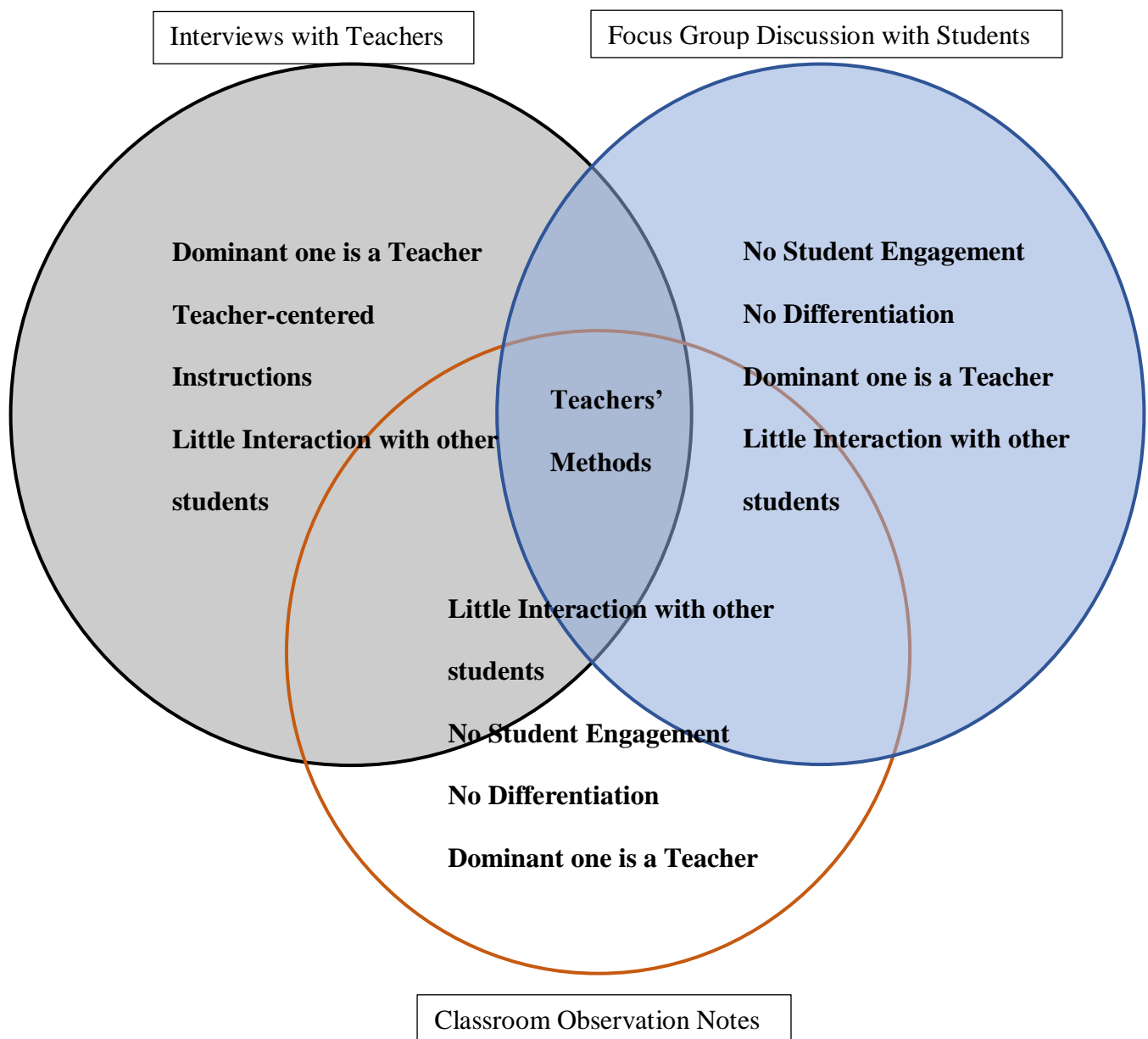
“Bir iki dəfə qrup işlərimiz olub amma effektiv deyildi, çünki müəllim hər qrupa bir misal vermişdi, ondansa özümüz tək-tək işləyərdik, çox maraqsız idi.” [We occasionally did group work, but it was ineffective because the teacher provided each group with an example. We would much prefer to work alone because it was so uninteresting.]

Furthermore, in one of the interview questions: “What types of homework and assessment items do students typically have?”, teachers of both schools mentioned the summative assessment. All teachers agreed that graded quizzes are the only tools they employ to assess students' understanding. They all use different kinds of items, such as open-ended, and multiple choice, and fill in the gaps in the quizzes. However, none of them use various types of problems in trigonometry. They only create the questions which students need to directly simplify or solve without drawing and imagining the task, so they were not using different kinds of word problems. One teacher from school A outlined as follow:

“Şagirdləri qiymətləndirdikdə daha çox misalların qoyulmasına üstünlük verirəm, məsələlərə isə daha az. Çünki kitablarda qoyulmuş situasiya məsələlərini heç bir uşaq

başə düşmür. Onsuz da ancaq biz onları izah edirik, şagird də heç nə anlamadan köçürür.” [I prefer to use more examples and fewer problems when grading students. because no child can comprehend the word problems from real life that are provided in the books. When we are only explaining things, the pupil simply copies them without understanding.]

All these data attested that teachers and students at schools A and B have teacher-centered classes meaning that mostly the instruction is one-way – calling to the whiteboard or assigning tasks individually. Teachers were the dominant ones in the classroom. They were the main actors in this process. Teachers were using teacher-centered instructions. There was little interaction between students (See *Figure 4* below).

Figure 4. *Triangulation for the finding – Teachers' Methods*

Subtheme 2: Teachers' Self-efficacy (i.e., Teachers' Confidence, Teachers' Motivation, and Students' Motivation)

Based on the findings of this research study, the term self-efficacy has been defined as teachers' confidence, teachers' motivation, and students' motivation.

Teachers' Confidence

Based on the semi-structured interviews with teachers and focus group discussion with students, teachers' confidence can be a reason for students' underperformance in trigonometry. All students mentioned the importance of teacher's confidence in their learning. One of the students from school B reported as follow:

“Bəli, müəllim özgüvənli olduqda uşaq da daha yaxşı öyrənir. Qarşında peşəkar biri olduğunu düşünürsən. Müəllimin heç vaxt səhv edə biləcəyini düşünməyib onun dediklərini rahatlıqla öyrənirsən. Amma bəzən müəllimlər var ki, biz nəyisə soruşduqda onu özgüvənli şəkildə araşdırıb həll yolunu sizə deyərəm demək yerinə, ya bizə sərt cavab verir, ya da bizə başqa sual verərək mövzunu dəyişir.” [Yes, the child learns better when the teacher is confident. You think you have a professional in front of you. You easily learn what the teacher says without thinking that he/she can ever make a mistake. But sometimes there are teachers who, when we ask something, instead of confidently answering it and telling you the solution, either give us a harsh answer or change the topic by asking us another question.]

Besides, other students from school A as well, mentioned that a teacher's confidence is important in their achievement in trigonometry. For instance, one of them mentioned the following:

“Müəllim dərsə özgüvənlə başladıqda, həmin mövzunu necə tez və rahat öyrəndiyimi müşahidə etmişəm. Düşünürəm ki, müəllimlər triqonometriyanı keçdikdə daha diqqətli olublar, ən azı dərsə yüksək motivasiya və özgüvənlə başlanılsa, düşünürəm ki, biz də daha yaxşı öyrənmiş olarıq.” [When the teacher started the lesson with confidence, I noticed how quickly and easily I learned that concept. I think teachers can be more careful when we go through

trigonometry, at least if the lesson is started with high motivation and confidence, I think we will learn better too.]

The semi-structured interviews with teachers also confirmed that teachers' confidence can be one of the reasons to contribute to students' underperformance. For instance, one of the teachers from school A mentioned:

“Bəzən triqonometriyada elə mövzular var ki, izahımın nə qədər effektiv olub olmadığına əmin ola bilmirəm. Çünki bəzən şagirdlərin motivasiyasız olması onların nə dərəcədə anlayıb anlamadığını göstərmir.” [Sometimes there are topics in trigonometry where I am not sure how effective my explanation is because sometimes students' lack of motivation does not show how well they understand.]

What the teachers and students mentioned was that when the teacher is confident then students are learning better, and when the student is demotivated and shows negative attitude towards trigonometry, it may contribute to teachers' confidence as well.

Teachers' Motivation and Students' Motivation

According to the focus group discussion with students, when a teacher's confidence and motivation is high it affects students' learning process. Students stated that when the teacher's confidence is high, they learn the subject very well. They believe that they have a skilled one in front of them. They can easily learn what the teacher says because they believe their teachers can never make a mistake. Students reported that teachers' confidence and motivation is essential for them because a subject they do not like can make them love. One student from school A explained the situation related to teacher confidence and motivation:

“Müəllim nə qədər özgüvənli və motivasiyalı olsa, və üstəlik mövzunun çətin olduğunu bildirməsə, bu çətinidir, bunun öyrənilməsi çətinidir deməsə, mən onu rahat öyrənə

bilirəm. Bu əksinə mənə motivasiya vermiş olur.” [If the teacher is confident and motivated and does not mention that the topic is difficult, it is hard to learn it, then I can learn the topic easily. In contrast, it motivates me.]

Almost all students from the two focus groups confirmed that when the topic is complicated their teachers start the lesson by saying it is a hard topic which affects their motivation and performance in the learning process. They do not think that their teachers have enough confidence to teach trigonometry. Another common response from school B was as follows:

“Müəllim nə qədər özgüvənli, həvəsli və yüksək motivasiya ilə dərsi keçsə mənə dərs bir o qədər maraqlı və asan gəlir. Halbuki, dərslər hə bu sizin üçün çətin mövzudur deyib başlayır. Bu da bizdə avtomatik ruh düşkünlüyü yaradır.” [The more confident, enthusiastic, and highly motivated the teacher is, the more interesting and easier the lesson is for me. But she starts the lesson by saying yes, this topic is hard for you. For this reason, it automatically demotivates us.]

One of the answers from school A teacher caught my attention. She mentioned the following:

"Artıq 30 ildir ki işləyirəm elə şeyə rast gəlməmişəm amma son 5-10 ildə hiss edirəm ki uşaqlar triqonometriyadan qaçmaq istəyirlər. Onlara düsturları öyrənmək çətin gəlir, bəzən qrafiklərin qurulması, əyaniliyə yol vermək istəmirlər. Bəzi düsturları sadəcə əzbərləyirlər, amma əyanilikdən o görüntüdə qaçırlar. Sözün düzünü desəm bir müəllim olaraq bu halların yaranması məni motivasiyadan salır..." [I have been working for 30 years and I have never come across anything like that, but in the last 5-10 years I feel that children want to avoid trigonometry. They find it difficult to learn formulas,

sometimes they don't want to allow graphs and visualization. Some formulas are simply memorized, but they avoid that image due to visuality. To be honest, the occurrence of these situations demotivates me...]

Based on the findings, we can claim that teacher self-efficacy – teachers' confidence, teachers' motivation and students' motivation affect each other which at the end lead the underperformance of students in trigonometry.

Theme 2: Student-related Reasons

The collected data from semi-structured interviews, focus group discussions, and non-participant observations revealed some main reasons which consisted of student-related causes.

Subtheme 1: Students' Motivation

The findings of this study indicate another major reason that contributes to learning, which is students' motivation. The collected data from interviews and classroom observations confirmed that students had low motivation toward trigonometry. Most teachers reported that when they start the topic of trigonometry students are starting to complain and demonstrate low motivation on it. Teachers mentioned that the topic trigonometry is boring for the students, they do not want to learn it. One teacher stated her experience as follows:

“Hər il şagirdlərin triqonometriya mövzusunə qarşı olan istək və motivasiyası eyni olur. Sanki uşaqlar öz aralarında o sevməyənlər sevgisizliklərini ötürürlər və psixoloji cəhətdən artıq aşağı sinif deyir ki, hə bu nə mövzudur, çətin olacaq, öyrənə bilməyəcəm. Amma sevən uşaqların sayı daha çox olsa, bir birlərinə də fərqli təsir edərdilər.” [Each year, the desire and motivation of students towards trigonometry is the same. It is as if the children transmit their lack of love among themselves, and psychologically, the lower class already says that what is this topic, it will be difficult, and I will not be able to learn

it. However, if the number of the children loving trigonometry was more, they would affect each other differently.]

Students also confirmed that they do not have high motivation to learn trigonometry. They are learning and even memorizing this topic for the sake of two or three questions on the state exam. They do not see any meaning in learning all those formulas. One of the 11th grade students from school A mentioned:

“Biləndə ki, yenə triqonometriyanı öyrənəcəyik, həmin günləri dərsə gəlmədim. 10-cu sinifdə oxuyanda mövzunu öyrənməyə çalışmışdım, amma mövzudan zəhləm getdi. Mənim bu mövzunu öyrənməyə heç bir motivasiyam yoxdur.” [When I knew that we would learn the topic trigonometry this year again, I did not attend the classes. I tried to learn in 10th grade, but I hated it. I do not have any motivation to learn it.]

Furthermore, based on the non-participant observations, it seemed that those students who were particularly unmotivated to learn trigonometry tended to sit at the final desks, which were far from the teacher and board. Students who expressed a lack of motivation in the interview were evidently very uninterested during the observation since they were talking to one another and not paying attention to the teacher. Although the teacher was explaining the topic, they were not listening to her.

Subtheme 2: Relating the Trigonometry to a Real Life

The result of the findings from focus group interviews showed that almost all students did not know the real-life application of trigonometry. All of them reported that it is not an essential topic for them, they do not see any reason behind that topic to learn it. It is only mandatory for them to learn because of the state exam. One of the most common comments from school A students was:

“Əgər mənim real həyatımda heç bir rol oynamayacaqsız, mən niyə bu mövzunu öyrənməliyəm. Gələcəkdə hər hansı bir işdə işləyəcəm, mənim nəyimə lazım olacaq ki, triqonometriya? Məsələn mən kompüter mühəndisliyi oxumaq istəyirəm, orada mənim sinus, cosinus nəyimə lazımdır ki? Mənə proqramlaşdırma lazım olacaq” [Why would I study this subject if it is not going to play any role in my real life? When I start working in any industry in the future, how will it help me? For instance, why would I need to know sine and cosine if I wanted to pursue computer engineering? I will need programming.]

The absence of real-world examples from teachers' lectures was another complaint made by students. None of the students could provide examples from real-life, despite practically all teachers confirmed that they were relating trigonometry concepts to real life. Another response from one of the students from school B was about authentic projects:

“Mən belə deyim ki, triqonometriya bir mövzu kimi olmasa da olardı, hətta daha yaxşı olardı. Əhəmiyyətli olduğunu ancaq imtahanıma düşəcəyinə görə deyə bilərəm amma həyatda heç bir mənası yoxdur. Mən onu öyrəndikdən sonra da tamamilə yadımdan çıxacaq.” [It would be better not to have a concept trigonometry. I can only say it is an important concept because of the state exam, but it has no meaning in real life. I will completely forget after whatever I learned from trigonometry concept.]

Besides, students reported that there are concepts that are harder than trigonometry, such as plane geometry concepts. Although plane geometry is a complicated topic, it is not as boring as trigonometry. They can see the big picture of geometry; they can imagine and draw pictures for the problems. However, they cannot imagine, see the big picture of trigonometry, and draw anything for trigonometry concepts. One of the students from school B mentioned the following:

“Birinci uşaqların zəif nöqtələrini öyrənərdim. Daha sonra ona uyğun dərsi keçərdim. Çünki zəif uşaqlar triqonometriya mövzusunda bir yerə qədər gələ bilir və sonrasını öyrənə bilmirlər. Elə izah etməyə çalışardım ki, mən izah etdikcə uşaq bunu beynində canlandırma bilsin.” [I would first find out about each student's weaknesses. Due to the fact that weak students are unable to acquire the subsequent trigonometric concepts. I would make an effort to clarify things so that the student could visualize them in their thoughts as I explained.]

During the non-participant observations, no real-life examples were provided by teachers at both schools A and B. During all the observations, teachers were directly starting the lesson. They were explaining the lesson by giving sample problems, after 5-10 minutes either they were calling students to the board or students individually were solving tasks. For instance, one of the teachers from school B, started a new topic “the function $\sin x = 0$, $\sin x = -1$, $\sin x = 1$ ” from trigonometry. She drew a circle and wrote all the formulas on it using the periods. She gave no explanation of why students need to understand this idea or how they may use it in the real world.

By considering classroom observations the relating trigonometry to real life reason can be considered as teacher related reason as well.

Theme 3: Beyond the Control of Student and Teacher Related Reason

The data also revealed the reason which was beyond the control of teacher as well as student related.

Subtheme 1: Lack of Resources for Teaching Trigonometry

Based on one of the interview questions “What would you like to change in the requirements for the topic of trigonometry in the curriculum?” for teachers, another reason was found in this research study.

Almost all teachers responded with the same answers that they would not change anything for the trigonometry concepts, but they would like to see more types and number of exercises in the book. Teacher 1 and Teacher 2 from school A mentioned:

Teacher 1: *"Triqonometriyaya aid heç bir mövzunu çıxarmaram. Sadəcə kitabda qoyulan tapşırıq tiplərinin və sayının daha çox olmasını istərdim."* [I would not remove any topic related to trigonometry. I just wish there were more types and number of exercises in the book.]

Teacher 2: *"Məktəb kitablarında triqonometriyaya aid tapşırıqlar azdır. Buna görə də artıq əlavə kitablara üz tuturam, şagirdlər əsasən test toplusundan test işləyirlər."* [There are few exercises related to trigonometry in schoolbooks. That's why I already had to use additional books; students mainly work on SEC tests from the test bank.]

In addition to that, other teachers also mentioned same from school B:

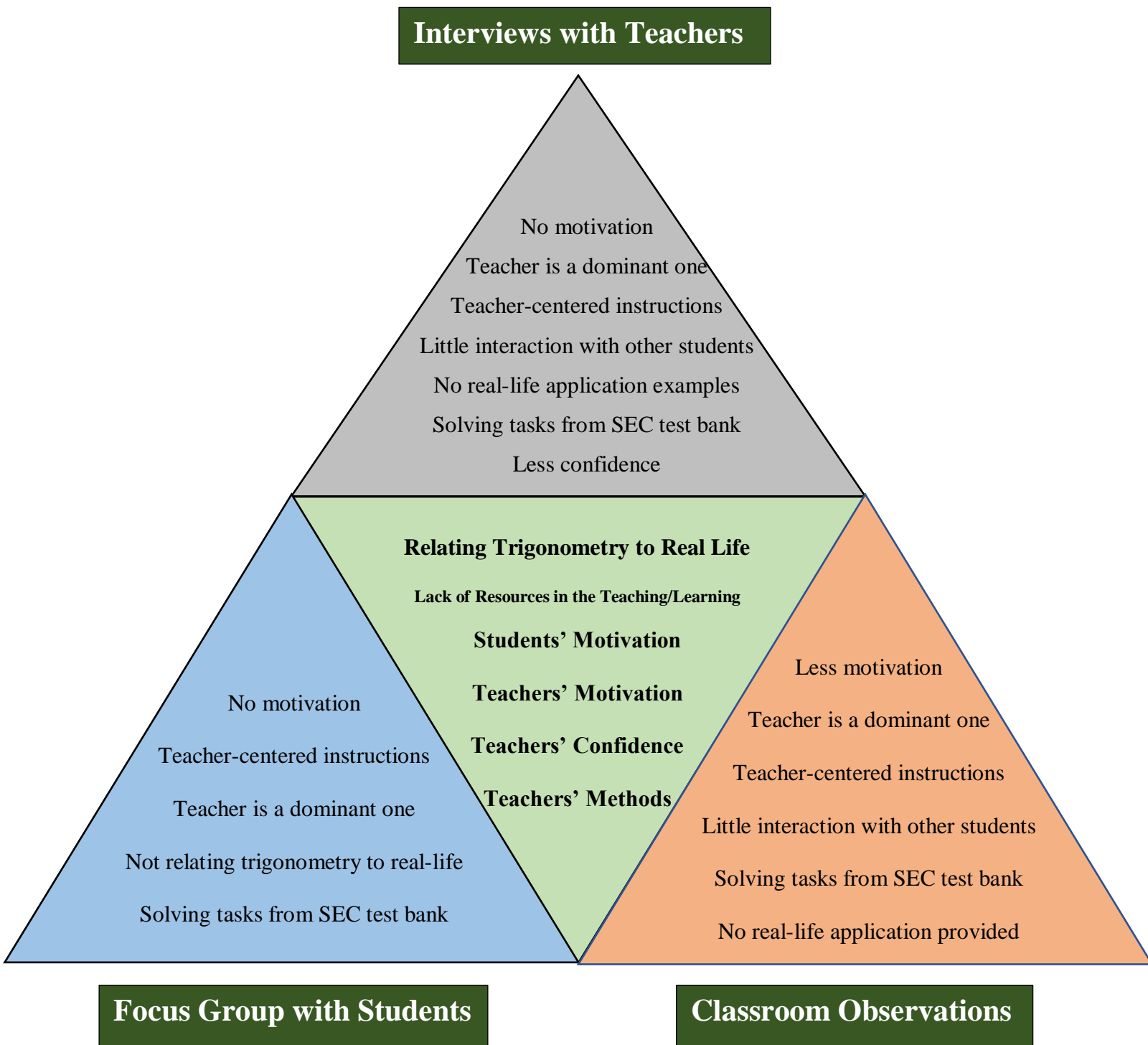
"Dəyişmək istədiyim kitabda olan misal sayının artırılmasıdır. Biz digər resuslardan da istifadə etməli oluruq." [What I would like to change is to increase the number of examples in the book. We must use another resource.]

While describing the lesson process for the trigonometry, students also mentioned that they are solving tasks from SEC test bank. For instance, one of the students from school A described that:

“Müəllimin dərsi izah etməsindən sonra da test toplusundan ən çətin tapşırıqları yermizdə tək işləyirik.” [After the teacher’s explanation, we start to solve individually the hardest tasks from the SEC test bank.]

Based on the classroom observations, indeed, after solving problems from textbook, students were practicing SEC test bank questions individually. These all findings showed that one of the reasons which was beyond the control of student and teacher related causes can be lack of resources for learning trigonometry. In the textbook, there were limited number and types of exercises which was also barrier for students homework assignments. They did not have enough exercises to practice as well as to assign to students for solving at home. There were also limited exercises for the real-life application of trigonometry which also led as a reason student relating trigonometry to their daily life.

Based on the semi-structured interviews with teachers, focus group discussions with students and non-participant observations, the major findings were found as follow: teacher-related reasons: teachers’ methods, teachers’ self-efficacy (i.e., teachers’ confidence, teachers’, and students’ motivation). Student-related reasons: students’ motivation, relating trigonometry to real life. Beyond the control of teacher and student related reasons: lack of resources for teaching trigonometry. The researcher analyzed all major findings and showed them as visual in *Figure 5*.

Figure 5. *Triangulation of all data*

Chapter 5: Discussion

The main purpose of this qualitative research was to explore the reasons behind the underperformance of students in trigonometry in the state examination in public secondary schools in Baku. A qualitative research approach based on Vygotsky's (1968) Social Constructivism theory was used to explore the reasons contributing to the underperformance of students in trigonometry in Baku secondary public schools in accordance with the study's purposes. The major findings of this study will be compared with those of the earlier reviewed literature in this chapter.

Teacher-related Reasons

Based on the findings, the data revealed two themes – teachers' methods and teachers' self-efficacy.

Teachers' Methods

Learners who are taught by utilizing various teaching methods behave and perform better than those who are taught through the lecture method (Ibrahim & Maruta, 2022). According to Adhkari and Subedi (2021), the use of teacher-centered instructions, as well as a focus on rote memorization rather than conceptual understanding are the reasons that influence students' performance in trigonometry. Likewise, the findings of this study indicate that teachers in the sample schools are using only teacher-centered methods. Therefore, while responding to the interview questions, all the participant students reported the weaknesses of their classmates and themselves. They all emphasized that they would plan the lesson not only according to strong students' needs but also for those who have some difficulties in math. In addition to this, students did not see any meaning in the group activities in the lesson process because when students had group work activities, teachers were not monitoring and facilitating them.

However, learners can improve their mathematics knowledge by participating in a variety of social activities, interacting with others, and during the discussions with others (Vygotsky 1978, as cited in Ibrahim & Maruta, 2022). Students can learn new mathematical concepts with the help of such interactions with one another, conversations, and cooperative activities. As a result, the students will be able to advance their comprehension of mathematics by referring to their own expertise and different cultural backgrounds.

Besides, according to Muharam et al. (2019), there is a significant impact of teachers' teaching approaches on students' mathematics performance. Likewise, various teaching approaches affect students' underperformance in mathematics in a different way (Granström, 2006). The students reported that academic explanation was not always understandable. They would explain trigonometry in an easy way. They would also teach the topic in a fun way and incorporate games. In addition, they would consider all students in the class based on their level and ability. They would create a place where they could cooperate and collaborate. Indeed, according to Oppendekker and Van Damme (2006), to increase the performance of students, teachers should encourage students to cooperate with their classmates, and let them understand the concepts and succeed. Teachers who have effective teaching approaches are more open to communicate and build a relationship with their students (Samuelsson, 2010).

Vygotsky (1978) also stated that the language employed to convey a topic should ensure that challenging concepts and ideas are simplifications, with word routes being addressed. The interactions that take place in the classroom as a part of the teaching and learning process are the main emphasis of Vygotsky's theory. Based on this theory, through verbal communication and maybe also through demonstration, knowledge is transferred from one person to another

(Vygotsky, 1978). So, to improve students' academic performance, the teacher is supposed to be an experienced one.

Teachers' Self-efficacy

According to Eberle (2011), teachers' self-efficacy has the potential to enhance the working environment generally and student mathematics achievement specifically. Furthermore, according to Suharta and Parwati (2020), teacher self-efficacy is another main reason that affects students' performance in mathematics. In addition to having an impact on students' academic performance, teachers' self-efficacy also has an impact on their motivation (Pajares, 1996 as cited in Sarac & Tutak, 2017). The current study findings also confirm that teachers' self-efficacy affects students' learning process. During the focus group interviews, students reported that under the term teacher's self-efficacy – teachers' confidence and teachers' motivation are essential for them because a motivated teacher can help you love a subject that you do not like. Likewise, specifically on the topic of trigonometry, students mentioned that when the topic is complicated their teachers start the lesson by saying it is a hard topic which affects their motivation and performance in the learning process. The data leads to the conclusion that teachers do not inspire their students to learn trigonometry in the classroom, which makes students feel as though trigonometry is a challenging topic and negatively impacts their performance. Whereas one of the primary purposes of Lev Vygotsky's Social Constructivism theory is to inspire students to take part in real-world, interactive learning experiences that put them at the center of the learning process and encourage them to grasp topics more deeply.

Student-related Reasons

One of the key contributing reasons to low performance in mathematics is a student-related reason which is crucial in the teaching and learning process (Acharya, 2017). Based on the collected data, two themes – students' motivation and relating trigonometry to their real life were identified.

Students' Motivation

Numerous studies have shown that student motivation is important in mathematics education and is correlated to mathematical achievement (Gelman & Greeno, 1989; Hannula, 2006; Middleton & Spanias, 1999; Singh, Granville, & Dika, 2002; Walker & Guzdial, 1999). Likewise, the literature revealed that students' attitudes toward mathematics affect their mathematics achievement (Mazana, Suero Montero, & Olifage, 2019). The findings also revealed that students' demotivation is one of the reasons contributing to underperformance. Students admitted that their motivation for learning trigonometry is minimal. To prepare for two or three questions in the state exam, they study and even memorize this topic. Teachers also confirmed that their students' motivation is low, and the topic of trigonometry is boring for the students, and they do not want to learn it. However, Paudel (2019) stated that having a positive attitude toward trigonometry is crucial in learning trigonometry.

Additionally, most social-cognitive theories of motivation claim that interactions, activities, and reinforcement methods in the classroom have an impact on students' motivation (Pintrich, 2003). Thus, a key factor for encouraging students' motivation is the teacher's instructional strategy. Hence, as Vygotsky (1978) stated learner-centered, group work and discussion strategies should be used by teachers to get students actively involved. In this case,

this means that children can learn skills with adult supervision, as well as with the help of peers who are more competent and capable.

Relating the Trigonometry to a Real Life

Ginsburg (2016) stated that trigonometry is important in real life for determining the height and distance of any objects, such as buildings. Trigonometry can also be employed in criminology, aviation, marine biology, and transportation. The literature revealed that there is a positive correlation between students' understanding of the daily-life application of trigonometry and their performance. According to the findings, the use of teacher-centered instructions, as well as a focus on rote memorization rather than conceptual understanding, and a lack of understanding of the trigonometry's importance to their daily lives are the reasons that influence students' performance in trigonometry (Adhikari & Subedi, 2021). Interviews and non-participant observations attested that students do not acknowledge the importance of trigonometry in their life. When it comes to authentic projects, none of the students could provide any example about it, and it was meaningless for them. They mentioned that they never had any individual or group work projects related to trigonometry in real life. However, according to Vygotsky (1978), without social interaction between teachers and peers, the top bound of the Zone of Proximal Development (ZPD) cannot create outcomes. Building on this idea, rather than employing teacher-centered instructions, teachers should use a learner-centered approach with the help of group work, discussion, and game-based learning. Also, scaffolding aids learners in being competitive and smart, and they may learn more from each other and knowledgeable adults (Bruner, 1960, 1966). According to the literature review findings, inquiry based and Polya's problem-solving methods help students perform better rather than those taught by utilizing the lecture method (Ibrahim & Maruta, 2022).

Beyond the Control of Teacher and Student Related Reason

Another reason was identified based on data obtained from semi-structured interviews with teachers, focus group discussions with students, and non-participant observations. This reason was beyond the control of teacher as well as student related.

Lack of Resources for Teaching Trigonometry

According to Akther and Akther (2018), students' math performances were low because of inexperienced teachers and insufficient resources. Our research identified similar reasons during the data collection process. Beside specific teacher and student related reasons, insufficiency of teaching resources was also highlighted by the participants as one of the obstacles for successfully acquiring trigonometry branch.

Implications

This section provides a reader with the description of implications for theory and practice by relying on the findings of this research study.

Implications for Theory

Although the scale of this study was relatively small, the findings of this study are still helpful to inform the researchers about the reasons that contribute students' underperformance in the state examination. State Examination Center analysis results obviously presented that the students demonstrate low performance in trigonometry. This research study may raise awareness in our context that students perform low in trigonometry. Further research employing quantitative methods to examine the reasons of high schoolers' underperformance can shed more light to the issue.

Implications for Practice

According to the findings of this study, as there were limited number and types of exercises in textbooks, it created barrier for assigning students diversified home assignments. There were also limited exercises for the real-life application of trigonometry which also may lead as a reason students' relating trigonometry to their daily life. In this case, for future research, I suggest analyzing school textbooks and increasing the number and type of exercises for the trigonometry concept.

Conclusion

This qualitative study had a purpose to explore the reasons behind the high school students' underperformance in trigonometry in the state examination in public secondary schools in Baku. Based on the study purpose, the research question of this study was: What are the main reasons contributing to students' underperformance in trigonometry?

In two public secondary schools in Baku, semi-structured interviews with four mathematics teachers, focus groups with a total of 16 students, and non-participant observations were conducted to find the answer to the research question.

Based on the study findings, the following reasons were explored: teachers' methods, teachers' self-efficacy (i.e., teachers' confidence, teachers', and students' motivation), relating trigonometry to real life, and lack of resources for teaching trigonometry. All the findings were discussed based on Vygotsky's Social Constructivism theory.

To sum up, these research results will be helpful for teachers in terms of exploring reasons contributing to students' underperformance in trigonometry and can be considered in the teaching process in the future. The findings of this research will enable teachers to better understand their students' needs and guide them through their achievements.

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APPENDICES**APPENDIX A****Tədqiqat İştirakçısı üçün Məlumat və Razılıq Forması****TƏDQIQATIN İZAHİ:**

Sizdən “Şagirdlərin Triqonometriyanı Öyrənməkdə Çətinlikləri” adlı araşdırmada iştirak etməyiniz xahiş olunur. Bu tədqiqatın məqsədi müəllim və şagirdlərin təcrübələrini araşdırmaq və həmçinin şagirdlərin triqonometriyadan zəif nəticə göstərmələrinə təsir edən amilləri müəyyənləşdirməkdir. Araşdırma üçün məlumatlar sizinlə müsahibə apararaq toplanacaq. Müsahibələr məktəb daxilində keçiriləcək. Hər müsahibə 45-60 dəqiqə çəkəcək.

Bu araşdırmada iştirakınıza qərar verməzdən əvvəl, araşdırmanın niyə aparıldığını və nə edəcəyinizi başa düşməyiniz vacibdir. Zəhmət olmasa aşağıdakı məlumatları diqqətlə oxuyun. Hər hansı bir sualınız varsa və ya əlavə məlumata ehtiyacınız varsa mənə bildirməyinizi xahiş edirəm.

SİZİN HAQLARINIZ: CAVAB VERMƏMƏK VƏ YA GERİ ÇƏKİLMƏK

Bu araşdırmada iştirakınız könüllüdür. Hər hansı bir suala cavab verməkdən imtina edə bilərsiniz və istədiyiniz zaman iştirakdan imtina edə bilərsiniz. İntervyuda iştirakın və ya iştirakdan imtinanın iş prosesinizə heç bir təsiri olmayacaq. Bu araşdırmada iştirak etmək qərarına gəlsəniz, bu razılıq formasını imzalamağınız xahiş olunacaq. Razılıq formasını imzaladıqdan sonra istənilən vaxt heç bir səbəb göstərmədən geri çəkilməkdə sərbəstsiniz. Məlumat toplama bitməmiş iştirakdan imtina etsəniz, məlumatlarınız sizə qaytarılacaq və ya tam silinəcəkdir.

GİZLİLİK

Bu müsahibəyə cavablarınız anonim olacaqdır. Zəhmət olmasa cavablarınız haqqında heç bir müəyyənədiçi məlumat verməyin. Aşağıdakılar daxil olmaqla məxfiliyinizi qorumaq üçün hər cür səy göstəriləcəkdir.

- Bütün tədqiqat qeydlərində və sənədlərdə kod adlarından istifadə olunacaqdır.
- Adınız (və ya istənilən bir şəxsi məlumatlarınız) və səs qeydiniz ikinci şəxslə paylaşılmayacaq.

POTENSİAL FAYDALAR və ya İŞTİRAK RİSKLƏRİ

Bu işdə iştirak etməyinizin sizə birbaşa faydası olmayacaq. Ancaq, ümid edirik ki, bu araşdırmadan əldə edilən məlumatlar bəzi məktəblərdə valideynlərin müxtəlif növ iştirakını təşviq edə bilər. Müsahibə prosesində iştirak etmək üçün heç bir fiziki, hüquqi, məşğulluq, psixoloji, sosial, maddi və ya nüfuz riski gözlənilmir. Müsahibə sualları həssas deyil, heç bir çətinliyə və ya narahatlığa səbəb olma ehtimalı yoxdur.

ƏLAQƏ MƏLUMATLARI

Bu araşdırma ilə əlaqədar hər hansı bir sualınız varsa və ya bu araşdırmaya qatılaraq mənfi təsirlərə məruz qalsanız, mənimlə və ya elmi rəhbərimlə əlaqə saxlaya bilərsiniz.

Dr. Samira Hacıyeva – shajiyeva@ada.edu.az

Ülkər Musayeva – umusayeva14608@ada.edu.az

MƏLUMAT VƏ RAZILIQ FORMASININ SƏNƏDLƏŞDİRİLMƏSİ

Verilmiş məlumatları oxudum və sual vermək imkanım oldu. İştirakımın könüllü olduğunu və istənilən vaxt, heç bir səbəb göstərmədən iştirakdan imtina etməkdə sərbəst olduğumu anlayıram. Bu razılıq formasının bir nüsxəsinin də mənə (iştirakçıya) veriləcəyindən xəbərdaram. Könüllü olaraq bu tədqiqatda iştirak etməyə razıyam.

İştirakçının

imzası: _____ Tarix: _____

Səsyazma üçün

icazə _____

Appendix B

Interview Questions for Teachers

1. Could you please introduce yourself? What is your name? How many years have you been working?
2. How important is the teaching of trigonometry to students in high school? Could you please provide examples.
3. What approaches do you use when teaching trigonometry? (Methods, etc.)
4. What are the attitudes and behaviors of students during the explanation of the topic of trigonometry? Please share your observations.
5. If you notice that any topic related to trigonometry is not interesting to the student, what measures do you take in this case?
6. When explaining trigonometry, do you inform students about how it is used in real life?
7. What points do students have the most difficulty in solving trigonometry tasks? What do you think is the reason for these difficulties? How do you support them during these challenges? Could you please provide examples.
8. What aspects (student levels, etc.) are taken into account during homework?
9. What types of homework and assessment items do students typically have?
10. What would you like to change in the requirements for the topic of trigonometry in the curriculum?

Appendix C

Interview Questions for Students

1. How many points would you rate the difficulty of the trigonometry subject on a ten-point scale? Why? (1 – not difficult, 10 – very difficult)

1	2	3	4	5	6	7	8	9	10
Very Easy	Easy	Slightly Easy	Medium	Close to Hard	Difficult	Harder	Very difficult	The Hardest	Extremely Difficult

2. How important do you consider the teaching of trigonometry as a subject?
3. Where do you see trigonometry being used in real life? Have you used the knowledge you received in real life? Could you please provide examples.
4. Do you think that the motivation and self-confidence of the teacher has any effect on your learning process?
5. How would you describe any lesson on trigonometry? (how the teacher starts the lesson, etc.)
6. How useful do you think the class work, homework, and tests are to your learning trigonometry?
7. Do you discuss the assignments with your classmates? Do you think it is more effective to work and solve tasks together or to solve them individually?
8. If you were a teacher, what factors would you consider and teach the subject of trigonometry? How would you go about explaining the topic and what methods would you use?

9. Do you have any difficulties in trigonometry? Can you share these challenges? How does your teacher support you to overcome these difficulties? Please provide examples of these challenges and how you were supported.

Appendix D

Observation Tool

Students' Behaviors	Comments
<input type="checkbox"/> Attentive to the teacher and instruction	
<input type="checkbox"/> Follow verbal instruction	
<input type="checkbox"/> Follow written instruction	
<input type="checkbox"/> Be a part of the class discussion	
<input type="checkbox"/> Appear organized and ready for activity	
<input type="checkbox"/> Work Effectively Alone, in Small Groups, and in Large Groups	
<input type="checkbox"/> Effectively communicate their wants, needs and emotions	
<input type="checkbox"/> Discuss a wide range of interests related to the topic	
<input type="checkbox"/> Students effectively apply the theory into practice	

Content	Comments
<input type="checkbox"/> The content standard for the grade level is the focus of the lesson	
<input type="checkbox"/> The lesson reflects the consistency of the standards by connecting mathematical ideas in the right way within and/or across grades	
<input type="checkbox"/> The lesson specifically emphasizes conceptual understanding, procedural skill, fluency, and application/daily-life application	

Practices	Comments
<input type="checkbox"/> Beyond simply showing students how to get the answer, the teacher makes mathematical tasks explicit by using accurate explanations, representations, and examples	

<p><input type="checkbox"/> The teacher creates a learning environment that encourages students to debate, defend, use, analyze, and evaluate their ideas in practical/real-life contexts</p>	
<p><input type="checkbox"/> The teacher adapts the lesson to promote understanding by purposefully posing questions and tasks that highlight students' understanding, including misconceptions</p>	
<p><input type="checkbox"/> The interactions between the teacher and students in the classroom are consistently and highly positive</p>	
<p><input type="checkbox"/> The teacher uses student-centered learning</p>	

Adapted from: Department of Education. (2019). PPST-based Classroom Observation Tool.

Philippine National Research Center for Teacher Quality. <https://rctq.ph/files/COT.pdf>

Appendix E**Müəllimlər üçün Verilən Müsahibə Sualları**

1. Zəhmət olmasa özünüzü təqdim edərdiniz. Adınız nədir? Neçə ildir işləyirsiniz?
2. Orta məktəbdə triqonometriya mövzusunun tədrisi şagirdlər üçün nə dərəcədə əhəmiyyətlidir? Zəhmət olarsa nümunələr göstərdiniz.
3. Triqonometriyanın tədrisi zamanı hansı yanaşmalardan istifadə edirsiniz? (metodlar və s.)
4. Triqonometriya mövzusunun izahı zamanı şagirdlərin bu mövzuya münasibət və davranışları necə olur? Zəhmət olmasa, müşahidələrinizi bölüşün.
5. Əgər triqonometriyaya aid hər hansı mövzunun şagirdə maraqsız olduğunu müşahidə edirsinizsə, bu halda hansı tədbirləri görürsünüz?
6. Triqonometriyanın izahı zamanı onun real həyatda necə istifadə edilməsilə bağlı şagirdləri məlumatlandırırırsınızmı?
7. Şagirdlər triqonometriyaya aid tapşırıqları həll edərkən daha çox hansı məqamlarda çətinlik çəkirlər? Sizcə, bu çətinliklərin səbəbi nədir? Bu çətinliklər zamanı onlara necə dəstək olursunuz? Zəhmət olarsa nümunələr göstərdiniz.
8. Triqonometriyaya aid ev tapşırıqları zamanı hansı məqamlar (şagirdlərin səviyyələri və s.) nəzərə alınır?
9. Şagirdlərin ev tapşırıqları və qiymətləndirmə üçün tapşırıqları (items) əsasən hansı tipdə olur?
10. Tədris proqramında triqonometriya mövzusu üçün qoyulan tələblərdə nələr dəyişmək istərdiniz?

Appendix F

Şagirdlər üçün Verilən Müsahibə Sualları

1. On ballıq şkalada triqonometriya mövzusunun çətinlik dərəcəsini neçə bal ilə qiymətləndirərdiniz? Niyə? (1 – çətin deyil, 10 – çox çətin)

1 Çox Asan	2 Asan	3 Bir az Asan	4 Orta	5 Çətinə Yaxın	6 Çətin	7 Daha Çətin	8 Çox Çətin	9 Lap çox Çətin	10 Hədsiz Çətin
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2. Triqonometriyanın bir mövzu kimi tədrisini nə dərəcədə əhəmiyyətli hesab edirsiniz?
3. Real həyatda triqonometriyanın istifadəsini harda görürsünüz? Aldığınız biliyi real həyatda istifadə etmişiniz? Zəhmət olarsa nümunələr göstərərdiniz.
4. Müəllimin motivasiyaya və özgüvənli olmasının sizin öyrənmə prosesinizə hər hansı bir təsiri olduğunu düşünürsünüzmü?
5. Triqonometriya mövzusunə aid hər hansı dərsi necə təsvir edərdiniz? (müəllim dərse necə başlayır, və s.)
6. Sınıf işləri, ev tapşırıqları və yoxlama işlərinin triqonometriyanı öyrənməyinizə nə dərəcədə faydalı olduğunu düşünürsünüz?
7. Tapşırıqları edərkən sinif yoldaşlarınızla müzakirə edirsinizmi? Sizcə tapşırıqları birlikdə işləyib həll etmək daha effektivdir, yoxsa fərdi həll etmək?
8. Əgər müəllim olsa idiniz hansı faktorları nəzərə alıb triqonometriya mövzusunə mütəlak tədris edərdinizmi? Mövzunun izahı zamanı necə bir yol izləyər və hansı metodlardan istifadə edərdiniz?
9. Triqonometriyaya aid hər hansısa bir çətinliyiniz varmı? Bu çətinlikləri bölüşə bilərsinizmi? Müəlliminiz bu çətinliklərin öhdəsindən gəlməyiniz üçün necə dəstək olur? Zəhmət olmasa bu çətinliklərə və necə dəstək olunmağınıza nümunələr göstərdiniz.