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Methods of teaching school students to solve systems of equations and inequalities in the conditions of digitalisation of education

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Abstract

The general purpose of this study was to form methods of teaching school students to solve systems of equations and inequalities in the conditions of digitalisation of education. The quantitative research method was used in the research; the research was carried out in the spring term of 2021–2022. The research was carried out with the participation of 278 volunteer students who continue their education in various schools in Kazakhstan. Equation and inequality systems solution training was given to the participant group in the form of a 4-week online training. In the study, the 'digital education and mathematics' data collection tool developed by the researchers and compiled by experts in the field was used. The

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measurement tool was delivered to the participant groups via an online method and collected. The analysis of the data was made by using the Statistical Package for the Social Sciences programme, frequency analysis, *t*-test and analysis of variance test, and the results were added to the research in the form of tables. According to the results obtained from the research, it was concluded that the equation and inequality solving and application dimensions of the participant groups were strengthened and used with digitalised education.

Keywords: Education, digital, distance education, equation, inequality systems;

1. Introduction

Distance education, which means that education reaches students as digitalised education with the help of Internet technologies and smart devices that are renewed and developed every day, although its examples and structuring are found and used in the infrastructure of many universities, has been developed with new solutions specific to a configuration and process called emergency distance education in this process. Adaptations were needed (Buyukkayhan & Yildirim, 2021). Developing and digitising education includes the use of completely virtual teaching solutions for education or training, which will be given as a face-to-face course by returning to its previous application when the emergency or crisis disappears (Sahli & Belaid, 2022). It is seen that the transition to digitalised education has started to continue the lessons and programmes with the digitalised education structured according to the formal education, which emerged due to COVID-19 and is a response to the students (Hrynevych, Khoruzha, & Proshkin, 2022). The reason why no evaluation can be made about the adaptation of students to the requirements of digitalised education and also to their modules is that this transition is realised very quickly (Maldonado-García, Ocampo-Díaz, & Portuguez-Castro, 2022).

Not being able to understand mathematics also affects the attitude towards mathematics. Since mathematics lessons in distance education are even more difficult to understand, negative thoughts have increased. The main reason for the negative attitudes was the thought that the mathematics course would not be useful in their daily lives (Batilantes, 2022). However, many of the things we encounter in our daily life are mathematical actions that we unconsciously do. The child, who cannot convert currencies to each other in terms of money in the classroom, unknowingly does this while shopping at the school canteen. When the applications in our lives are considered, mathematics is a human activity. It can be said that the school's function of teaching by doing is lacking in distance education (Efthymiou, 2022). When we think that the most important skills in the traditional mathematics teaching approach are memorisation and processing, in this approach, even the basic mathematical concepts are given to the student in abstract forms (Wang, Alassafi, & Keir, 2021). In the student-centred mathematics teaching approach, on the other hand, it is more important to develop mathematical reasoning, increase communication and maintain mathematical thinking. There is a need for some tools in schools to transfer the thoughts and facts in mathematics to others. Among these tools, representations are of great importance. Representations are used to support students' understanding when teaching a new concept or solving a problem (González-Betancor, López-Puig, & Cardenal, 2021).

With technological development, distance education has become more common and while creating an important alternative, it has become the only education method during the pandemic process. This situation made it inevitable to develop studies and new theories for distance education and to take steps towards multiple representations (Valdebenito Zambrano, Duran Gisbert, & Uzunboylu, 2021). In this process, efforts were made to provide students with a more effective

education by taking advantage of multiple representation opportunities, but the ideal structure was moved away from the daily living conditions in the world (Kim, Yi, & Hong, 2021). From this point of view, it is undeniable that individuals who cannot live their daily lives fluently experience various disruptions in their education life. Therefore, there is a prevailing opinion that multiple representations in distance education cannot fully reflect its potential (Boca, 2021). Although it is difficult for individuals who have lost their motivation, habits and social life to focus and learn, it is possible to state that these weaknesses are minimised with multiple representations. Multiple representations, with their effective use in mathematics teaching and learning, allowing concepts to be handled in different ways, improve communication skills and conduct investigations (Burgos-Videla, Castillo Rojas, López Meneses, & Martínez, 2021). Thanks to these opportunities, it is thought that in addition to increasing the interest of the students in the lesson, it will be possible to deepen their thinking structures, take on a more flexible mindset and evaluate the events more analytically, and the same is expected from this research.

1.1. Related research

Schmid and Petko (2019) aimed to investigate the use of digital technologies in school for personalised learning in connection with students' self-assessed digital skills and their beliefs about the usefulness of digitalisation in learning and as a result, self-reported digital skills and self-perceived digital education-related beliefs had a positive effect.

Kliziene, Taujanskiene, Augustiniene, Simonaitiene, and Cibulskas (2021) aimed to provide education through virtual teaching/learning platforms in primary education by using mathematical environments, natural science, history and language application and as a result, it was concluded that 7-year-old children have high values in virtual learning tasks.

In a blended and collaborative modality course, Araújo Filho and Gitirana (2022) aimed to reveal pre-technology, pedagogical and content knowledge in the study. As a result, the students concluded that they had completed the mathematics teaching methodology discipline and they had the content knowledge they had during the educational experiment.

When the studies in the related research section are examined, it is seen that the students in the school environment have reached the values that they achieve success with the digitalisation of education. In this context, having the same value from this article is among the targets in the below sections.

1.2. Purpose of the study

The purpose of this study is to determine the methods of teaching school students to solve systems of equations and inequalities in the conditions of digitalisation of education. In line with the purpose of the study, answers to the following questions were sought in the study:

1. What are the digitalised education use cases of the participants participating in the research?

2. How are the equation and inequality subject levels of the participants participating in the study?

3. Is there a difference between the digitalising education levels of the participants participating in the research?

4. Is there a difference between the performance levels of the participants participating in the research?

5. Is there a difference between the smart device and the tracking levels of the participants participating in the research?

2. Method

In this section, information on the method used, the type and source of the numerical values included, the data collection tool used and the information included and arranged are given.

2.1. Research model

It is seen that among the research methods in the study, the quantitative research method was used and benefited. Quantitative research is defined as the systematic investigation of phenomena by collecting quantitative data and applying statistical, mathematical or computational techniques. By using sampling methods and sending online surveys to current and potential customers collecting quantitative research information, survey results can be depicted in numerical form (Caliskan et al., 2020). In this context, it is designed on the formation of methods of teaching school students to solve systems of equations and inequalities on the conditions of digitalisation of this education.

2.2. Working group/participants

The research was carried out in the spring academic year of 2021–2022. The data of the research consist of 278 volunteer students studying at schools in Kazakhstan at random. All of these students take their lessons in conjunction with digitalised education.

2.2.1. Gender

Table 1. Distribution of university students by gender

Gender	Male		Female	
	F	%	*F*	%
Variable	141	50.71	141	50.71

Gender concepts were chosen randomly and close to each other in the research. In Table 1, it is seen that 50.71% (141 people) of the study group students are male and 49.29% (137 people) are female. In the gender section, the findings reflect the actual gender distribution.

2.2.2. Class

The distribution of students participating in the study according to the class is given in Table 1.

Table 2. Distribution of students participating in the study by class

Class	5th grade		6th grade		7th grade	
	F	%	*F*	%	*F*	%
Variable	78	28.05	97	34.89	103	37.06

In Table 2, it is seen that the class information of the study group students is included and tabulated. 37.06% (103 people) are seventh-grade students. In the class division, the findings reflect the actual division distribution.

2.2.3. Digitised education use cases of the participants participating in the research

According to the education model given to the participant group participating in the research, the use of digital education was investigated and the information is given in Table 3, in light of the numerical values examined.

Table 3. Digitised education use cases of the participants participating in the research

Time	1 hour		2 hours		3 hours and above	
	F	%	*F*	%	*F*	%
Variable	107	33.65	110	34.59	101	31.76

When Table 3 is examined, the study group was asked how often the use of digitalised education is during the day, and it is seen that detailed information is added. 34.59% (110 people) stated that they allocate 2 hours and 31.76% (101 people) allocated 3 hours and more. It can be said based on Table 3 that they prefer to allocate 3 hours and more to digitalised education.

2.3. Data collection tools

It is seen that the research includes the data collection tool developed by the researchers for this study to determine the values of the students and organised by showing it to experts in the field. During the data collection process, the measurement tool was shown to the professors in the fields of mathematics and informatics, and the reliability coefficient was found as α = 0.91, which was developed by the researchers with the questionnaire form, whose content validity was ensured by taking the opinions of seven different field experts. In addition, a tool called the 'digital education and mathematics' questionnaire was used as the interview form. The questions in the research were compiled one by one and it was aimed to form them from general to specific.

1. Personal information form (demographic data): In the personal information form, information such as gender, class and digitised education status are included.

2. Digital education and mathematics data collection tool: A 5-point Likert-type questionnaire was prepared to get information about the opinions of the participating students about the equations and inequalities in digitalised education and mathematics. 20 items of the measurement tool consisting of 23 items in total were used and 3 items were removed from the measurement tool, thanks to expert opinion. The opinions of the participants participating in the research were sought from two factorial dimensions, such as 'Digitalising Education' and 'Mathematics Topics', of the participant group participating in the research. The Cronbach alpha reliability coefficient of the measurement tool as a whole was calculated as 0.91. The measuring tool was in the range of 'strongly disagree' (1), 'disagree' (2), 'undecided' (3), 'agree' (4) and 'strongly agree' (5). The measurement tool was collected from the people who participated in the research in the form of an online environment with Google Survey.

2.4. Application

It is seen that there are definitions for the delivery of the desired data as application words to the appropriate audience. In this context, it is aimed to give live lessons in the form of 4 sections to 278 students continuing their education in Kazakhstan. During the 4-week training period, technology-related courses were prepared regarding the identification of students' digitalised education and mathematics topics, and the participation of the participant groups was ensured on how to combine mathematics with digitalised education, how to use it, how to solve questions with time, what is information adaptation etc. After the 4-week training, a data collection tool was applied to the students and the data are given in tables in the findings section. The training was arranged via the Zoom Meeting programme, which is used and preferred by most schools, and each section is distributed over weeks to be limited to 70 people, each lesson was taught in 30 minutes, and in the case of online training, participant groups are expected to attend the lesson with video and microphone, thanks to their smart devices. The interview form applied to the students was obtained with the help of the online questionnaire together with their families.

2.5. Analysis of data

In the data analysis part, the statistical data obtained from the participants participating in the study group were analysed in the Statistics programme by using frequency (*f*), percentage (%), mean (*M*), standard deviation (SD) and *t*-test, respectively. 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 determination of the professional activity adaptation of the participant groups participating in the research based on the dimensions of digitalised education and mathematics and the findings related to the objectives are included.

3.1. Descriptive statistical findings of equation and inequality subject levels of course participation of the participants in the research

The descriptive statistics regarding the course participation of the participants in the research and the determination of the equation and inequality subject levels are given in Table 4.

Table 4. Descriptive statistical findings of equation and inequality subject levels of course participation of the participants in the research

Dimension	Course name	*N*	*M*	*S*
Introduction to equation topics	Digitised mathematics	278	4.32	0.475
Inequality issues in problem-solving		278	4.28	0.542
Evaluating mathematics subjects	Digitised mathematics	278	4.37	0.468

In Table 4, it is seen that digitalised education levels for the mathematics course related to the determination of professional activity adaptation based on descriptive statistics regarding the determination of equation and inequality topic levels were given to the course participation of the participants participating in the research. It is seen that the value is 'inequality issues in problem-solving' had a score of *M* = 4.28 and 'Evaluating Mathematics Subjects' had a score of *M* = 4.37. In light of these findings, it can be said that the equation and inequality subject levels and dimensions of the participant groups participating in the research are high.

3.2. T-test analysis findings by gender variable among the digitalised education levels of the participant groups participating in the research

To determine whether there is a significant difference between the genders of the digitalised education levels of the participant group participating in the research, relevant data are given to the independent sample *t*-test findings.

Table 5. *T*-test analysis findings by gender variable among the digitalised education levels of the participant groups participating in the research

Dimension	Gender	*N*	*M*	SS	SD	*t*	*p*	Explanation
Registration to the digitalised education system	Boy	141	4.38	2.758	278	1.03	0.302	$p > 0.05$ (Difference meaningless)
	Girl	137	4.34	2.811				
Digitalised education technical support	Boy	141	4.36	2.508	278	1.21	0.328	$p > 0.05$ (Difference meaningless)
	Girl	137	4.32	2.642				

Digitized education evaluation	Boy	141	4.37	2.641	318	1.28	0.341	$p > 0.05$ (Difference meaningless)
	Girl	137	4.31	2.662				

When examining Table 5, according to the gender variable, for 'Registration to the Digitalised Education System', male students had a score of *M* = 4.38, while female students had a score of *M* = 4.34. From the findings, it can be said that there is no difference between male and female students and their scores are high. In addition, when another finding was examined, it was seen that for 'Digitalised Education Technical Support', male students had a score of *M* = 4.36, while female students had a score of *M* = 4.32. From the findings, it can be said that the scores of male and female students are higher than the digitalised education technical support department and there is no difference between them. Finally, it is seen that for 'Digitised Education Evaluation', male students had a score of *M* = 4.37, while female students had a score of *M* = 4.31. From the findings, it can be said that the scores of male and female participants are high according to the digitalised education evaluation feature and there is no difference between them.

3.3. T-test analysis findings of the performance levels of the participants in the field of mathematics

In this section, data are given regarding the independent samples *t*-test values applied to determine whether there is a difference between the *t*-test analysis findings of the performance levels of the participants in the field of mathematics.

Table 6. *T*-test analysis findings of the performance levels of the participants in the field of mathematics

Dimension	Criterion	*N*	*M*	SS	SD	*t*	*p*	Explanation
Math applications	Yes	272	4.40	2.522	278	−5.11	0.000	$p < 0.05$ (Difference significant)
	No	6	2.58	1.268				
Equation problem-solving	Yes	272	4.38	2.571	278	−7.27	0.000	$p < 0.05$ (Difference significant)
	No	6	2.34	1.127				

In Table 6, the arithmetic mean and SD scores of the students who answered yes according to the variable related to mathematics applications among the performance levels of the participants in the field of mathematics (*M* = 4.40) and the arithmetic mean and SD scores of the students who answered no to this field (*M* = 2.58) are determined. From the findings obtained, it can be said that there is a significant difference between the students according to the variable in the field of

mathematics and they have adopted this field. In addition, as seen in Table 6, the arithmetic mean and SD scores of the students who answered yes according to the equation question-solving performance variable were determined as *M* = 4.38 and the arithmetic mean and SD scores of the students who answered no according to the equation question-solving variable were determined as *M* = 2.34. Based on Table 6, it can be said that there is a significant difference when both dimensions are considered from the findings obtained and that the students achieved success in digitalised education.

3.4. One-way analysis of variance (ANOVA) results of the study participants' levels of following education and mathematics applications digitised with smart devices

To determine whether there is a difference according to the levels of following the smart device with the smart device of the participants participating in the research, data about the values of the one-way ANOVA results are given.

Table 7. One-way ANOVA results of the study participants' levels of following education and mathematics applications digitised with smart devices

Dimension	Source of variance	Sum of squares	SD	Average of squares	*F*	*p*	Description
Digitalised education applications	Intergroup	7.65	6	6.700	6.668	0.000	$p < 0.05$ (Difference significant)
	In-group	39.02	272	0.318			
	Total	46.67	278				
Mathematics field live events	Intergroup	8.96	6	9.036	9.357	0.000	$p < 0.05$ (Difference significant)
	In-group	44.37	272	0.508			
	Total	53.33	278				

In Table 7, it is seen that there is a statistically significant difference between the digital education applications of the participant group participating in the study and their levels of following up with smart devices. According to the findings, it can be said that students are more effective than their smart device-tracking dimension performances. Finally, in Table 7, it is seen that there is a statistically significant difference between the participant group participating in the research according to their views of following 'Maths field live events'. According to the findings, it can be said that the dimension of following the technologies of the smart devices and live events of the participant group participating in the research is effective.

4. Discussion

Ceyhan and Sahin (2017) aimed to determine the sensitivity of science teachers towards technology and environmental ethics in their study, and they also stated that they should focus on the use of technology on students. In this context, when this value is combined with the result of the research, it is seen that the situation of spending time on digitalised educational technologies is a maximum of 2 hours and it is a student platform that enjoys using technologies. In this context, it can be said that technology dimensions are beneficial for both fields.

In the study of Darmayanti, Sugianto, Baiduri, Choirudin, and Wawan (2022), the aim was to produce digital environments based on character values based on mathematical critical thinking skills in solving the problems related to the learning styles of eighth-grade students and as a result, the digital comics learning environment was determined by the verification of the values of the material expert. It is also seen that, based on the confirmation of the media expert, it is seen that eighth-grade students benefit from their mathematical thinking skills. In this context, when this value is combined with the values of the research, it is seen that the values that digitalised education technologies provide benefits on equations and inequalities among mathematical subjects are reached.

Strielkowski, Korneeva, and Gorina (2022) aimed to focus on the sustainable development and digital transformation of education systems. They also stated that they supported the digital surge, the mass closure of schools and universities and the dissemination of online and home learning. In this context, when this value is combined with the results of the research, it was concluded that the people participating in the research benefited and used it in the fields of digitalised education and mathematics.

In this context, when all these studies in the discussion section are compiled and discussed, it is seen in the related studies that they are important for students with the use of the digitalised education model, which gives meaning to education today. It is thought that the repetition and renewal of such studies in the coming periods will be important for the literature.

5. Results

When the results part of the research is considered, it is seen that the number of participants that give meaning to all dimensions in the research is included and given first. The frequency of education use cases during the day has been investigated and as a result, it is seen that they spend a maximum of 2 hours on digitalised education. In this context, it is seen that this value will benefit digitalised education. When another result of the research is focused on, it is seen that the digitalised education status for the mathematics course related to the determination of professional activity adaptation based on descriptive statistics regarding the determination of the equation and inequality subject levels of the participants in the course participation was examined and as a result, it is seen that the dimensions are high.

When another value of the research is considered, according to the gender variable, it is seen that there is no difference between the genders. For the ‘Registration to the Digitalised Education System’, male students had a high score. Another result is that there is no difference between genders in ‘Digitalised Education Technical Support’, with high scores being reached. Another value of the study is that there is a significant difference between the arithmetic mean and SD scores of the students who answered yes according to the variable related to mathematics applications among the performance levels of the participants in the field of mathematics, and the students who answered no, and it was concluded that they adopted this field. In addition, when the results of the students who answered yes according to the equation question-solving performance variable were considered compared to the students who answered no, it was concluded that there was a significant difference and that the students achieved success in digitalised education. When the final value of the research

is considered, it is seen that there is a statistically significant difference between the 'Digital Education Applications' follow-up views of the participant group participating in the research with the smart device and the follow-up levels. Finally, the 'Mathematics field live events' of the participant group participating in the research showed that there is a statistically significant difference between them according to the followers' opinions. According to the results obtained, it is seen that the dimension of following the technologies of the smart devices and live events of the participant group participating in the research is effective. According to the results obtained from the research, it was concluded that the equation and inequality solving and application dimensions of the participant groups were strengthened and used with digitalised education.

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