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EXAMINATION OF THE RELATIONSHIP BETWEEN SCIENCE FICTION SELF-EFFICACY AND SPATIAL ABILITY OF SCIENCE TEACHER CANDIDATES

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Abstract: In the study, it is aimed to examine the relationship between science fiction self-efficacy and spatial ability of science teacher candidates. The study is quantitative research and correlation research was used as a research design. The study group consisting of 200 science teacher candidates was formed by using the convenience sampling method. The data collection tools are Santa Barbara Solids Test, Spatial Ability Self-Report Scale and Science Fiction Self-Efficacy Scale for Science Teacher Candidates. Correlation analysis was performed in the analysis of data and Pearson Correlation for normally distributed data and Spearman Correlation for non-normally distributed data was used. As a result of analyzes, for science fiction candidates it was concluded that there is a moderately positive and significant relationship between spatial ability and spatial ability self-report, a moderately positive significant relationship between science fiction self-efficacy and spatial ability self-report, and a weak positive significant relationship between science fiction self-efficacy and spatial abilities. According to the findings, it was concluded that science teacher candidates make a consistent self-assessment in terms of their spatial ability. Moreover, it has been determined that some improvement in spatial ability can be achieved by using science fiction as a tool to develop spatial ability.

Key words: science education, science fiction, science teacher candidate, spatial ability, survey model

1. Introduction

The universe has secrets that mankind is trying to discover. To discover the secrets of the universe, some scientific studies are being done. (Karaçam, 2018, p. 24). Therefore, scientific studies are very important at our age. The importance of scientific studies makes science education come to the fore. With science education, people can use science effectively in their daily lives (Dragoş & Mih, 2015, p. 167). Moreover, individuals with science education can comment on technological studies. Science education is necessary for individuals to keep up with our age of great technological developments (Hançer et al., 2003, p. 81-82).

In many studies, various goals of science education have been included. One of these goals of science education is improving students' scientific knowledge and skills (Zhou, 2012, p. 109). Furthermore, with science education, students can evaluate the world with a scientific attitude (Longbottom & Butler, 1999, p. 473). In a report named "Science Education in Europe: Critical Reflections", it is recommended that the aim of scientific education in European Union should be teaching how to do scientific studies to students (Osborne & Dillon, 2008, p. 8). It is possible to diversify the goals of science education. However, when it is necessary to gather all the goals of science education under a single concept, the concept of "scientific literacy" is encountered. According to Osborne, the most important thing for science education is to educate science literate individuals (2007, p. 173).

The concept of scientific literacy has been used since the 1940s and has changed in terms of content until it reaches today (Holton, 1999, p. 181). Nowadays, scientific literacy is defined as "the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen" for its accepted form in our age (OECD, 2017, p. 24). Scientific literacy has evolved from memorizing scientific knowledge to interpreting how scientific knowledge will affect society (Valladares, 2021, p.

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558). In other words, memorizing scientific concepts is not enough for scientific literacy. Thus, rote-based methods and techniques used in the past for science teaching are not accepted anymore. Instead, methods and techniques that allow student-centered lessons are preferred. There are many current methods and techniques for teaching science such as activity-based learning, cooperative learning, inquiry-based learning, game-based learning, STEM education, argumentation, online learning, engineering-based learning, learning with Lego (Okumuşoğlu and Geçikli, 2021, p. 403). These methods and techniques allow the student to be actively involved in the learning process. This is necessary for effective learning (Başaran, 2004, p. 8).

Choosing the right technique and method during education is an effective way for achieving the targeted success (Yılmaz, 2017, p. 493). However, the only condition for success in science teaching is not to use the right method and technique. Because, to ensure effective learning, the learning process must also be evaluated in terms of the "learner" (Başaran, 2004, p. 8). In this case, the concept of "intelligence" comes to the fore. According to Gardner, intelligence is the skill to solve problems or to fashion products that are valued in one or more cultural or community settings (Gardner & Hatch, 1989, p. 5). Intelligence is not only affected by biological factors but also environmental factors (Oliver, 1997). Therefore, it is possible to say that intelligence can be developed through environmental factors.

There are different theories about intelligence. One of these theories, which is still valid today, is Gardner's Theory of Multiple Intelligences. In his study titled "Multiple Intelligence", Gardner stated that there are seven different types of human intelligence (1993, p. 8). Later, he continued studies about the existence of different types of intelligence in addition to these seven intelligence types (Gardner, 1999, p. 47). One of intelligence types included in Gardner's study published in 1993 is “spatial intelligence”. Individuals with advanced spatial intelligence can visualize three-dimensional objects in their minds and perceive three-dimensional objects without difficulty (Gürel & Tat, 2010, p. 350). "Spatial intelligence" and "spatial ability" are related concepts (Küçükay & Yenilmez, 2021, p. 34). Spatial ability is expressed as the ability to imagine objects from different angles in a three-dimensional universe (Turğut, 2007, p. 9). Linn and Petersen express spatial ability as the skill of converting and remembering visual knowledge and obtaining new shapes based on visual information (1985, p. 1482).

Spatial ability is related to science (Kozhevnikov et al., 2007, p. 549; Pallrand & Seeber, 1984, p. 507; Uttal & Cohen, 2012, p. 153; Yolcu & Kurtuluş, 2010, p. 258) and it is possible to develop an individual's spatial ability with the environmental factors (Küçükay & Yenilmez, 2021, p. 41; Yılmaz, 2009, p. 94). As an environmental factor, it is known that one of the ways to improve spatial ability is using concrete 3D objects (Yıldız & Tüzün, 2011, p. 504). However, it may not always be possible to have concrete objects. Therefore, it is possible that the use of alternative tools to concrete objects will have a positive effect on the development of spatial ability. When research is conducted within the framework of "spatial ability" and "science", "science fiction" stands out as a possible alternative tool that can be used.

Science fiction is explained by Amis as a work that includes unusual events, has science and technology in its infrastructure, and takes place in the world or outside the world (1960, p. 18). Because, just like spatial ability, science fiction has common aspects with science. For example, there are three-dimensional visuals and figures in both science curriculum and science fiction works (such as books, magazines, comics, movies, TV series). Also, studies show that science fiction has a relationship with science education and science literacy. (Bilgin, 2016, p. 38; Segall, 2002, p. 419; Tatlı & Şahin, 2020, p. 63; Vrasidas et al., 2015, p. 12). The fact that both spatial ability and science fiction are related to science raises the question of whether there is a relationship between science fiction and spatial ability or not. Starting from this point, the study is aimed to determine whether science fiction influences the spatial ability of pre-service science teachers. A problem statement as "Does science fiction have an effect on spatial ability in pre-service science teachers?" was formed. The sub-problems created depending on the problem statement of the research are as follows.

• Is there a relationship between science teacher candidates’ spatial ability self-report and their spatial ability?

• Is there a relationship between science teacher candidates' science fiction self-efficacy and their spatial ability self-report?

• Is there a relationship between science teacher candidates' science fiction self-efficacy and their spatial ability?

2. Methods

2. 1. Research Design

In this study, which is quantitative research, the survey model was used as a research design. Survey researches are realized with the aim of determining the characteristics of a group on a subject (Büyüköztürk et al., 2013, p. 177). Skills and abilities are also included in these characteristics. Since it was aimed to determine the scientific self-efficacy and spatial abilities of the study group, the survey model was preferred. With survey model, data can be collected with the questions asked to the participants, and it is sufficient to ask the questions to the participant group, not to the universe (Fraenkel et al., 2011, p. 393). The survey model was deemed appropriate in terms of the data collection tools to be used in the research and the fact that the research would be carried out with a certain participant group. In addition, survey model offers the opportunity to work with a larger number of participants compared to other research models (Büyüköztürk et al., 2013, p. 177). Moreover, the survey model allows more than one variable to be compared with each other and the data obtained are generalizable (Gürbüz & Şahin, 2018, p. 106). These features of the survey model are also compatible with the research process.

The survey model consists of two sub-types as "case study" and "general". General survey models are divided into "singular" and "relational"; the relational survey model, on the other hand, consists of two sub-categories as "correlation" and "comparison" models. Correlation studies can determine whether variables change together (Bedir Erişti et al., 2013, p. 26-27). Since it is aimed to determine whether there is a correlation between the variables of science fiction self-efficacy and spatial ability, correlation research was preferred.

2. 2. Participants

The universe of the research consists of all science teacher candidates in Turkey. The study group of the research, on the other hand, consists of 200 science teacher candidates from different levels, who are studying at the Elementary Science Education department at a state university in Turkey. To determine the number of participants, the research design, and the number of items in the data collection tools used in the research were considered. In addition, since it is thought that all science teacher candidates studying at the undergraduate level in Turkey are similar in terms of research subject, the "convenience sampling" method, which is one of the non-random sampling methods, was preferred in the study. By using this method, it is possible to create participants who can represent the universe more easily (Taherdoost, 2016, p. 22).

2. 3. Data Collection Tools

In the research, a spatial ability achievement test named "Santa Barbara Solids Test (SBST)" was used. Moreover, two scales named as "Science Fiction Self-Efficacy Scale for Science Teacher Candidates (SFSES)" and "Spatial Ability Self-Report Scale" (SASRS) were used as data collection tools.

SBST was developed by Cohen and Hegarty in 2007 (p. 3) and was revised in 2012. With use of SBST, it is aimed to measure the spatial abilities of individuals. The most up-to-date version of the test was used in the study. The reliability coefficient of the SBST, which was revised in 2012, was calculated as .91. The test consists of 30 multiple choice questions. The questions in the test are divided into five sub-categories according to the way the questions are formed. These are questions with simple figure (SF), joined figure (JF), embedded figure (EF), orthogonal cutting plane (OrCP) and oblique cutting plane (ObCP). The reliability coefficients calculated according to the question categories are as follows.

• Questions with simple figure: .79
• Questions with joined figure: .80
• Questions with embedded figure: .85
• Questions with orthogonal cutting plane: .84
• Questions with oblique cutting plane: .85 (Cohen & Hegarty, 2012, p. 870).

The Turkish version of the SBST was used in the study. The SBST was translated into Turkish by Uygan (2011, p. 121-125) and the reliability coefficient of the test was calculated as .84 (Uygan & Kurtuluş, 2016, p. 518).

SFSES, developed by Aksoy (2022, p. 47), aims to measure the individuals' proficiency in science fiction. SFSES, which is a likert-type scale, consists of 18 items. Each item has five options named as "Strongly Disagree", "Disagree", "Undecided", "Agree" and "Strongly Agree". SFSES consists of one dimension. As a result of the reliability study of the scale, the Cronbach Alpha value was calculated as .88.

The other scale used in study is SASRS, which was developed by Turgut (2015, p. 1997). With this scale, it is aimed to enable individuals to make self-assessments about their spatial abilities. The scale consists of 18 items. It is a likert-type scale, and each item of the scale has five options named as "strongly disagree", "disagree", "undecided", "agree" and "strongly agree". The scale consists of three sub-dimensions called Object Manipulation Spatial Ability (OMSA), Visual Memory (VM) and Spatial Navigational Ability (SNA). As a result of the reliability analysis, the Cronbach Alpha coefficient for the whole scale was calculated as .884. As a result of the reliability analysis performed for the sub-dimensions of the scale, the Cronbach Alpha coefficient for Object Manipulation Spatial Ability was calculated as .883, for Visual Memory as .622 and for Spatial Navigational Ability as .802 (Turgut, 2015, p. 2010).

2. 4. Data Collection

Data collection was ensured by applying SBST, SFSES and SASRS to science teacher candidates forming the study group of the research. Before applying the data collection tools to the science teacher candidates, each participant was given the necessary information about the research and the application of the data collection tools was performed on a completely voluntary basis.

Since the data collection process coincided with the Covid Pandemic, the data were collected online. For online data collection, "Google Forms" was preferred. A form consisting of five parts (introduction part and then four parts) was created over Google Forms. In the introduction part of the form, information about research and data collection tools is given. In the section after the introduction, which is called the "first section", there are questions based on the determination of the demographic characteristics of the participants. The second section includes SFSES, the third section includes SASRS, and the last section includes SBST. The explanations in the original data collection tools are included in the entries of the sections where the achievement test and scales are located. In the process of transferring the data collection tools to the digital environment, the originality of the data collection tools was maintained, and any changes were made. After the application of the data collection tools to all participants, the Google Forms link was deactivated. The obtained data were transferred to the computer as a single file and the analyzes were made with the statistical package program.

2. 5. Data Analysis

The data in statistical package program was checked and it was determined that the data is suitable for analysis. Then, the normality analysis of the data was performed. For the skewness value is between +1 and -1; mode, median and arithmetic mean values close to each other; the z-score (for α=0.05) is between +1.96 and -1.96, data are considered to be normally distributed (Büyüköztürk, 2013, p. 40-42). The skewness, mode, median, arithmetic mean and z-score values of the data (including sub-dimensions) are as in the Table 1.

Table 1. *Skewness, Mode, Median, Arithmetic Mean, Z-Score Values of Data Collection Tools*

	SBST	SF	JF	EF	OrCP	ObCP	SFSES	SASRS	OMSA	VM	SNA
Skewness	.729	.516	.485	.363	.386	1.042	-.233	-.086	-.172	-.271	-.702
Mode	9.000	2.000	3.000	3.000	5.000	3.000	53.000	70.000	44.000	12.000	16.000
Median	10.500	3.000	4.000	4.000	7.000	4.000	50.000	67.000	42.000	11.000	15.000
Mean	11.820	3.590	4.070	4.160	7.385	4.435	48.735	67.585	41.620	11.205	14.760
Z-Score	4.238	3.000	2.820	2.110	2.244	6.058	-1.355	-.500	-1.000	-1.576	-4.081

When the data obtained from the SBST and its sub-dimensions (SF, JF, EF, OrCP and ObCP) were examined separately, it was determined that the mode, median and arithmetic mean values were not close to each other, and the z-scores were out of the range. Therefore, it was concluded that the data obtained from the SBST, and all its sub-dimensions were not normally distributed. For SFSES, it is seen that the skewness and z-score values are in the range; mode, median and arithmetic mean values were found to be close to each other. Therefore, the data from SFSES are normally distributed. When the data obtained from the whole of SASRS and its sub-dimensions OMSA, VM and SNA are analyzed separately, it was concluded that the skewness and z-score values for SASRS, OMSA and VM are in the range; mode, median and arithmetic mean values of them are close to each other. Therefore, data from SASRS, OMSA and VM are normally distributed. However, since the z-score of the SNA was not within the specified range, it was concluded that the data were not normally distributed. The findings obtained from the normality analysis of the data are given in the Figure 1.

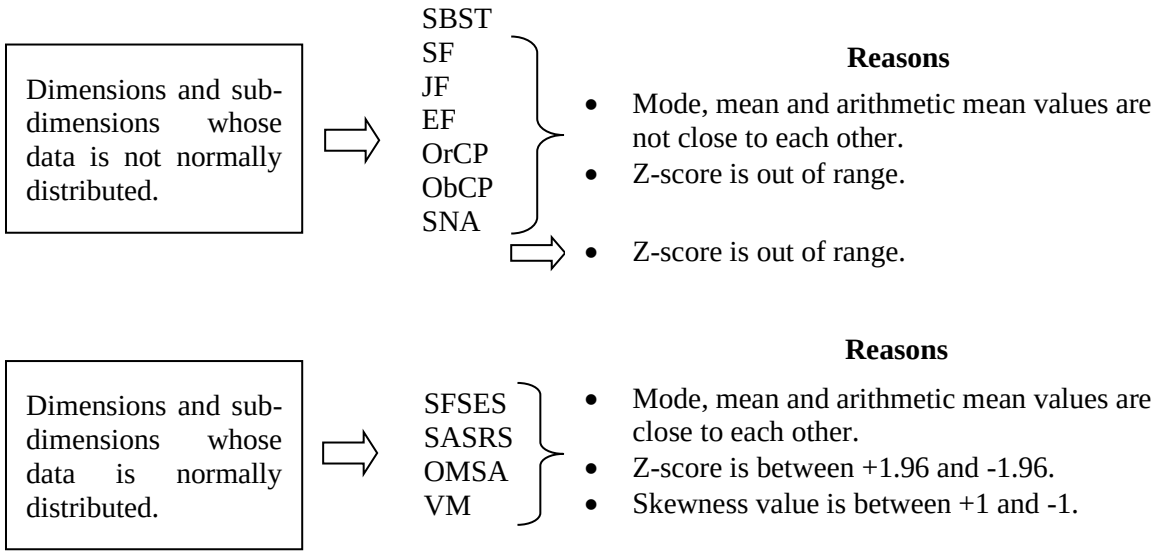

Figure 1. *The Findings Obtained from the Normality Analysis of Data*

Correlation analysis was performed to compare the results obtained from the data collection tools with each other. "Pearson" correlation was used to compare normally distributed data, and "Spearman" correlation was used to compare non-normally distributed data. If the correlation coefficients obtained from the correlation analysis are between 0.00-0.30, "low level of relationship"; between 0.30 and 0.70, "moderate relationship"; and between 0.70-1.00, "high level of relationship" is assumed (Büyüköztürk, 2013, p. 32).

3. Results

3. 1. Examining the Correlation Between Spatial Ability and Spatial Ability Self-Report

Correlation analysis of data obtained from SBST and SASRS (including sub-dimensions) was performed to determine whether there is a correlation between science teacher candidates' spatial

abilities and their spatial ability self-report. The findings obtained from the analysis are as in Table 2.

Table 2. *The Correlation Findings of Spatial Ability and Spatial Ability Self-Report*

		SF (Sub-dimension)	**JF** (Sub-dimension)	**EF** (Sub-dimension)	**OrCP** (Sub-dimension)	**ObCP** (Sub-dimension)	**SBST** (Total)
OMSA (Sub-dimension)	r	0.303*	0.239*	0.294*	0.292*	0.289*	0.321*
	p	0.000	0.000	0.001	0.000	0.000	0.000
	n	200	200	200	200	200	200
SNA (Sub-dimension)	r	0.159*	0.169*	0.069	0.148*	0.090	0.142*
	p	0.025	0.017	0.330	0.036	0.205	0.046
	n	200	200	200	200	200	200
VM (Sub-dimension)	r	-0.007	0.049	0.134	0.064	0.054	0.065
	p	0.918	0.493	0.058	0.370	0.449	0.360
	n	200	200	200	200	200	200
SASRS (Total)	r	0.277*	0.252*	0.269*	0.288*	0.267*	0.307*
	p	0.000	0.000	0.000	0.000	0.000	0.000
	n	200	200	200	200	200	200

r: correlation coefficient p: significance n: the number of participants

In the left column of Table 2, there are the sub-dimensions of Spatial Ability Self-Report Scale and the sum of the scale is in the bottom cell of the column. In the top row, there are the sub-dimensions of the Santa Barbara Solids Test and the total of the test are located in the far-right cell of the top row.

According to Table 2, there is a moderate positive correlation between OMSA - SF, and between OMSA - SBST. There is a low level of positive correlation between OMSA and other sub-dimensions of SBST which are JF, EF, OrCP and ObCP. The findings show that, there is a moderate correlation between the ability to mentally manipulate an image from a certain angle and the spatial ability and the ability to imagine what the image of a single figure cut from a certain plane might look like. Moreover, there appears to be a low level of correlation between the ability to mentally manipulate an image from a certain angle and the ability to imagine how joined and embedded figures cut from a certain plane; figures cut from orthogonal and oblique planes might look like.

There is a low level of positive correlation between SNA and SF, JF, OrCP, SBST (total). It was found that there is no correlation between SNA - EF, and between SNA - ObCP. These findings show that individuals with mental mapping and direction finding skills may have the ability to imagine how single and joined figures cut from a certain plane and figures cut from orthogonal planes might look like, albeit at a low level. It was also determined that there was a low level relationship between mental mapping and wayfinding skills and overall spatial ability, but no correlation with the ability to imagine the visual of a embedded figures cut from a certain plane and figures cut from oblique planes.

No correlation was found between VM – SBST (total), and between VM and all sub-dimensions of SBST. Based on these findings, it is understood that there is no relationship between the ability to imagine new visuals of folded or rotated objects and the ability to imagine new visuals of single, joined, and embedded figures cut from oblique or orthogonal planes. In addition, it is possible to say that there is no relationship between the ability to imagine new visuals of folded or rotated objects and the overall spatial ability.

It was determined that there is a low level of positive correlation between SASRS and all sub-dimensions of SBST. In addition, it was determined that there is a moderate positive correlation between SASRS and SBST. These findings show that there is a moderate correlation between individuals' spatial ability self-report skills and their spatial abilities.

3. 2. Examining the Correlation Between Science Fiction Self-Efficacy and Spatial Ability Self-Report

Correlation analysis of data obtained from SFSES and SASRS (including sub-dimensions) was

performed to determine whether there is a correlation between science teacher candidates' science fiction self-efficacy and their spatial ability self-report. The findings obtained from the analysis are as in Table 3.

Table 3. *The Correlation Findings of Science Fiction Self-Efficacy and Spatial Ability Self-Report*

		OMSA (Sub-dimension)	**SNA** (Sub-dimension)	**VM** (Sub-dimension)	**SASRS** (Total)
SFSES (Total)	r	0.468*	0.366*	0.212*	0.500*
	p	0.000	0.000	0.003	0.000
	n	200	200	200	200

The left column of Table 3 contains Science Fiction Self-Efficacy Scale for Science Teacher Candidates. On the top line, the sub-dimensions of Spatial Ability Self-Report Scale and on the far right of the line are the total of Spatial Ability Self-Report Scale are located.

According to Table 3, there is a moderate positive correlation between SFSES - OMSA and SFSES – SNA. There is a low level of positive correlation between SFSES - VM. In addition, it was determined that there is a moderate positive correlation between SFSES and SASRS. These findings show that there is a moderate relationship between individuals' science fiction self-efficacy skills and their ability to manipulate an image from a fixed angle, and their mental mapping - wayfinding skills. In addition, there is a relationship between science fiction self-efficacy skill, albeit at a low level, and the ability to imagine new visuals of objects which are folded or rotated. Moreover, it was determined that the participants' science fiction self-efficacy skills were moderately related of their spatial ability self-report skills.

3. 3. Examining the Correlation Between Science Fiction Self-Efficacy and Spatial Ability

Correlation analysis of data obtained from SFSES and SBST (including sub-dimensions) was performed to determine whether there is a correlation between science teacher candidates' science fiction self-efficacy and their spatial ability. The findings obtained from the analysis are as in Table 4.

Table 4. *The Correlation Findings of Science Fiction Self-Efficacy and Spatial Ability Self-Report*

		SF (Sub-dimension)	**JF** (Sub-dimension)	**EF** (Sub-dimension)	**OrCP** (Sub-dimension)	**ObCP** (Sub-dimension)	**SBST** (Total)
SFSES (Total)	r	0.183*	0.133	0.149*	0.153*	0.173*	0.179*
	p	0.010	0.060	0.035	0.031	0.015	0.011
	n	200	200	200	200	200	200

The left column of Table 4 contains Science Fiction Self-Efficacy Scale for Science Teacher Candidates. On the top line, the sub-dimensions of Santa Barbara Solids Test and on the far right of the line, the total of Santa Barbara Solids Test are found.

When Table 4 is analyzed, it is seen that there is a low level of positive correlation between SFSES and all sub-dimensions of SBST (SF, JF, EF, OrCP and ObCP). In addition, it was determined that there is a low-level positive correlation between SFSES and SBST. These findings show that there is a low-level relationship between individuals' science fiction self-efficacy and their spatial abilities. There is also low-level relationship between science fiction self-efficacy and their ability to imagine a new visual in mind as a result of cutting single, joined or embedded objects from oblique or orthogonal planes.

4. Conclusion, Discussion and Recommendations

4. 1. Conclusion

In the study, it was aimed to examine the relationship between science fiction self-efficacy and spatial abilities of science teacher candidates. During the study, an achievement test and two scales were applied to 200 science teacher candidates.

Correlation analysis of data obtained from SBST and SASRS was conducted to examine the relationship between spatial ability and spatial ability self-report in science teacher candidates. As a result of the analysis, it was concluded that there is a moderately positive correlation between the spatial abilities of science teacher candidates and their spatial ability self-report. This result is the broadest result from the correlation analysis between spatial ability self-report and spatial ability.

In terms of sub-dimensions, it was concluded that there is a low level of positive correlation between object manipulation spatial ability and joined figures, embedded figures, orthogonal cutting plane, oblique cutting plane. There is a moderate positive correlation between object manipulation spatial ability and simple figure. In addition, it was determined that there is a moderate positive correlation between object manipulation spatial ability and spatial ability. There is a low level of positive correlation between spatial navigational ability and simple figures, joined figures, orthogonal cutting plane. There is no correlation between spatial navigational ability and embedded figures, oblique cutting plane. In addition, it was concluded that there is a low level of positive correlation between spatial navigational ability and spatial ability. There is no correlation between visual memory self-report and spatial ability. There is a low level of positive correlation between spatial ability self-report and simple figures, joined figures, embedded figures, orthogonal cutting plane and oblique cutting plane. All these results show that there is a low or moderate positive correlation between spatial ability and spatial ability self-report skill, except for a few sub-dimensions.

Correlation analysis of data obtained from SFSES and SASRS was conducted to examine the relationship between science fiction self-efficacy and spatial ability self-report in science teacher candidates. As a result of the analysis, it was seen that there is a moderately positive correlation between the science fiction self-efficacy of science teacher candidates and their spatial ability self-report. This result is the broadest result from the correlation analysis between science fiction self-efficacy and spatial ability self-report.

When the sub-dimensions of SASRS were also included in the correlation analysis, it was concluded that there is a moderate positive correlation between science fiction self-efficacy and object manipulation spatial ability and spatial navigational ability. Moreover, it was determined that there is a low level of positive correlation between science fiction self-efficacy and visual memory.

Correlation analysis of data obtained from SFSES and SBST was conducted to examine the relationship between science fiction self-efficacy and spatial ability. With the analysis, it was found that there is a low-level positive correlation between the science fiction self-efficacy and spatial ability of science fiction candidates. This result is the most important result for the purpose of research. When the sub-dimensions of SBST were included in the correlation analysis, it was found that there is a low level of positive correlation between science fiction self-efficacy and simple figures, embedded figures, orthogonal cutting plane, oblique cutting plane. Furthermore, there is no correlation between science fiction self-efficacy and joined figures.

4. 2. Discussion

Regarding the first problem statement of the study, it was revealed that there is a moderate positive relationship between the spatial ability of science teacher candidates and their spatial ability self-report. This finding is similar to the finding obtained in Dokumacı Sütçü's research (2019, p. 309). In the study with the participation of science and mathematics teacher candidates, Dokumacı Sütçü concluded that there is a positive and significant relationship between teacher candidates' spatial ability and their spatial ability self-report. In addition, in the same study, the relationship between spatial ability and sub-dimensions of spatial ability self-report (object manipulation spatial ability, spatial navigational ability, visual memory) was examined. As a result of the examination, it was

concluded that there is a significant positive relationship between spatial ability and object manipulation spatial ability. There is no significant relationship between spatial ability and other sub-dimensions (spatial navigational ability, and visual memory) (Dokumacı Sütçü, 2019, p. 306). In terms of sub-dimensions, the findings obtained in both studies partially overlap. When the literature was searched, no other study was found that directly overlaps with the first problem statement of the research. However, the study of Kozhevnikov and Hegarty (2001) shows some similarities with the first problem statement of the research. In this study, which was made with the participation of undergraduate students, the separation between object manipulation spatial ability and spatial orientation ability (one of the basic components of spatial ability) is reviewed. In the study, it was stated that object manipulation spatial ability and spatial orientation ability are different abilities, but there is a connection between each other (Kozhevnikov & Hegarty, 2001, p. 755). This statement coincides with the result of our research. Moreover, Yılmaz (2017, p. 15) stated in his study on the spatial ability self-report of mathematics teacher candidates that more detailed studies should be conducted on the spatial ability and spatial ability self-report of teacher candidates. Therefore, this study, which investigates the correlation between spatial ability and spatial ability self-report of science teacher candidates, is an advanced research in line with Yılmaz's suggestion.

For the second problem statement, the relationship between science fiction self-efficacy and spatial ability self-report of science teacher candidates was analyzed, and a positive significant relationship was determined. For the third problem statement, the relationship between science fiction self-efficacy and spatial ability of the science teacher candidates was analyzed and a positive significant relationship was determined. However, when national and international studies are reviewed, it has been seen that there is no study conducted for similar purposes. Thus, concepts related to both spatial ability and science fiction self-efficacy were investigated and at the end of research, the concepts of "science achievement", "imagination", "creative thinking skills" were determined. Therefore, the relationship between science fiction self-efficacy and spatial ability was investigated in terms of the concepts of "science achievement", "imagination" and "creative thinking skills".

Studies have shown that science fiction improves science literacy (Bilgin, 2016, p. 38; Tatlı & Şahin, 2020, p. 503), increases science achievement (Tatlı & Şahin, 2020, p. 63), and is effective in increasing interest, curiosity towards science (Karadeniz & Değirmençay, 2020, p. 238; Vrasidas et al., 2015, p. 12). Similarly, spatial ability is also necessary for science (Ganley et al., 2014, p. 1420); effective about success in physics (Kozhevnikov et al., 2007, p. 560; Pallrand & Seeber, 1984, p. 514), learning chemistry (Wu & Shah, 2003, p. 486) and understanding some earth science texts (Sanchez and Wiley, 2014, p. 41). Moreover, according to Sezen Yüksel (2013, p. 29), to understand science subjects high level of spatial ability is required. In line with all these studies, it has been concluded that both science fiction and spatial ability are associated with science achievement. The concepts of "spatial imagination" and "science fiction-based imagination", which are included in some studies, were influential in the determination of another concept, "imagination" (Dilshod, 2021; Finn & Wylie, 2021; G´orska, 2005). These concepts suggest that both science fiction and spatial ability are related to imagination. In addition, in studies examined in terms of science fiction - imagination relationship, it has been stated that science fiction improves the imagination of individuals (Balbağ et al., 2012, p. 239; Bilgin, 2016, p. 39). Similarly, in the study examined in terms of spatial ability - imagination relationship, it was stated that spatial ability is directly related to imagination (Abay et al., 2018, p. 59). As a result of the literature review, it was concluded that both science fiction and spatial ability are related to imagination. Lin (2014, p. 96), who studied science fiction and creative thinking, stated that there is a positive relationship between science fiction movies and creative thinking in high school students. In another study conducted with the participation of middle school students, it was concluded that science fiction films develop creativity (Lin et al., 2013, p. 191). In addition, according to Bilgin (2016, p. 39), science fiction, and according to Orçan (2013, p. 67), science fiction comics improve the creative thinking skills of individuals. On the other hand, Yenilmez and Çalışkan (2011, p. 61) stated in their study that there is a positive relationship between spatial ability and creativity, albeit at a low level. In short, as a result of the examination of the mentioned studies, it was concluded that both science fiction and spatial ability are related to creative thinking skills.

As a result of examining the studies on the subject, it is understood that both science fiction and spatial

ability have a positive and significant relationship with "science achievement", "imagination" and "creative thinking skills". This situation supports the results obtained from the studies on the second and third problem statements of the research with a certain probability. However, since there is no previous study about the relationship between science fiction self-efficacy and spatial ability has been found, the results obtained from the studies conducted for the second and third problem statements of the research cannot be supported by the literature with 100% clarity.

4. 3. Recommendations

Based on the results obtained from the research, some suggestions were made to the researchers and educators. The research was carried out with the participation of science teacher candidates. As a recommendation to researchers, the scope can be expanded by carrying out similar studies with the participation of teacher candidates from different branches. As a suggestion to educators, science fiction can be used as an alternative tool in curricula with content related to spatial ability for the development of spatial ability.

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