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Analysis of Mathematical Thinking Skills of Sportsmen According to Certain Demographic Characteristics

Halil Önal[1], Mehmet Inan[1], Sinan Bozkurt[2]

[1]Marmara University, Ataturk Education Faculty, Istanbul, Turkey

[2]Marmara University, Faculty of Sport Sciences, Istanbul, Turkey

Correspondence: Halil Önal, Marmara University, Ataturk Education Faculty, Istanbul, Turkey.

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Abstract

The aim of this research was examining the mathematical thinking of athletes who are actively engaged in sports in a sports club in terms of various variables. The research was designed as a screening model. The sample of the study consisted of 229 licensed athletes in various clubs. The "Mathematical Thinking Scale" developed by Ersoy (2012) was used in the research. Percentage frequency analysis was used for descriptive analyzes in the analyzes of the data. Mann Whitney-U and Kruskal-Wallis tests were performed among the non-parametric tests to measure the differences between the groups. According to the results of the research, the scores of the athletes depending on the gender variables on the mathematical thinking scale do not differ statistically. According to the educational variables, the total scores of the athletes attending primary education on the mathematical thinking scale are significantly higher than the other groups, and athletes with the lowest scores were the ones that still continue their undergraduate studies. According to the gender variables, there was a difference only in the scores of the problem-solving sub-dimension in mathematical thinking scale dimensions. When the educational status is analyzed by variables, statistical differences are observed among subscales of the mathematical thinking scale except for reasoning. There was no statistically significant difference between the total scores of individual athletes (billiards, tennis, shooting, archery) on the mathematical thinking scale and the scores they got from all subscales of the scale. In the case of team athletes (football, volleyball, basketball), there was a statistically significant difference in favour of those who played soccer and volleyball sports between the total scores they received on the mathematical thinking scale and the scores they received from all the subscales of the scale.

Keywords: sports, sportsman, thinking skills, mathematical thinking

1. Introduction

The concept of thinking involves the critical and creative aspects of the mind. These aspects of the thinking concept are the reasons behind the creation of thoughts. Thinking involves mental activities to solve problems and formulate. Through thinking, we give meaning and direction to our lives (Fisher, 2005). The concept of thinking is defined as the independent and distinctive state of mind, and the ability to make comparisons, separations, unions, connections without using the senses, impressions and designs (TDK, 2005). Thinking is a limitless skill of our minds. In the process of thinking, there is a continuous logical process in our mind. These are named according to the operations performed; problem-solving, decision making, critical thinking, reflective thinking, creative thinking, reasoning, and so on. (Sun, 2012). During the thinking phase, the individual must carry out the process in an effective and meaningful way. At this stage, the individual needs to properly structure his thinking system (Ersoy and Baser, 2012). The most important feature that distinguishes man from other living things is the ability to think; the ability to rearrange the events by interpreting them from their own perspective. Because of these reasons, mathematics education constitutes one of the most important building blocks of basic education, perhaps the most important. Mathematics education provides important skills such as thinking in life, establishing relationships between events, reasoning, estimating, problem-solving besides the calculation skills that come from teaching numbers and operations (Umay, 2003). These skills support each other and are learned and developed as they are used. Mathematical skills are the skills used to acquire or develop the meaning of one another (Olkun and Toluk, 2006). Mathematics is a discipline that requires a certain way of thinking, is associated with many fields and can develop to a certain degree (Maddox, 2002).

Mathematics is a subject that exists at every level of education, from primary school to university. Mathematical properties are different from those of other sciences. Mathematical knowledge is information created from the thought that an experience is a specific object or an event (Husnaeni, 2016).

According to Cotton (2010); everyone can think mathematically, mathematical thinking can be improved by reflection, mathematical thinking awakens the feelings of contradiction, tension and excitement, mathematical thinking is supported by the questioning atmosphere, difficulties and reflection, mathematical thinking helps us in understanding ourselves and our world. Physical, mental, and emotional connections are seen as requirements that provide mathematical thinking (Hudson, Henderson, and Hudson. A, 2016). As with every thought, there is an effort to reach to an output with our perceptions in mathematical thinking. There may be individual differences in approaches used during this effort (Alkan and Bukova, 2005). Mathematical thinking will take place if a solution to a problem requires high-level thinking skills such as customization, generalization, estimation, hypothesis generation, and control of hypothesis accuracy. For these reasons, it can be said that mathematical thinking is a form of thinking which is realized not only in numbers and abstract mathematical concepts but also in daily life (Yesildere and Turnuklu, 2007). Mathematical thinking involves all important skills such as logical and analytical thinking as well as quantitative reasoning (Devlin, 2012). Liu (2003) expresses mathematical thinking as a combination of complex processes such as predicting, induction, deduction, definition, generalization, analogy, formal and informal reasoning, validation and so on. Sevgen (2002) states that mathematical thinking allows people to develop a systematic, correct, and quick approach to the events they meet in their daily lives. Three factors affecting how effective mathematical thinking is are; competence in using mathematical inquiry processes, understanding the content and practice of mathematics, coping with emotional and psychological situations, and self-confidence in adverse situations. (Mason, Burton, & Stacey, 2010)

Improving mathematical thinking is the main goal of mathematics education. In today's knowledge-based society, it is desirable to develop process skills such as finding innovative solutions for problems. Mathematics is necessary for innovation because creative and critical thinking in particular spaces develop mathematical and statistical thinking (Isoda & Katagiri, 2012).

When we look at the studies about mathematical thinking, it is seen that these studies are mostly concerned with mathematics education. (Alkan & Bukova, 2005, Yesildere & Turnuklu, 2007, Arslan & Yildiz, 2010, Ersoy & Baser, 2012, Tataroglu, Celik & Erduran, 2013, Ersoy & Guner, 2014, Gibney, 2014, Herlina, 2015, Saragih and Napitupulu, 2015, Hudson, Henderson and Hudson, A, 2016).

When we look at the studies related to physical education, it is seen that these studies are mostly concerned with thinking skills and different types of intelligence (Bozkurt, 2004; Hosgor & Katranci, 2007; Tekin, 2009; Coskuner, Gacar & Yanlic, 2010; Certel, Catikkas & Yalcinkaya, 2011; Hekim & Tokgoz, 2012; Cinkilic& Soyer, 2013; Kucuk & Oncu, 2014;Kiremitci & Canpolat, 2014;Holmes, Liden & Shin 2013, Shalar, Strikalenko & Ivaschenko, 2013; Chatzipanteli, Digelidis, Karatzoglidis & Dean, 2014; Furley & Memmert, 2015; Singh, Singh & Singh, 2015;Jakovljevic, Pajic & Gardasevic, 2015; Gogoi, 2016).

Team sports contribute to the development of the individual's ability to socialize, communicate well with people, win and lose together, teamwork and help. Individual sports, on the other hand, enhance the individual's ability to develop will, self-transcendence, self-defence and self-confidence (Salar, Hekim and Tokgoz, 2012). The purpose of the study is to examine the mathematical thinking of the licensed athletes who actively play sports, in terms of various variables.

2. Material and Methods

In this part of the study, information on model, universe and sample, data collection tools and statistical analyses are given.

2.1 The Model of the Research

The research was designed as a screening model. Screening models are a type of research aimed at describing a situation that exists in the past or the present. The subject, person or object to be investigated is tried to be defined within the circumstances of its own. No attempt is made to alter or influence (Karasar, 2009).

2.2 Participants

The universe of the research is made up of licensed athletes engaged in individual sports and team sports in various clubs. And the sample consists of 229 licensed athletes in various clubs. In the sample, 229 licensed athletes were selected through criterion sampling which is amongst the interpretative sampling methods.

Table 1. Table Regarding Sample That Constructs Research

Variables	Group	Frequency	Percentage
Sex	Female	59	% 25,7
	Male	170	% 74,3
Education Level	Elementary	23	% 10,1
	Secondary	48	% 21,0
	Undergraduate	146	% 63,8
	Postgraduate	12	% 5,2
Sports Branch	Football	60	% 26,2
	Basketball	29	% 12,7
	Volleyball	43	% 18,8
	Tennis	13	% 5,7
	Billiards	6	% 2,6
	Shooting	17	% 7,4
	Archery	61	% 26,6

2.2 Data Collection Tools

In the research, the "Mathematical Thinking Scale" developed by Ersoy (2012) was used. The mathematical thinking scale consists of high-order thinking tendencies, reasoning, mathematical thinking skills and problem-solving sub-dimensions. It's a 5 point Likert scale consist of 20 positive and 5 negative items. Through the result of the analysis made, the reliability of the scale was calculated as 0.78. The highest score that can be acquired from the scale is 125, and the lowest is 25.

2.3 Collection of Data

The "Mathematical Thinking Scale" was brought to the licensed athletes in various clubs and the athletes were asked to fill the questionnaire during the face-to-face interviews conducted by the researchers.

2.4 Data Analysis

SPSS package program was used to perform statistical analyzes in the study. In the analysis of the data, the percentage and frequency analysis is used for the descriptive analysis. Mann Whitney-U and Kruskal-Wallis tests were performed among the non-parametric tests to measure the differences between the groups.

3. Results

In this section, there are tabulations and interpretations of the results obtained as a result of analysis of the data gathered through the research.

Table 2. The Table Regarding the Comparison of the Total Scores Obtained from the Mathematical Thinking Scale According to the Gender Variable

Group	N	Rank Av..	Rank Total	U	p
Female	59	103,25	20243,5	4321,5	,114
Male	170	119,08	6091,5		

As seen in the table, the scores of the athletes participating in the survey according to gender variables did not differ statistically (p> .05). Although the scores of male athletes were higher than the scores of female athletes, the difference was not statistically different.

Table 3. The Table Regarding the Comparison of the Total Scores Obtained from the Mathematical Thinking Scale According to the Educational Condition Variable

Group	N	Rank Total	Chi-Square	p
Elementary	23	167,54	26,05	,000
Secondary	48	132,22		
Undergraduate	146	99,81		
Postgraduate	12	130,25		

As seen in the table, the mathematical thinking scale scores of the athletes participating in the research according to the variables of educational status differ statistically(p <0.05). The Mann-Whitney U test was used to determine which groups this difference was in. According to these results, the total scores of the athletes attending primary education were significantly higher on the mathematical thinking scale than the other groups. Athletes with the lowest score were the ones that currently continue their undergraduate studies.

Table 4. The Table Regarding the Comparison of the Total Scores Obtained from the Sub-Dimensions of Mathematical Thinking Scale According to the Gender Variable

Dimension	Group	N	Rank Av..	Rank Total	U	p
High Level Thinking Tendency	Female	59	107,22	6326,0	4556,0	,293
	Male	170	117,70	20009,0		
Reasoning	Female	59	121,08	7143,5	4656,3	,406
	Male	170	112,89	19191,5		
Mathematical Thinking Skill	Female	59	102,31	6036,0	4266,0	,087
	Male	170	119,41	20299,0		
Problem-Solving	Female	59	97,91	5776,5	4006,5	,021
	Male	170	120,93	20558,0		

As seen in the table, there was a statistically significant difference between the scores of the athletes participating in the research only in the problem-solving sub-dimension of mathematical thinking scale dimension according to gender variables ($p < 0.05$). According to these results, it was seen that male athletes have higher problem-solving skills than women. There was no difference in the other sub-dimensions. Although the score of male athletes in total was higher than that of women, this difference was not statistically different.

Table 5. The Table Regarding the Comparison of the Total Scores Obtained from the Sub-Dimensions of Mathematical Thinking Scale According to the Educational Condition Variable

Dimension	Group	N	Rank Av.	Chi-Square	p
High Level Thinking Tendency	Elementary	23	161,43	21,391	,000
	Secondary	48	129,16		
	Undergraduate	146	101,20		
	Postgraduate	12	137,29		
Reasoning	Elementary	23	138,48	7,055	,070
	Secondary	48	113,28		
	Undergraduate	146	109,24		
	Postgraduate	12	147,00		
Mathematical Thinking Skill	Elementary	23	156,83	19,666	,000
	Secondary	48	132,76		
	Undergraduate	146	101,29		
	Postgraduate	12	130,63		
Problem-Solving	Elementary	23	151,46	12,082	,007
	Secondary	48	128,21		
	Undergraduate	146	105,51		
	Postgraduate	12	107,79		

As seen in the table, when the educational status of the athletes participating in the research was analyzed, statistical differences were observed among sub-dimension of the mathematical thinking scale except for reasoning sub-dimension ($p<,05$). The Mann-Whitney U test was used to determine which groups this difference was in. According to these results, the total scores of the athletes attending primary education were significantly higher on dimension except the reasoning sub-dimension, than the other groups. In the dimension of reasoning, participants who had education status as a postgraduate was found to have higher scores on the scale sub-dimension than the other groups.

Table 6. The Table Regarding the Comparison of the Total Scores of Individual Sports Participants Obtained from the Mathematical Thinking Scale

Group	N	Rank Av.	Chi-Square	p
Tennis	13	40,77	4,438	,218
Billiards	6	65,67		
Shooting	17	42,44		
Archery	61	50,94		

There was no statistically significant difference in the total score between sportsmen who perform individual sports regarding the mathematical thinking scale ($p>, 05$). It was seen that these results did not differ according to the sports branch of the participants.

Table 7. The Table Regarding the Comparison of the Total Scores of Individual Sports Participants Obtained from the Sub-Dimensions of Mathematical Thinking Scale

Dimension	Group	N	Rank Av.	Chi-Square	p
High Level Thinking Tendency	Tennis	13	49,08	,061	,996
	Billiards	6	51,58		
	Shooting	17	48,35		
	Archery	61	48,91		
Reasoning	Tennis	13	48,81	2,396	,494
	Billiards	6	65,33		
	Shooting	17	49,85		
	Archery	61	47,20		
Mathematical Thinking Skill	Tennis	13	39,62	3,896	,273
	Billiards	6	57,25		
	Shooting	17	41,79		
	Archery	61	52,20		
Problem-Solving	Tennis	13	40,85	5,924	,115
	Billiards	6	69,25		
	Shooting	17	40,97		
	Archery	61	50,98		

There was no statistically significant difference between the scores of the sub-dimensions of mathematical thinking scale among the sportsmen who perform individual sports (p>, 05). The difference, which was not seen in terms of the total points they have acquired from the scale, was not seen in terms of sub-dimensions either.

Table 8. The Table Regarding the Comparison of the Total Scores of Team Sports Participants Obtained from the Mathematical Thinking Scale

Group	N	Rank Av.	Chi-Square	p
Football	60	73,60	12,209	,002
Basketball	29	44,67		
Volleyball	43	71,31		

There was a statistically significant difference between the sportsmen who perform team sports in terms of the total score of the mathematical thinking scale ($p < 0.05$) in favour of those who play soccer and volleyball sports. Participants who played soccer and volleyball were found to be more successful in terms of mathematical thinking.

Table 9. The Table Regarding the Comparison of the Total Scores of Team Sports Participants Obtained from the Sub-Dimensions of Mathematical Thinking Scale

Dimension	Grup	N	Rank Av.	Chi-Square	p
High Level Thinking Tendency	Football	60	72,46	7,270	,026
	Basketball	29	49,84		
	Volleyball	43	69,42		
Reasoning	Football	60	72,40	12,552	,002
	Basketball	29	44,57		
	Volleyball	43	73,06		
Mathematical Thinking Skill	Football	60	70,83	6,518	,038
	Basketball	29	50,53		
	Volleyball	43	71,22		
Problem-Solving	Football	60	74,53	7,921	,019
	Basketball	29	50,28		
	Volleyball	43	66,23		

There was a statistically significant difference between sportsmen who perform team sports in terms of points taken from mathematical thinking scale sub-dimensions in favour of those who play soccer and volleyball sports in all sub-dimensions ($p < 0.05$). The results from the scale total score were also valid for the sub-dimensions. According to this, the participants who play soccer and volleyball were more successful in terms of mathematical thinking for all sub-dimensions.

4. Discussion and Conclusion

The aim of this research was determining the mathematical thinking levels of athletes who are actively engaged in individual or team sports. The mathematical thinking scale scores of the athletes participating in the research do not differ statistically according to gender variables.

Tekin (2009) examined different levels of the intelligence of the male and female athletes in individual and team sports according to class and sport type variables and found; according to the gender variable, male students have a higher level of logical-mathematical intelligence than female students.

In Cinkilic's and Soyer's (2013) studies called "Multiple Intelligence Fields of Physical Education Teacher Candidates" and "Investigation of the Relationship Between Problem Solving Skills"; there was no significant difference to be found between the mean of logical-mathematical intelligence scores of the physical education teacher candidates participating in the survey in terms of gender variable.

When the scores of the athletes participating in the study were compared according to their educational status variables, the total scores of the athletes on the mathematical thinking scale who attended primary education were found to be significantly higher than the other groups. Athletes with the lowest score were the ones that continue their undergraduate education. Tekin (2009) found a meaningful difference between the logical-mathematical intelligence areas of the students who are actively engaged in terms of class variables. According to this difference, the students in the 9th class had higher logical-mathematical intelligence than the students in the 11th class. The fact that the primary school students had higher scores in the study can be considered contradictory.

When the scores of the athletes participating in the survey were compared according to the variables of their sports type, it was seen that the scores of the participants who played billiards and archery were significantly higher than the other groups. Participants with the lowest score were the ones that played basketball. According to the findings obtained, it is anticipated that the mathematical thinking levels of the participants who play billiards and archery sports to be high, since they require concentration and geometric calculations.

According to the gender variables, there was a difference only in the scores of the problem-solving sub-dimension in mathematical thinking scale dimensions. It was seen that male athletes have higher problem-solving skills than women. There was no difference in the other sub-dimensions. Although the score of male athletes in total was higher than that of women, this difference was not statistically different.

Kiremitci and Canpolat (2014) investigated the role of physical education sports college students and multiple intelligence areas in metacognitive awareness and problem-solving skills. In these researches, it was determined that there is a positive relationship between metacognitive awareness, problem-solving and multiple intelligence areas. It has been shown that multiple intelligence areas can explain problem-solving at the rate of 25% and metacognitive awareness in the rate of 47%. Another consequence of their work was that logical/mathematical, bodily/kinesthetic, and inner intelligence fields have risen to the forefront of intelligence areas in terms of problem-solving and metacognition.

Ersoy and Güner (2014) investigated the problem-solving skills and mathematical thinking levels of third-year classroom teacher candidates in their work titled "Mathematics Teaching and Mathematical Thinking". In the analysis of the mathematical thinking scale, the students' problem-solving skills were found to be effective in mathematical thinking. Tataroglu, Celik and Erduran (2013) in their studies which focused on mathematics teacher candidates' views on mathematical thinking and the development of mathematical thinking of students, found that in order to develop mathematical thinking, mathematics teacher candidates should pay close attention to the subjects such as relating the topics to the daily life, problem-solving and asking effective questions.

According to the results of the research, there is a statistically significant difference between individual sports participants and team sports participants in favour of individual sports participants. Participants in individual sports were found to be more successful in terms of mathematical thinking. There is no statistically significant difference in the total scores acquired from the mathematical thinking scale between the individual sports participants.

In the case of team athletes, there was a statistically significant difference in favour of those who played soccer and volleyball sports between the total scores they received on the mathematical thinking scale. Participants who played football and volleyball were found to be more successful than those who played basketball in terms of mathematical thinking.

There was a statistically significant difference between sportsmen who perform team sports in terms of points taken from mathematical thinking scale sub-dimensions in favour of those who play soccer and volleyball sports in all sub-dimensions.

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