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AN INVESTIGATION OF STUDENTS' ORIENTEERING PROCESS AS TO THE STEPS OF POLYA'S PROBLEM-SOLVING METHOD

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Abstract

Orienteering is an enjoyable sporting activity, which is believed to contribute to its participants' problem-solving skills. People who are engaged in orienteering is expected to hold a map correctly, find their exact place on the map, read the map, make a plan and carry it out to reach the checkpoint, as well as checking the accuracy of the destination. Such steps to be followed during orienteering resemble those of Polya's problem-solving method in education. From this standpoint, this study focused on Polya's problem-solving steps in the field of mathematics, in relation to the outdoor sport of orienteering. On the whole, the present study aimed to examine fourth-grade students at primary school concerning their involvement in an orienteering process as to the steps of Polya's problem-solving method. A case study method was employed from among qualitative research approaches, and a program implementation was adopted as one of the sub-types of the case study method. In this context, the study sample was selected with the convenience sampling technique, from among the purposive sampling techniques. Observations, semi-structured interviews, and head cameras were used as data collection tools. The results indicated that the steps of Polya's problem-solving method can be used for problem-solving during the orienteering process. Based on the results, it is recommended that practical studies be conducted with similar or different research methods so as to contribute to the field.

Keywords: Orienteering, problem solving, primary school students, case study, mathematics.

INTRODUCTION

Orienteering is a sport that requires the use of a map and compass in unknown terrain and includes physical and mental challenges (Orienteering New Zealand, 2021). Having begun as a military exercise in Scandinavia at the end of the 19th century, orienteering became popular owing to a scout leader, Ernst Killander. To attract young people to athletics, Killander prepared courses requiring the use of a map and compass in the Swedish countryside. It is, therefore, regarded to have begun in Sweden and started to spread to other countries (Bektaş et al., 2019; Boga, 1997). Bjorn Kjellstrom, the Swedish inventor of the protractor-type compass, also introduced the sport of orienteering to the USA upon moving there in 1946 (August, 1975; Boga, 1997).

Orienteering can be considered as either a competitive outdoor sport or an entertaining activity. In this activity, the skills of map reading and using a compass are combined with a challenging physical activity (Campbell & Burton, 1996). Participants try to find control points on a land map in as short a time as possible (Cambridge Dictionary, 2021). Orienteering is, therefore, both a game (Celestino & Pereira, 2012; Kim, 2010) and a cross-country running art that stimulates interest in coordination between the brain and body (Boga, 1997; British Schools Orienteering Association [BSOA], 2015). Additionally, it can be considered in connection with adventure education (Bomgardner, 2014).

Orienteering is a form of navigation and requires map and compass skills (Cordes & Hutson, 2015). In this sense, participants must learn what a map is and orienteer with the aid of a map, and then learn how to use a compass, and finally, orienteer with the aid of the map and compass (Morisbak, 1982). Apart from map and compass skills, participants are supposed to be physically fit, mentally alert, and be able to make decisions while orienteering (Kiwi-O Manual, 2014). If participants act too fast and go in the wrong direction while orienteering, they are not likely to win. To win the competition, participants must move by solving the problems encountered on the course (Hugglestone & Howard, 1983). The direction that the participant is to take is not limited to the direction that the facilitator expects (Hodgson & Bailie, 2011). In a sense, orienteering is a thinking person's sport (Bektaş et al., 2019). It can exert a positive impact on the development of the brain and body (Deniz et al., 2011; Larkin & Grogger, 1975), and can contribute to an individual's all-round development (Celestino & Pereira, 2012; Kelly, 2014). It can, therefore, be suggested that orienteering is also a beneficial activity for children.

Contributing to the holistic development of individuals of all ages, orienteering is included in the curriculum in Türkiye and around the world (Bektaş et al., 2019). It can be made use of in physical education, mathematics, and geography curricula as well as an extra scholastic learning and adventure activity. Moreover, orienteering can enable interdisciplinary collaboration and function as a multi-faceted extracurricular activity resource (BSOA, 2015). It contributes to the development of many skills of individuals and can thus be considered as a student sport (Aksın, 2019).

Orienteering is believed to be an important learning resource (Di Tore et al., 2015). It enables the skills and understanding involved in teaching programs to be put into practice in a social context (Bradford, 1977; Kiwi-O Manual, 2014). Through orienteering, students can acquire knowledge of maps, contours, landforms, and land use concerning social studies/geography. It is also possible to argue that orienteering is of importance for physical education and health benefits since students are to walk, run and acquire agility in tracking through orienteering. Similar to the outcomes in mathematics, students may achieve with orienteering in subjects/skills such as planning, establishing spatial relationships, using scales, angles, symbols, time, distance, and speed, as well as thriving in arithmetic, measurement, and estimation. Regarding personal development, students can have the opportunity through orienteering to practice advanced planning, solve problems and make decisions, develop their memory and concentration skills, and increase their self-confidence and self-esteem (Kiwi-O Manual, 2014). Furthermore, students can also learn their strengths and weaknesses (Hammes, 2007) and improve their creativity and flexible thinking skills (Kim, 2010).

One of the skills that orienteering develops is the skill of problem solving (Bradford, 1977; Deniz et al., 2011). A problem is a special relationship that turns a task into a problem for a person. This relationship should involve an intellectual difficulty rather than a calculation (Schoenfeld, 1985). In other words, a problem can mean questions whose answers are not immediately certain (National Council of Teachers of Mathematics [NCTM], 2000). Problem solving is the process of solving a situation that requires a solution. During this process, by using their knowledge, skills, and understanding, people try to master a situation in which they have difficulty (Krulik & Rudnick, 1989; Posamentier & Krulik, 2016). The skill of problem solving is critical for all levels of education and is also one of the mathematical skills (Baykul, 2016).

Mathematical problem solving is the process of understanding how to solve a mathematics problem whose solution is unknown (Mayer & Hegarty, 1996). Problem solving is also a principal component of mathematics. A lack of problem-solving ability can limit the effect of mathematical knowledge, ideas, and skills (NCTM, 2000). The skills of mathematical thinking and of solving problems that are encountered in daily life should, therefore, be improved in children through problem-solving studies (Dinç-Artut & Tarım, 2009). Problems that are used in studies focusing on problem-solving in particular should also have certain characteristics such as being appropriate for children's cognitive level, being related to children's daily life, and stimulating their interest (Altun, 2008). In this context, good problems can set the stage for discovery and retention of mathematical ideas, and comprehension and implementation of mathematical features, patterns, and strategies, thereby prompting students to think.

These problems can be generated from students' environments or a mathematical context (NCTM, 2000). There might not be a formula for a solution to the problems generated, but the exact steps to solution can be developed (Altun, 2015). In this connection, Reys et al. (1998), for example, stated that G. Polya contributed a great deal to the process of problem solving. Lenchner (2005) also stated that Polya presented a four-step guide to successful problem solving.

Polya's problem-solving process consists of four steps, namely, understanding the problem, devising a plan, carrying out the plan, and looking back and checking. First of all, the problem should be understood by students. Following an understanding of the problem, a plan aimed at a solution to the relevant problem should be made, after which the plan should be carried out. Finally, the problem-solving process should be reviewed and evaluated (Polya, 1997). In this context, Polya considered heuristic strategies to be a tool in problem solving (Schoenfeld, 1985). Considering that orienteering can also develop problem-solving skills (Bradford, 1977; Deniz et al., 2011), it may be of great value to investigate whether or not there is a relationship between orienteering and the steps of problem-solving. Orienteering is reported to have positive impact on mental processes (Vaskan et al., 2019), thinking skills (Özal & Girgin, 2013; Pouya et al., 2017), attention and memory (Atakurt et al., 2017), problem-solving (Taş, 2010), and development of logical-mathematical intelligence (Özcan, 2007). Nevertheless, it is notable that Quenneville (1979) referred to orienteering as a tool to be used in mathematics teaching. Besides that, mathematical skills can be used during orienteering (Balkwill, 1996). Based on the results of such studies, it can be argued that orienteering may be used as an effective tool in education and the development of cognitive skills. However, there has not been much research on the reasons behind the effectiveness of orienteering in these processes. Not many different studies are present in the literature on why orienteering can be effective on problem-solving skills. Participants in orienteering events go through the same processes, repetitively, which are similar to Polya's problem-solving process. For this reason, the present study differs from those in the literature in this respect, and is believed to contribute to the literature with respect to problem-solving and orienteering. Finding a relationship between the mathematical problem-solving process and orienteering will contribute to both theory and practice. In other words, the existence of a relationship between an entertaining outdoor sport and the mathematical problem-solving process can contribute to the educational practices.

This study aimed to examine the orienteering process in primary school students according to Polya's steps of problem-solving. The stages of the orienteering process were revealed and evaluated according to the steps of Polya's problem-solving method. The relevant literature review has shown that no other study has ever discussed orienteering and Polya's problem-solving steps in the way presented in this study, which can offer a different understanding of why orienteering is an effective sport on problem-solving processes and how it can function as a tool in the education process. In this sense, it is considered that this study is important and its results will contribute to the field of orienteering and problem-solving in relation to theory and practice. From this standpoint, answers have been sought to the following research questions:

1. How is the orienteering process of primary school students investigated according to Polya's steps as a problem-solving method?
2. What are primary school students' feelings and thoughts about the orienteering process?

METHOD

This study employed the case study methodology, which is mostly included within the scope of qualitative research approaches. The case study method is a holistic research method. It uses multiple sources of evidence to evaluate or analyze a specific phenomenon or event (Anderson, 2005). Moreover, the case study makes it possible to discuss and examine a case thoroughly (Datta, 1990). In the present study, the orienteering process with primary school students was examined according to the steps of Polya's problem-solving method. Thus, a program implementation, which is one of the sub-types of the case study method, was taken as the basis (Datta, 1990).

Participants

A study sample was selected with the convenience sampling and maximum variation sampling methods, which are purposive sampling techniques. Within the scope of maximum variation sampling, utmost attention was paid to ensure that the study sample consisted of students with as many different characteristics as possible (Şimşek & Yıldırım, 2011). For that reason, students with different achievement levels and genders were selected in line with the purpose of this study. To achieve convenience sampling, it is essential to involve individuals who are convenient to reach in the research process (Ekiz, 2009). This study, therefore, involved a study sample being drawn from among a population with maximum diversity and easy access. Consequently, the sample study consisted of primary school students at fourth grade. Table 1 presents background information regarding the sample.

Table 1. Background information regarding the study sample

Student codes	Grade level	Gender	Academic grade point average in the subject of mathematics	Does the child enjoy solving mathematics problems?	Does the child enjoy games that involve running?	Does the child have any health problems to the extent that it prevents him/her from orienteering?
S1	4	Female	74	Yes	Yes	No
S2	4	Female	90	Yes	Yes	No
S3	4	Female	70	Yes	Yes	No
S4	4	Female	66	Yes	Yes	No
S5	4	Female	52	Partly	Yes	No
S6	4	Male	82	Yes	Yes	No
S7	4	Male	29	Partly	Yes	No

Note: For ethical reasons, participating students were given pseudonyms in the form of "Student 1 (S1)"

As can be seen in Table 1, the study sample consisted of seven participants, five of whom were girls and two boys, who all studied in the same class with a class size of seven students. The participants' average grade in the subject of mathematics was 66.14, but it was found that participants had different academic levels in the class. Two of the participants (S5, and S7) ended up enjoying solving mathematics problems only partly, while the other participants (S1, S2, S3, S4, and S6) enjoyed solving mathematics problems thoroughly. All participants reported that they enjoyed games involving running. Moreover, it appeared that participants had no prior knowledge related to orienteering and that none of them had any health problems that could prevent them from orienteering. Table 1 provides the relevant information given by teachers and students.

Instruments

The data collection tools were qualitative observations, semi-structured interview forms, and head cameras. Generally speaking, in qualitative observation, the researcher takes field notes based on the participants' activities and behaviors (Creswell, 2016a). In this study, the researcher took the required observation notes by making unstructured qualitative observations. The semi-structured interview is an open-ended process aimed at revealing participant views through a face-to-face or on the phone technique, including a series of questions (Creswell, 2016a). In this study, the semi-structured interviews were conducted by interviewing the participants face-to-face in order to reveal participants' feelings and thoughts while orienteering. For this purpose, the participants were asked what they thought about orienteering, and what feelings and thoughts they had while orienteering.

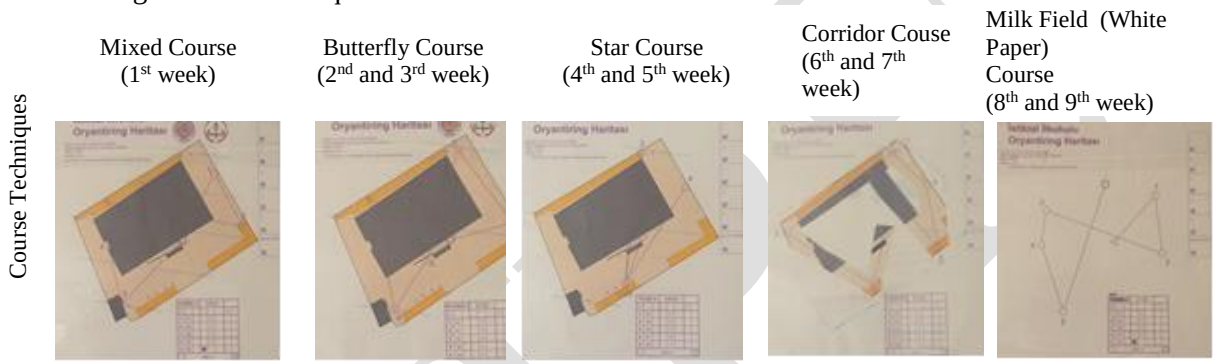
An additional study was conducted to monitor orienteering processes by having the students use head cameras. The field of view of the head camera was adjusted in such a way as to support the purpose of the study. Utilizing this field of view of the head camera made it possible to access data that would support the present study. With the aid of the head camera, participants' behaviors during the orienteering process could be examined in more detail, and detailed data were collected concerning how participants read the map, how they reached the checkpoints on the course, where they made mistakes

on the course, which problems they considered on the course, the length of time they spent thinking about the problems they encountered on the course, and the length of time it took them to complete the course. Therefore, first, the participants were fitted with head cameras, and were given their maps in turn. They then took their maps, went to the course and completed the course.

Data Collection Process

In this study, the participants' orienteering process was examined according to Polya's problem-solving steps. Accordingly, the data collection process was as follows:

1. The study sample was selected.
2. An orienteering map was drawn for the area where the orienteering was to take place.
3. While the course was being planned, a number of different orienteering course techniques were utilized, including: Mixed, butterfly, star, corridor, and white paper techniques. Figure 1 illustrated the images of the techniques used:



Mixed Course: This includes various orienteering activities (Karaca, 2008).
Butterfly Course: This consists of small courses with the same starting and ending points (Kelly, 2014)
Star Course: This is a course consisting of destinations that involve commuting to a center (Kelly, 2014).
Corridor Course: Destinations are found only according to the information about the corridor given on the map (Ferguson & Turbyfill, 2013).
Milk Field (White Paper): There is only course information on the map (Karaca, 2008).
Orienteering courses are planned from easy to difficult.
The type of each course can be seen on the relevant maps.

Figure 1. Maps of the orienteering techniques used

4. The participants were given the necessary preliminary information about orienteering.
5. The implementation took five weeks.
6. During the five weeks, nine exercises were performed.
7. The exercises were performed in the schoolyard.
8. During the exercises, observation was made by the researcher.
9. Data related to the orienteering process were collected with the head camera fitted to the students. The visuals of the materials used in the research are presented in Figure 2.
10. At the end of the procedure, semi-structured interviews were held with the students.

Image1. Orienteering map

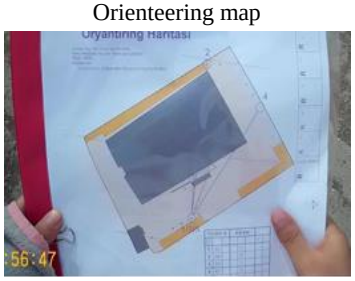


Image2. Control point (punch)

Image3. Head Camera

Figure 2. Images of the materials used in the study

Data Analysis

The data obtained using observation, semi-structured interviews, and head cameras were analyzed. While the data obtained from the observations and semi-structured interviews were subjected to descriptive analysis (Ekiz, 2009; Strauss & Corbin, 1990), those obtained from the head cameras were subjected to inductive content analysis (Patton, 2014). The data analysis results are presented in tables. Some encodings are used in tables. For instance, the expression "yes" indicates that the given action was fully performed, whereas the expression "no" indicates that the given action was not performed at all. The expression "partially" indicates that the given action was performed from time to time. In other words, it is used to indicate a point between yes and no.

In the descriptive analysis, analysis of data obtained from sources such as observations and interviews constituted the case, and a direct description of a situation formed the basis (Ekiz, 2009; Strauss & Corbin, 1990). During this process, through observations and semi-structured interviews within the framework of the steps outlined by Creswell (2016a; Creswell, 2016b), the raw data were collected, organized for analysis, read, coded manually, and converted into themes. In order to create the relevant themes, analysis was made based on the questions used in the interviews and the subjects discussed in the observations (Ekiz, 2007). Therefore, the participants were interviewed about the orienteering processes while the interviews were being recorded with a voice recorder. The interviews were then transcribed and read, and the codes (happiness, freedom, play puzzle, running game, etc.) were created and then combined under the theme of feelings and thoughts.

The data captured from the head cameras were subjected to inductive content analysis since there was an interaction between the researcher and the data, and exploration of the concepts by the researcher was the case (Patton, 2014). The images obtained from the head cameras were recorded in the form of behaviors. Such images were monitored without any template, coded, and converted into themes in this form. Here, coding was done by considering numerous behaviors ranging from the participants' holding of the map to their apparent way of thinking.

Regarding the quality (validity and reliability) of the qualitative data, triangulation was utilized and a long period was spent in the field (Creswell, 2016b; Merriam, 2015). In the study, triangulation was utilized by using observations, semi-structured interviews, and head cameras. In this regard, an attempt was made to answer the research questions with a deeper understanding by using the data obtained from semi-structured interviews, observations, and head cameras. The researcher made observations by spending time in the field and thereby, achieved a deeper understanding of the implementation process. In the end, the results were verified with two researchers and three data collection tools (Merriam & Tisdell, 2016).

RESULTS

Participants' Orienteering Process and Polya's Problem-Solving Steps

With the aid of the head cameras, data related to the participants' orienteering process were collected and analyzed, and certain findings were obtained. The tables (from Table 2 to Table 10) include the stages of "start, process and finish". These can be taken into consideration in terms of Polya's problem-solving process. The start means understanding the problem, the process means planning and implementation, and the finish denotes evaluation. Table 11 presents the findings that were reached through exploration. Under each table are explanations related to the findings. Table 2 presents the findings related to the first course.

As can be seen in Table 2, at the start of the first mixed orienteering course, some participants (S1, S3, and S6) were able to hold the map correctly, some participants (S2, S5, and S7) were partially able to hold it correctly, while one participant (S4) was not able to hold it correctly. While some of the participants (S1, S3, S5, and S6) went in the right direction at the start, the remaining participants were only partially able to go in the right direction. Some participants (S1, S3, S5, and S6) were able to go to the checkpoints on the map in the right order, while one participant (S7) partially followed the

checkpoint order and one participant (S2) could not follow the checkpoint order. Except for one of the participants (S2), the others were able to correctly punch the checkpoints given on the map.

Table 2. Findings related to mixed orienteering course-I.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Partially	Yes	No	Partially	Yes	Partially
	Did the participant go in the right direction at the start?	Yes	Partially	Yes	Partially	Yes	Yes	Yes
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Yes	No	Yes	No	Yes	Yes	Partially
	Did the participant correctly punch the checkpoints given on the map?	Yes	No	Yes	Yes	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	If so, how many times did he/she do that?	2	4	4	7	3	4	4
	What was the participant's main movement type on the course?	Walking	Running	Walking	Walking	Walking	Walking	Running
	What was the length of time for the participant's problem-solving on the course?	02 min 31 sec	01 min 29 sec	58 sec	13 sec	01 min 40 sec	01 min 06 sec	01 min 15 sec
	Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Partially (sometimes followed others)	Yes	Yes	Yes
	Finish							
	How long did it take the participant to complete the course?	07 min 07 sec	10 min 46 sec	05 min 09 sec	6 min 52 sec	08 min 53 sec	06 min 20 sec	08 min 21 sec

On the first course, all participants went to the wrong checkpoint at least twice, and the mean number of times that they went to the wrong checkpoint was 4. The main movement types of the participants on the course were walking (S1, S3, S4, S5, and S6) and running (S2, and S7). Moreover, the length of time for the participants' problem-solving on the course ranged between 13 sec and 02 min 31 sec, while that of the course completion ranged from 05 min 09 sec to 10 min 46 sec. One participant (S4) partially adhered to the code of conduct on the course, while the other participants adhered to that in full.

Findings related to the second course are shown in Table 3.

Table 3. Findings related to butterfly orienteering course-II

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	Partially	Partially	Yes	Partially	Partially
	Did the participant go in the right direction at the start?	Yes	Yes	No	Yes	Yes	No	No
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Partially	No	Yes	No	Yes	Yes	No
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	No	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	If so, how many times did he/she do that?	2	1	8	7	5	6	8
	What was the participant's main movement type on the course?	Running	Walking	Running	Running	Running	Walking	Running
	What was the length of time for the participant's problem-solving on the course?	01 min	48 sec	11 sec	17 sec	40 sec	02 min 30 sec	27 sec
	Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Partially (sometimes followed others)	Yes	Yes	Yes
	Finish							
	How long did it take the participant to complete the course?	04 min 18 sec	04 min 28 sec	04 min 21 sec	05 min 01 sec	05 min 08 sec	08 min 09 sec	06 min 18 sec

As shown in Table 3, the findings related to the second course, i.e., butterfly orienteering, indicate that some participants (S1, S3, and S5) were able to hold the map correctly, while some participants (S3, S4, S6, and S7) were partially able to hold it correctly. Furthermore, while some of the participants (S1, S2, S4, and S5) went in the right direction at the start, the remaining participants were unable to go in the right direction. Some participants (S3, S5, and S6) were able to go to the checkpoints given on the map in the right order, while one participant (S1) partially followed the checkpoint order, and some participants (S2, S4, and S7) failed to follow it order at all. Except for one of the participants (S4), the others were able to correctly punch the checkpoints given on the map. On the second course, all participants went to the wrong checkpoint at least once, and the mean number of times that they went to the wrong checkpoint was 5.3. The main movement types of the participants on the course were walking (S2, and S6) and running (S1, S3, S4, S5, and S7). Moreover, the length of time for the participants' problem-solving on the course ranged between 11 sec and 02 min 30 sec, while that of the course completion times ranged from 04 min 18 sec to 08 min 09 sec. One participant (S4) partially adhered to the code of conduct on the course, while the other participants adhered to that in full.

Findings related to the third course are given in Table 4.

As is seen in Table 4, findings related to the third course, i.e., butterfly orienteering, indicate that, at the start, some participants (S1, S2, and S5) were able to hold the map correctly, while some participants (S3, S4, S6, and S7) were partially able to hold it correctly. While some of the participants (S1, S2, and S5) went in the right direction at the start, the remaining participants were unable to go in the right direction. Some participants (S1, S2, S5, and S6) were able to go to the checkpoints given on the map

in the right order, while some participants (S3, S4, and S7) found the checkpoints without following the checkpoint order.

Table 4. Findings related to butterfly orienteering course-III.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	Partially	Partially	Yes	Partially	No
	Did the participant go in the right direction at the start?	Yes	Yes	No	No	Yes	No	No
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Yes	Yes	No	No	Yes	Yes	No
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	If so, how many times did he/she do that?	2	4	9	7	3	8	6
	What was the participant's main movement type on the course?	Walking	Walking	Running	Running	Running	Walking	Running
	What was the length of time for the participant's problem-solving on the course?	03 min 29 sec	57 sec	10 sec	12 sec	36 sec	03 min 02 sec	38 sec
	Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Finish							
	How long did it take the participant to complete the course?	05 min 47 sec	04 min 55 sec	06 min 24 sec	03 min 30 sec	04 min 37 sec	09 min 16 sec	05 min 20 sec

All of the participants were able to correctly punch the checkpoints. On the third course, all participants went to the wrong checkpoint at least twice, and the mean number of times that these participants went to the wrong checkpoint was 5.6. The main movement types of the participants on the course were walking (S1, S2, and S6) and running (S3, S4, S5, and S7). Moreover, the length of time for the participants' problem-solving on the course ranged between 12 sec and 03 min 29 sec, while that of the course completion ranged from 03 min 30 sec to 09 min 16 sec. All of the participants adhered to the code of conduct on the course.

Findings related to the fourth course can be seen in Table 5.

As evident in Table 5, findings related to the fourth course, i.e., star orienteering, indicate that, at the start, some participants (S1, S2, and S7) were able to hold the map correctly, some participants (S3, S5, and S6) were partially able to hold it correctly, while one participant (S4) failed to hold it correctly. While some of the participants (S1, S2, and S7) went in the right direction at the start, the remaining participants were unable to go in the right direction. Some participants (S1 and S5) were able to go to the checkpoint given on the map in the right order, some participants (S2, S3, and S6) partially followed it, and some participants (S4 and S7) tried to find the checkpoints without following the checkpoint order. All of the participants were able to correctly punch the checkpoints given on the map. On the fourth course, all participants went to the wrong checkpoint at least once, and the mean number of times that these participants went to the wrong checkpoint was 5.4.

Table 5. Findings related to star orienteering course-IV.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	Partially	No	Partially	Partially	Yes
	Did the participant go in the right direction at the start?	Yes	Yes	No	No	No	No	Yes
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Yes	Partially	Partially	No	Yes	Partially	No
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	If so, how many times did he/she do that?	3	1	3	6	8	8	9
	What was the participant's main movement type on the course?	Running	Running	Running	Running	Running	Running	Walking
	What was the length of time for the participant's problem-solving on the course?	45 sec	50 sec	05 sec	15 sec	01 min 07 sec	46 sec	44 sec
	Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Finish							
	How long did it take the participant to complete the course?	04 min 48 sec	03 min 33 sec	01 min 24 sec	03 min 52 sec	05 min 45 sec	06 min 10 sec	07 min 09 sec

The main movement types of the participants on the course were walking (S7) and running (S1, S2, S3, S4, S5, and S6). Moreover, the length of time for the participants' problem-solving on the course ranged between 05 sec and 01 min 07 sec, while that of course completion ranged from 01 min 24 sec to 07 min 09 sec. All of the participants adhered to the code of conduct on the course.

Findings related to the fifth course are given in Table 6.

Table 6. Findings related to star orienteering course-V.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	Partially	No	Partially	Yes	Yes
	Did the participant go in the right direction at the start?	Yes	Yes	Yes	No	No	Yes	Yes
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Partially	Partially	Partially	No	Yes	Yes	No
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6 (Continued). Findings related to star orienteering course-V.

Participants	S1	S2	S3	S4	S5	S6	S7
Did the participant go to the wrong checkpoint?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
If so, how many times did he/she do that?	2	1	6	8	3	3	9
What was the participant's main movement type on the course?	Running	Running	Running	Running	Running	Walking	Running
What was the length of time for the participant's problem-solving on the course?	17 sec	57 sec	13 sec	07 sec	35 sec	01 min 20 sec	42 sec
Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Finish							
How long did it take the participant to complete the course?	03 min 44 sec	02 min 31 sec	03 min 04 sec	03 min 22 sec	03 min 38 sec	05 min 38 sec	06 min 12 sec

As can be seen in Table 6, findings related to the fifth course, i.e., star orienteering show that, at the start, some participants (S1, S2, S6, and S7) were able to hold the map correctly, some participants (S3, S5) were partially able to hold it correctly, while one participant (S4) failed to hold it correctly. While some of the participants (S1, S2, S3, S6, and S7) went in the right direction at the start, the remaining participants were unable to go in the right direction. Some participants (S5 and S6) were able to go to the checkpoints given on the map in the right order and some participants (S1, S2, and S3) partially followed the checkpoint order, while some participants (S4 and S7) failed to follow the checkpoint order. All of the participants were able to correctly punch the checkpoints given on the map. On the fifth course, all participants went to the wrong checkpoint at least once, and the mean number of times that participants went to the wrong checkpoint was 4.6. The main movement types of the participants on the course were walking (S6) and running (S1, S2, S3, S4, S5, and S7). Moreover, the length of time for the participants' problem-solving on the course ranged between 07 sec and 01 min 20 sec, while that of the course completion ranged from 02 min 31 sec to 06 min 12 sec. All of the participants adhered to the code of conduct on the course.

Findings related to the sixth course are shown in Table 7.

As shown in Table 7, findings related to the sixth course, i.e., corridor orienteering indicate that, at the start, some participants (S1, S2, S6, and S7) were able to hold the map correctly, one participant (S5) was partially able to hold it correctly, while one participant (S4) failed to hold it correctly. While some of the participants (S1, S2, S5, S6, and S7) went in the right direction at the start, the remaining participants were only partially able to go in the right direction. Some participants (S1, S5, and S6) were able to go to the checkpoints on the map in the right order, while one participant (S2) partially followed the checkpoint order and some participants (S3, S4, and S7) did not follow the checkpoint order. All of the participants were able to correctly punch the checkpoints given on the map. On the sixth course, all participants went to the wrong checkpoint at least twice, and the mean number of times that these participants went to the wrong checkpoint was 3.4. The main movement types of the participants on the course were walking (S2, S5, and S6) and running (S1, S3, S4, and S7). Moreover, the length of time for the participants' problem-solving on the course ranged between 03 sec and 03 min 17 sec, while that of the course completion ranged from 03 min to 11 min 52 sec. All of the participants adhered to the code of conduct on the course.

Table 7. Findings related to corridor orienteering course-VI.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	No	No	Partially	Yes	Yes
	Did the participant go in the right direction at the start?	Yes	Yes	No	No	Yes	Yes	Yes
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Yes	Partially	No	No	Yes	Yes	No
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	If so, how many times did he/she do that?	2	2	4	3	6	3	4
	What was the participant's main movement type on the course?	Running	Walking	Running	Running	Walking	Walking	Running
	What was the length of time for the participant's problem-solving for the course?	32 sec	01 min 22 sec	05 sec	03 sec	03 min 17 sec	44 sec	12 sec
	Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Finish							
	How long did it take the participant to complete the course?	03 min 49 sec	05 min 55 sec	03 min 02 sec	03 min	11 min 52 sec	03 min 51 sec	04 min 07 sec

Findings related to the seventh course are presented in Table 8.

Table 8. Findings related to corridor orienteering course-VII.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	Yes	No	Partially	Yes	Yes
	Did the participant go in the right direction at the start?	Yes	Yes	Yes	No	Yes	Yes	Yes
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Yes	Yes	Yes	No	Yes	Yes	Yes
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	No	Yes	Yes	Yes	Yes
	If so, how many times did he/she do that?	2	4	0	8	5	2	2

Table 8 (Continued). Findings related to corridor orienteering course-VII.

Participants	S1	S2	S3	S4	S5	S6	S7
What was the participant's main movement type on the course?	Running	Walking Running	Running	Running	Walking	Walking	Walking
What was the length of time for the participant's problem-solving for the course?	21 sec	01 min 05 sec	08 sec	13 sec	01 min 52 sec	25 sec	10 sec
Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Finish							
How long did it take the participant to complete the course?	03 min 59 sec	04 min 37 sec	02 min 09 sec	4 min 58 sec	08 min 32 sec	03 min 55 sec	01 min 37 sec

As seen in Table 8, findings related to the seventh course, i.e., corridor orienteering show that, at the start, some participants (S1, S2, S3, S6, and S7) were able to hold the map correctly; one participant (S5) was partially able to hold it correctly, while one participant (S4) failed to hold it correctly. While some of the participants (S1, S2, S3, S5, S6, and S7) went in the right direction at the start, the remaining participant (S4) was unable to go in the right direction. Some participants (S1, S2, S3, S5, S6, and S7) were able to go to the checkpoints given on the map in the right order, while one participant (S4) tried to find the checkpoints without following the checkpoint order. All of the participants were able to correctly punch the checkpoints given on the map. On the seventh course, all of the participants except for one (S3) went to the wrong checkpoint at least twice, and the mean number of times that these participants went to the wrong checkpoint was 3.2. The main movement types of the participants on the course were walking (S2, S5, S6, and S7) and running (S1, S2, S3, and S4). Moreover, the length of time for the participants' problem-solving on the course ranged between 08 sec and 01 min 52 sec, while that of the course completion ranged from 01 min 37 sec to 08 min 32 sec. All of the participants adhered to the code of conduct on the course.

Findings related to the eighth course are given in Table 9.

Table 9. Findings related to milk field (white paper) orienteering course-VIII.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	Yes	No	Partially	Yes	Yes
	Did the participant go in the right direction at the start?	Yes	Partially	Yes	No	Yes	Yes	No
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Partially	Partially	Partially	No	Yes	Yes	No
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	No	Yes	Yes	Yes	Yes

Table 9 (Continued). Findings related to milk field (white paper) orienteering course-VIII.

Participants	S1	S2	S3	S4	S5	S6	S7
If so, how many times did he/she do that?	2	9	0	4	11	6	3
What was the participant's main movement type on the course?	Walking	Running	Running	Running	Running	Running	Running
What was the length of time for the participant's problem-solving on the course?	49 sec	01 min 20 sec	05 sec	04 sec	01 min 12 sec	29 sec	08 sec
Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Partially (sometimes followed others)	Yes	Yes	Yes
Finish							
How long did it take the participant to complete the course?	03 min 49 sec	08 min 10 sec	02 min 24 sec	03 min 30 sec	06 min 41 sec	06 min 49 sec	03 min 02 sec

As seen in Table 9, findings related to the eighth course, i.e., white paper orienteering demonstrate that, at the start, some participants (S1, S2, S3, S6, and S7) were able to hold the map correctly, one participant (S5) was partially able to hold it correctly, while one participant (S4) failed to hold it correctly. While some of the participants (S1, S3, S5, and S6) went in the right direction at the start, one of the remaining participants (S2) was only partially able to go in the right direction and two of them (S4 and S7) were unable to go in the right direction. Some participants (S5 and S6) were able to go to the checkpoints given on the map in the right order, while some participants (S1, S2, and S3) partially followed the checkpoint order and some participants (S4 and S7) did not follow the checkpoint order at all. All of the participants were able to correctly punch the checkpoints given on the map. On the eighth course, all of the participants except for one (S3) went to the wrong checkpoint at least twice, and the mean number of times that these participants went to the wrong checkpoint was 5. The main movement types of the participants on the course were walking (S1) and running (S2, S3, S4, S5, S6, and S7). Moreover, the length of time for the participants' problem-solving on the course ranged between 04 sec and 01 min 20 sec, while that of the course completion ranged from 02 min 24 sec to 08 min 10 sec. One participant (S4) partially adhered to the code of conduct on the course, while the other participants adhered to this in full.

Findings related to the ninth course are presented in Table 10.

As can be seen in Table 10, findings related to the ninth course, i.e., white paper orienteering indicate that, at the start, some participants (S1, S2, S3, S5, and S6) were able to hold the map correctly, one participant (S7) was partially able to hold it correctly, while one participant (S4) failed to hold it correctly. While some of the participants (S1, S2, S3, S5, S6, and S7) went in the right direction at the start, one remaining participant (S4) was unable to go in the right direction. Some participants (S1, S5, and S6) were able to go to the checkpoints given on the map in the right order, while the other participants (S2, S3, S4, and S7) only partially followed the checkpoint order. All of the participants were able to correctly punch the checkpoints given on the map. On the ninth course, all of the participants except for one (S6) went to the wrong checkpoint at least twice, and the mean number of times that these participants went to the wrong checkpoint was 3.4. The main movement types of the participants on the course were walking (S2 and S7) and running (S1, S2, S3, S4, S5, and S6). Furthermore, the length of time for the participants' problem-solving on the course ranged between 05 sec and 02 min 08 sec, while that of the course completion ranged from 02 min 30 sec to 06 min 44 sec. All of the participants adhered to the code of conduct on the course.

Table 10. Findings related to milk field (white paper) orienteering course-IX.

	Participants	S1	S2	S3	S4	S5	S6	S7
Orienteering Process: Understanding, Planning, Implementation, Evaluation	*Start*							
	Did the participant hold the map correctly at the start?	Yes	Yes	Yes	No	Yes	Yes	Partially
	Did the participant go in the right direction at the start?	Yes	Yes	Yes	No	Yes	Yes	Yes
	Process							
	Did the participant go to the checkpoints given on the map in the right order?	Yes	Partially	Partially	Partially	Yes	Yes	Partially
	Did the participant correctly punch the checkpoints given on the map?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Did the participant go to the wrong checkpoint?	Yes	Yes	Yes	Yes	Yes	No	Yes
	If so, how many times did he/she do that?	3	6	3	6	2	0	4
	What was the participant's main movement type on the course?	Running	Running Walking	Running	Running	Running	Running	Walking
	What was the length of time for the participant's problem-solving on the course?	28 sec	02 min 08 sec	05 sec	12 sec	21 sec	08 sec	11 sec
	Did the participant adhere to the code of conduct on the course?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Finish							
	How long did it take the participant to complete the course?	05 min 51 sec	06 min 44 sec	03 min 03 sec	02 min 45 sec	02 min 30 sec	02 min 39 sec	05 min 37 sec

The stages that the participants followed while orienteering were evaluated according to the steps of Polya's problem-solving method. The findings obtained as a result of this are given in Table 11.

Table 11. Findings related to orienteering process according to Polya's problem-solving steps

Polya's Problem-Solving Steps (Polya, 1997)		Orienteering Process	Exercise	Participants
Orienteering Process: Understanding, Planning, Implementation, Evaluation	Understanding	Holding the map correctly Finding one's place on the map Reading the map	Arranging the map Making the necessary connections between the map and the related environment	S1, S2, S3, S4, S5, S6, and S7
	Planning	Making the necessary plan for reaching the checkpoint	Determining the route leading to the checkpoint from the place located on the map Determining the route leading to the checkpoint from the place located in the related environment	
	Implementation	Putting the plan into practice	Using the route specified at the planning stage in the related environment	
	Evaluation	Checking the accuracy of the checkpoint reached	Checking the accuracy of the checkpoint reached: If the wrong checkpoint has been reached, the process must be reviewed. If the correct checkpoint has been reached, the same processes must be carried out for the next checkpoint	

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Participants' Feelings and Thoughts Related to the Orienteering Process

Following the implementation, the participants were asked to state their feelings and thoughts regarding orienteering. The findings obtained as a result of this are given in Table 12.

Table 12. Findings related to participants' feelings and thoughts about orienteering

Participants Views	S1	S2	S3	S4	S5	S6	S7
Orienteering was fun.	✓	✓	✓	✓	✓	✓	✓
Feelings	Happiness Health	Happiness Self-Confidence Excitement	Happiness Self-Confidence	Happiness	Happiness	Freedom	Happiness
Thoughts	Running	Checkpoint number Finding treasure	Sport	Running Game	Play Puzzle	Finding checkpoint Running	Running Finding treasure

As can be seen in Table 12, all participants stated that they enjoyed orienteering. When asked about the possible reasons for such enjoyment, the participants stated their feelings and thoughts revealing the following concepts of "happiness", "running", "checkpoint", "fun", "game", "puzzle" and "finding treasure".

The analysis results of the observations made by the researcher during the implementation support the findings related to the participants' feelings and thoughts about orienteering. The findings obtained in this regard are given in Table 13.

Table 13. Findings related to researcher's observations

Observations	Situations that were the source of the observations
Participants enjoyed orienteering and found it fun.	Participants' words and behaviors during the process can be interpreted to mean that they liked orienteering.
Participants were curious, interested, and willing towards orienteering throughout all the exercises.	After each exercise, participants stated that they were curious about the next course and asked when it would be done.
Participants began to hold and read the map more correctly during the exercises.	During the exercises, participants read the map better, and found the checkpoints more quickly and correctly (In this context, these results were obtained by comparing the data from each exercise with the previous ones).
Participants got adapted to orienteering with the head camera.	Participants stated that they found orienteering with the head camera enjoyable.
Participants experienced different problems in different orienteering courses. However, it can be suggested that participants displayed better and more assured performances as the exercises progressed.	In each exercise, participants orienteered in the same area but on courses prepared according to different orienteering techniques. Participants displayed better performances in terms of finding the checkpoints, thinking, and implementation as the exercises progressed (In this context, these results were obtained by comparing the data from each exercise with the previous ones).
Participants began to read and understand the map better as they advanced from the first exercise towards the last exercise,	Some of the participants were able to run towards the checkpoints without paying much attention to the map, but that in later exercises, they ran by paying more attention to the map.

Table 13 (Continued). Findings related to researcher's observations

Observations	Situations that were the source of the observations
During the implementation, participants orienteered with increasing willingness in the face of challenging courses.	It can be suggested that participants' words and behaviors during the process were an indicator of this finding.
Participants began to solve problems they encountered in the courses more rapidly.	Orienteering can involve certain difficulties between the start and finish. These can be stated simply as orienting and reading the map, finding the checkpoints correctly, punching, going to the wrong checkpoint, etc. It was observed that participants were able to solve these problems that they encountered throughout the exercises more easily as the exercises progressed (In this context, these results were obtained by comparing the data from each exercise with the previous ones).
The orienteering process involved certain stages.	In orienteering, participants tried to understand the map, plan where to approach the checkpoint from, implement this plan and finally, check the accuracy of the checkpoint.

As shown in Table 13, the observable situations (words, behaviors, gestures, etc.) that were the source of the findings demonstrate that the participants were interested, willing, and curious about orienteering and that they enjoyed themselves during orienteering. It appeared that the participants began to orient the map in a better way and to read it more accurately as the exercises progressed. As a result of this, the participants found the checkpoints on the course more successfully and derived a great deal of pleasure from orienteering. Moreover, it was apparent that the participants began to solve the problems they encountered on the course more easily as the activities progressed. For example, when a participant was unable to find a checkpoint, he/she continued orienteering by making a plan. Based on this, it was clearly seen that participants followed certain steps while orienteering. These steps included understanding the map, making a plan for finding the checkpoint on the map, putting the plan into practice, and checking the accuracy of the checkpoint.

DISCUSSION, CONCLUSION, and SUGGESTIONS

The results obtained in the current study can be discussed in two dimensions, the first of which include the findings related to the investigation of the orienteering process according to the steps of Polya's problem-solving method; and the second dimension includes the findings related to what the participants' feelings and thoughts were about orienteering.

The data analysis about the orienteering process revealed that the participants followed certain steps during orienteering. In this context, skills specific to each stage of orienteering can be mentioned. For example, participants who cannot orient the map correctly may not be able to make a successful start to orienteering; when they orient the map incorrectly, it is more likely that they will go in the wrong direction. In this context, a participant's correct orientation of the map can be considered as a correct start to orienteering. Therefore, in this process, it is a matter of whether the participant has ever encountered a problem, and got involved in a solution process related to that problem. As the participant attempts to find a solution to an unknown situation, he/she becomes ready and highly likely to solve the problem (Reys et al., 1998). For this reason, orienteering is a means that can be used for the development of problem-solving skills (Kelly, 2014), and can be used in mathematics education (Quenneville, 1979). At this point, it can be interpreted that orienteering is a process of doing mathematics. Therefore, it can be stated that orienteering has the potential to improve general problem-solving skills and improve mathematical problem-solving skills.

During the orienteering process, the findings relating to orienteering skills include the participants' ability to orient the map correctly at the start, go in the right direction, reach the checkpoints given on the map in the right order, punch these checkpoints correctly, and follow the code of conduct on the course, together with the probability and frequency of going to the wrong checkpoints. In this context, reading the map, taking a course, and following a route are among the basic skills of orienteering. Since the participants had no previous experience of orienteering, the fact that they faced various problems related to these skills can be regarded as a natural consequence. It appeared that the more they encountered problems about correctly orienting the map, locating the checkpoint, punching the checkpoint, going to the wrong checkpoint or checkpoints, and observing the codes of conduct on the course, the more they began to solve these more easily as the activities progressed. In this sense, it can be suggested that the participants made progress in exhibiting skills specific to orienteering and solving the problems they experienced on the course. The fact that the time taken by participants to solve the problems they met on the course decreased can be regarded as a factor that supports evidence of this progress. Within the framework of the data obtained from the participants' head cameras, the length of time for problem-solving were determined based on the parts in which they contemplated on the map and made plans. Accordingly, it was seen that between the first and last exercises, the length of time for most of the participants' problem-solving decreased. Similarly, the time that participants took to complete the course also decreased. However, the fact that the participants orienteered in the same area may also have had an effect on the decrease in the length of time for their problem-solving ability on the course. On the other hand, different course types were utilized for each exercise, and between the first and last exercises, the degree of difficulty of the course was gradually increased. Increases and decreases were determined regarding the length of time for participants to carry out the process according to the difficulty of the course. In this context, the participants' fondness for running games, the absence of any health conditions that prevent orienteering and their general interest in solving mathematical problems may have been effective in their success in problem-solving processes in orienteering. It can be said that the differences in the academic achievements of the participants in the mathematics course did not have a direct effect on the results. However, it can be said that there was a small difference between the thinking behaviors in the process of finding the checkpoints on the course considering the participants with low academic achievement in mathematics and those with high academic achievement. It can be said that students with high academic achievement in mathematics and who liked problem solving more tended to act more thoughtfully on the course. In other words, it was observed that all students enjoyed participating in orienteering. However, it was observed that students with higher academic achievement in the thinking processes of finding the checkpoints on the course spent more effort. Consequently, it can be stated that the implementation contributed to some extent to the participants' ability to solve the problems encountered more quickly since orienteering is a thinking person's sport (August, 1975; Hugglestone & Howard, 1983) and is also a problem-solving process that involves thinking (Bradford, 1977; Kjellstrom & Kjellstrom-Elgin, 2010). Moreover, orienteering also develops skills such as problem solving, decision making, and spatial thinking (Kelly, 2014). The study conducted by Taş (2010) concluded that people interested in the sport of orienteering were able to solve problems better than those who did not take an interest in it. Although the results of that study did not directly support the results obtained in the present study, they can throw light on the research findings to some extent. Furthermore, Uzuner and Şahin (2021) tried to improve attention, metacognition and problem-solving skills by teaching orienteering to children with ADHD in their study, as a result of which positive results were reported. Therefore, orienteering is an area that develops skills not only in certain disciplines (geography, physical education and sports) (İmamoğlu & İmamoğlu, 2018), but also develops deeper skills in other areas such as mathematical problem solving. In this context, Kaya (2020) stated that orienteering has relations with many learning areas and can be used in these areas. For that reason, in the context of problem solving, it can be interpreted that orienteering itself is a problem-solving process and can intuitively improve problem-solving skills.

Mathematical skills can also be used during orienteering (Balkwill, 1996; BSOA, 2015). Moreover, orienteering can also be used for teaching certain subjects in mathematics (angles, measurement, speed,

estimating, etc.) (BSOA, 2015; Kelly, 2014). Indeed, research has shown that orienteering has great interdisciplinary potential (Tammaro et al., 2017) and is effective in teaching cognitive skills (Huikko & Raus, 2020). Sezgin (2020) suggested the use of mathematics, physical education and orienteering to develop spatial skills. Besides, it has been reported that since orienteering has a physical and mental potential, it has properties related to abstract (long-term memory, short-term memory, planning, attention, etc.) concepts (Gölgeli, 2020). For example, orienteering was handled with the Quantum Learning Approach and as a result, it was seen that academic achievement increased (Beyaztaş, 2022). In this study, it is thought that there is an intuitive mathematical problem-solving process in the orienteering process based on these different studies. It is also stated that integrating physical activities into mathematics lessons is a practical pedagogical method (Sneck et al., 2020). The findings related to the fact that the orienteering process shows parallelism with Polya's problem-solving steps can be considered as a different contribution from what is known in the mathematics and orienteering literature. Therefore, the existence of the relationship between orienteering and the steps of Polya's problem-solving method can be investigated. In this way, the reasons for the benefits that orienteering provides for individuals can also be examined from a different perspective. According to the research findings, it can be suggested that the steps that the participants followed while engaging in orienteering corresponded with Polya's problem-solving steps to a certain extent. When the participants' orienteering process in all the exercises was considered, it was seen that some steps repeated themselves and came to the fore as an important finding. At the first stage, participants held the map correctly, found their place on the map, and read the map. At the second stage, participants made a plan for reaching the checkpoints given on the map. At the third stage, participants put their plan into practice to reach the checkpoints. At the final stage, participants checked whether they had reached the correct checkpoint in line with the plan they had determined. Participants who were unable to reach any checkpoint or who reached the wrong checkpoint realized they had made a mistake and began the process again. If the participant reached the correct checkpoint, then, in this case, he/she headed for the other checkpoints by following the same steps. Participants continually went through these stages during the orienteering process. It can be said that the steps followed by the participants in the orienteering process showed similarity with Polya's problem-solving steps (Polya, 1997). That is to say, first of all, understanding the problem, then developing a plan for solving the problem, implementing the solution plan that is developed, and finally, checking the accuracy of the result achieved about the problem, are involved in both processes. Consequently, it can be stated that within the scope of the findings obtained in the study, a participant engaged in orienteering also follows similar steps to the steps of Polya's problem-solving process. This study may, therefore, shed light on the development process of problem-solving skills of participants involved in orienteering. At this point, it can be argued that there is an intuitive process underlying the high interdisciplinary potential of orienteering. Besides, it can be stated that this process is like the problem-solving process designed by Polya.

As a result, this study revealed that individuals doing orienteering go through a problem-solving process and this problem-solving process is similar to Polya's problem-solving stages. Considering that orienteering has positive effects on individuals' cognitive skills, it can be thought that the source of these effects is related to problem-solving approaches from a different perspective. Besides, it was seen that the participants were physically and mentally active in the orienteering process and that their feelings and thoughts about this process were positive. In this context, participants expressed their feelings towards orienteering with the concepts of happiness, health, self-confidence, freedom, and excitement; while they expressed their thoughts with the concepts of running, checkpoint number, treasure, sport, game, and puzzle. Moreover, it was observed that the participants derived pleasure from orienteering with a head camera. Ekiz and Uzuner (2019) reported that primary school students liked orienteering and found it enjoyable. Consequently, participants were active, solved problems, and were active in this process. It can, therefore, be argued that orienteering has the potential to have positive effects on participants' feelings, thoughts, and behaviors.

Study Limitations

The results obtained in terms of the limitations of the present study may shed light on future research. The limitations of the study include the facts that it was conducted with only seven participants in five weeks, by using the same geographical area for orienteering, and was conducted only with 4th-grade students in primary school. It can, thus, be recommended to carry out studies that can contribute more to the relevant literature by taking these limitations into account. In other words, studies with different samples, data collection tools, implementation periods, and research methods can be done. In this way, the relationship between orienteering and the problem-solving process of Polya can be better explained. Further studies can be conducted to investigate the potential of orienteering in developing problem-solving skills. In this way, the steps that a person follows during orienteering can be seen more clearly, since orienteering is not only a sport, but is also an interdisciplinary educational tool (Larkin, 1976; BSOA, 2015; Bradford, 1977). Moreover, orienteering enables the use of skills targeted in curricula (BSOA, 2015), and problem solving is also one of the basic skills required for the new age (Altun, 2015; Baki, 2018; Ministry of National Education, 2018).

Directions and Implications for Practice and Future Research

It is recommended that studies be carried out in which similar and different research methods are used to examine the use of orienteering in the development of students' problem-solving skills, and in which orienteering is used for the teaching of Polya's problem-solving steps to children. The Higher Education Institution should add orienteering education to the training process of primary school teachers; the Ministry of National Education should provide primary school teachers with the necessary in-service training on orienteering, and orienteering should be included in one of the compulsory courses in primary school, such as mathematics. In short, orienteering should take its place in the curriculum as both a teaching technique and a learning area for instructors.

Ethics and Conflict of Interest

This paper was generated from Asst. Prof. Dr. Fatma Gül UZUNER's doctoral thesis, titled "An Investigation of the Effects of Orienteering on the Development of Primary School Students' Math Problem-Solving Skills". Ethical permission for this study was obtained from the General Secretariat of the Presidency of Trabzon University on 26.10.2018 with the number 81614018-25. Ethical principles were taken into consideration in this study. There is no conflict of interest between the authors.

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