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INVESTIGATION OF GRAPHIC READING AND INTERPRETATION SKILLS IN SOCIO-SCIENTIFIC-BASED PROBLEM SITUATIONS: THE EXAMPLE OF COVID-19 PARABOLIC GRAPH

(Research article)

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Abstract

The aim of this study is to examine the graphic reading and interpretation skills of teacher candidates with problem situations prepared in the context of the Covid-19 pandemic, which is a socio-scientific situation. The study is conducted with case study of qualitative research methods. The participants of the study consisted of 52 elementary school mathematics pre-service teachers studying in the third year. Participants were determined via the typical case sampling method, one of the purposive sampling methods. As a data collection tool, an open-ended question form consisting of five options based on a socio-scientific situation-based scenario with a vital aspect was used. In the analysis of the data, content analysis method was used together with descriptive statistics (frequency, percentage). When the data obtained from the research were examined, it was seen that a significant part of the pre-service teachers had the skills to read and interpret the parabola graphs given in the context of Covid-19. However, it was determined that most of the pre-service teachers who gave wrong answers to the questions about graphic reading and interpretation were at the level of visual or quantitative perception and had difficulties in transitioning between representations. For this reason, drawing activities that require more context-based qualitative understanding or technology-assisted teaching applications can be made in the teaching of graphics.

Keywords: Socio-scientific, graph reading, graph interpretation, Covid-19, parabola

1. Introduction

The transformation of the data obtained from the abstract developments of science into products with technology affects societies deeply. This dynamic structure develops civilizations and makes everything accessible. As the famous communication scientist Marshall McLuhan expressed in the 1960s, the world has now become a "Global Village" (McLuhan, 2001). In this globalizing village, there is no country that is not neighbor to each other anymore. However, these developments have positive aspects as well as negative aspects. As we experience today, when a problem in any part of the world is ignored, it spreads in waves to the whole universe with a butterfly effect. Therefore, nothing is left as an internal matter of a country anymore. Because, when scientific developments are considered only in one dimension and separated from social goals and responsibilities, they lose their spirit and become independent of values, abstract and unrelated to goals (Pedretti, 1999). For this reason, it is important for individuals to express their opinions, think, discuss and comment on issues that may affect societies deeply. These topics, which represent social dilemmas and problems that include both scientific and social issues at the same time, are called socio-scientific issues (Sadler, 2004; Zeidler, Walker, Acett & Simmons, 2002).

Events such as environmental events (pollution rates, change in rainforest areas), health research (drug trials and vaccines, drug addiction rates, AIDS, EBOLA, MERS, SARS transmission rates), unemployment figures, global warming, birth and death rates within socio-scientific issues is located. Although these subjects seem to be mostly within the scope of science and social studies, mathematical skills are also needed in order to fully understand the scientific issues that affect social life and are frequently discussed in daily life. This situation is expressed as social mathematics in the literature (Rosander, 1937 cited. Öntaş, 2006). According to Öntaş (2006), for teaching and learning social mathematics; many mathematical skills are required, such as interpreting maps, charts and graphs, collecting and measuring data, rate-proportionality, range, standard deviation, converting verbal, written and other forms of information into statistical formats, percentage change (increase/decrease). For this reason, in the early 1980s, it was stated by the National Council of Teachers of Mathematics [NCTM] NCTM teachers that the K-12 mathematics program should be associated with social mathematics and that more statistics and probability subjects should be included. In the 2000s, NCTM revised the Principles and Standards for School, and integrated data analysis, problem solving, and real-life applications into mathematics education. In addition, it is seen that the Ministry of National Education [MoNE] draws attention to the necessity of using data-based decision-making, discussion and critical thinking skills by examining the real-life situations of students in many achievements of the MoNE's(2018) elementary school mathematics curriculum. In this respect, it is important to use socio-scientific problem situations that take their basis from real life in mathematics teaching. However, when the relevant literature is examined, it is seen that most of the domestic and international studies based on socio-scientific status are focused on science education (Fowler, Zeidler & Sadler, 2009; Karpudewan & Roth, 2018; Öztürk & Doğanay, 2019; Öztürk & Erabdan 2019). In mathematics education, it was seen that there were very few studies (Maass, Doorman, Jonker & Wijers 2019; Paige & Hardy 2014) abroad on socio-scientific issues or problem situations and no studies were found in Turkey.

One of the most discussed and most important socio-scientific events affecting people's lives on a global scale in recent days is the new coronavirus (Covid-19) pandemic. In this process, how the virus spreads, how many people it infects in how long, what its symptoms are, how many degrees it withstands, etc. researchers are conducted on such topics, different results are reached and constantly discussed. The daily numerical data obtained are given in various graphics for the understanding of all segments of the society and people are expected to realize the seriousness of the event by making them think about the subject. The authorities also observe the process with the help of graphics, make predictions for the future and decide on the measures to be taken. Therefore, it is important to read, understand, interpret and evaluate the graphics correctly by all segments of the society in the management and understanding of the pandemic process. Otherwise, failure to understand the graphics correctly by individuals may cause different individual applications on such vital issues that require social determination, leading to failure and confusion. In this sense, it is thought that it is important for individuals of all ages to have graphic literacy skills and to detect errors and misconceptions made in graphics. When the relevant literature is examined, it has been seen that many studies have been carried out in mathematics and different disciplines to determine the mistakes and misconceptions made with graphic literacy skills. The mistakes made in some of these studies were systematically examined, and the students' levels of perception of graphics were considered as visual perception, quantitative perception and qualitative (global) perception (Bell & Janvier, 1981; Leinhardt, et al, 1990; Kieran, 1992; Even, 1998; Connery, 2007). The most common misconception about graphics is "perceiving graphics as a picture" and this type of error is expressed as "level of visual perception" (Bell & Janvier, 1981). According to Bell and Janvier (1981), individuals at the visual perception level understand the graph only as a picture and do not have knowledge about the correlation and mathematical relations that give meaning to the graph. At the level of quantitative perception, students have knowledge about the relationship and mathematical relationships that add meaning to the graph. However, while commenting on these correlations and mathematical relations, they deal with graphics point-by-point (point-by-point) or they need to perform algebraic and arithmetic operations (Leinhardt, et al., 1990). Since students with quantitative perception focus on critical points (start point, intersection point, height, etc.) in the graph, they cannot evaluate the holistic development of the graph. At the qualitative (global) perception level, students can think about the holistic development of the graph without dealing with point, algebraic and arithmetic, and can obtain a new graph by using a given graph (Bayazıt, 2011). It is predicted that the errors to be detected in this study may be similar to the errors made at the aforementioned perception levels. This situation will be evaluated in the discussion section of the study according to the findings to be obtained. When the studies on the determination of errors and misconceptions with graphic literacy skills are examined, it is seen that most of the studies are in elementary education (Curcio, 1987; Kaynar & Halat, 2012; Kranda, 2018; Özmen, Güven & Kurak 2020; Polat, 2016; Sezgin Memnun, 2013; Şahin, 2019; Wu, 2004; Yayla & Özsevgeç, 2015; Yılmaz & Ay, 2016) and university students (Aydın & Tarakçı, 2018; Bayazıt, 2011; Bragdon, Pandiscio & Speer, 2019; Coştu, Ercan& Coştu, 2017; Dündar & Yaman, 2015; Ergül, 2018). Since most of the studies on the graphic skills of university students are aimed at science and classroom pre-service teachers, formal questions that are not context-based, mostly about physics concepts (path-time, height-slope, etc.) were asked to prospective teachers (Ersoy, 2004; Bayazıt, 2011). It is thought that the coronavirus pandemic we are in is an important socio-scientific situation and in this context, examining the graphic literacy levels of teacher candidates is an important research area. Therefore, in this study, it is aimed to examine the graphic reading and interpretation skills of elementary school mathematics pre-service teachers with questions in the context of the Covid-19 pandemic.

Graphic literacy skills include reading, creating (drawing), interpretation, comparison and evaluation dimensions (Özmen, Güven, & Kurak, 2020). When the relevant literature is examined, it is stated that the difficulties experienced in graphics are frequently experienced in reading and interpreting graphics, drawing graphics, making transitions between graphics and other representations (Bayazıt, 2011). In particular, graphic interpretation can be defined as a basic skill that includes showing the relationships between variables in a given graphic and reading and understanding graphics (Gültekin, 2009). Since graphic reading and interpretation is a basic skill for the development of other skills, graphic reading and interpretation skills were examined in this study. When the related literature is examined, it is seen that there are many studies on reading or interpreting function graphs at different learning levels (Abdullayeva, 2021; Bayazıt, 2011; Bragdon, Pandiscio & Speer, 2018; Egin, 2010; Font, Bolite & Acevedo, 2010; Moschkovich, Zahner & Ball, 2017; Tekin, Konyalıoğlu & Işık, 2009). However, it can be said that these studies are generally far from contextualism. However, in the relevant literature, it is seen that many contextual studies on different topics of mathematics have produced positive results for students (Yurtyapan, Tapan Broutin & Kaleli Yılmaz, 2020; Roth & Bowen, 2001). Roth & Bowen (2001) emphasizes that individuals should include contextual elements from their lives in order to be able to read and interpret graphics, and it is stated that people can express more effective ideas about graphics by internalizing graphics. In this study, it is aimed to examine the graphic reading and interpretation skills of pre-service teachers within the framework of the problem situations prepared in the context of the Covid-19 pandemic, which is a socio-scientific situation. For this reason, it is thought that this study differs from other studies in mathematics education with its vital and contextual aspects and is original. In addition, parabola graphs are discussed in problem situations. Therefore, it is thought that the results of this study will also contribute to the relevant literature in terms of identifying misconceptions about parabola graphs. In this context, the problem of the research is "*How are the graphic reading and interpretation skills of elementary school mathematics pre-service teachers in the context of Covid-19, which is a socio-scientific situation?*" formed in the form. The sub-problems are:

- *How are the graphic reading skills of elementary school mathematics pre-service teachers in the context of Covid-19?*
- *How are the graphic interpretation skills of elementary school mathematics pre-service teachers in the context of Covid-19?*

2. Method

2.1. Research design

The study was carried out using the case study method, which is included in qualitative research. As is known, the case study method allows one or more cases to be investigated in depth (Yıldırım & Şimşek, 2016). At the same time, the researcher observes the examined situation in its own flow and provides convenience in determining and evaluating the meanings that the participants have constructed in their minds about the subject (Denzin & Lincoln, 1998). The point that distinguishes case studies from other research methods is that it is used when there is a need to ask how and why questions on various educational topics (Yin, 1984). In addition, different research methods and various data collection tools can be used in case studies. Thus, sample cases can be examined in detail in their own nature. As a special case in this study; The special case study method was preferred because the skills of pre-service teachers in reading and interpreting the graphics given in the context of Covid-19, which is their vital and socio-scientific aspect, will be examined.

2.2. Participants

The study group of the research consists of 52 elementary school mathematics pre-service teachers studying in the third year at a state university in the west of Turkey. While determining the study group, the typical case sampling method, one of the purposive sampling methods, was adopted. According to Patton (1987), purposive sampling in qualitative research allows for an in-depth examination of special cases with rich information on the target of the research (Cited at. Yıldırım & Şimşek, 2016). In typical case sampling, people who have average knowledge about the research subject are included in the research and an average level of opinion about the subject is obtained. Since the graphic reading and interpretation skills in the context of Covid-19 were examined in the research, it was taken as a criterion that the pre-service teachers should have taken courses such as basic and general mathematics, geometry, and mathematics teaching. Since third year students have completed these field-specific core courses, it was found appropriate to conduct the research with these students. In addition, since the relatives of the pre-service teachers may become ill or die from Covid-19, the participants were sensitive during the selection and the researchers were taken as a basis to participate in the study voluntarily. In this direction, a total of 52 third grade pre-service teachers, 45 females and 7 males, participated in the research. The pre-service teachers participating in the research were coded as $Ö_1$, $Ö_2$,…,$Ö_{52}$ and these abbreviations were used in the next process.

2.3. Data collection tool

In the study, an open-ended question form with five options was developed focusing on a socio-scientific situation-based scenario, and requiring a vital aspect of graphic reading and interpretation.

The options of “a” and “b” require reading graphics, and the options of “c”, “d”, “e” are for graphical interpretation. In the graph reading questions (a, b), it is aimed to read the existing information on the graphs, and in the graph interpretation questions (c, d, e) it is aimed to go beyond the data by using the read information. In order to ensure the content validity of the questions, the opinions of two mathematics educators who are experts in their fields were consulted. Necessary adjustments were made on the questions in line with the opinions. The questions, which were finalized after the expert opinion, were administered to 10 pre-service teachers about two months before the actual study, and areas that were not understood were identified and corrected. The finalized problems were applied to pre-service teachers online. Pre-service teachers were asked to upload screenshots of their answers to Google Classroom within a week. Since the important thing here is to learn how the pre-service teachers interpret the given scenarios, the duration was flexible.

The question and the options utilized in the research are as in the following:

QUESTION: The Minister of Health held a press conference on the day of the new Corona Virus case in Turkey. In this press conference, in order to inform the public about the spread of the virus, he brought the following graphic with two scenarios to the attention of the society, and stated that; “We must not exceed the critical value. We need to flatten the curve.”

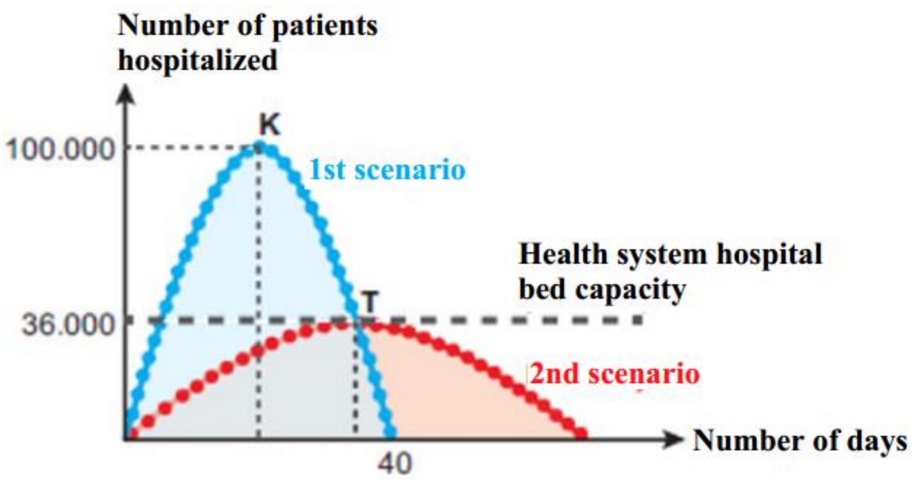


Figure 1. The graphical illustration of the scenarios concerning Covid-19 question

They are the peaks of the K and T curves. The parabolas intersect at the T point. Journalists are asking the following questions to the Minister of Health regarding the graphic. Let's help the minister answer the questions:

a) Journalist: Mr. Minister, what is the critical value you are talking about? Why is this value important? (Specify and Explain)

b) Journalist: If the 1st scenario is realized, in how many days will the process be completed? (Specify and Explain)

c) Journalist: Mr. Minister, if the 1st scenario comes true, on what day will we see the summit? (Specify and Explain)

d) Journalist: Mr. Minister, if the 2nd scenario is realized, on what day will we see the summit?" (Specify and Explain)

e) Journalist: Mr. Minister, if the 2nd scenario is realized, in what day will the number of patients hospitalized with the diagnosis of Covid-19 end? (Specify and Explain)

As it is seen in Figure 1, in the open-ended question prepared, the line graph of the two scenarios that can be experienced regarding the relationship between the number of patients who need to be hospitalized during the epidemic and the day is given as parabolic. Through this question, it was aimed to understand the thoughts of the pre-service teachers about the graphics by associating the difference between the scenarios with the line of the number of patients that the health system can handle.

In option a, from the pre-service teachers; In order to flatten the curve in case of a problem, it is required to read the critical value based on the data on the graph and to explain how it found this value with verbal expressions. In this context, it is expected that the critical value will be expressed by the participants that the hospital bed capacity of the health system is 36.000 in order to answer the question prepared for graphic reading correctly.

In option b, the pre-service teachers are asked to read the numerical data on the parabola in the 1st scenario correctly and to explain the reason with verbal expressions. In this context, it is expected by the participants that the question prepared for graph reading will be completed in 40 days by looking at the parabola in the 1st scenario.

In option c, pre-service teachers are asked to examine the related graph given in the question and interpret that the vertex is the symmetry axis of the parabola. In this context, it is expected to find the apse of the apex of the graph as 20, based on the vertex formula or the symmetry axis, and to explain how this solution is done with verbal expressions, in order to answer the question prepared for graphic interpretation correctly.

In option d, pre-service teachers are expected to interpret that both graphs given in the case of a problem intersect at the apex of the 2nd scenario. In this context, in order to answer the question prepared for graphical interpretation correctly, the equation of the 1st scenario parabola should be created and the first coefficient of the equation should be calculated by writing the abscissa and ordinate of the vertex of the 1st scenario in this equation. Then, in the equation obtained, the ordinate of the vertex of the 2nd scenario should be written instead, the apse of the vertex should be calculated as 36 and how this solution was made should be explained with verbal expressions.

In option e, pre-service teachers are expected to comment that the apse of the vertex of the 2nd scenario graph is the axis of symmetry where the graph intersects the x-axis. In order to answer question 1(e) correctly, it is necessary to calculate the apex of the vertex of the 2nd scenario parabola. Then, since the vertex is the axis of symmetry, twice the value obtained, the point where the graph of 2nd scenario cuts the x-axis should be calculated as 72. In addition, it is necessary to explain how the solution is made with verbal expressions.

2.4. Analysis of the data

In the study, content analysis method was used together with descriptive statistics (frequency, percentage) in the analysis of the data obtained from the open-ended interview form. Content analysis method is generally used in the analysis of texts (interview transcripts, diaries and documents) (Patton, 2014). In addition, content analysis is an analysis method that enables the concepts underlying the data obtained in a research to be examined in detail and the relationships between these concepts to be revealed (Miles, Huberman & Saldana, 2014). In this study, the content analysis method was used since the answers given by the pre-service teachers to the open-ended questions about graphic reading and interpretation were examined in detail.

The coding was conducted as; “Correct” if the questions for graph reading and interpretation were answered correctly and adequate explanation was given, “Incomplete Answer” if only the correct answer was given but there was no explanation to confirm this answer or if the answer was partially correct, “False” if the wrong answer was given, and “Blank” if no answer was given. The coding was checked by both of the researchers, and the analysis was continued until a consensus was reached on each coding. In addition, in order to increase the validity and reliability, scan images of the solutions created by the teachers were given directly in some questions. However, since the scan images took up too much space, these images were not given in all questions; instead the opinions were given in quotation marks.

3. Results

In this section, the findings obtained from the research are presented in line with the sub-problems. In the first sub-problem, graphic reading skills of prospective elementary mathematics teachers were examined in the context of Covid-19. For this purpose, the teachers were invited to answer the questions a and b, which were about graphic reading in case of a problem.

The data analysis results obtained from the solutions and explanations of the pre-service teachers for question 1(a) are presented in Table 1.

Table 1. Analysis of the data about the question 1(a)

Accuracy Status	**Codes of the Pre-service teachers**	**F**	**%**
Correct	$Ö_1$, $Ö_4$, $Ö_5$, $Ö_6$, $Ö_7$, $Ö_8$, $Ö_{10}$, $Ö_{11}$, $Ö_{12}$, $Ö_{14}$, $Ö_{15}$, $Ö_{16}$, $Ö_{17}$, $Ö_{18}$, $Ö_{19}$, $Ö_{20}$, $Ö_{21}$, $Ö_{22}$, $Ö_{23}$, $Ö_{24}$, $Ö_{25}$, $Ö_{26}$, $Ö_{28}$, $Ö_{29}$, $Ö_{30}$, $Ö_{31}$, $Ö_{32}$, $Ö_{33}$, $Ö_{34}$, $Ö_{35}$, $Ö_{36}$, $Ö_{37}$, $Ö_{38}$, $Ö_{39}$, $Ö_{40}$, $Ö_{41}$, $Ö_{42}$, $Ö_{43}$, $Ö_{44}$, $Ö_{45}$, $Ö_{46}$, $Ö_{47}$, $Ö_{48}$, $Ö_{49}$, $Ö_{50}$, $Ö_{51}$, $Ö_{52}$	47	90,38
Incomplete answer	-	0	0
False	$Ö_2$,$Ö_9$, $Ö_3$, *$Ö_{13}$*, *$Ö_{27}$*	5	9,61
Blank	-	0	0
Total		52	%100

As can be seen from Table 1, a significant part of the pre-service teachers said, “Journalist: Mr. Minister, what is the critical value you mentioned? Why is this value important? (Explain)”. One of the pre-service teachers who gave the correct answer, $Ö_1$ explained this view with the following sentences:

$Ö_1$: “According to the table, the critical value is 36,000, which is the hospital bed capacity of the healthcare system. If there are patients who need to be hospitalized more than this number, there will be a problem because the capacity will be full.”

When Ö$_1$'s answer is examined, it is seen that the numerical value of the concept of "critical value" that is wanted to be read in the graph and why this value is important are successfully expressed with verbal explanations. When the explanations of the pre-service teachers who answered this question correctly were examined, it was noticed that they read the graph correctly by using statements that the critical value mentioned was the hospital bed capacity. When Table 1 is examined, it is seen that very few of the pre-service teachers (9.61%) gave wrong answers, and there were no pre-service teachers who gave incomplete answers or left blank. The opinions of the pre-service teachers who gave wrong answers are as follows:

Ö$_2$: "*The critical value is the peak and the reason why it is important is that it decreases after this value. Critical value is 20, as the vertex will divide the parabola into two equal parts.*"

Ö$_3$: "*The critical value for the 1st scenario is 100,000. Our critical value for the 2nd scenario is 36.000. These values are important in order not to experience an explosion in Corona virus cases in our country*."

Ö$_9$: "*The minister should say the critical value considering the situation of hospitals and doctors, I think the critical value should not exceed this value, the peak number of 100,000 patients.*"

Ö$_{13}$: "*Critical value is important. Because we determined this rate according to our hospital capacities.*"

Ö$_{27}$: "*The critical value mentioned is our hospital bed capacity in our health system.*"

Pre-service teacher Ö$_2$ states that the critical value is 20, which is the apse of the peak. This shows that Ö$_2$ considers the apse of the vertex of the parabola as the largest-smallest element. Ö$_3$ and Ö$_9$ pre-service teachers know that the peak for the critical value is an important point. However, when the explanations made by the pre-service teachers for the critical value mentioned in the problem situation are examined, it is seen that they focused on the peak of the scenario I and therefore gave wrong answers. Therefore, it can be said that the pre-service teachers who misread the graph make an inference that the peak is a critical value in every graph or in every scenario situation, and this may be a mistake in the type of over-specification. On the other hand, Ö$_{13}$ and Ö$_{27}$ who gave wrong answers did not specify any numerical value for the graph in their explanations. Since these pre-service teachers could not read the numerical value in the graph, it was determined that the critical value was important only in verbal expressions in their explanations and they associated this value with the hospital capacity or bed capacity. Another question prepared for the graphic reading skill is question 1(b). The data analysis results obtained from the solutions and explanations of the pre-service teachers for question 1(b) are presented in Table 2 below.

Table 2. Analysis of the data about the question 1(b)

Accuracy Status	**Codes of the Pre-service Teachers**	**F**	**%**
Correct	Ö$_1$, Ö$_2$, Ö$_5$, Ö$_6$, Ö$_7$, Ö$_{10}$, Ö$_{12}$, Ö$_{16}$, Ö$_{17}$, Ö$_{19}$, Ö$_{20}$, Ö$_{21}$, Ö$_{22}$, Ö$_{23}$, Ö$_{24}$, Ö$_{25}$, Ö$_{28}$, Ö$_{29}$, Ö$_{30}$, Ö$_{31}$, Ö$_{32}$, Ö$_{36}$, Ö$_{37}$, Ö$_{38}$, Ö$_{39}$, Ö$_{40}$, Ö$_{41}$, Ö$_{43}$, Ö$_{44}$, Ö$_{45}$, Ö$_{46}$, Ö$_{47}$, Ö$_{49}$, Ö$_{50}$, Ö$_{51}$	35	67,31
Incomplete answer	Ö$_3$, Ö$_4$, Ö$_9$, Ö$_{11}$, Ö$_{14}$, Ö$_{15}$, Ö$_{18}$, Ö$_{27}$, Ö$_{33}$, Ö$_{37}$, Ö$_{38}$, Ö$_{39}$, Ö$_{52}$	13	25
False	Ö$_8$, Ö$_{26}$, Ö$_{48}$	3	5,77
Blank	Ö$_{13}$	1	1,92
Total		52	%100

As can be seen from Table 2, a significant part of the pre-service teachers said, "If the 1st scenario is realized, in how many days the process will be completed? (Specify and Explain)". $Ö_{36}$, one of the pre-service teachers who gave the correct answer, explained his opinion with the following sentences:

$Ö_{36}$: "*In the parabola given for the 1st scenario, the points where the parabola intersects the x-axis are given. Accordingly, it is given as $x_1 = 0$ and $x_2 = 40$. Therefore, the value given as $x_2 = 40$ indicates how many days the1st scenario was completed. Therefore, the answer should be answered in 40 days.*"

When $Ö_1$'s explanation is examined, it is seen that he correctly reads the numerical data of the question asked about reading graphics and at the same time supports his solution with verbal explanations. In Table 2, it is seen that there are 35 pre-service teachers who gave correct explanations both numerically and verbally to the question 1(b) regarding the graphic reading skill. Therefore, it can be said that most pre-service teachers read the graph correctly.

On the other hand, Table 2 shows that some pre-service teachers gave incomplete answers (25%) while reading the graph. When the answers of the pre-service teachers who gave incomplete answers were examined, it was observed that they made the same type of explanation. For an example, a pre-service teacher's statement is presented below.

$Ö_{33}$: "*If the 1st scenario is realized, the process will be completed in 40 days.*"

When $Ö_{33}$'s explanation is examined, he can only read the data in the graph and say, "It was completed in 40 days." appears to be using the phrase. It was determined that the pre-service teachers in this group could not verbally explain how they found this value among the many numerical values in the graph.

When Table 2 is examined, it is seen that very few of the pre-service teachers (9.61%) gave wrong answers. The opinions of the pre-service teachers who gave wrong answers are as follows:

$Ö_8$: "*According to the 1st scenario, it is assumed that a maximum of 100,000 patients are treated at the same time and these patients are discharged within 40 days. Turkey's population in 2021 seems to be 83,614,000. If the ratio of the population to the maximum number of patients is 83,614,000 / 100,000 = 83,614 (Approximately 84) Assuming that the hospitals are filled and emptied at maximum capacity in approximately 84 periods, and if it is assumed that each period is 40 days on average, the process is completed in 84 x 40 = 3360 days.*"

$Ö_{26}$: "*We expect it to be completed in about 40 days. The lower axis of the graph shows the days and the end point of 1st curve shows 40.*"

$Ö_{48}$: "*In the 1st scenario, the number of people who need to be hospitalized is reset to zero in 40 days. However, since the process did not end when the number of people who had to be hospitalized was zero, it was completed in more than 40 days.*"

When the explanations of the pre-service teachers who gave wrong answers were examined, it was stated that $Ö_{26}$'s "The end point of the 1st curve shows 40." Although he gave a definite answer as "We expect it to be completed in about 40 days" in his explanations, it causes a contradiction and shows that the pre-service teacher reads the numerical data expected to be read in the graph. Therefore, the pre-service teacher's answer was evaluated as wrong. When Ö$_{8}$ and Ö$_{48}$ pre-service teachers examine their answers, they can read from the graph that if the 1st scenario is realized, the number of patients who have to be hospitalized will be reset in 40 days. However, they claim that if 1st scenario happens, the process does not end in 40 days. In addition, it is seen from the transactions and explanations that they make different calculations by constructing the information (Turkey population, etc.) that are not in a problem situation with the data in the graph, and that they reach an incorrect result by using expressions such as "average" or "approximately". However, there is a clear answer to question 1(b) about reading graphics. Therefore, since Ö$_{8}$, Ö$_{26}$ and Ö$_{48}$ pre-service teachers' calculations using non-problematic data and using expressions such as "approximately" created a contradictory situation in terms of graphic reading skills, the answers of these pre-service teachers were evaluated as wrong.

In the second sub-problem of the study, the graphic interpretation skills of elementary mathematics pre-service teachers in the context of Covid-19 were examined. For this purpose, pre-service teachers were asked to answer questions 1(c), 1(d) and 1(e).

The data analysis results obtained from the solutions and explanations of the pre-service teachers for question 1(c) are presented in Table 3.

Table 3. Analysis of the data about question 1(c)

Accuracy Status	**Codes of the Pre-service Teachers**	**F**	**%**
Accuracy Status	Ö$_{1}$, Ö$_{2}$, Ö$_{4}$, Ö$_{5}$, Ö$_{6}$, Ö$_{7}$, Ö$_{10}$, Ö$_{12}$, Ö$_{14}$, Ö$_{16}$, Ö$_{17}$, Ö$_{19}$, Ö$_{21}$, Ö$_{22}$, Ö$_{24}$, Ö$_{25}$, Ö$_{26}$, Ö$_{28}$ Ö$_{29}$, Ö$_{30}$, Ö$_{31}$, Ö$_{32}$, Ö$_{36}$, Ö$_{37}$, Ö$_{38}$, Ö$_{39}$, Ö$_{40}$, Ö$_{41}$, Ö$_{43}$, Ö$_{44}$, Ö$_{45}$, Ö$_{46}$, Ö$_{47}$, Ö$_{48}$, Ö$_{49}$, Ö$_{50}$, Ö$_{51}$, Ö$_{52}$	38	73,08
Correct	Ö$_{3}$, Ö$_{9}$, Ö$_{13}$, Ö$_{15}$, Ö$_{18}$, Ö$_{23}$, Ö$_{27}$, Ö$_{33}$, Ö$_{34}$	9	17,31
Incomplete answer	Ö$_{8}$, Ö$_{11}$, Ö$_{20}$, Ö$_{35,}$ Ö$_{42}$	5	9,61
False	-	0	0
Blank		52	%100

As can be seen in Table 3, a significant portion of the pre-service teachers said, "Journalist: Mr. Minister, on what day will we see the summit if the 1st Scenario is realized? (Specify and Explain)".

In order to correctly answer the question 1(c) about calculating the vertex of the parabola graph belonging to the 1st scenario, the graph given by the pre-service teachers should be examined and it should be interpreted that the vertex is the symmetry axis of the parabola. Another solution is to apply the formula for the vertex by using the data in the graph appropriately. In both solutions, pre-service teachers are required to use the skill of transitioning from visual representations to algebraic representations while interpreting the graph. One of the pre-service teachers who answered the question 1(c) about the graphic interpretation skill correctly, Ö$_{52}$ explained his opinion with the following sentences:

Ö$_{52}$: "*If 1st scenario happens, we will see the summit on the 20th day. Our curve is a parabola. The apse of the apex of the parabola divides the parabola into two equal parts. In that case, since the process is completed in 40 days in the 1st scenario, the peak coincides with the 20th day.*"

When Ö$_{52}$'s explanation is examined, it is seen that the pre-service teacher determines the peak point by interpreting the graph in order to find the numerical data that is not on the graph, and reaches the conclusion based on the knowledge that this point is the axis of symmetry. In Table 3, it is seen that there are 38 pre-service teachers who gave correct explanations both numerically and verbally to the question 1(c) regarding the graphic interpretation skill. Therefore, it can be said that the majority of pre-service teachers interpreted the graph correctly.

According to Table 3, it is seen that some pre-service teachers gave incomplete answers (17,31%) while interpreting the graph. It was observed that the pre-service teachers who gave incomplete answers expressed the numerical result in their explanations, but did not mention how they followed the mathematical interpretation of the graph by using the data on the graph, but only said the answer. $Ö_{23}$, one of the pre-service teachers who gave incomplete answers, explained his opinion with the following sentences:

$Ö_{23}$: "*If the 1st scenario is realized; the number of cases will peak on the 20th day from the first day.*"

When $Ö_{23}$'s explanation is examined, it is seen that there is only a numerical answer and the obtained data cannot be combined with the interpretation of the graph.

When Table 3 is examined, it is seen that very few of the pre-service teachers (9.61%) gave wrong answers. The opinions of the pre-service teachers who gave wrong answers are as follows:

$Ö_{8}$: "*According to the 1st scenario, if the process is completed in 3,360 days, half of it, that is, the day when half of the entire population is diagnosed with the disease, treated and discharged is considered the peak. 3.360/2 = 1.680. One day the summit will be reached.*"

$Ö_{11}$: "*From the information given, it is known that the process will be completed in 40 days. Based on the graph, if the 1st scenario is realized, we will probably see the peak on the 20-22nd day.*"

$Ö_{20}$: "*The summit seems to be the 20th day. I can't say for sure, but I can say 20th Day by using the chart. Or we can see the peak in a day close to the 20th day.*"

$Ö_{35}$: "*We predict that we will reach the peak of the number of patients on the 20th day.*"

$Ö_{42}$: "*20-21. We'll see the peak in days.*"

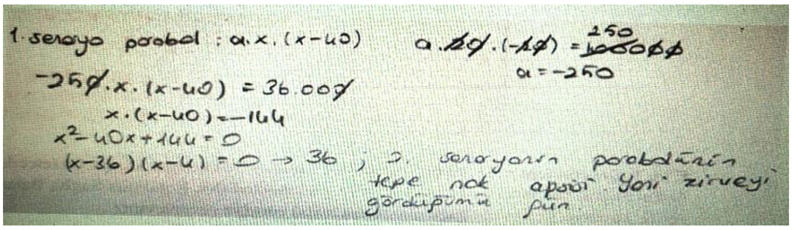
When the answers of the pre-service teachers who gave wrong answers were examined, "about", "20-21.days" or "20-22. It has been observed that they use imprecise expressions such as "every day". It is noteworthy that Ö8 reached an erroneous conclusion by adding the information not given in the root of the question. Therefore, when the answers of the pre-service teachers who gave wrong answers were evaluated in general, it can be said that they tried to give an approximate answer by not interpreting the parabola graph in the question mathematically, since they could not make the transition between the representations.
The data analysis results obtained from the solutions and explanations of the pre-service teachers for question 1(d) about graphic interpretation are presented below, in Table 4.

Table 4. Analysis of the data about question 1(d)

Accuracy Status	**Codes of the Pre-service Teachers**	**F**	**%**
Correct	Ö$_{1}$, Ö$_{2}$,Ö$_{6}$, Ö$_{7}$, Ö$_{10}$, Ö$_{15}$, Ö$_{16}$, Ö$_{17}$, Ö$_{19}$, Ö$_{21}$, Ö$_{22}$, Ö$_{24}$, Ö$_{25}$, Ö$_{27}$, Ö$_{28}$, Ö$_{30}$, Ö$_{32}$, Ö$_{33}$, Ö$_{36}$, Ö$_{37}$, Ö$_{38}$, Ö$_{41}$, Ö$_{43}$, Ö$_{46}$, Ö$_{48}$, Ö$_{50}$, Ö$_{51}$, Ö$_{52}$	28	53,85
Incomplete answer	Ö$_{29}$, Ö$_{45}$	2	3,85
False	Ö$_{3}$, Ö$_{4}$, Ö$_{5}$, Ö$_{8}$, Ö$_{9}$, Ö$_{11}$, Ö$_{12}$, Ö$_{13}$, Ö$_{14}$, Ö$_{18}$, Ö$_{20}$, Ö$_{23}$, Ö$_{26}$, Ö$_{35}$, Ö$_{39}$, Ö$_{40}$, Ö$_{42}$, Ö$_{44}$, Ö$_{47}$, Ö$_{49}$, Ö$_{31}$	21	40,38
Blank	Ö$_{34}$	1	1,92
Total		52	%100

As can be seen from Table 4, a significant part of the pre-service teachers said, "Journalist: Mr. Minister, on what day will we see the summit if the 2nd scenario takes place? (Specify &Explain)". In order to answer the question 1(d) about calculating the peak of the 2nd scenario correctly, it should be noticed that both graphs intersect at the apex of the 2nd scenario. Then they need to write the equation of the 1st scenario parabola and calculate the apse of the vertex. When the answers of the pre-service teachers who gave correct answers are examined, it is seen that they reached the correct solution in this way. The sample solution made by one of the pre-service teachers, who gave the correct answer, Ö$_{10}$, is given below:

Ö$_{10}$:



When Ö$_{10}$'s solution is examined, it is seen that he uses the data on the graphs, relates the graphs to each other, and calculates the apse of the apex of the 2nd scenario parabola using the intersection point of the two graphs. In Table 4, it is seen that there are 28 pre-service teachers who gave correct explanations both numerically and verbally to the question 1(d) regarding the graphic interpretation skill. Therefore, it can be said that the majority of pre-service teachers interpreted the graph correctly.

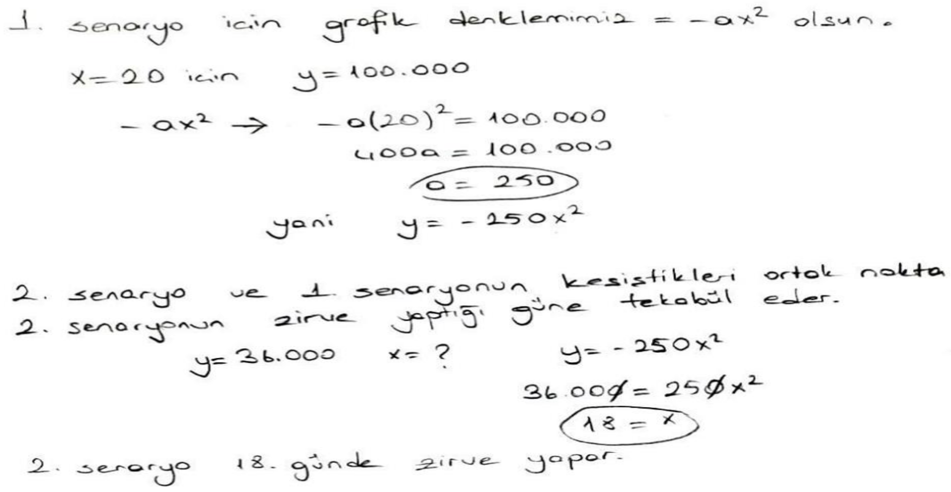
According to Table 4, it is seen that very few of the pre-service teachers gave incomplete answers (3.85%) when interpreting the graph. It is seen that the pre-service teachers who gave incomplete answers explained the operations to be done in order to reach the result with only verbal explanations and did not perform mathematical operations. Questions for graph interpretation skills require finding the points not given on the graph using operational skills by writing the equations of the graphs. Therefore, the fact that pre-service teachers solve the questions about graphic interpretation skills in detail by using their operational skills shows that they form a scientific basis for their answers. On the other hand, explaining the operations to be done in the questions about graphic interpretation skills only verbally remains superficial. Therefore, although it was stated to the pre-service teachers that they should support their explanations with mathematical operations, the answers given by these pre-service teachers were coded as "incomplete" because they only gave verbal explanations. Ö$_{29}$ and Ö$_{45}$ who gave incomplete answers explained their views with the following sentences:

Ö$_{29}$: "*In the 2nd scenario, we see the peak on the 36th day. Using the equation of the 1st scenario, the apse of the 2nd scenario is found. At this value, it gives us 36.*"

Ö$_{45}$: "*Since the peak is the intersection point of the two graphs, we first find the equation of the 1st graph from the given information, then find the roots of the equation by equating this equation to 36,000, and the appropriate value will be our answer, and this value will be 36.*"

When the explanations of Ö$_{29}$ and Ö$_{45}$ are examined, it is seen that they only make verbal explanations, but they cannot use their operational skills while interpreting the graph.
When Table 4 is examined, unfortunately, it is seen that a significant part of the pre-service teachers (40.38%) gave wrong answers. The opinions of these pre-service teachers are as follows:
Ö$_4$, Ö$_{11}$, Ö$_{12}$, Ö$_{14}$, Ö$_{18}$, Ö$_{20}$, Ö$_{26}$, Ö$_{35}$, Ö$_{39}$, Ö$_{40}$, Ö$_{47}$, Ö$_{49}$: *"We can see it in approximately 35 days."*

Ö$_3$:



Ö$_5$: "*If the 2nd scenario is realized, we will see the summit on the 36th day. From the equation of the parabola, the abscissa of the vertices is found; 36.-a (x-46) x= y*
-100 (x-46) x = y"

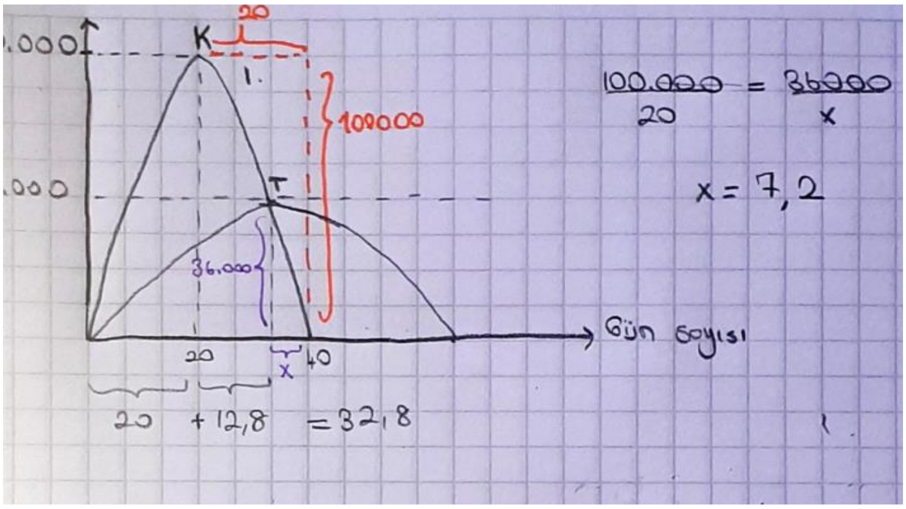
Ö$_9$: "*I think it will take 70 days as it will take more time than the 1st scenario.*"

Ö$_8$: "*According to the 2nd scenario, suppose a maximum of 36,000 patients are treated at the same time and these patients are discharged within an average of 70 days. Turkey's population in 2021 seems to be 83.614.000. If the population is proportioned to the maximum number of patients,* $83.614 \div 36.000 = 2.322{,}611$ *(Approximately 2.323)* $2.323 \times 70 = 162.610$ *days, the process is completed. According to 2nd scenario, if the process is completed in 162.610 days, half of it is 81.305. one day the summit will be reached.*"

Ö$_{13}$: "*We will see the summit in 20 days.*"

Ö$_{23}$: "*If the 2nd scenario is realized; we will see the peak on the 40th day. However, the number of cases continues to increase. After the 40th day, it starts to decrease at the same pace. In other words, since it increases at the same pace from the first day, it peaks on the 40th day.*"

Ö$_{31}$:



"*In the 2nd scenario, the graph consists of 2 parts. The first part is the part where the number of our patients started to increase and reached the peak, in the second part it decreased from this peak and reached zero. When we reach the critical value, we see the peak. The day we see the summit is the 33rd day. Solution: Find the day corresponding to the critical value from similarity in the triangle. From the similarity, 32.3 is found. The 33rd day is taken from here.*"

Ö$_{42}$: "*35. We'll see the top one day.*"

Ö$_{44}$: "*Since the point that cuts the x-axis is not given, we cannot calculate what day the peak coincided with.*"

When the answers of the pre-service teachers who gave wrong answers were examined, it was determined that the majority of them gave an approximate answer to the graph and did not make operational explanations. This may be due to the fact that the pre-service teachers could not write the equations of the parabola graphs in the question and could not perform operations by writing the data in the graphs into the equations. As a matter of fact, Ö44's statement that he could not solve this question because the apse of the apex of the apex of the 2nd scenario graph was not given, meant that Ö$_{4}$, Ö$_{9}$, Ö$_{11}$, Ö$_{12}$, Ö$_{13}$, Ö$_{14}$, Ö$_{18}$, Ö$_{20}$, Ö$_{23}$, Ö$_{35}$, Ö$_{39}$, Ö$_{40}$, Ö$_{42}$, Ö$_{47}$, Ö$_{49}$ pre-service teachers "approximately". "The fact that he said a number directly without giving an answer or taking any action, and Ö$_{8}$'s solution with hypothetical data independently of the graph equations, supports this situation. On the other hand, when the solutions made by Ö$_{3}$ and Ö$_{5}$ pre-service teachers are examined, it is seen that they know that they need to write the equations of the graphs while solving the question. However, since they did not write the equations of the parabolas in the question, they solved the question incorrectly. It is seen that the pre-service teacher Ö$_{31}$, on the other hand, thinks that the parabola graph is linear and applies the similarity rule in triangles. Therefore, when the wrong answers given to question 1(d) are evaluated in general, it can be said that the lack of pre-knowledge of the pre-service teachers about the parabola subject and their inability to switch between representations (from visual representations to algebraic representations) cause difficulties in graphical interpretation.

Another question prepared for the graphic interpretation skill is question 1(e). The data analysis results obtained from the solutions and explanations of the pre-service teachers for question 1(e) are presented in Table 5.

Table 5. Analysis of Data for Question 1(e)

Accuracy Status	**Codes of the Pre-service Teachers**	**F**	**%**
Correct	$Ö_1$, $Ö_2$, $Ö_6$, $Ö_7$, $Ö_{10}$, $Ö_{15}$, $Ö_{16}$, $Ö_{17}$, $Ö_{19}$, $Ö_{21}$, $Ö_{22}$, $Ö_{24}$, $Ö_{25}$, $Ö_{27}$, $Ö_{28}$, $Ö_{29}$, $Ö_{30}$, $Ö_{32}$, $Ö_{33}$, $Ö_{36}$, $Ö_{37}$, $Ö_{38}$, $Ö_{41}$, $Ö_{43}$, $Ö_{45}$, $Ö_{46}$, $Ö_{50}$, $Ö_{51}$, $Ö_{52}$	29	55,77
Incomplete answer	-	0	0
False	$Ö_4$, $Ö_{12}$, $Ö_{14}$, $Ö_{40}$, $Ö_{42}$, $Ö_{18}$, $Ö_{20}$, $Ö_{26}$, $Ö_{39}$, $Ö_{49}$, $Ö_{23}$, $Ö_{35}$, $Ö_3$, $Ö_5$, $Ö_8$, $Ö_9$, $Ö_{11}$, $Ö_{13}$, $Ö_{31}$, $Ö_{47}$	20	38,46
Blank	$Ö_{34}$, $Ö_{44}$, $Ö_{48}$	3	5,77
Total		52	%100

As can be seen from Table 5, a significant part of the pre-service teachers said, “Journalist: Mr. Minister, if the 2nd scenario is realized, on what day will the number of patients hospitalized with the diagnosis of Covid-19 end? (Specify and Explain)”. It is necessary to calculate the apex of the vertex of the 2nd scenario parabola in order to answer the question 1(e) about finding the place where the 2nd scenario graph intersects the x-axis. Therefore, in order for question 1(e) to be solved correctly, question 1(d) must first be solved correctly. As a matter of fact, it can be seen from Table 4 and Table 5 that all pre-service teachers who gave wrong answers to question 1(d) in which the vertex of the 2nd scenario parabola graph was asked, also gave wrong answers to question 1(e). The sample solution of T6, one of the pre-service teachers who answered the question 1(e) about the graphic interpretation skill, is given below.

$Ö_6$: "*The parabola is a symmetrical shape. If the peak day is 36, the number of hospitalized patients will be reset in* $36 \times 2 = 72$ *days.*"

When Ö6's solution is examined, it is seen that the vertex is the symmetry axis of the parabola and then he reaches the result by using the operation skill. In Table 5, it is seen that there are 29 pre-service teachers who gave correct explanations both numerically and verbally to the question 1(e) regarding the graphic interpretation skill. Therefore, it can be said that the majority of pre-service teachers interpreted the graph correctly. According to Table 3, it is seen that there was no pre-service teacher (0%) who gave an incomplete answer to the question 1(e) regarding the graphic interpretation skill, and very few of them (5.77%) did not answer the question. On the other hand, it is seen that a significant part of the pre-service teachers (38.46%) gave wrong answers. The opinions of the pre-service teachers who gave wrong answers are as follows. (As many pre-service teachers' opinions have almost the same meaning, these views are combined):

$Ö_4$, $Ö_{12}$, $Ö_{14}$, $Ö_{40}$, $Ö_{42}$: “If the 2nd scenario is realized, the peak can be seen at a point between 30-40 days on an average of 35 days. Depending on these data, if the 2nd scenario is realized, the number of patients hospitalized with the diagnosis of Covid-19 will be between 60-80 days. ends on the 70th day on average.”

$Ö_{18}$, $Ö_{20}$, $Ö_{26}$, $Ö_{39}$, $Ö_{49}$: “It will end in less than 80 days. Because we expect the critical period to coincide with less than 40 days. The number of our patients increases until about 40 days, then gradually decreases in recent days. We expect it to slow down fast and be finished in less than 80 days.”
$Ö_{23}$, $Ö_{35}$: “*It reaches its peak in the first 40 days and decreases in the last 40 days. If the second scenario is realized, the number of patients hospitalized with the diagnosis of Covid-19 will end in 80 days.*”

$Ö_3$: "*As the critical value of the process is reached exactly on the 18th day, the process ends on the 36th day.*
$Ö_5$: "*If the 2nd scenario is realized; the number of hospitalized patients will be reset on the 46th day. We can reach this result by creating the equation of the parabola.*"
$Ö_8$: "*According to the above calculation, if the hospitals are assumed to be filled and emptied at maximum capacity in approximately 2,323 periods, and if it is assumed that each period is 70 days on average, the number of patients who can be hospitalized in* $2{,}323 \times 70 = 162{,}610$ *days is completely over*."
$Ö_9$: "*If the second scenario is realized, I think that the number of patients hospitalized with the diagnosis of Covid-19 will end in 35 days. Because the cut-off points of these two scenarios show that they are less than 40 days.*"
$Ö_{11}$: "*Based on the given graphic, considering the 40th day and 35-38 of the 2nd scenario. We can interpret it as it will end between the 60-65th days, considering that it will peak between days.*"
$Ö_{13}$: "*It will end in 25 days.*"
$Ö_{31}$: "*When we look at the graph, we reach the critical value on the 33rd day. After this day, the number of our patients starts to decrease and the number of hospitalized patients ends on the 66th day.* $32{,}5 + 32{,}8 = 65{,}6$ *(66th day is taken from here.)*"
$Ö_{47}$: "*If we consider the probability of the 2nd scenario to happen, the number of patients who can be hospitalized is 36.000. This is as much as the bed capacity of hospitals. With the realization of the second scenario, the disease will completely disappear in approximately 80-85 days.*"

When the answers of the pre-service teachers who gave wrong answers to the question 1(e) regarding the graphic interpretation skill are examined, it is seen that the pre-service teachers indicated an average or numerical range, as in the question 1(d). Therefore, it can be said that the sources of error made by the pre-service teachers in the questions asked for graphic interpretation are similar, and that a significant part of the mistakes made are due to the deficiencies in their prior knowledge about the parabola topic and the lack of transition between representations (from visual representations to algebraic representations).

4. Discussion and Conclusions

Graph reading skills were discussed in the first sub-problem of this study, which was conducted to examine the ability of elementary school mathematics pre-service teachers to read and interpret parabola graphs prepared in the context of Covid-19, a socio-scientific situation. For this purpose, the answers given to the questions directed to the pre-service teachers were examined and coded as "correct", "incomplete answer", "wrong" and "blank".
When the answers given to the questions about graphic reading skills are examined, it is seen that most of the pre-service teachers who participated in the research gave correct answers. On the other hand, while there was no teacher candidate who gave an incomplete answer to the question 1(a) about reading graphics, 25% of the pre-service teachers gave an incomplete answer to the question 1(b). It allowed the pre-service teachers to examine the scenario situation given in question 1(a) in detail, to discover the concept of critical value and to read this value from the graph correctly. Pre-service teachers who correctly read the critical value in question 1(a) from the graph, benefited from the information given in the scenario in their mathematical explanations, thus minimizing the rate of incomplete answers to this question. In question 1(b), however, it is necessary to explain how many days the 1st scenario process was completed by directly using the data in the graph. Although most of the pre-service teachers gave correct answers, the fact that they could not explain what data they used in the

graph caused a higher rate of incomplete answers to question 1(b). As a result, the high rate of missing answers does not indicate that the pre-service teachers' graphic reading skills are completely deficient. Considering that the incomplete answers are close to the correct and the rate of correct answers is high, it can be said that a significant part of the pre-service teachers participating in the research have the skills to read the parabola graphs given in the context of Covid-19. However, when the wrong answers given to the questions about graphic reading are examined, it is seen that some of the pre-service teachers participating in the research have misconceptions about the peak point. It is noteworthy that most of the pre-service teachers who gave the wrong answer when asked about the critical value in case of 1(a) problem focused on the top of the aforementioned graph ($Ö_2$, $Ö_3$, $Ö_9$). The critical value of $Ö_2$ pre-service teacher mentioned in the question is explained as; “The critical value is the peak and the reason why it is important is that it starts to decrease after this value. The critical value is 20, as the vertex will divide the parabola into two equal parts.”.This shows that $Ö_2$, focusing excessively on the vertex, considers the apse of the point as the largest value of the parabola. As a matter of fact, in the study by Kobak Demir and Gür (2019) in which the process of abstracting the concept of parabola in technology-supported learning environments was examined, it is a similar misconception in the relevant literature that 10th grade students said that the largest-smallest element in the parabola is the apse of the apex. When the wrong answers given by $Ö_3$ and $Ö_9$ pre-service teachers are evaluated within the scope of the study, it is seen that they expressed the critical value as 100.000, which is the ordinate of the peak of the graph of the 1st Scenario. However, the critical value mentioned in the question is the hospital bed capacity given in the graph. Therefore, it can be said that these pre-service teachers focused excessively on the peak of the graph and from their explanations they made an inference that the peak is a critical value in every graph or in every scenario situation, and this may be a mistake in the type of over-specification.

Looking at the graphs as a point by concentrating on a certain concept and not examining the whole and development of the graph can cause such misconceptions. As a matter of fact, in Bayazıt's (2011) study, it is stated that the basis of misconceptions such as "point-spacing" or "height-slope", which are the most common graphic errors in the literature, is the analysis by over-concentrating on the point context, regardless of the general structure and development of the graphics. In addition, it is possible to say that these pre-service teachers (Ö2, Ö3, Ö9), who focus on a certain point and examine the graph locally, in a point context, are at the level of quantitative perception. Students at the quantitative perception level are aware of the relation, mathematical concepts, and especially the critical points in the graph (start point, intersection point, inflection points, distance from the origin, height, etc.) (Bayazıt, 2011). The fact that pre-service teachers gave answers at the level of quantitative perception while reading the graphics may be due to the teaching practices that require quantitative understanding while teaching graphic drawing. It is known that especially in the teaching carried out according to the traditional education approach, graphic drawing activities that require more quantitative understanding are made by the students (Leinhardt, et al., 1990). These teaching practices consist of activities for marking the ordered pairs given to the students on the coordinate plane and for obtaining graphics by combining the points. Giving students a limited number of ordered pairs in the activities and dealing with them pointwise on an analytical plane may prevent students from understanding the general structure and development of the graph. As a matter of fact, it is stated in the related literature that too many drawing activities that require quantitative understanding may make it difficult to understand that graphics are visual structures consisting of an infinite number of points (Dunham & Osborne, 1991). Therefore, in the teaching of graphics, students can be given drawing activities that require qualitative understanding, in which they can draw another graphic from this graphic. In addition, it may be more remarkable that the graphics are given to the students within the framework of a context while the activities are carried out, and that these contexts are selected from current and discussed socioscientific issues. As a matter of fact, it is stated in the related literature that presenting graphics on the basis of a context and choosing from current situations will facilitate the development of qualitative knowledge (Dugdale, 1993). For this purpose, technology-supported applications (graphic calculators, desmos, etc.) can be used within the framework of constructivist teaching approach in teaching graphics. In many studies on the teaching of graphics, enriching the teaching with technology according to the constructivist approach, and the global interest of students in graphics makes it easier for them to understand the multiple transitions between representations (Çetin, 2017; Erduran, 2020; Keller & Hirsch, 1998; Kieran, 1992; Smart, 1995; Schwarz and Dreyfus, 1995). On the other hand, Ö13 and Ö27 pre-service teachers, on the other hand, see the critical value in the problem situation as "our hospital bed capacity" by looking at the graph. They could not express this value numerically by reading from the graph. Therefore, it can be said that these pre-service teachers are at the level of visual perception. Visual perception students perceive the graphic only as a picture and try to solve the problem by concentrating on the visual features of the graphic (Bayazıt, 2011; Bell & Janvier, 1981). The fact that pre-service teachers with visual perception level associate the word "health system hospital bed capacity" with the critical value in the question shows that they only focus on visual features. As a matter of fact, the fact that the aforementioned pre-service teachers could not tell how much the hospital bed capacity of the health system is by looking at the graph, supports this result. It is a remarkable finding that three pre-service teachers who have a numerically complete answer and who gave the wrong answer to question 1(b) on reading graphics used expressions such as "approximately" or "average". Especially the fact that they make calculations by considering the data in the graph and the data and variables that are not in the graph shows that they cannot understand the problem situation by looking at the development of the graph.

In the second sub-problem of the research, the ability of elementary school mathematics pre-service teachers to interpret parabola graphs prepared in the context of Covid-19 was discussed. When the answers given to the questions about graphic interpretation skills are examined, it is seen that the majority of the pre-service teachers who participated in the research gave correct answers, and the rate of giving wrong answers was higher than the rate of missing and leaving blanks. In this context, it can be said that the majority of the pre-service teachers participating in the research have the skills to interpret the parabola graphs given in the context of Covid-19. However, in terms of graphic interpretation skills, it is noteworthy that the rate of incorrect, incomplete and empty answers is substantial.Therefore, it can be said that pre-service teachers have various difficulties in graphic interpretation. This finding obtained from the research is similar to the results of many studies in the related literature (Deniz, 2016; Duijzer, Van den Heuvel-Panhuizen, Veldhuis & Doorman, 2019; Kertil, Erbaş & Çetinkaya, 2017; Kültür, Kaplan, & Kaplan, 2008; Moschkovich , Zahner & Ball, 2017; Özdoğan, 2018). In Özdoğan's (2018) study, in which the pedagogical content knowledge of pre-service mathematics teachers about the difficulties and misconceptions they experience within the scope of the concept of function was examined, it was determined that the concept images of function were mostly algebraic and they had the most difficulty in creating-interpreting graphics. Graph interpretation skill generally requires being able to reveal the relationships between variables by examining the graph (Gültekin, 2009). Therefore, students who have this skill can perform algebraic operations by switching from visual representations (graphs) to algebraic representations. For this reason, all three questions asked in the research for graphical interpretation require writing the parabola equations from the graphs and performing operations on them. When the wrong answers are examined in detail in order to identify the sources of error within the scope of this study, it is noteworthy that the pre-service teachers gave an answer directly without taking any action, used the expressions "approximately", "average" or failed to write the parabola equations. Therefore, this situation shows that pre-service teachers have difficulties in transitioning between representations. As a matter of fact, in the studies conducted in the related literature, it is stated that individuals at different levels experience difficulties in the transition from graphical representation to algebraic representation (De Bock et al., 2015; Eraslan & Aspinwall, 2007; Tekay & Doğan, 2015; Pehlivan, 2013). In the study conducted by Pehlivan (2013), in which the thinking processes of pre-service mathematics teachers were examined during the transition from graphical representation in functions to model representation, it was determined that some participants experienced confusion between the shape of the graph and the behavior of the graph during the transition to model representation. It is stated that this situation is due to the limited knowledge of pre-service teachers about mathematical model representation. In addition, it is among the results of the research that there are deficiencies in the conceptual knowledge of the pre-service teachers about the concept of function, and that there are problems in making sense and interpreting the change between dependent and independent variables. On the other hand, in the study conducted by De Bock et al. (2015) to examine students' conceptual understanding of linear and “almost-linear” functions and how various external representations mediate this understanding; when converting a graph to a formula or a formula to a graph. Therefore, in order to reduce and eliminate these difficulties, activities can be carried out to ensure that the transition between representations is versatile in teaching applications in graphic teaching.

5. Recommendations

As a result of this study, which was conducted to examine the graphic reading and interpretation skills of elementary school mathematics pre-service teachers in the context of Covid-19, which is a socio-scientific situation, the following suggestions were presented to researchers and teachers:

- As a result of the research, it is thought that most of the pre-service teachers who gave wrong answers to the questions about graphic reading skills were at the level of visual or quantitative perception. Therefore, drawing activities that require more qualitative understanding can be done in teaching the subject of graphics.
- While planning activities for the development of qualitative perception in the teaching of graphics, graphics and problem situations can be presented in a way that is based on the current and discussed socio-scientific context.
- Activities that improve visual, quantitative and qualitative perception can be used in graphic teaching. In addition, while the aforementioned activities are being planned, technology-supported (graphic calculators, desmos, etc.) teaching applications can be used within the framework of the constructivist learning approach.
- Researchers can conduct studies to examine the skills of reading, interpreting and drawing graphics on various topics in mathematics (function, relation, statistics, etc.) in the context of different socio-scientific situations.
- Considering a socio-scientific situation, it is thought that academic studies in which activities to improve qualitative perception for teaching context-based graphic reading, interpretation and drawing skills will contribute to the relevant literature.

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