

Technology of forming the competence of plausible reasoning of mathematics students by solving open problems

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Abstract

This research aimed to form a technology for creating reasonable reasoning competence of mathematics students by solving open problems using the help of mathematics and technology, and the research was prepared for this purpose. The research was prepared and designed in the fall academic year of 2022–2023, and 256 students studying in the mathematics department in Kazakhstan participated in the research. An application dimension was prepared for the students participating in the research and they were allowed to participate in this application for 3 weeks. Immediately after the trainings to be given in the research were given, the data collection tool was applied to the participant groups and this information was obtained from them.

Keywords: Mathematics, technology, reasoning, distance education;

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1. Introduction

It is known that the most basic form of behaviour change in education, training and individual is to raise students who produce, solve problems and develop in a desired way (Mazhitovna et al., 2022). It is known that in our globalised centre, changes occur in education, and it is aimed to raise individuals who are conscious of education and students' own learning time, and who have the knowledge and skills to solve problems and problems (Sahin, Gurbey, & Mertoglu, 2022). It is known that mathematics, which is an area preferred by the society and even by the students, has a high impact on applications in the technology used together with the production and production (Ng'elenge, Damas, & Kilima, 2022). It is known that students' interest in the field of mathematics and its effects and their level of development have increased. These achievements in societies that have reached the level of contemporary civilisation today are based on the importance they attach to basic sciences, especially to mathematics (Caligaris & Laugero, 2022). Considering the meaning of science and education on students, it gives the belief that it is not possible to progress in other branches of science without the help of mathematics (Ocheja, Agbo, Oyelere, Flanagan, & Ogata, 2022). In this context, the education that students will receive from primary school to university is of great importance in order to ensure the continuation of the value of science in education in the field of mathematics once again (Chansanam & Li, 2022).

It is an often overlooked fact that among the students of tomorrow, great mathematicians are among the students of today. Mathematics and technology are among the main objectives of contemporary mathematics education, to identify and reveal students in a timely manner, to prepare these talents, who will be great scientists of the future, for scientific studies from school age, to introduce them to extraordinary problems that are not at all easy to solve and to enable them to think deeply rather than superficially (Lin, Tang, Lin, Changlai, & Hsu, 2022). Technology education, while providing students with the opportunity to learn real-world problems, aims to solve the problems they will encounter in the future, with the help of this method, students acquire knowledge in a more holistic and organised way and transfer what they have learned to different disciplines and disciplines (Vaicondam, Sikandar, Irum, Khan, & Qureshi, 2022). It is to produce at an early age by using different fields and other abilities. The goals of the field of mathematics are to increase the number of people who want to make a career in technology, secondly, to realise technology literacy, and thirdly, to increase participation and use of technology (Kaur & Bhatia, 2022).

It is stated that professions in the field of technology may be popular professions of the future that can increase a country's economic growth, global competition, innovation and living standards (Mendez, Mendez, & Anguita, 2020). It is aimed to contribute to the economy by increasing the workforce potential in areas related to technology-based education. With technology teaching, the aim is not only success or failure in course areas, but also to be economically strong and not to slow down in the race between countries (Chen, Zou, & Xie, 2022). For this reason, it is very important to disseminate science and technology literacy by raising future science experts and engineers (Othman et al., 2022). In this research, it is thought that it is possible to increase technology literacy and develop positive attitudes of students in technology fields by knowing the mutual relations of science, mathematics, engineering and technology (Al-Hoorie, Oga-Baldwin, Hiver, & Vitta, 2022).

1.1. Related studies

In the research conducted in González-Pérez and Ramírez-Montoya (2022), Education 4.0 are 21st-century skills framework analyse teaching and learning methods being considered and affected, and are intended to identify key stakeholders and as a result, with the merger of technology and mathematics, problem solving and complex reasoning capabilities to address the needs and social support auto-systemic thinking to develop educational models for creating create a reflection they achieved.

Aladağ, Arıkan, and Özenoğlu (2021), in the year literacy skills and reflective thinking skills for problem solving in the work of map for problem solving and reflective thinking skills to determine the impact on literacy skills, and as a result, technology in business studies was undertaken to investigate the relationship between students' map literacy skills in reflective thinking and problem-solving skills developed to a statistically significant extent, and that there is a strong correlation between the two skills, it is observed that achieves results.

Gagnier, Holochwost, and Fisher (2022), in their work to improve students' spatial thinking skills, Science, Technology, Engineering and Mathematics education is used to develop the skills of the students and they expressed great promise for improving classroom is intended to focus on the development of spatial interventions, and as a result, in their studies that students' spatial thinking skills for academic achievement during their belief in the importance of science teaching and students' spatial skills while developing self-occur with the competencies, it is seen that reaches values.

As seen in the related research section that mathematics and thinking skills, with the help of technology students themselves are specific to that area as they are better prepared in mathematics and competence in solving problems by using technology to help the students build math reasoning open to reasonable prepared in this study, it is known that the same has been entered into with the expectation. Other parts of the research will continue to progress in a way that is fit for purpose.

1.2. Purpose of the study

When the problem situation of the research was handled carefully, it was aimed to form a technology for creating the reasonable reasoning competence of mathematics students by solving open problems using the help of mathematics and technology, and answers were sought for the following questions regarding the determined general purpose:

1. What is the use of mathematics and technology for the participant group included in the study?
2. What is the level of knowledge about the reasoning competence of the participant groups included in the study?
3. What are the views of the participant groups participating in the research on mathematics and problem-solving technology?
4. What are the views of the participant groups participating in the research on reasoning and technology in the field of mathematics?
5. Is there a difference between the mathematics and technology education levels of the participant groups participating in the research according to the gender criteria?

6. How is the reasoning and technology status of the participant groups participating in the research according to their class distribution?

2. Method

When the study is emphasised as a method, it is seen that first of all, information about the way to be followed in the study will be given. In this section, it is seen that the people who created the research, the place of the research and other information.

2.1. Research model

In this content validity process, it is seen that the quantitative research model is supported and benefited from the research. The main purpose of the quantitative research method is known as revealing the cause–effect relationship as far from bias as possible, as objectively as possible (Uzunboylu, Prevalle Ethem, & Hamidi, 2021). In this sense, it was designed on the formation of technology to create the reasonable reasoning competence of mathematics students by solving open problems using the help of mathematics and technology by the participant groups participating in the research.

2.2. Working group/participants

In this section, it is seen that there is information about the participant groups that make up the study. In this context, it is seen that this study consists of 256 participants who continue their education in Kazakhstan. These participant groups continue their education in the primary school. Participant groups participating in the research take it over the live lesson in the activity studies.

2.2.1. Gender

In this section, it is seen that information about the gender concepts of the participant groups that make up the research is included and formed. All data about this part are given in Table 1.

Table 1. Distribution of the participant groups participating in the research by gender variable

Gender	Male		Female	
	F	%	F	%
Variable	129	50.39	127	49.61

In this section, it is seen that there is information about the concepts of gender. When Table 1 is examined and handled carefully, it is seen that 50.39% (129 people) are male participants, while 49.61% (127 people) are female participants. In the gender section, the findings reflect the actual gender distribution.

2.2.2. Mathematics and technology use cases of the participant group included in the research

In this section, it is seen that an answer is sought for a question concerning the problem situation. Mathematics and technology application activities developed by the researchers and shared with the study group were given in order to improve the reasoning and technology

dimensions of the participant groups in the study, and these activities were asked to be used during the day, and these values are given in Table 2.

Table 2. Mathematics and technology usage situations of the participant group included in the research

Use of mathematics and technology	1 hour		2 hours		3 hours and above	
	F	%	F	%	F	%
Variable	24	9.37	75	29.30	157	61.33

As can be seen in Table 2, there are use cases related to the use of mathematics and technology prepared for primary school students and given to them in the research. In this context, 9.37% (24 people) stated that they spared time for mathematics and technology applications for 1 hour, while 29.30% (75 people) stated that they used it between 2 hours and 61.33% (157 people) stated that they spend 3 hours or more on mathematics and technology applications.

2.2.3. The level of knowledge about the reasoning competence of the participant groups included in the study

In this section, the knowledge levels of the participant groups included in the study about fairy tale therapy technology were researched and examined. Detailed information is given in Table 3.

Table 3. The knowledge levels of the participant groups included in the study about reasoning competence

Reasoning ability	I have information		I have no information		I have partial information	
	F	%	F	%	F	%
Variable	35	13.67	175	68.36	46	17.97

It is seen that some activities will be given to the participant groups regarding the problem situation of the research on the application part of the research. Regarding this definition, it is seen that whether the participant groups participating in the research have reasoning competence information is investigated and added to Table 3. Regarding all these explanations, it is seen that 13.67% (35 people) answered I have information, 68.36% (175 people) answered I do not know and 17.97% (46 people) answered I partially know. It appears to respond to the var option. In this context, it is thought that the reasoning competence training and the information to be given at the same time will be beneficial and beneficial to the participants in the research.

2.2.4. Class status

In this section, it is seen that the numerical values of the participant groups added and included in the study were examined according to the class data and added to Table 4.

Table 4. Distribution of the participant groups included in the study by class status

Class	Third grade		Fourth grade		Fifth grade	
	F	%	F	%	F	%
Variable	78	30.47	71	27.73	107	41.80

When Table 4 is examined, it is seen that the distribution of the participant groups included in the research according to their class status is discussed and the information regarding this section is added to the table. In this context, when Table 4 is considered, 30.47% (78 people) stated that they were in the third grade, 27.73% (71 people) stated that they were in the fourth grade and 41.80% (107 people) stated that they were in the fifth grade. In the class situations section, the findings reflect the actual distribution.

2.3. Data collection tools

In this section, it is seen that there is information about the problem situation and what the data collection tool about the research is and how it will be. The data collection tool was created by the researchers specifically for this study and examined by experts and simplified by removing the unsuitable items from the study. It is seen that the personal information form called 'Mathematics and Technology' data collection tool, which was applied and created by the researchers, was used to measure the opinions of the participants included in the research. The content validity of the developed measurement tool was examined by experts with the title of two professors and two associate professors working on mathematics and technology education, and unnecessary items were removed from the measurement tool and simplified and rearranged.

1. Personal information form (demographic data): In the personal information form, information such as gender, class, use of mathematics and technology, reasoning competence and knowledge status are included.

2. Mathematics and technology data collection tool: A 5-point Likert-type data collection tool was prepared in order to create some values in the participant groups. 22 items of the measuring tool consisting of a total of 24 items were used and 2 items were removed from the measuring tool, thanks to expert opinion. The opinions of the participant groups from two factorial dimensions, such as 'mathematics' and 'technology', were consulted. The Cronbach alpha reliability coefficient of the measurement tool as a whole was calculated as 0.84. Measuring tool; 'strongly disagree' (1), 'disagree' (2), 'undecided' (3), 'agree' (4) and 'strongly agree' (5). The measurement tool was also collected from the participant groups in the form of an online environment.

2.4. Application

In this research, when the application part and its size are handled carefully, it is seen that there is some information about the study and it is created for this research. First of all, it is known that the most basic behaviour in this research is to strengthen the dimensions of mathematics and technology by using reasoning competencies and to make problem-solving behaviours meaningful.

After this training, transferring some applications related to the field of mathematics to the students is among the targets. Since these application trainings will be realised with technology, it was aimed by the researchers to provide training in this field immediately after the live lessons. Immediately after all these trainings, it was aimed to apply the data collection tool to the participant groups participating in the research in order to localise the data in the research in a beautiful way. This data collection tool will reach the participant groups online with the help of their families, and it is planned that this information will be collected one by one, coded and sent to the analysis programme. An avatar model was prepared for each participant group member in the training and participation in this environment was provided by the researchers with the created avatar model. 35 minutes of each activity and 15 minutes of the activity were covered in the form of questions and answers in a total of 50 minutes. Finally, the data collection tool applied to the people who participated in the research in the light of the information given above was collected by means of an online questionnaire and transferred to the Statistical Package for the Social Sciences programme by making coding in the computing software environment.

2.5. Analysis of the data

In the analysis of the data collected and analysed from the participant groups participating in the research, the statistical data obtained from the opinions and the answers given using frequency (f), percentage (%), mean (M), standard deviation (SD), t -test and analysis of variance (ANOVA). The statistics were analysed in the programme. The numerical values of the data obtained from the programme are given in tables, accompanied by comments in the findings section.

3. Findings

In this section, the numerical findings obtained as a result of the analysis of the statistical data obtained from the participant groups consisting of the primary school group were added to this section in tables, and various interpretations were included in the direction of the findings.

3.1. Mathematical problem-solving views of the participant groups participating in the research

In this section, it is seen that the data on the views of the participant groups included in the research about mathematics and problem solving are given and examined in Table 5.

Table 5. Mathematical problem-solving opinions of the participant groups participating in the research

No	Mathematics and problem-solving insights	M	S
1	I was able to get used to mathematics education easily	4.42	0.48
2	I saw that I could easily use it in my mathematics and problem-solving education classes.	4.56	0.42
3	I found the problem-solving materials helpful and educational	4.52	0.47
4	I could easily connect to math and problem-solving applications	4.46	0.35
5	I was able to access math and problem-solving applications with drive technologies with the help of my family.	4.41	0.37
6	Thanks to the mathematics education and problem-solving education, I had no difficulty in repeating the	4.41	0.39

	subject.		
7	I was able to use my problem-solving skills in preparation for exams with technology	4.47	0.43
8	I strengthened my problem-solving behaviours in the technology environment by discussing with my friends.	4.42	0.45
9	I was able to communicate with the instructor who explained and participated in the mathematics education	4.48	0.48
10	I can say that I find problem-solving and fluid reasoning technologies sustainable.	4.46	0.46
11	I would like to see math and problem-solving skills again and in my other lessons.	4.46	0.32
Total		4.47	0.42

When Table 5 is taken into consideration, it is seen that the groups of participants participating in the research have mathematical problem-solving views and statistical values. Based on all this, when examined in Table 5, the values are high points of the research participants, it is seen that have a high problem-solving skills and mathematical findings of the research, the most obvious expression is being examined, 'when I saw that I could use my training and problem-solving in math classes', $M = 4.56$ finding was reached. In addition, it was found that 'I was able to communicate with the instructor who explained and participated in mathematics education' $M = 4.48$ was one of the most obvious statements of the research. Of the participants surveyed is quite high when it is seen that the views of mathematics and problem-solving finding another 'math practice and problem-solving drive technologies with the help of my family I was able to access the LE', and 'mathematics education and problem-solving thanks to the education I was not able to repeat the subject' two values $M = 4.41$ finding was reached. Another finding of the research is, 'I strengthened my problem-solving behaviours in the technology environment by discussing them with my friends. It was found that the point value of the expression' $M = 4.42$ and 'I can say that I found problem solving and fluent reasoning technologies sustainable' $M = 4.46$. In addition, finally, it is seen that the general average is found to be $M = 4.47$.

When Table 5 is examined, math and problem-solving skills are aligned with the technology of better groups of participants surveyed was told that when the materials in the environment, technology, math and problem-solving that they can use while preparing for exams and also provide support for the training of the research participants, it is observed that the useful information is reached at math and problem solving. In this context, since all the values in Table 5 have a positive meaning, it can be said based on the findings that the inclusive education of the participants participating in the study is positive.

3.2. Opinions of the groups of participants participating in the research on reasoning and technology related to the field of mathematics

In this section, the opinions of the groups of participants who were voluntarily included in the research on reasoning and technology related to the field of mathematics and the findings given as statistics are shown in Table 6.

Table 6. Opinions of the groups of participants participating in the research on reasoning and technology related to the field of mathematics

No	Views on reasoning and technology related to the field of mathematics	M	S
1	Online math classes conducted with reasoning and technology become more effective	4.39	0.36
2	Taking classes with reasoning and technology has allowed me to devote more time to the field of mathematics in my daily life	4.37	0.32
3	Instant correspondence and asking questions about the field of mathematics with the teacher, who explains the lesson with reasoning and technology, is a very effective method	4.48	0.38
4	Reaching the record of the course processed with reasoning and is more effective in reinforcing the course	4.41	0.34
5	It is an advantage for me to be able to learn the information in my reasoning and technology and mathematics lessons whenever and wherever I want	4.46	0.36
6	Reasoning and technology in the mathematical environment, I do not experience any disconnection while the lesson is being processed	4.38	0.38
7	I have the opportunity to take a math class with reasoning and technology and learn how to use smart devices	4.47	0.39
8	I can use my ability to chat while taking math lessons with reasoning and technology	4.36	0.41
9	I can join the created math groups in the reasoning and technology environment at any time.	4.42	0.31
10	I can access live course recordings of mathematics courses processed with reasoning and technology at any time	4.41	0.34
11	I would be happy to see the reasoning and technology system in my other activities and lessons	4.43	0.37
	Overall average	4.42	0.36

When Table 6 is examined, the research participants regarding their opinions of statistical reasoning in relation to the field of mathematics and technology among the findings are that although each answer carries a different meaning from the statements of the participating groups participating in the survey, 'reasoning about the lesson with the teacher in the field of mathematics and technology with the instant a very effective method for correspondence and to ask questions is' $M = 4.48$ findings, it is seen that that is reached in, in addition to these, it was found that one of the most obvious statements of the research is 'I have the opportunity to take a math lesson with reasoning and technology and learn how to use smart devices' $M = 4$ October 47. While it is seen that the opinions of the participants participating in the research regarding the field of reasoning and technology are quite high, another finding is that 'I would be happy to see the reasoning and

technology system in other activities and lessons' $M = 4.43$ was found. Another finding of the research is that 'Reasoning and technology in a mathematical environment, I do not experience any disconnection while studying' $M = 4.38$ and 'I can access live course recordings of mathematics courses processed with reasoning and technology at any time' $M = 4.41$. In addition, another value of the research is that 'I can use my ability to chat while taking math lessons with reasoning and technology' It was found that $M = 4.36$, finally, it is seen that the overall average is found to be $M = 4.42$.

Table 6 group of study participants when examining the field of mathematics in relation to reasoning and problem-solving in math with this technology and also technology, the high authority in the reviews themselves feeling happy and successful, the technology that they can use smart devices from anywhere, they are happy to spend time with a lot more positive and it is seen that value is reached, in this context, since all the values in Table 6 have a positive meaning, it can be said based on the findings that the opinions of the groups of participants participating in the study about mathematics and technology are positive.

3.3. Mathematics and technology education status of the participant groups participating in the research by gender

In this section, the mathematics and technology education levels of the participant groups included in the study were examined, according to the gender criteria, and the information whether there is a significant difference is given in Table 7.

Table 7. Inclusive education status of the participant groups participating in the research by gender criteria

Mathematics and technology education situations	Gender	N	M	SD	Df	t	p
	Boy	129	4.40	0.38	256	-189	0.154
	Girl	127	4.38	0.27			

When Table 7 is examined, the mathematics and technology education levels of the participant groups participating in the research were examined according to the gender variable, and it is seen that there is no significant difference according to the gender criterion [$t(256) = -189, p < 0.05$]. When the mathematics education status of the participant groups participating in the research is examined, it is seen that the male participants have an average score in this area ($M = 4.40$), while the female participants have an average score on mathematics and technology education ($M = 4.38$). In this context, it can be said in the findings part of the research that there is no difference between the scores of male participants in mathematics and technology education compared to female participant groups in this study.

3.4. Reasoning and technology status of the participant groups participating in the research by class

In this section, reasoning and technology statuses were examined according to the sections of the participant groups included and participated in the study, and detailed findings are given in Table 8.

Table 8. Reasoning and technology status according to the sections of the participant groups participating in the research

Department	N	Rank average	SD	χ^2	p
Third grade	78	30.47	3	1.638	0.183
Fourth grade	71	27.73			
Fifth grade	107	41.80			

When Table 8 was examined, it was found that there was no significant difference between the results of comparing the reasoning and technology status of the participants using ANOVA according to the class criteria ($\chi^2 (3) = 1.638; p = 0.183; p > 0.05$). Considering the reasoning and technology findings of the participants according to the class criteria, it is seen that the fifth grade is the highest, the second highest value is seen to be in the third grade range and it is the fourth grade. It can be said that the participants participating in the research did not show a significant difference between reasoning and technology status for the class criterion.

4. Discussion

Bulkani, Fatchurahman, Adella, and Setiawan (2022), in their research in online learning in animation based on local wisdom to palangkaray, sought to develop a learning environment and Primary School Muhammadiyah elementary school Panarung, was joined by students from elementary school 123 Negeri pahandut. When they discussed the conclusion of the study, the scores of the experimental group Students with the technology they use and the results they achieve, it is observed that the development of meaning. In this context, when this value is combined with the results of the research, it is seen that the problem-solving skills of the students included in the research with technology are higher after the research and the results that the students listen to the lessons more efficiently with this method are reached. In this context, it can be said in the discussion section of the research that the results of the research with this value will benefit the field literature.

Marchisio, Remogna, Roman, and Sacchet (2022), in studies in mathematical science students and a lesson on problem solving by designing for particular applications, intended to assist learners to develop proficiency in research and as a result encouraging interaction between them, so that they become active users of the content to be adapted according to the personal requirements of learning and, at the same time, students problem-solving approach and the usefulness of the software achieves the results it is observed that the importance of the role that is high. This value, when combined with the results of the research, research problem-solving activities using technologies in application is given and up to 3 hours and by taking the time to applications of mathematics, and problem-solving skills potentiated the development of students, it is seen that results have been achieved. In this context, it can be said in the discussion section of the research that these two studies compiled with technology show importance for the participant groups in their field.

Tahir, Mitrovic, and Sotardi (2022) SQL queries in the work they have done in the year they mature, who has taught its students how to express in SQL tutor was undertaken to investigate the effects on learning in causal research, and as a result of oyunlastirman dramatisation, by acting as an intermediary in the duration of OFCE as they affect student learning and students' background information, students should take the time and unless they finally badges on duty did not affect the students interested in the field (motivational structure), they found that the results they managed decoupled the relationship between badges and time spent on duty. In this context, this value when

combined with the results of the research with the help of technology in research to create an avatar for students who participated in the research is important, and very good use of technology by using these avatars are dominated by reasoning with their math and reached the conclusion that it is seen that all these technologies.

It is seen that the combination of application areas such as mathematics with technology benefits students. First of all, this research shows that while the impact on students is important for the application of a given problem because it is important for the study to be useful in a situation where the mass of this research group in another time and place, is one of repeat prospects.

5. Conclusion

When the results part of the research is considered, it is seen that the number of participants exists and is formed first, it is seen that 256 primary school students participated and participated in this research, which was studied meticulously. Another value of the research is that the use cases regarding the use of mathematics and technology prepared for primary school students and given to them in the research were investigated and it was concluded that the participants preferred the most amount of use for 3 hours or more. In order for the research to progress in a healthy way and to support the students, it was investigated whether they had reasoning competence information and it was concluded that most groups answered no to this question in the research and they did not know. With this scope, reasoning competence training was given to the students. Another value of the research is that it is seen that the groups of participants participating in the research have mathematical problem-solving views and statistically it is concluded that there are values. When the results of the most obvious expression is being examined, math and problem-solving training courses that they could use, they can communicate with the instructor and participating describing mathematics education, math practices and problem-solving math with the help of family and drive technologies in the environment with technology they can access the materials that they can use while preparing for exams and also provide support for the training of the research participants, it is observed that the useful information is reached at math and problem solving.

Another outcome of the research discussed when the research participants regarding their opinions of reasoning in relation to the field of mathematics and technology is located researched and statistical results, it is seen that, although each answer carries a different meaning, reasoning and technology in the field of mathematics with the teacher about the lesson with the instant meaning that they are a very effective method for correspondence and to ask questions, reasoning, mathematics and technology with the opportunity to take a course to learn how to use smart devices they have no difficulty in finding, Reasoning, Mathematics, and technology in the environment, of course, that they haven't had any disconnected during the processing, and problem solving in math with this technology in authority themselves feeling happy and successful, the technology that they can use smart devices from anywhere, they are happy to spend time with positive results and it is observed that a lot more is reached. Another value of the research is that the mathematics and technology education status of the participant groups participating in the research was examined according to the gender variable and it seems that there is no significant difference according to the gender criterion. Finally, it is seen that there is no significant difference between the value in the results of the study between the results of the deficiency of the participants participating in the study

by using ANOVA support according to the class criterion, and the results of the comparison of reasoning and technology.

In the results section of the research and study, it is seen that technology benefits in solving open problems and it is also concluded that technology helps reasoning.

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