Mathematics of Justice

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ABSTRACT

This study aimed to evaluate the value of justice, one of the 10 core values in the mathematics course curriculum, in the context of an exemplary activity in classroom practice and student interviews, where it was integrated into mathematics learning goals. The case study model was employed. The sample of the study included eight 7th-grade students in the 2018-2019 academic year. An activity prepared about the value of justice and a semi-structured student interview form were used as data collection tools. The data obtained following the implementation of the activity were analyzed using content analysis. Students stated that it was necessary to carry out value-based activities in mathematics classes to understand the importance of the value of justice and to increase social awareness about it. According to the results of the study, it is recommended to plan, implement, and discuss in-class activities in which students can explain their value perceptions according to mathematical problems and actively participate in the process so that their awareness of the value of justice can be increased.

Keywords: mathematics education, values education, 10 core values, justice, middle school students

Adaletin Matematiği

ÖZ

Çalışmanın amacı, matematik dersi öğretim programındaki 10 kök değerden birisi olan adalet değerinin, matematik ders kazanımlarıyla bütünleştirildiği örnek bir etkinliğin sınıf içi uygulama ve öğrenci görüşmeleri çerçevesinde değerlendirilmesidir. Çalışmada durum çalışması modeli kullanılmıştır. Araştırmanın örneklemini 2018-2019 eğitim öğretim yılında 7. sınıf öğrencisi olan 8 kişidir. Araştırmada Adalet değeri ile ilgili olarak hazırlanan etkinlik ve yarı yapılandırılmış öğrenci görüşme formu veri toplama aracı olarak kullanılmıştır. Etkinliğin uygulanmasından sonra elde edilen veriler içerik analizi yöntemiyle çözümlenmiştir. Öğrenciler, adalet değerlerinin öneminin kavranması ve adalet konusu hakkındaki toplumsal bilincin arttırması için matematik derslerinde değer temelli etkinliklerin yapılmasını gerekli gördüklerini belirtmişlerdir. Araştırmanın sonuçlarına göre, öğrencilerin değer konusundaki farkındalıklarını artırmak için kendi değer algılarını matematiksel problem durumuna göre açıklayıp sürece aktif olarak katılabilecekleri ders içi etkinliklerin planlanması, uygulanması ve tartışılması önerilmektedir.

Anahtar kelimeler: matematik eğitimi, değerler eğitimi, 10 kök değer, adalet, ortaokul öğrencileri

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INTRODUCTION

Values are the elements that guide human emotions and thoughts, form the source of behaviors, help distinguish right from wrong, and shape attitudes and behaviors (Bacanlı, 2011; Dede, 2007; Mutlu & Dinç, 2019; Schwartz, 1992; Yaman, 2012). They are one of the most significant factors that hold society together and can change over time and across societies (Aydın and Akyol-Gürler, 2012).

The primary duties of educational institutions include supporting students in making the right choices, making critical decisions, exhibiting positive behaviors, and having a desired level of morality, and raising individuals equipped with values (Hökelekli, 2013).

Studies addressing the affective dimension of mathematics focus more on students' attitudes and beliefs toward it (Leder, 2019; Wang et al., 2022). Research into values in mathematics education is limited (Clarkson et al., 2023; Seah and Bishop, 2000). Values education starts first in the family and society. In the following years, values education can be carried out in a more scientific and planned manner in schools (Taymur, 2015). Values education aims to provide individuals with merits that integrate them into society, organize social life, ensure happiness and peace, and protect them against all adversities (Ministry of National Education [MoNE], 2010). It is thought that the goals of values education can be achieved through teachers equipped with the methods and techniques to be followed in values education and teaching activities that support the active participation of students in the process (Kale, 2007).

Özkaya and Duru (2020) examined middle school mathematics textbooks in the context of values and revealed that the value that was most exemplified was equality, while the values that were the least handled were justice, savings, and aesthetics. It is thought that including content on values education in mathematics course and textbooks and supporting it with sample in-class applications is necessary so that students can internalize national and moral values and behave following them in their lives. This study aimed to raise students' awareness about the value of justice. A sample application on how the value of justice could be imparted to students with an in-class activity was presented in the study. It was thought that this activity would be guiding for mathematics teachers, program developers, and all stakeholders related to the subject.

The goals of the mathematics course also include helping students develop mathematical thinking skills as well as raising individuals who have internalized national and moral values (Bishop, 1999; Dede, 2007; MEB, 2018). When the mathematics course curriculums of 2005 and later in Türkiye were examined in this context, it was found that values education was initiated following the program updated in 2009 (MoNE, 2009). Since the 2018-2019 academic year, values education has been included in the curriculum at all grade levels in the updated programs (MoNE, 2017). In the current mathematics course curriculum, the significance of raising individuals who have internalized national and moral values has been included among the objectives of the course, and it has been stated that mathematics is not a course isolated from values and that they can be taught to students, especially by associating them with daily life problems (MoNE, 2018).

The values intended to be taught in the mathematics education process in the program have been determined as justice, friendship, honesty, self-control, patience, respect, love, responsibility, patriotism, and helpfulness. It has been emphasized that the 10 core values determined in the programs should be associated with the appropriate mathematics course learning goals and taught to students; however, it has not been fully clarified in the programs which values teachers will integrate with which learning goals and how they will do this during the lesson. However, some explanations have been provided for mathematics teachers in the course curriculum about what learning goals these values can be associated with and how teaching environments can be designed so that students can internalize these values. For example, it has been stated that justice and sharing, among these values, can be included in the learning goals related to fractions and division and that it should be emphasized that equal sharing will not always be fair. Additionally, it has been put that it is important to consider students' active participation when designing in-class activities. According to Çağlayan (2013), determining the

relevance of values to real life and students' understanding of the meanings attributed to values facilitate the teaching of values to students. While the activity in this study was designed, the problem situation was related to daily life to reveal the relationship between mathematics and real life situations and values and to have students notice them. According to Bottery (2000), empathic thinking is a concept that should be emphasized in values education. In this context, questions such as "What would you do in this situation?" were frequently included in activity questions to ensure that students approached the case in the problem with empathy.

SIGNIFICANCE OF THE ACTIVITY

It is thought that this study, which aimed to present a tangible activity example for associating the value of justice, one of the values that students are expected to gain in the current mathematics course curriculum, with the learning goals, will contribute to the field. This activity helps students question the value of justice in the context of daily life through a mathematical problem. In addition, the feedback obtained from the implementation of the activity can be guiding for improving the integration of values into mathematics education. In this context, it is thought that the study will contribute to the field in terms of both mathematics and values education.

PURPOSE OF THE ACTIVITY

In this context, an exemplary in-class activity in which the value of justice was integrated into mathematics course learning goals was designed, and students were asked to explain the things they observed while making a fair choice in a given situation. The objective of the activity was to evaluate the meaning that students attributed to the value of justice in the context of their answers to a mathematics problem. In the process, students were asked to exchange ideas about the value of justice and to make the choice they thought would be the fairest. It was intended to ensure that students expressed their own thoughts and developed more awareness of this issue by considering different views on justice.

Assumptions

- It was assumed that students participating in the study would respond to the interview questions sincerely and share their true thoughts.

Limitations

- The research is limited to the second semester of the 2018-2019 academic year.
- The activity is limited to the value of "justice," selected from ten core values.
- The interviews conducted after the activities are limited to eight students.

PREPARATION OF THE ACTIVITY

To associate the value of justice with mathematics course learning goals, firstly the activities in the mathematics course curriculum, textbooks, and the literature related to mathematics were examined and the core value of justice was developed based on the two learning goals listed below in the "data processing" and "statistics" learning areas (MoNE, 2018).

To determine what learning goals of the mathematics course the justice value could be associated with, first, relevant studies in the literature were examined (Bottery, 2000; Çağlayan, 2013; Doruk, 2012; İpekçi, 2018; Şahin & Başgül, 2018). Then, mathematics textbooks were scanned to find out how the values were included. Finally, the learning goals of the mathematics course curriculum were evaluated and a consensus was reached among the researchers on which learning goal the justice value could be most appropriately associated with. As a result of this process, it was concluded that the following learning goal in the "data processing" learning area was suitable for imparting the value of justice (MoNE, 2018).

> *M.7.4.1.2. Finds and interprets the mean, median, and upper values of a data group.*

An activity called "Javelin Throw," which was designed for the study and whose theme was

determined as "justice," was explained in the next heading.

JAVELIN THROW

An athlete will be selected for the national javelin throw team from Nevşehir province.

Figure 1. Javelin Throw

Three athletes, Hakan, Koray, and Nadir, participate in the eliminations. Each athlete is given the right to do five throws. The javelin throw rankings of the athletes are given in Table 1.

Table 1. Athletes' javelin throw performances

Javelin throw	1st trial	2nd trial	3rd trial	4th trial	5th trial
Hakan	75.3 m	76.2 m	72 m	82.3 m	79.2 m
Koray	76.4 m	76 m	73 m	74 m	85.6 m
Nadir	77 m	71.7 m	80 m	83.2 m	63.1 m

According to the data in the table;

1. Which athlete should be selected for the national team? Explain why.

2. Do you think you have made a fair choice? Explain why.

3. What do you think is the role of mathematics in ensuring justice?

4. What would you do if you were one of the competitors and you were not selected for the national team even though you think you deserve it?

5. Would you intervene in an unfair situation? Why?

In this activity, where the value of justice was questioned, the students were asked which athlete deserved to be selected for the National Team in the javelin throw branch among three competitors, whose rankings for five throws were given. Following a collective discussion in the class, they were asked to answer the question individually. In this activity, students were expected to give written answers to the activity questions by using central education measures. In addition, they were asked to explain how they would feel and what they would do when they were faced with an unfair situation or when there was an unfair situation that affected others, and thus the value of justice was intended to be questioned. It was thought that this process would help the students gain some insights into the value of justice and express their responses more consciously.

IMPLEMENTATION OF THE ACTIVITY

At the outset, the approval of the Nevşehir Hacı Bektaş Veli University Ethics Committee (number: 2019.07.75) and the permission of the Nevşehir National Education Directorate were obtained to implement the activity. The activity was implemented in one lesson with eight students who volunteered to participate in the study and attended seventh grade of a public middle school in a province in the Central Anatolia Region of Türkiye in the 2018-2019 academic year. The application was implemented in the mathematics applications elective course by the researcher at the school where the second author, a mathematics teacher, worked. The purpose of the mathematics applications course is to allow students to perform mathematical applications by comparing them with real or fictional events and problems appropriate for their levels and to positively develop both their mathematical competence and attitudes toward mathematics (Aydın, 2016).

The value clarification (explanation) approach was used to implement the in-class activity. Kirschenbaum (2000) stated that there were four steps in the value clarification process. First, a topic related to values or a moral

problem, such as family, friendship, work, health, drug abuse, or free time, is selected. These topics can also be chosen by students. Then, the teacher helps the students think, talk, write, and read about the selected topic by using questions and activities. The teacher provides an environment where everyone can express their opinions freely during the activity and discussions. Finally, the values are explained by using value acquisition processes (Kirschenbaum, 2000). This method helps the teacher reach an opinion about what the students know and think about that subject (Arendt, 1998; Can, 2008; Gözel, 2018).

In this study, the scope and purpose of the mathematics applications course, student levels, and environmental characteristics were considered, and students were provided with a problem situation taken from real life. During the implementation of the activity, students were guided so that they could understand the problem and perform mathematical operations, but no guidance was given to them regarding the value of justice. In addition, their answers were not evaluated as correct or incorrect. During the activity, students were encouraged to explain their own approaches to the value of justice.

Since the students were likely to attribute different meanings to values and therefore their approaches to the value of justice could emerge in different ways, influenced by their characters and the education they received in their families and schools (Gamage et al., 2021), first, they were allowed to discuss the value of justice by sharing their individual thoughts verbally and question it by feeding on different ideas. Following the group discussion, the participants answered the activity questions about the value of justice individually and in writing.

Data Collection

The application was audio-recorded. A student interview form was used as a data collection tool. This was a semi-structured form prepared and applied by the researchers to obtain students' opinions, thoughts, and suggestions about the activity implemented in the lesson.

Data Analysis

Content analysis was used to analyze the data obtained from the student responses given to questions on the in-class activity sheet. Content analysis requires categorizing the responses within the framework of certain rules and summarizing and presenting them systematically (Büyüköztürk et al., 2017). The written responses were coded separately by two coders, the researcher and an expert with a PhD degree in the field of mathematics education, and appropriate categories were determined. The coders reached an agreement on the codes on which they had disagreements and decided to combine some codes. The codes were placed in appropriate categories and the categories and codes were specified under the themes determined for each question on the measurement tool. The results section of the study included relevant category-code-frequency information and direct quotes from student responses.

THE RELIABILITY AND VALIDITY OF THE RESEARCH

Various measures were taken to increase the reliability and validity of the research. For internal reliability, all interviews and activities were audio-recorded, each stage of the research and the methods followed were explained in detail, and inter-coder agreement was checked. Frequencies of inter-coder agreement and disagreement were determined. Inter-coder reliability was calculated using the formula by Miles and Huberman (1994) (Reliability = agreement / (agreement + disagreement). The inter-coder agreement rate was calculated as 91%.

For internal validity, voluntary participation in the research was ensured, participants were informed before the research, interviews were conducted face-to-face, in-class activities and student interviews were conducted to diversify the data obtained from students, and expert opinions were sought at every stage of the research.

For external reliability, in addition to direct quotations, all raw data obtained in the research, data collection tools, and studies in the data analysis process were planned to be stored for at least five years. While the findings were presented, student answers to questions requiring mathematical calculations in the activities were first explained. Although the students' solutions were generally correct, those who had difficulty in calculations got help from group members and the researcher. In this

context, students' solutions were presented in general. Afterward, individual answers were emphasized and the similarities and differences between the students' answers to the questions about the value of justice in the activity were categorized and presented with visuals from the answers.

RESULTS

The learning goals (M.7.4.1.2.) of the activity included calculating and interpreting the mean, median, and upper values of a data group. For this purpose, students were asked to make a rational inference about which situation would be more fair by using central education measures. Students were told that there was no single correct answer and that they needed to make their choices by questioning their own understanding of justice. The answers given to the questions related to the activity were examined under separate headings.

Findings about the first question of the activity

In the mathematical operations in the first question of the activity, all students calculated the arithmetic mean of the total javelin throws of the athletes to make their choices. As a result of these calculations, they found that the mean scores of two athletes were the same and the mean score of the other athlete was lower. All students eliminated the athlete with the lower mean score. The eliminations between the remaining two athletes to choose the one who would be in the national team were done based on three categories: "the probability of becoming the winner," "competing again," and "achieving the farthest throw." According to the findings, two students stated that they would choose the athlete according to the probability of becoming the winner, five of the students stated they would choose the athlete after they having them compete again, and four of them stated that they would choose the one who would do the farthest throw in five trials. They added that their selection would be fair in this way.

An example solution based on the first category, the probability of becoming the winner, is shown in Figure 2. English translations of the Turkish contents in each figure are explained below the figure.

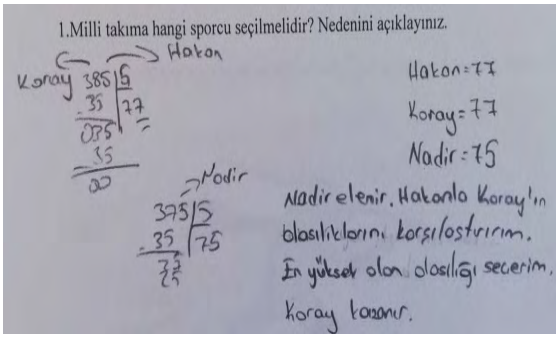

Figure 2. The probability of becoming the winner

[1. Which athlete should be selected for the national team? Explain why.

Nadir is eliminated. I compare the probability of becoming a winner for Hakan and Koray. I select the athlete with the highest probability. I believe Koray wins.]

Figure 3 shows an example solution in the second category, competing again.

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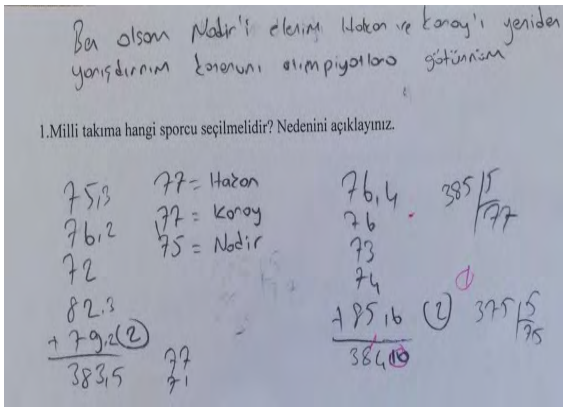

Figure 3. Competing again

[1. Which athlete should be selected for the national team? Explain why.

I would eliminate Nadir and have Hakan and Koray compete again and I would send the winner to the Olympics.]

An example solution in the third category, achieving the farthest throw, is shown in Figure 4.

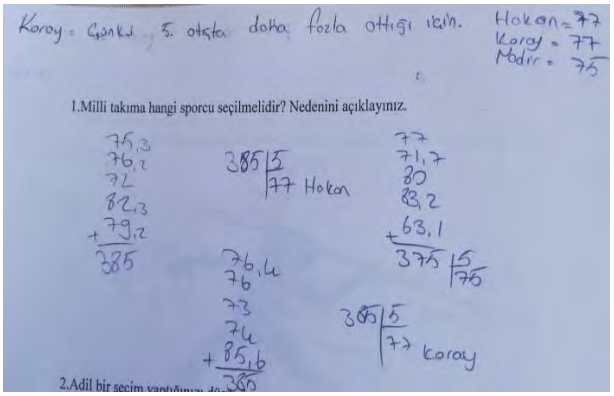

Figure 4. Achieving the farthest throw

Findings about the second question of the activity

The second question was "Do you think you have made a fair choice? Explain why."

According to the findings, seven students stated that their choice was fair, while one student thought that it was not. It can be said that the majority of the students generally thought that mathematical calculations helped make fair choices, prevented injustice, and made them sure of their choices. Students explained the reasons why their choices were fair in parallel with their answers to the first question. Two students stated that making a choice according to the probability of becoming the winner was fair. An example explanation is given in Figure 5.

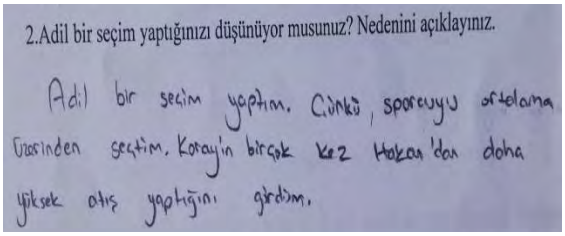

Figure 5. Probability

[2. Do you think you have made a fair choice? Explain why.
I made a fair choice because I made it based on their average scores. I noticed that Koray did more distant throws than Hakan many times.]

Five students stated that having the two athletes compete again was fair. An example explanation is given in Figure 6.

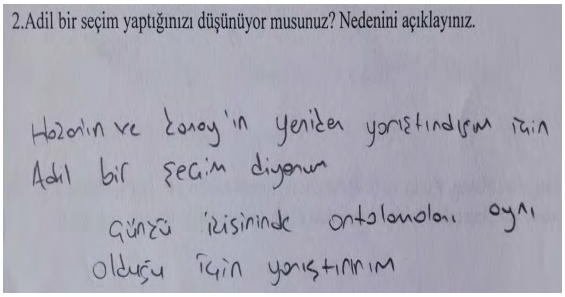

Figure 6. Competing again

[2. Do you think you have made a fair choice? Explain why.
I think it is a fair choice as I have had Hakan and Koray compete again. I had them compete again because their average scores were close to each other.]

Three students stated that it was fair to choose the athlete who could do the farthest throw. An example explanation is given in Figure 7.

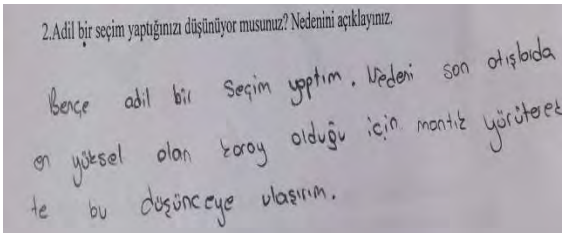

Figure 7. The highest score

[2. Do you think you have made a fair choice? Explain why.
I think I have made a fair choice. I have come to this conclusion by using logic. Koray scored the highest in final throws.]

Findings about the third question of the activity

In the third question, students were asked to answer the question, "What is the role of mathematics in ensuring justice?" In response, they stated that mathematical calculations helped them make fair choices, prevented injustice, and made them sure of their choices. An example answer is given in Figure 8.

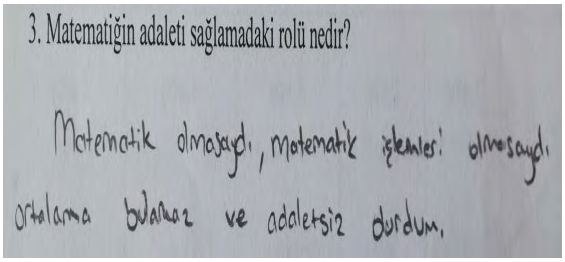

Figure 8. Mathematics ensures justice.

[What is the role of mathematics in ensuring justice?

If there were no mathematics or mathematical operations, I would not be able to find a mean score and would be unfair.]

Findings about the fourth question of the activity

The fourth question was "What would you do if you were one of the competitors and you were not selected for the national team even though you think you deserve it?" In response to this question, nine students stated that they would object to the unfair situation and seek their rights, while two students stated that they would accept it. A sample answer from students who stated that they would object to the unfair situation and seek their rights is shown in Figure 9.

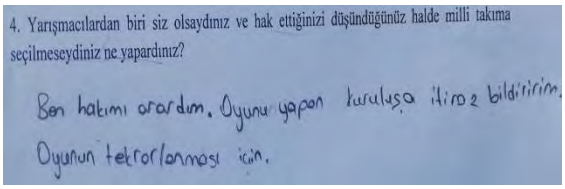

Figure 9. Objecting

[What would you do if you were one of the competitors and you were not selected for the national team even though you think you deserve it?

I would seek my rights. I would express my objection to the institution organizing the event so that they would repeat the process.]

A sample answer from students who stated that they would accept the situation is shown in Figure 10.

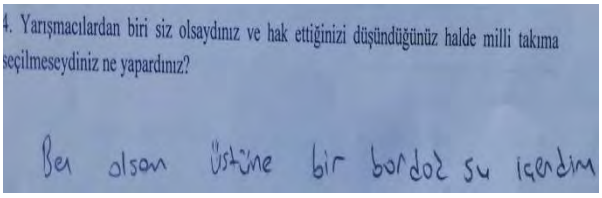

Figure 10. Acceptance

[What would you do if you were one of the competitors and you were not selected for the national team even though you think you deserve it?

If I were the athlete, I would give in and forget about it.]

Findings about the fifth question of the activity

In the fifth question, students were asked to answer the question, "Would you intervene in an unfair situation? Why?" All students stated that they would intervene in unjust situations. In the fourth question, two students who stated that they would not object to an unjust situation if their own rights were violated also stated that they would intervene if someone was treated unfairly. It was observed that the students thought they would not tolerate injustice and would respect people's rights and that they would prefer a fair world. A sample answer is shown in Figure 11.

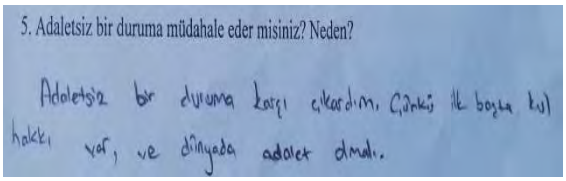

Figure 11. Intervention

[Would you intervene in an unfair situation? Why?

I would object to an unfair situation because the right of the servant is in question and justice must prevail in the world.]

CONCLUSIONS AND DISCUSSION

The javelin throw activity, which was prepared to help middle school students internalize the value of justice through mathematics lessons, revealed that the students believed that objective evaluation of athletes' performances could only be possible through mathematical calculations. This activity allowed them to question the value of justice and put forward

ideas on how justice could be achieved. It is thought that the mathematical calculations used in the selection process minimized subjective evaluations and ensured making a fair assessment. It is known that such activities are effective in imparting values (e.g. Dede, 2007; Demirhan İşcan, 2007; Doruk, 2012; El Hassan & Kahil, 2005; Engin, 2014; Izgar, 2013; İpekçi, 2018; Katılmış, 2010; Keskinoğlu, 2008; Kunduroğlu, 2010; Öğretici, 2011). It was observed that students generally evaluated each athlete based on the total distance they achieved with five shots.

Kurtdede-Fidan (2009) stated that activities that allowed students to explain their values and participate more actively in the process needed to be preferred in the internalization of values. During the implementation of the activity in this study, students were allowed to question different perspectives on justice through group work and discussion methods and they were encouraged to express their ideas freely, thus contributing to the development of their self-confidence.

It was observed that students did not think enough about the value of justice before the activity, did not question it, and did not care about it; however, following the activity, they thought more about this value, began to care about it, and were able to realize what kind of meanings both they and their friends attributed to the value. It is known that activities, involving student opinions, on values contribute to students in areas, such as caring about that value, questioning it, and realizing its meaning (Deniz, 2018; Gürhan and Çiftçi 2017; Öğretici, 2011). The results of this study also support this finding.

With the activities, students realized that mathematics was not just about numbers and operations but was intertwined with daily life and our values. They thought that they could help people or ensure justice with mathematical calculations. Therefore, it can be said that the activity both tested mathematical gains and enabled students to question values. İpekçi (2018) stated that value-based activities increased students' interest in the lesson.

In the "javelin throw" activity, it was observed that students made their choices according to their own understanding of justice when choosing athletes for the national team. It was determined that all students who participated in the activity eliminated the athlete with a low mean value of javelin throw distance and focused entirely on athletes with the same mean throw values. When choosing among athletes with the same mean scores, students selected the athlete with the highest probability of becoming the winner out of five throws or the athlete who achieved the farthest throw in any trials. Some students stated that they thought it was necessary to have the two athletes with similar mean scores compete again at the last stage and thus they could make a fairer choice. In the activity, it was observed that students generally tried to ensure justice by making mathematical calculations. It was seen from the answers to the activity question that students realized the role of mathematics in ensuring justice. Students stated that they would seek their rights in an unfair situation and intervene in such a situation, which was an indication that they cared about ensuring justice. In addition, it is thought that value clarification and value discussions through in-class activities can give teachers an idea about the level of students' internalization of values.

For values education to be implemented more effectively in mathematics course, it is thought that a guide that associates values with the learning goals of the course should be developed and made available to teachers or sample activities should be included in the content of the curriculum. Yalar (2010) mentioned this deficiency in the field of social studies, and the same applies to the mathematics course. It is thought that family education and cooperation with families should be increased, and values education should be supported in cooperation with teachers of other branches and other courses.

Students also mentioned that activities that would make mathematics course popular, help notice the significance of values, increase social awareness, and contribute to the improvement of the new generation and the structure of society in general over time needed to be carried out. İpekçi (2018) and Doruk (2012) also mentioned that value-themed activities needed to be integrated into classroom activities so that students could adopt a positive view of mathematics course, reduce their prejudices against the course, and internalize values. In this context, it is possible to say that including

value-themed activities in in-class practices can contribute to increasing students' awareness and internalization of these values.

RECOMMENDATIONS

It is recommended that teachers should include in-class activities in their lessons where students can explain their understanding of values and actively participate in the process in terms of internalizing values.

Mathematics course curriculum should include detailed content on acquiring values by relating them to course learning goals and sample activities can be added to the program.

The content of middle school mathematics textbooks can be enriched with values education activities.

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