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Original Article

Improving Spatial Thinking Skills of Gifted Students Through Social Studies Course: An Instructional Module *

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Abstract

This research aims to examine the extent of success the students enrolled in the 5th Grade Individual Talent Recognition (ITR) program of the Science and Arts Center (BILSEM) would achieve in terms of spatial concepts and spatial thinking through an instructional module on spatial thinking skills embedded in the social studies course. The research process has been completed in accordance with embedded experimental design, which is one of the mixed method designs. The research sample consists of 30 students in the 5th Grade ITR program of Muğla Science and Arts Center. An Instructional Module on Spatial Thinking Skills (IMSTS) was developed to facilitate and improve the students' spatial concepts and spatial thinking skills. The research data have been gathered via spatial thinking skills test, spatial concepts test, student journals, expert opinion forms, and focus group discussion forms for both students and teachers. Quantitative data obtained after the administration of IMSTS to the gifted students were subjected to parametric analyses while qualitative data were analyzed through content and descriptive analyses. The findings indicate a significant difference between the pre and post-test scores of the gifted students in favor of the post-test results. In the same vein, the findings distilled from the focus group discussions and student journals reflect students' opinions underlying the necessity of training on spatial thinking skills within the social studies course. The instructional module developed within the scope of the present study has been found effective on improving spatial concepts and spatial thinking skills of the gifted students. In line with the research findings, it is suggested that the IMSTS developed by the researcher can be employed by the social studies teachers to better the spatial concepts and spatial thinking skills of the 5th graders in the ITR program of BILSEM.

Keywords

Social studies
Spatial thinking skills
Spatial concepts
Instructional module
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Introduction

Organizing their lives in line with the affordances of the spaces they dwell, humans perform their actions in accordance with the spatial conditions to be able to create a quality living space and to attain professional success. For instance, people would opt for places near the streams to settle during the early ages, we generally reference the location of our homes as a landmark when we are navigating towards a novel place, an orienteering player has to reach the checkpoints as quickly as possible after locating her/his whereabouts on a map, and a space engineer should not make any mistakes when determining the exact places of stars and planets by observing the sky. All such actions performed during the daily life require use of information and skills that comprise spatial thinking. Thus, spatial thinking skills are significant for the execution of not only daily activities, but also many disciplines and professions (Tversky, 2005).

Lee and Bednarz (2009) define spatial thinking skills as an amalgam of three components that scaffold each other: the nature of the space, methods to represent spatial information, and spatial reasoning process. Self and Golledge (1994, p. 235), on the other hand, provide the following definition, "being able to interpret the distributions such as climate, fauna, or soil structure through spatial relations, to think geometrically, to transform time and space, to make educated guesses about direction and distance, and to perceive three dimensional structures in two dimensions." A closer look at the definitions reveals that spatial thinking skills are everywhere, from the activities of daily living to various professions. Goodchild (2006) regards spatial thinking skills as one of the important intelligence types to be improved in any society due to its inclusive nature. Given that the skills necessary for language, math, and science are learned through courses, spatial thinking skills also stand as a major set of skills to be taught within educational settings (Zwartjes et al., 2017).

One of the most extensive research studies on spatial thinking skills was conducted by the National Research Council (NRC), which is a branch of the National Academy of Sciences in the US (Şanlı, 2019). According to the report presented by the NRC, spatial thinking skills include three components, namely, spatial concepts, representational tools, and cognitive processes (NRC, 2006). Based on the scope outlined by the NRC, spatial thinking skills encompass spatial concepts, use of tools, and cognitive actions. Likewise, Lohman (1979) underpins three dimensions of spatial thinking skills: spatial visualization, spatial orientation, and spatial relations. Spatial visualization refers to the ability to spin, turn, and manipulate objects through mental representations. Visual orientation represents the ability to view a space or an object from various angles and directions (Carroll, 1993; Self & Golledge, 1994). Spatial relations, on the other hand, includes a variety of activities such as recognizing spatial distribution and patterns, recalling and representing the order in a space, recognizing spatial association and hierarchy, navigating in real world settings, creating shortcuts, recognizing landmarks, and comparing and overlapping maps (Self & Golledge, 1994, p. 236). Furthermore, Gersmehl and Gersmehl (2011) identified eight dimensions of spatial thinking skills based on neurological research studies: spatial comparisons, spatial effect (aura), spatial groups (area), spatial transition, spatial hierarchy, spatial analogies, spatial patterns, and spatial associations.

Spatial thinking skills are open to individual differences with respect to performance and strategies employed. For instance, upon request for directions to a certain place, some responders may use geographical directions, some might refer to certain landmarks, and some others may prefer using terms like right and left when giving directions. Scientific endeavors focusing on such individual differences were first directed to determine the success of technical and vocational high schools in the 20th century (Hegarty & Waller, 2005). The cumulative results of these research studies conclude that spatial thinking skills may vary in line with several variables such as cultural differences, age, gender, education, geographical conditions, experience, travel, technology, occupation, neuropsychological phenomena, learning difficulties, and even personality (Asfuroğlu & Fidan, 2016; Bilge, 2020; Bryant, 1982; Can & Karakaş, 2005; Durukan, Türkbay, & Cöngöloğlu, 2008; Kirasic, 2000; Lawton, 2010; Öcal, 2007, Turgut, Erden, & Karakaş, 2010). In other words, the scientific attempts to examine spatial thinking skills have revealed that there are many variables that could influence these skills. In addition, researchers have also shown interest to find out at what age spatial concepts and skills emerge (Piaget & Inhelder, 1967), the reasons as to why these skills differ across individuals and genders (Saucier, Green, Leason, MacFadden, Bell, & Elias, 2002; Vieites, Pruden, & Reeb-Sutherland, 2020; Wolbers & Hegarty, 2010), the skills that vary according to gender (Silverman et al., 2000), and how these differences can be eliminated (Rafi, Anuar, Samad, Hayati, & Mahadzir, 2005).

An overview of relevant body of research yields a prevalent interest especially in the differences across genders (Battista, 1990; Hamilton, 1995; Maccoby & Jacklin, 1978; Morris, 2018; Noachtar, Harris, Hidalgo-Lopez, & Pletzer, 2022; Reilly, Neumann, & Andrews, 2017). For example, women are generally known to pay attention to landmarks and turns in a route whereas men develop a rather general perspective and are mostly responsive to global clues (e.g. geographical directions) (Lawton, 2010). Noachtar et al. (2022) examined brain activation to identify different navigation strategies employed by males and females. According to the findings, different navigation strategies activate different brain regions in men and women. Silverman and Eals (1992) suggested the hunter-gatherer theory to explain these differences between genders. This theory posits that the differences between the genders in terms of spatial skills stem from the division of labor. As women adopted a more active role both in workplace and education as of 21st century and have become an indispensable part of many community activities (Köşker, 2012), a myriad of research studies conducted at primary, secondary and tertiary education levels point out that the disparity between men and women have gradually lessened (Contreras et al., 2020; Duarte, Teodoro, & Gonçalvez, 2022; Hyde, 2005; Kang, David, Jean, & Jan, 2004; Korkmaz & Tekin, 2020; Lizarraga, & Ganuza, 2003; Roberts & Bell, 2000; Rodán, Contreras, Elosúa, & Gimeno, 2016; Samsudin, Rafi, & Hanif, 2011).

Geographical properties of the place where a person resides and her/his personal experiences are another factor that influences spatial thinking process. Some studies have concluded that spatial thinking skills are affected by several variables such as social environment, spatial experiences, and where one lives (Newcombe, Bandura, & Taylor, 1983; Purwanto et al., 2021; Tomaszewski, Vodacek, Parody, & Holt, 2015; Verma, 2014; Yang & Chen, 2010), all of which underline that variables such as environment and place do also play a significant role in spatial thinking process (Purwanto et al., 2021). Collins (2018), for instance, report that there is a weak relationship between spatial thinking skills and travel experiences of 8th graders. Spatial experiences seem to be prone to variation depending on whether a person lives in the rural or urban areas. City centers are mostly denser and more complex in terms of population, transportation, economic diversity, and settlement while villages and the like exhibit quieter and simpler characteristics. These factors may eventually shape an individual's experiences and the process s/he develops spatial thinking skills.

There are different views as to at what age range is the best to teach spatial thinking skills and when is the critical age period. From a cognitive development perspective, Piaget and his supporters argue that children cannot perform specific spatial tasks up until pre-operational stage since perspective-taking is not sufficiently developed in children before the age of 9 or 10 (Newcombe & Stieff, 2012). In contrast, Gersmehl and Gersmehl (2007), examining neurological studies, have determined that the brain regions representing spatial thinking begin to develop in early childhood. According to Newcombe and Frick (2010), some spatial skills, such as mental rotation and perspective-taking, are present in preschool children and show significant development during the primary school period. Sorby (2009) has explained in her study on developing middle school students' spatial skills that the middle school period is the most suitable age range to enhance female students' spatial skills. Özak and Gökmen (2009) have found in their studies on human and space that adults generally tend to remember spatial information that dates back to the age range of 7-12. All these studies pinpoint that one of the critical age ranges to teach spatial thinking skills is the middle school period.

International studies report that spatial thinking skills can be improved in educational settings through specific programs, methods, techniques, activities, plans, or well-designed approaches (Holliday-Darr, Blasko, & Dwyer, 2000; Lohman, 1996; Newcombe, 2013; Sarno, 2019; Sorby, 2009; Wai & Uttal, 2018). Particularly, promoting spatial thinking skills in gifted individuals who represent a significant potential for the future of their countries holds paramount importance because spatial thinking permeates various aspects of life, ranging from daily activities to work, arts, sports, and scientific endeavors. Kell, Lubinski, Benbow, and Steiger (2013) underscore the significance of spatial thinking as a crucial indicator of talent alongside numerical and verbal skills. Spatial ability plays a pivotal role in assimilating existing knowledge, utilizing it effectively, and generating new insights. Consequently, acquiring spatial thinking skills becomes a multifaceted necessity for gifted children to achieve success in their future pursuits (Andersen, 2014).

In 1995, the Ministry of National Education [MoNE] of the Republic of Turkey established science and arts centers (BILSEM) with the aim of nurturing the interests and talents of gifted individuals (Ministry of National Education, 2007). BILSEM's curriculum is characterized by student-centered, interdisciplinary approaches, and the promotion of advanced skills (Ministry of National Education, 2019). Within the primary education, the social studies course has a distinctive place in the cognitive development of children. This course stands out as an interdisciplinary field that integrates various disciplines within the realm of social sciences. Its unique nature encompasses a wealth of knowledge, concepts, and skills related to the relationship between humans and space. Consequently, social studies course bears a crucial role in fostering the development of spatial thinking skills among gifted students.

Review of studies on teaching spatial thinking skills yields certain challenges experienced by both teachers and students. In a study conducted by Öcal (2007), 6th grade middle school students demonstrated greater proficiency in describing distant locations as opposed to nearby places. Some studies considering social studies teachers’ opinions about map skills and spatial thinking abilities (Gökçe, 2015; Uğurlu & Aladağ, 2015) found that teachers often struggle to find sufficient tools or activities to enhance these skills, with limited resources at their disposal. In a study conducted by Gunderson, Ramirez, Beilock, and Levine (2013) with 1st and 2nd grade elementary school teachers, it was identified that teachers with high spatial anxiety tended to avoid conducting spatial activities. Çelikkaya's study (2011) suggest that social studies teachers could teach spatial skills only “partially”. Additionally, Çalık (2022) found that both social studies teachers and teacher candidates lacked adequate knowledge in the sub-dimensions of spatial thinking skills. The collective data from these studies underscore the existence of challenges in the instruction of spatial thinking skills from both the teachers’ and students’ perspectives.

The literature on spatial thinking skills is mostly populated by research studies that concentrate around courses such as geometry, mathematics, and science or participants mostly from preschool period, with a primary emphasis on spatial thinking in general (Batdal & Davaslıgül, 2019; Taşcan, 2019). Both national and international literature on spatial thinking skills cover a range of themes, including spatial concepts and spatial thinking skills in children (Akarsu, 1984; Anthamatten, 2010; Baksi, 2018; Battersby & Kessler, 2012; Canoğlu & Geçimli, 2020; Gersmehl, 2005; Piaget & Inhelder, 1967), programs, models, activities, and methods to improve spatial skills (Alyamâni, Khaled, & Jabali, 2021; Arıkan, 2023; Putra, Deffinika, & Islam, 2021; Samsudin et al., 2011; Sorby, Casey, Veurink, & Dulaney, 2013; Yiğit, & Karatekin, 2021), tendencies of teacher candidates in teaching spatial thinking (Lee, Jo, Xuan, & Zhou, 2017), teachers' and teacher candidates' spatial thinking skills and opinions (Atayeter, Yayla, Tozkoparan, & Sakar, 2018; Merç, 2011; Safi, 2010; Shin, Milson, & Smith, 2015; Yurt, & Tünkler, 2016), the impact of technologies such as Google Earth, Geographic Information System (GIS), animation, and technology-supported applications on spatial thinking skills (Aktürk, Yazıcı, & Bulut, 2013; Bodzin, 2011; Cevher, 2022; Jo, Hong, & Verma, 2016; Keskin, 2018; Kim & Bednarz, 2013; Koç & Topu, 2022; Samsudin, & Ismail, 2004; Yayla, 2019), scales for the instructions of spatial thinking skills (Şanlı & Sezer, 2019), spatial thinking skills in social studies textbooks, programs, and questions

(Baduroğlu, 2018; Elbay, 2020; Şanlı, 2020a), teacher perspectives on spatial perception skills (Uğurlu & Aladağ, 2015), the influence of out-of-school learning environments on spatial perception skills (Aktaş, 2022; Seyhan, 2019), middle school students' map skills (Akkuş & Kuzey, 2018; Ertuğrul, 2008; Görmez, 2021), and studies on gifted students and their spatial intelligence (Lubinski, 2010; Mann, 2006; Young, 2021). Within this extensive body of literature, there are studies emphasizing the importance of spatial thinking skills for gifted students and underlying the role of these skills in identifying gifted students (Andersen, 2014; Lubinski, 2010). Andersen (2014) presented experimental evidence demonstrating the significant role of spatial thinking skills in fields such as science, technology, engineering, and mathematics (STEM), pinpointing that spatial thinking is a versatile component of intelligence. However, the literature lacks adequately developed modules or programs. Gagnier and Fisher (2020) stand out as the only ones who have outlined a general framework for incorporating spatial thinking skills into the science curriculum. Therefore, the literature highlights the necessity for diverse educational designs to effectively implement spatial thinking skills through accurate programs, courses, or activities. Existing studies suggest that spatial thinking skills can be cultivated through well-organized educational activities (Holliday-Darr et al., 2000; Newcombe, 2013; Wai & Uttal, 2018). In this regard, the present study is deemed significant for the design and implementation of an appropriate instructional module to enhance the spatial thinking skills of gifted children, with the hope of contributing to the development of new modules in the future.

Research Aim

This study aims to design an instructional module within the social studies course to improve spatial concepts and spatial thinking skills of 5th-grade enrollees in the Individual Talent Recognition (ITR) program of BİLSEM. Additionally, the effectiveness of the designed module will be evaluated by collecting data through student journals and focus group discussions to determine the students' perspectives on the educational process. The sub-problems based on the research aims are as follows:

1. Is there a statistically significant difference between the pre and post-test scores of 5th graders in the ITR program of BİLSEM on the spatial concepts test?
2. Is there a statistically significant difference in the pre and post-test scores of 5th graders in the ITR program of BİLSEM on the spatial concepts test in terms of:
   a. Gender,
   b. Place of residence (rural and urban)?
3. Is there a statistically significant difference between the pre and post-test scores of 5th graders in the ITR program of BİLSEM on the spatial thinking skills test?
4. Is there a statistically significant difference in the pre and post-test scores of 5th graders in the ITR program of BİLSEM on the spatial thinking skills test in terms of:
   a. Gender,
   b. Place of residence (rural and urban)?
5. What are the opinions of 5th graders in the ITR program of BİLSEM regarding the spatial thinking skills module?

Method

Research Design

One of the mixed-methods where qualitative and quantitative approaches are simultaneously employed, embedded design was opted to conduct a more detailed and comprehensive examination of the research process. The embedded design allows both the collection and analysis of qualitative and quantitative data to be integrated within either a qualitative or quantitative research framework (Creswell & Plano Clark, 2011). This design is suitable when a single data set is insufficient, when there are different questions to be answered, when the primary data set needs to be enhanced, and when various types of questions lead to a different set of data (Creswell, 2012; Creswell & Plano Clark, 2011). This type of research is also referred to as a nested mixed-methods design by Creswell, Plano Clark, Gutmann, and Hanson (2003). Within the embedded design, there are two significant types: the embedded relational model and the embedded experimental model (Creswell & Plano Clark, 2006, p. 69). This research followed an embedded experimental design, characterized by the incorporation of qualitative data into an experimental design. In this model, the priority is determined by the quantitative, experimental method, and the qualitative data set supports this method (Creswell & Plano Clark, 2006). To assess the effectiveness of this module, a pre-test using the Spatial Thinking Skills Test (STST) and Spatial Concepts Test (SCT) was conducted before the implementation. Qualitative data were collected through student journals during the implementation and via focus group interviews after the post-test. The aim was to complement quantitative data with qualitative insights. The detailed process of the mixed embedded experimental design followed in this study is illustrated in Figure 1.

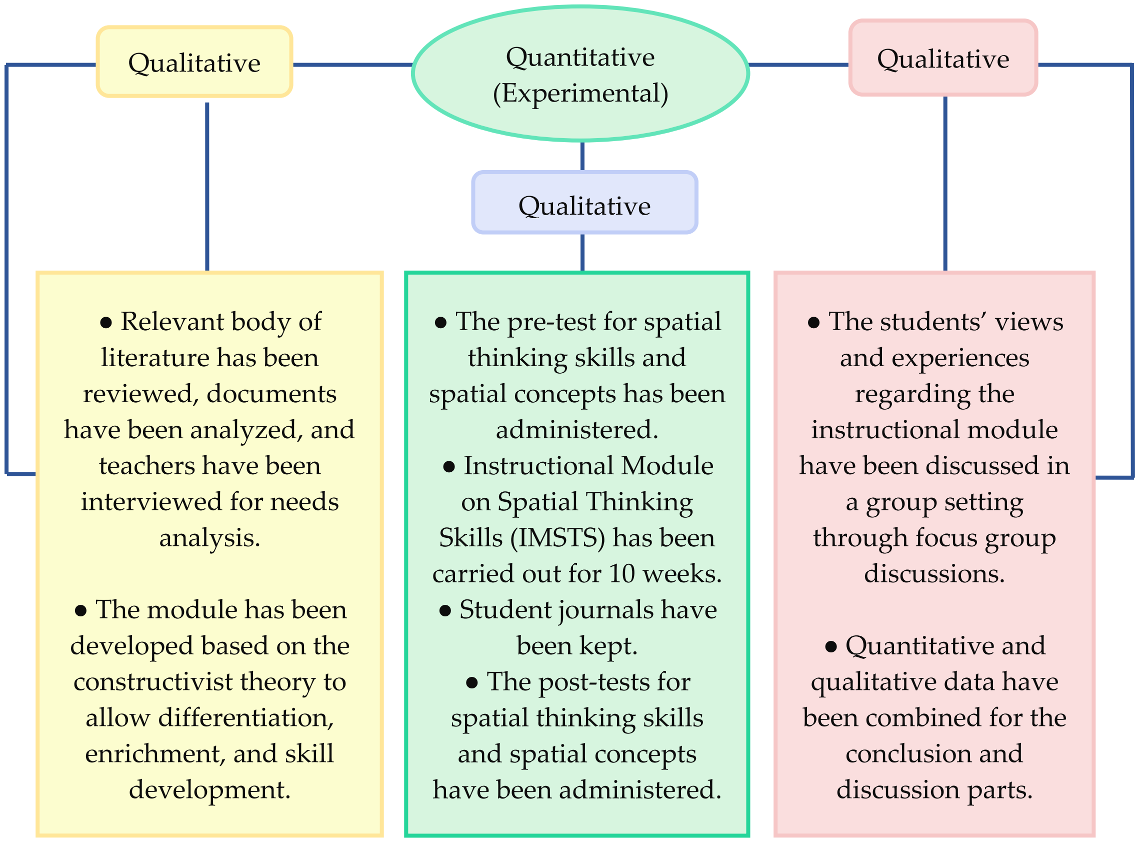

Figure 1. The Research Process in line with Mixed Embedded Experimental Design (Creswell & Plano Clark, 2011)

Figure 1 shows that both qualitative and quantitative data were collected in a simultaneous and sequential manner, structuring the research according to a multi-stage timeline. In this context, the data obtained through qualitative data collection tools were integrated into an experimental design, employing a single-group pre-test and post-test experimental design as the core of quantitative data.

According to this design, the impact of the process was examined within a single group. Although a single-group experimental design is typically considered a less robust design, Creswell (2012) argue that it is inherent in studies involving the development and implementation of a new educational attempt. Prior to implementing the module, a pre-test was conducted using the Spatial Thinking Skills Test (STST) and Spatial Concepts Test (SCT) for the gifted students. The instructional intervention spanned a 10-week period. Following the completion of the training, the same measurement tools (STST and SCT) were utilized for the post-test with the gifted students.

In the qualitative aspect of the research, student journals were employed to capture the emotions, thoughts, and expressions of the gifted students regarding their experiences and learning. This allowed students to articulate their experiences in their own words, serving as the primary data source for the research. Following the implementation of each component of the module, focus group discussions were conducted to gather students' perceptions, views, and expressions about their experiences. Focus group discussions are particularly useful for developing or evaluating an educational program or tool, identifying needs, determining the effectiveness of content, assessing the knowledge gained by students in class, and revealing their thoughts (Williams & Katz, 2001). This approach aimed to bring forth the shared perceptions, thoughts, and experiences of students through brainstorming and discussions within the group.

Research Sample

The research sample for this study comprised 30 students in the 5th grade ITR (Individual Talents Recognition) program at Muğla BILSEM during the 2020-2021 academic year. The sequential mixed sampling technique was employed to determine the study group, where probabilistic and purposive sampling techniques are sequentially applied in a quantitative-qualitative or qualitative-quantitative order. The sample used in the quantitative stage ultimately determined the sample for the qualitative stage (Baki & Gökçek, 2012). Demographic information for the 30 gifted students in the research sample is presented in Table 1.

Table 1. Demographic Information regarding 30 Students who Attended the Pre-Test and Post-Test

Category	Variables	f	%
Gender	Female	15	50,0
	Male	15	50,0
	Total	30	100
Residence	Urban	24	80,0
	Rural	6	20,0
	Total	30	100
Mothers' Educational Background	Primary school	1	3,3
	Middle school	10	33,3
	Undergraduate	17	56,7
	Graduate	2	6,7
	Total	30	100
Fathers' Educational Background	Primary school	-	-
	Middle school	8	26,7
	Undergraduate	16	53,3
	Graduate	6	20,0
	Total	30	100

According to Table 1, the research sample consists of a total of 30 gifted students, with 15 (50.0%) female and 15 (50.0%) male participants. Among these students, 24 (80.0%) reside in urban areas while 6 (20.0%) live in rural areas. Looking at the mothers' educational levels, 1 mother (3.3%) is a graduate of primary education, 10 (33.3%) secondary education, 17 (56.7%) hold a bachelor's degree, and 2 mothers (6.7%) have postgraduate degrees. As for fathers' educational levels, there is no father who just graduated from primary education, but 8 fathers (26.7%) are graduates of secondary education, 16 (53.3%) hold a bachelor's degree, and 6 (20.0%) have postgraduate degrees.

To determine the qualitative phase participants, a purposive sampling method, particularly maximum diversity sampling, was employed. In this sense, the students were selected based on their scores—low, moderate, and high – on the STST and SCT, resulting in the formation of a total of 3 focus groups. This method facilitated the examination of each case with its distinctive characteristics, ultimately identifying similar categories (Patton, 1987). Details about the students participating in the focus group discussions are provided in Table 2.

Table 2. The Gifted Students in the Focus Group Discussions

Post-Test Score	Female	Male	Total
STST-High	-	1	1
STST-Average	1	1	2
STST-Low	1	1	2
SCT-High	1	1	2
SCT-Average	1	1	2
SCT-Low	1	-	1
Total	5	5	10

According to Table 2, a total of 10 participants were included in the focus group discussions. This group consisted of 2 individuals with low scores on the STST, 1 individual with a low score on the SCT, 2 individuals with average scores on both the STST and SCT, 1 individual with a high score on the STST, and 2 individuals with high scores on the SCT.

In the qualitative phase, student journals were employed. A total of 5 students, comprising 3 females and 2 males, actively participated in keeping these journals. Regarding their residential locations, 4 students were situated in urban areas whereas 1 student resided in a rural setting. After the application of each module, the students submitted their journals to their teacher through web-based platforms, utilizing them as e-portfolios.

After conducting a literature review on IMSTS, 3 social studies and 2 geography teachers who had worked at BİLSEM were interviewed for needs analysis. The participant group was determined using the convenient sampling method. Before the interviews, communication was established with the teachers, and suitable times were agreed upon for online meetings.

Researcher Role

The researcher actively contributed to the development of the module plan, including the content and methods before the implementation of the IMSTS. The planning and execution of the module were personally undertaken by the researcher. Throughout the process, the researcher actively engaged in a participant role in terms of administering the data collection tools and gathering research data.

Development of the Instructional Module on Spatial Thinking Skills

The Instructional Module on Spatial Thinking Skills was developed based on the Taba-Tyler model within the educational programs. The selection of this model was driven by its flexibility to readjust objectives if the desired outcomes were not achieved during implementation. To initiate the process, a needs analysis was conducted, relevant national and international literature was reviewed, and relevant documents by the Ministry of National Education were examined (MoNE, 2016, Regulations on BİLSEM, 2016; MoNE, 2013, From 2013 to 2017, Strategic and Practical Plans for the Gifted Individuals, 2013; MoNE, 2014, Draft Curriculum Framework for the Gifted, 2014). A total of 150 minutes of online meetings were conducted with a team of 5 teachers at BİLSEM, including 3 social studies teachers and 2 geography teachers, at the specified day and time. A 6-question interview form was prepared for the meetings. Teachers were asked about the challenges they face when teaching spatial thinking skills, their views on the essential information, concepts, and representation tools, and how the teaching-learning process should be. As a result of the interviews, it was expressed that spatial thinking skills training should be skill-based, practical, interdisciplinary, activity-based, projectfocused, and should involve concept teaching, consist of GIS topics, use differentiation strategies, and assess students throughout the process. Accordingly, the general framework was established for the goals, content, educational situations, and assessment stages. The content and educational situations were prepared considering the sub-dimensions of STST developed by Şanlı (2021) based on the tests in the literature to measure spatial thinking (Bednarz & Lee, 2011; Collins, 2018; Jo et al.; 2016; Lee, 2005; Tomaszewski et al., 2015). Some objectives and outcomes of the module were designed by examining BİLSEM Social Studies Instructional Program (MoNE, 2020), Secondary Education Instructional Program for 9th, 10th, 11th, and 12th Grades Geography Course (MoNE, 2018), and the Instructional Plan for Astronomy and Space Sciences Course (MoNE, 2010). Accordingly, four components of the module were prepared: recognizing the space, finding the space, creating spatial information via GIS, and spatial distribution and change. Each component is designed from easy to difficult, simple to complex. Exemplar information for "Recognizing the Space" is presented in Table 3.

Table 3. Spatial Thinking Skills Training – The Content of Recognizing the Space

Module	Theme	Learning Outcomes	Concepts	(Rep.) Tools
Recognizing the Space	**Order of the Universe**	1- Explains the concepts of universe, space, galaxy, solar system, and planet, and hierarchically analyzes them. 2- Questions the location of the earth within the universe and the solar system.	Location, Change, Relation, Hierarchy	Maps, Visuals, Google Earth,
	Time, Change, and Continuity	3- Defines the concepts of time, change, and continuity, and explains the relation among them. 4- Notices the time difference between the Earth and space and evaluates the relativity of time.		

Table 3 indicates that the themes and outcomes within the "Recognizing the Space" module were determined by the sub-dimensions of STST and by the needs analyses conducted by the researcher. The outcomes were structured in accordance with Costa's (2001) taxonomy, which encompasses three levels (input, process, output). This taxonomy was selected due to its suitability and appropriateness in expressing or describing cognitive processes related to spatial thinking (Jo & Bednarz, 2009). In the identification of concepts and representational (Rep.) tools, guidance was taken from the American National Research Council's (NRC, 2006) report and the framework established by Jo and Bednarz (2009), which center on spatial concepts, representational tools, and cognitive processes.

Throughout the instructional process, the foundational strategies of differentiation and enrichment were employed as outlined by the Ministry of National Education in the Social Studies Curriculum for BİLSEM (MoNE, 2020). Therefore, a differentiation approach was embraced in the design of content, process, product, and learning environment stages. Special attention was given to ensuring that the content is interdisciplinary, relevant to contemporary issues, and problem oriented. Learning experiences and activities were meticulously crafted to align with the purpose, content, and desired outcomes. Activity and lesson plans were intentionally designed to be more demanding than those for non-gifted peers, tailored to the interests, abilities, and learning styles of the gifted students.

In IMSTS, assessments were strategically conducted with regards to the learning process. Before, during, and after each module, web-based activities and skill-based questions were directed to the students. At the end of each module, students engaged in self-assessment by composing daily reflections on their learning experiences. Moreover, tasks were assigned to students, prompting them to generate a product related to the given problem. The activities, designs, and products completed by the students throughout the application were closely tracked through e-portfolios on Google Classroom, encompassing their responses within lessons and daily reflections.

In the research, the module was initially developed as a draft, and expert opinions were sought before implementation. After incorporating necessary adjustments based on expert feedback, a pilot application was carried out with 5th grade students in the ITR program of BİLSEM. For the pilot application, a sample module was selected and implemented online for three hours each day, spanning one week at the researcher's institution. Following the pilot study, online interviews were conducted with the students. The interviews revealed that the content was dense, and the number of outcomes was high, suggesting that the lesson duration might be insufficient. Therefore, the goals, content, and the number of outcomes were revisited, resulting in a reduction in the number of outcomes.

Implementation Process

Prior to the implementation of IMSTS, necessary permissions were obtained from Muğla Provincial Directorate of National Education. Meetings were then conducted with school administrators at Muğla BİLSEM to determine the timing of the implementation. The researcher implemented the prepared module at the institution where she worked. Due to the global COVID-19 pandemic in June, July, and August of the 2020-2021 academic year, the module was carried out online once a week for 4 class hours with thirty-minute breaks across 10 weeks.

Data Collection Tools

Demographic Information Form

The form was created to gather personal information about the students participating in the research. After receiving input from experts, necessary adjustments were made to this form. The personal information form included six questions regarding the students' age, gender, place of residence (rural-urban), duration of education at BİLSEM, and the educational backgrounds of their parents.

Expert Opinion Form for the Instructional Module on Spatial Thinking Skills

The module was developed for spatial thinking skills training, encompassing key elements of program development such as goals, outcomes, content, educational scenarios (lesson plans, activities, tools), and assessment. To evaluate the module, the researcher created the IMSTS Expert Opinion Form, featuring four sub-dimensions: goals and outcomes, content, educational scenarios, and assessment. This form includes a total of 28 items, with 8 related to goals and outcomes, 10 to content, 7 to educational scenarios, and 3 to the asessment section. For expert evaluations, each item provides options for "agree," "partially agree," and "disagree," along with space for comments and suggestions. The IMSTS were sent via email, and the IMSTS Expert Opinion Forms were distributed through Google Forms to six experts in the field of social studies education, including two academic faculty members, one curriculum development expert, one geography education professional, one social studies teacher at BİLSEM, and one special education specialist. After collecting expert responses through Google Forms, their comments and evaluations regarding the module were considered to revise the goal statements related to spatial thinking skills, and to reword some outcomes for consistency between goals and outcomes. The outcome statements in the "Finding the Space" module were reorganized based on Costa's (2001) taxonomy into input, process, and output categories.

Spatial Thinking Skills Test

The STST, developed by Şanlı (2021), was utilized as both the pre-test and post-test in the experimental process to assess the spatial thinking skill levels of gifted students. Legal permissions for the test's usage in this research were obtained through email communication with the author. The rationale behind selecting this test for the study lies in its theoretical inclusiveness of sub-dimensions of spatial thinking, its alignment with tests in the literature designed to measure spatial thinking (Bednarz & Lee, 2011; Collins, 2018; Jo et al., 2016; Lee, 2005; Tomaszewski et al., 2015), and its status as the most current measurement tool in this domain (Şanlı, 2021). Comprising 23 items, the test addresses nine sub-dimensions of spatial thinking. The distribution of items for each dimension in the test is presented in Table 4.

Table 4. Sub-Test Items of Spatial Thinking Skills Test

Characteristics	Item #	Number of Questions
Location and navigation	2, 3, 6	3
Graphic display of map patterns	4	1
Converting a 2-dimensional topographic map into a 3-dimensional one	7, 8	2
Profiling based on a topographic map	15	1
Understanding the correlation between spatial patterns	16, 17, 18, 19	4
Choosing the ideal place in spatial areas	1, 5	2
Applying overlay-resolution procedures on spatial factors	20, 21, 22, 23	4
Spatial hierarchy	9, 14	2
Indicating geographical data (point, line, polygon)	10, 11, 12, 13	4
Total		**23**

Table 4 reveals a total of 23 questions, distributed across various spatial thinking dimensions. These include 3 questions related to locating and orienting oneself, 1 question concerning graphically representing patterns on a map, 2 questions about selecting an optimal location within spatial areas, 1 question involving drawing a profile based on a topographic map, 4 questions assessing the understanding of correlation among spatial patterns, 2 questions on transforming a two-dimensional topographic map into three dimensions, 4 questions evaluating the application of overlay-resolution procedures on spatial factors, 4 questions addressing the display of geographical data (point, line, polygon), and 2 questions exploring spatial hierarchy. All test items are designed in a multiple-choice format, with each question having only one correct answer. An illustrative test item is presented in Figure 2.

Item 8. Where is the probable location on the map that the picture below was taken?

A. (...) B. (...) C. (...) D. (...) E. (...)

Figure 2. Spatial Thinking Skills Test – Sample Item

The pilot study for STST was implemented with students in the 5th and 6th grade ITR program, as well as with those in the 7th grade STI (Special Talent Improvement) program at Mugla BİLSEM. In the literature, the general approach suggested for the number of participants is at least 5 times the number of the items in the scale or test (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2012). Accordingly, a total of 125 students participated in the pilot study. The data collected from students were coded into Microsoft Office Excel 2021, where correct answers were coded as 1, and incorrect, blank, or invalid answers were coded as 0. The analysis revealed that the average difficulty of the test was found to be 0.48. An average difficulty index of 0.50 is desired (Büyüköztürk et al., 2012). The skewness value of the test was found to be 0.34, and the kurtosis value was -0.49. Since skewness and kurtosis values were close to 0, the test data was normally distributed. The difficulty coefficients of the test items ranged from 0.32 to 0.78, and the discrimination coefficients ranged from 0.30 to 0.64. These data indicate that the test had moderate difficulty and discriminatory properties.

The test's KR-20 internal consistency coefficient was found to be 0.74, indicating that the test was reliable (Büyüköztürk et al., 2012). To determine the stability of the test over time, the reliability coefficient was examined using the test-retest method. For this purpose, the test was applied to a group of 20 students in the 5th grade at Muğla BİLSEM. After one month from the initial application, the same group was retested, and the correlation between the two applications was calculated. The Pearson correlation coefficient was calculated as 0.89 (high level), which indicates that the test was reliable (Çepni et al., 2009).

Spatial Concepts Test

The development of the Spatial Concepts Test (SCT) was guided by the test development stages outlined by Turgut and Baykul (2010). In creating the test items, the spatial thinking taxonomy developed by Jo and Bednarz (2009) and the concepts and levels in the NRC (2006) report were followed along with relevant studies in the literature on spatial concepts (Gersmehl & Gersmehl, 2007; Golledge, Marsh, & Battersby, 2008; Janelle & Goodchild, 2009).

In the spatial concepts test developed by the researcher, students were presented with two or more visual stimuli and asked to choose the most accurate concept that could describe the difference or relationship between these visuals. The draft test consisted of a total of 24 items, categorized into three levels: basic, simple, and complex. At the basic level, concepts such as location, shape, and direction were included; at the simple level, concepts like profile, scale, and change were included, and at the complex level, concepts such as relation, pattern, diffusion, and hierarchy were covered. An illustrative test item is provided in Figure 3.

Item 19. Choose the concept that best describes the process between the two pictures below.

A) Diffusion B) Magnitude C) Distribution D) Design

Figure 3. Spatial Concepts Test – Sample Item

The content validity of the draft test was determined by the opinions of a social studies teacher and a Turkish language teacher working at BİLSEM, a social studies education specialist, and a faculty member specialized in social studies education teacher training program. Based on the feedback, one item deemed inappropriate for the students' level was removed from the test, resulting in a total of 23 questions in the draft test. A pilot study was conducted with 20 students from the 5th grade ITR program at Muğla BİLSEM. Two additional questions were also removed from the test based on the feedback from the students. The test was then administered to a total of 104 students from the 5th and 6th grade ITR program and 7th grade STI program for item analysis. Having four multiple choices, each item was scored 1 for each correct answer and 0 for incorrect answers, unanswered items, or items with more than one answer. The average difficulty index of the test was determined to be 0.50, indicating a moderate difficulty level. The skewness value was 0.76, and the kurtosis value was 0.34. Since both skewness and kurtosis values were close to 0, the test data exhibited a normal distribution. One item with an item discrimination index below 0.19 and an item difficulty index above 0.61 was removed from the SCT. The remaining 20 items showed a difficulty index between 0.30 and 0.74 and a discrimination index between 0.31 and 0.80, indicating a moderately difficult and discriminating test. The reliability of the test, measured by the KR-20 coefficient, was found to be 0.77, indicating sufficient reliability. The test-retest method was employed to determine the internal consistency of the SCT. A group of 20 students from the 5th grade ITR program at Muğla BİLSEM participated in the initial test, and the same test was administered to the same group one month later. The Pearson correlation coefficient between the first and last administrations was found to be 0.88, indicating high internal consistency and reliability.

Student Journals

To enhance the richness of the research data and explore students' emotions and thoughts, student journals were used. Four guiding headings were formulated for the draft student journal in line with the research aims. These headings pertained to what students learned in class, their emotional experiences, preferred sections, and challenging areas. To ensure the content validity of the student journal, input was sought from a social studies teacher and two faculty members specialized in social studies education. Following the feedback, the headings were revised to be more concise and explicitly phrased. Upon completion of each component of the module, student journals were distributed to voluntary participants via Google Classroom, and within a week, they were collected through the same platform after being filled out.

Focus Group Discussion Form

In the research, focus group discussions – a qualitative data collection technique – was employed to determine students' experiences, emotions, and thoughts regarding the training they received. In Krueger's (1994) approach, the primary objective of focus groups is not to create meaning but to understand; not to generalize but to describe diversity; not to make inferences about participants but to identify how participants perceive the event. Thus, the perspectives of different groups regarding the instructional module were examined in detail. A total of 8 questions were formulated for the preliminary discussion form. After 2 experts in social studies education and 2 social studies teachers evaluated the preliminary form, necessary corrections were applied to the sentences in the form, and it was piloted with 3 students. Following the pilot discussion with students, 2 questions yielding similar responses were discarded. After providing students with preliminary information about the upcoming interview, specific days and times were allocated for 3 groups. The discussions were conducted online via Zoom, sequentially engaging high, average, and low-scoring groups on the same day. Each group discussion lasted a minimum of 150 minutes. To prevent data loss, permissions were secured, and audio-visual recordings were made during the discussions. Subsequently, these recordings were transcribed verbatim into written text. When transcribing the data obtained from the discussions, students were coded based on their achievement levels: students with a high score as SHS1, average-scoring students as SAS1, and low-scoring students as SLS1.

Interview Form for Needs Analysis

A needs analysis was conducted to improve spatial thinking skills of 5th grade students participating in the ITR program at BİLSEM and develop a module for this purpose. After a comprehensive literature review, a semi-structured interview form containing 6 questions was prepared for teacher opinions. For the content validity of the form, the draft was sent to 2 social studies education experts and 1 curriculum development expert via email. Based on the feedback received, the content of the questions was revised, and the interview form was finalized with 6 questions. During the interviews with teachers, they were asked about the content, concepts, and representational tools they considered important in developing spatial thinking skills. Their opinions were also sought on the way activities should be designed and the challenges they faced in teaching spatial thinking skills. After preliminary interviews with 3 social studies teachers and 2 geography teachers working at BİLSEM, the interviews were conducted online via Zoom at a mutually convenient time.

Validity and Reliability Analyses

In the quantitative phase of the research, validity analysis was conducted to make sure that the tests were suitable for the testing objectives and reliability analysis was carried out to check the tests' consistency and stability. Recognizing the potential impact of an extended time span in longitudinal studies, the implementation period for IMSTS was deliberately set at 10 weeks to minimize variations in participants' experiences due to external factors like changes and maturation (Büyüköztürk et al., 2012). Moreover, the implementation process was conducted with students from the researcher's institution, mitigating potential biases and reactions within the research sample. To prevent participants from becoming familiar with the test content, equivalent forms were meticulously prepared for both the pre-test and post-test maintaining the internal validity.

To enhance the external validity of the research, a comprehensive description was provided for the assessment tools, participant group, and implementation process; the purposive sampling method was employed, and direct quotations from the data were incorporated into the findings section.

After devising a specification table for the content validity of STST and SCT, adjustments were made based on the feedback from experts in the respective fields. Following the pilot application to determine the validity and reliability of the tests, item analyses were conducted, and the KR-20 coefficient was calculated.

In the qualitative research approach, the concept of validity is expressed as credibility and transferability while the concept of reliability refers to consistency and confirmability (Ary, Jacobs, Sorensen, & Walker, 2010). According to Merriam and Tisdell (2015), the internal validity in the positivist approach is equivalent to credibility in the qualitative approach. Accordingly, the interview questions for the needs analysis, focus group discussion questions, and student journals were developed through participant confirmation and expert opinions. The outcomes, content, learning experiences, and assessment aspects of the IMSTS were examined by experts using an expert opinion form. Following feedback, a pilot implementation was conducted to identify deficiencies in the module, and necessary corrections were made based on the results obtained.

In the research, purposive sampling technique was employed for transferability. In this context, the selection criteria and detailed information about both the research process and the environment were provided together with the participants' statements included in the findings section. For research consistency (internal reliability), support was obtained from a social studies teacher with 12 years of experience to analyze the data. The teacher was asked to evaluate both the data analysis and the appropriateness of the findings. At this stage, the researcher aimed to both contain her subjectivity and identify potential methodological issues (Yaşar, 2018). For confirmability (external reliability), all stages (data collection, data organization, coding, theme analysis, reporting) were detailed, information was provided about the research environment and processes, and all data were securely stored in a computerized environment.

Data Analysis

The data collection tools, STST and SCT were administered to the students as pre-test and post-test. The obtained data were analyzed using the SPSS 21 program. To determine whether parametric or non-parametric analyses would be used in the research, normality values were examined. Since the size of the study group was less than 50, the Shapiro-Wilk test was used to determine the normal distribution of the data (Büyüköztürk, 2002). Following the Shapiro-Wilk test analysis, with a p-value greater than 0.05, the decision was made to proceed with parametric tests. A normality test analysis was conducted based on the difference between participants' pre-test and post-test scores on the Spatial Concepts Test (SCT). The results of the Shapiro-Wilk test are presented in Table 5.

Table 5. Normality Test Results for Spatial Concepts Test

Kolmogorov-Smirnov(a)			Shapiro-Wilk			Skewness	Kurtosis
Statistics	df	p	Statistics	df	p		
,120	30	,200*	,949	30	,158	-,046	-,671

According to the Shapiro-Wilk analysis results in Table 5, the gain scores of the Spatial Concepts Test exhibit a normal distribution (S-W: $p > 0.05$). The test value being greater than 0.05 indicates that the data are normally distributed (Tabachnick & Fidell, 2013).

Table 6 presents the results of the normality test for the distribution of the dependent variables (pre and post-test scores obtained from spatial concepts test) according to the subcategories of gender and location (independent variables).

Table 6. Normality Test Results in terms of Gender and Location for Pre and Post-Test Scores on the Spatial Concepts Test

Test	Gender	Shapiro-Wilk Test		
		Statistics	sd	p
Pre-test	Female	,936	15	,331
	Male	,913	15	,148
Post-test	Female	,864	15	,062
	Male	,975	15	,924
Test	**Location**	**Statistics**	**sd**	**p**
Pre-test	Rural	,905	6	,405
	Urban	,943	24	,189
Post-test	Rural	,912	6	,452
	Urban	,904	24	,061

The Shapiro-Wilk analysis presented in Table 6 shows that pre and post-test scores, based on gender and location variables, exhibit a normal distribution (S-W: $p>0.05$).

A normality test was carried out based on the difference between pre and post-test scores (gain scores) on the STST, and the results of the Shapiro-Wilk test are presented in Table 7.

Table 7. Normality Test Results for the Spatial Thinking Skills Test

Kolmogorov-Smirnov(a)			Shapiro-Wilk			Skewness	Kurtosis
Statistics	df	p	Statistics	df	p		
,136	30	,165	,959	30	,300	-,029	-,292

The Shapiro-Wilk analysis given in Table 7 indicates that the gain scores of Spatial Thinking Skills Test have a normal distribution (SW: 0.300, $p > 0.05$).

Table 8 shows the results of the normality test results for the distribution of the dependent variables (pre and post-test scores obtained from STST) according to the subcategories of gender and location (independent variables).

Table 8. Normality Test Results in terms of Gender and Location for Pre and Post-Test Scores on the Spatial Thinking Skills Test

Test	Gender	Shapiro-Wilk Test		
		Statistics	sd	p
Pre-test	Female	,955	15	,614
	Male	,949	15	,512
Post-test	Female	,958	15	,659
	Male	,953	15	,571
Test	**Location**	**Statistics**	**sd**	**p**
Pre-test	Rural	,927	6	,560
	Urban	,966	24	,563
Post-test	Rural	,944	6	,692
	Urban	,964	24	,517

The Shapiro-Wilk analysis results in Table 8 show that pre and posttest scores are in normal distribution in terms of gender and location variables (S-W: $p>0.05$).

Cohen's d statistics was utilized in the research to determine the effect size, i.e., how much significant difference exists. Morris and DeShon (2002) suggest an approach that considers correlation to determine effect size in single group pre and post-test studies. Cohen's d value less than 0.2 indicates a small effect size, 0.5 indicates a medium effect size, and greater than 0.8 indicates a large effect size (Kılıç, 2014, p. 45).

For the evaluation of the instructional module, frequencies and percentage distributions were examined based on the expert opinion form. Accordingly, experts responded to 28 items for IMSTS, with 24 items marked as "agree," 2 items as "partially agree," and 2 items as "disagree."

A frame of headings was created for the student journals utilized in this study, and the data were analyzed descriptively based on these headings. The data obtained from the needs analysis form and focus group discussions form were analyzed according to content analysis. Since there is no aim of generalization to the universe in focus group discussions, concepts and connections are formulated without quantifying the data (Fern, 2001) (Selçuk, Palancı, Kandemir, & Dündar, 2014). In this sense, the data obtained from student journals, the needs analysis form, and the focus group discussion form were analyzed by both the researcher and a teacher pursuing a doctorate in the field of education. The codes determined by two researchers were compared according to the formula created by Miles and Huberman (1994) ([Agreement / (Agreement + Disagreement)] x 100), and agreement regarding the codes was calculated. After the codes were determined, the data were presented in tables based on categories and themes.

Limitations

Due to the COVID-19 pandemic, the research process involved collecting data through online platforms, specifically using Google Forms and Google Classroom. Additionally, the focus group discussions were conducted online via Zoom. The research is limited to 5th grade enrollees at Muğla BİLSEM 5th grade ITR program during the spring semester of the 2020-2021 academic year.

Ethical Approval

The ethical approval for the appropriateness of this research has been obtained from the Anadolu University Board of Scientific Research and Publication Ethics with the approval number 69185 dated 07.06.2021 A pre-application was made through ayse.meb.gov.tr to request permission to conduct the study and collect data from BILSEMs affiliated with the Ministry of National Education and. As a result of the application, necessary permissions were granted by Muğla Provincial Directorate of National Education with the approval number 91453 dated 02.07.2021.

Findings

This section presents the findings regarding the research problem and sub-problems in line with the research aims.

Findings Regarding the Pre and Post-Test Scores of the Gifted Students on the Spatial Concepts Test

Table 9 displays the results of the paired-sample t-test analysis for the pre and post-test scores of Muğla BİLSEM 5th grade ITR program students on the SCT.

Table 9. Paired-Sample t-Test Results for Pre and Post-Test Scores on the Spatial Concepts Test

Test	N	$\bar{X}$	Ss	Sd	t	p
Pre-Test	30	7,5	2,73	29	-27,6	,000*
Post-Test	30	16,3	2,90			

According to the t-test analysis results in Table 9, a significant difference was found between students' pre and post-test scores ($t(29) = -27.6$; $p < 0.05$) on the SCT. Cohen's d value was examined to determine the magnitude of this difference. The analysis revealed a Cohen's d value of 5.153. Since Cohen's d value is greater than 0.8, it indicates a strong effect size (Kılıç, 2014). Therefore, the implemented module has shown a high level of effectiveness in enhancing students' spatial concepts.

Table 10 presents the paired-sample t-test analysis results for the pre and post-test scores of Muğla BİLSEM 5th grade ITR program students on the sub-dimensions of the spatial concepts test.

Table 10. Paired Sample t-Test Results for Pre and Post-Test Scores on the Sub-Dimensions of the Spatial Concepts Test

Sub-dimensions of Spatial Concepts Test	Test	N	$\bar{X}$	Ss.	Sd	t	p
Basic Concepts	Pre-Test	30	2,50	1,137	29	6,88	,000*
	Post-Test	30	3,96	,927	29		
Simple Concepts	Pre-Test	30	3,13	1,136	29	16,26	,000*
	Post-Test	30	6,86	1,407	29		
Complex Concepts	Pre-Test	30	1,90	1,446	29	15,28	,000*
	Post-Test	30	5,46	1,252	29		

In Table 10, a significant difference is displayed between the pre and post-test scores of the gifted students on the sub-dimensions of the SCT ($p < 0.05$). It is observed that the highest differences are in the sub-dimensions of simple concepts ($t(30) = 16.26$; $p = .000 < 0.05$), complex concepts ($t(30) = 15.28$; $p = .000 < 0.05$), and basic concepts ($t(30) = 6.88$; $p = .000 < 0.05$). Accordingly, the students have shown the highest achievement in the sub-dimensions of simple, complex, and basic concepts, respectively.

Findings Regarding the Pre and Post-Test Scores of the Gifted Students in terms of the Gender Variable on the Spatial Concepts Test

Table 11 shows the independent sample t-test results for the pre and post-test scores of Muğla BİLSEM 5th grade ITR program students on the SCT in terms of the gender variable.

Table 11. Independent Sample t-Test Results in terms of the Gender Variable for Pre and Post-Test Scores on the Spatial Concepts Test

	Test	Gender	N	$\bar{X}$	Ss	t	p
Spatial Concepts Test	Pre-Test	Female	15	8,1	3,1	1,210	,237
		Male	15	6,9	2,1		
	Post-Test	Female	15	16,8	3,2	,942	,354
		Male	15	15,8	2,5		

According to the t-test analysis shown in Table 11, there is no significant difference between the pre ($t(28)=1.210$; $p>0.05$) and post-test scores ($t(28)=0.942$; $p>0.05$) of students in terms of the gender variable. Based on this data, gender is not a variable definitive over how much students know about spatial concepts both before and after the instructional module.

Findings Regarding the Pre and Post-Test Scores of the Gifted Students in terms of the Location Variable on the Spatial Concepts Test

Table 12 displays the independent sample t-test analysis results for the pre and post-test scores of Muğla BİLSEM 5th grade ITR program students on SCT in terms of the location variable.

Table 12. Independent Sample t-Test Results in terms of the Location Variable for Pre and Post-Test Scores on the Spatial Concepts Test

	Test	Location	N	$\bar{X}$	Ss	t	p
Spatial Concepts Test	Pre-Test	Urban	24	7,8	2,8	1,210	,237
		Rural	6	6,3	2,1		
	Post-Test	Urban	24	16,4	3,1	,434	,668
		Rural	6	15,8	1,9		

In the independent sample t-test analysis presented in Table 12, no significant difference was determined between pre ($t(28)=1.210$; $p>0.05$) and post-test scores ($t(28)=0.434$; $p>0.05$) of the students in terms of the location variable. Despite an increase in the pre and post-test scores in terms of the location variable, statistically, it does not indicate a significant difference.

Findings Regarding the Pre and Post-Test Scores of the Gifted Students on the Spatial Thinking Skills Test

Table 13 presents the paired-samples t-test analysis results for the pre and post-test scores of Muğla BİLSEM 5th grade ITR program students on the STST.

Table 13. Paired Sample t-Test Results for Pre and Post-Test Scores on the Spatial Thinking Skills Test

Test	N	$\bar{X}$	Ss	Sd	t	p
Pre-Test	30	12,4	4,16	29	-19,0	,001*
Post-Test	30	17,5	3,40			

According to the t-test analysis presented in Table 13, there is a statistically significant difference between the pre and post-test scores of the students ($t(29) = -19.0$; $p<0.05$). Cohen's d analysis yielded an effect size of 3.631. Therefore, it can be concluded that the IMSTS had a significantly high impact on improving the spatial thinking skills of the students.

Findings Regarding the Pre and Post-Test Scores of the Gifted Students in terms of the Gender Variable on the Spatial Thinking Skills Test

Table 14 shows independent sample t-test results for the pre and post-test scores of Muğla BİLSEM 5th grade ITR program students on the STST in terms of the gender variable.

Tablo 14. Independent Sample t-Test Results in terms of the Gender Variable for Pre and Post-Test Scores on Spatial Thinking Skills Test

	Test	Gender	N	$\bar{X}$	Ss	t	p
Spatial Thinking Skills Test	Pre-Test	Female	15	13,1	3,4	,963	,344
		Male	15	11,6	4,7		
	Post-Test	Female	15	18,0	2,9	,855	,400
		Male	15	17,0	3,8		

As shown in Table 14, there is no statistically significant difference between the pre ($t(28)=0.963$; $p>0.05$) and post-test scores ($t(28)=0.855$; $p>0.05$) of the female and male students on the STST. While there may be a numerical difference in the pre and post-test averages between the female and male students, this difference is not statistically significant. Accordingly, it is plausible to conclude that gender is not a variable determining spatial thinking skills.

Findings Regarding the Pre and Post-Test Scores of the Gifted Students in terms of the Location Variable on the Spatial Thinking Skills

Table 15 displays independent sample t-test results for the pre and post-test scores of Muğla BİLSEM 5th grade ITR program students on the STST in terms of the location variable.

Table 15. Independent Sample t-Test Results in terms of the Location Variable for the Pre and Post-Test Scores on the Spatial Thinking Skills Test

	Test	Location	N	$\bar{X}$	Ss	t	p
Spatial Thinking Skills Test	Pre-Test	Urban	24	12,8	3,8	1,146	,262
		Rural	6	10,6	5,3		
	Post-Test	Urban	24	17,8	3,0	1,105	,279
		Rural	6	16,1	4,6		

According to the t-test analysis results in Table 15, there is no statistically significant difference in the pre ($t(28)=1.146$; $p>0.05$) and post-test scores ($t(28)=1.105$; $p>0.05$) of the students in terms of the location variable. Thus, location is not a variable affecting the students' spatial thinking skills.

BİLSEM ITR Program Students' Opinions regarding the Instructional Module on Spatial Thinking Skills

The findings concerning the responses to "What I Learned in Class" given by the students who attended spatial thinking skills training in the social studies course are presented in Table 16 with direct quotations from the students' journals.

Table 16. Findings Regarding What Students Learned During Spatial Thinking Skills Training in the Social Studies Course

Theme	Category	Codes	f
What the Students Learned Through Spatial Thinking Skills Training in the Social Studies Course	Knowledge	Navigation	5
		Reading topographical maps	5
		Spatial evaluation	4
		The relation between people and nature	4
		Relativity of time	3
	Skills	Creating geographical data on maps	4
		Thinking in two and three dimensions	4
		Perceiving the space	2
		Perceiving the change	2
	Values	Environmental sensitivity	4
	Concepts	Hierarchy	3
		Diffusion	2
		Design	1

A closer examination of Table 16 indicates that the gifted students noted gains in four categories through spatial thinking skills training — knowledge, skills, values, and concepts. In the knowledge category, the most frequently emphasized gains are navigation (f=5) and reading topographic maps (f=5). In the skills category, the students highlighted creating geographical data on maps (f=4) and thinking in two and three dimensions (f=4). Regarding values, they mostly expressed developing environmental sensitivity whereas hierarchy (f=3) is the most frequent gain in terms of spatial concepts. Some expressions taken from the students' journals are given below to reflect what they learned:

> ***Participant S4***: *"Our teacher taught us how to determine the north by looking at the sun, stars, the length of shadows, a compass, and a phone. Additionally, I demonstrated how to find my way from BİLSEM to my home by drawing a route on Google Maps."*
>
> ***Participant S2:*** *"In this week's class, I saw how maps are created for the first time. Together with our teacher, I learned the meanings of points, areas, and lines on the map by creating my own map."*
>
> ***Participant S1:*** *"I learned the hierarchical order of the components of the universe, Earth, galaxies, and the solar system, and how we exist in a certain order."*

The findings regarding the replies to "What I Liked About the Course" given by the students who attended spatial thinking skills training in the social studies course are presented in Table 17 with direct quotations from the students' journals.

Table 17. Finding Regarding What Students Liked about the Social Studies Course

Theme	Category	Codes	f
Liked Components	Content	Infinity of the universe	4
		Giving directions	4
		Formation of natural phenomena	3
		Profiling on maps	2
	Activities	Virtual Orienteering	4
		Solving puzzles	4
		3-D models	3
	Materials & Tools	Google Earth	3
		GIS	3
		Web 2.0. tools	3

Table 17 points out that the gifted students liked the categories of content, activities, and materials and tools during spatial thinking skills training. In the content category, the infinity of the universe (f=4) and giving directions (f=4) were liked the most. In the activity category, virtual orienteering (f=4) and solving puzzles (f=4) were the most appreciated. Additionally, students also liked the tools they used in the training, such as Google Earth (f=3), GIS (f=3), and web 2.0 tools (f=3). Some of the relevant quotations taken from the students' journals are as follows:

> ***Participant S1:*** *"The part I liked the most was the section where we looked at the universe with an application because it was astonishing to see that there are millions of galaxies beyond us in the universe."*
>
> ***Participant S3:*** *"The parts I liked the most in class were when we examined the Earth's surface features with Google Earth. I saw the Butterfly Valley, which I had never seen before, with Google for the first time. Indeed, when viewed from above, it really looks like the letter 'V'."*
>
> ***Participant S5:*** *"I really enjoyed learning through orienteering in class. I had fun trying to find the target, and I would like to do it again."*

The findings regarding the replies to "What I Found Difficult About the Course" given by the students who attended spatial thinking skills training in the social studies course are presented in Table 18 with direct quotations from the students' journals.

Table 18. Findings Regarding What the Students Found Difficult About the Social Studies Course

Theme	Category	Codes	f
Difficult Components	Content	Map scales	3
	Activities	Profiling	3
		Calculating distance and time	1
	Materials & Tools	GIS application	3
	Easy Training	Nothing is difficult	4

Table 18 indicates that the gifted students faced challenges mostly in the content, activities, and materials and tools categories during spatial thinking skills training. Conversely, four students mentioned that they did not find any part of the training challenging. Students had difficulties particularly with map scales (f=3) in the content category and with creating profiles (f=3) in the activity category. In the materials and tools category, they struggled while using only the GIS program (f=3). Some of the relevant quotations from the students' journals are as follows:

Participant S4: *"I am mixing up small-scale maps with large-scale maps. The name is small, but the map seems big."*

Participant S2: *"When drawing maps on the Internet, I sometimes mix up certain places. It gets confusing whether I should represent landforms as points or areas."*

Participant S1: *"No part of the course was difficult for me."*

These findings underline that the gifted students have gained skills in the categories of knowledge, skills, values, and concepts during spatial thinking skills training. It has been determined that the most liked and difficult parts of the training consist of content, activities, and the materials and tools categories.

Focus Group Discussions with BİLSEM 5th Grade ITR Program Students about the Instructional Module on Spatial Thinking Skills

Muğla BİLSEM 5th grade ITR program students were asked to compare the spatial thinking skills training module carried out in the social studies course with the regular social studies course they followed at BİLSEM. Relevant findings distilled from the students' responses are given in Table 19.

Table 19. Findings Distilled from the Comparison of the Instructional Module on Spatial Thinking Skills Carried Out in the Social Studies Course with the Social Studies Course at BİLSEM

Focus Group	Theme	Category	Codes	f
The Focus Group with a High Score	Content and Instruction	Outcomes	Interpreting topographic maps	3
			Natural and humane spaces	2
			Spatial changes	2
			The order of the universe	1
		Activities	Virtual orienteering	2
			2 and 3 dimensional drawings	1
			Splitting the continents-Puzzle	1
		Materials & Tools	GIS program	1
			Simulation applications	1
			Google Maps	1
The Focus Group with an Average Score	Content and Instruction	Outcomes	Natural and humane spaces	3
			Interpreting topographical maps	2
			Spatial changes	1
		Activities	Virtual orienteering	4
			2 and 3 dimensional drawings	2
			Experimenting	2
		Materials & Tools	GIS program	2
			Google Earth	2
The Focus Group with a Low Score	Content and Instruction	Outcomes	Interpreting topographical maps	3
			Spatial changes	3
			Natural and humane spaces	1
		Activities	Virtual orienteering	3
			2 and 3 dimensional drawings	2
			Splitting the continents-Puzzles	2
		Materials & Tools	GIS program	2
			Google Earth	1

As displayed in Table 19, focus groups with high, average, and low scores compared the two courses in terms of "content and instruction." This comparison was made across outcomes, activity, and materials and tools. The common opinion of all groups with high, average, and low scores was that topographic map interpretation (f=8), spatial change (f=6), and natural and human-made spaces (f=5) in the outcome category, virtual orienteering (f=9) and 2D and 3D drawings in the activity category, and the GIS program (f=5) in the materials and tools category were challenging.

During the discussions conducted with high, average, and low scoring students, some students expressed their opinions as follows:

> ***Participant SHS2****: "The difference between time on Earth and time in space, the change in the cryosphere, topographic maps, and the Pangea Continent were things I hadn't seen before. It was different from the social studies course. Learning about landforms and the earth's crust through orienteering felt unique. I played orienteering for the first time, and it was very fun…"*

> ***Participant SMS5****: "In my opinion, there are similar topics, but the things that were different were the ones related to the universe. I hadn't seen these in our social studies class; we mostly covered them in science class. I had never played orienteering before; it was a fun activity for me. Also, making a 3D model of the Earth's crust was different. We never did that in the social studies course."*

> ***Participant SLS8:*** *"Studying landforms in topography was different for me. I learned the meaning of colors and lines, and that as contours get closer, the slope increases. We tried to find the most suitable settlement areas on the map. It was different from our previous lessons. We found and discussed both natural and man-made spaces using Google Earth."*

All groups have compared the two social studies courses across the categories of content, activity, and materials and tools. The shared opinion of the groups with respect to what they learned was topographic maps. Likewise, the common expressions shared by all groups in the activity and materials and tools categories were "virtual orienteering" and the "GIS program" respectively.

Table 20 presents the findings filtered from what Muğla BİLSEM 5th grade ITR program students stated that they learned through spatial thinking skills training in the social studies course.

Table 20. Findings Regarding What the Gifted Students Learned through the Instructional Module on Spatial Thinking Skills in the Social Studies Course

Focus Group	Theme	Category	Codes	f
The Focus Group with a High Score	Learning	Knowledge	Relationships in natural and humane areas	3
			Evaluating maps, graphs, and tables	2
			Spatial concepts	2
			Learning new information	1
		Skills	Thinking in 2 and 3 dimensions	3
			Using a map	2
			Designing a map on GIS	2
			Problem solving	2
			Giving directions	1
			Perceiving change and continuity	1
			Playing virtual orienteering	1
		Values	Environmental sensitivity	3
The Focus Group with an Average Score	Learning	Knowledge	Spatial concepts	3
			Evaluating maps, graphs, and tables	2
			Relations in natural and humane areas	1
		Skills	Designing maps on GIS	4
			Playing virtual orienteering	4
			Using a map	2
			Thinking in 2 and 3 dimensions	2
			Giving directions	2
			Perceiving change and continuity	2
		Values	Environmental sensitivity	4
The Focus Group with a Low Score	Learning	Knowledge	Relations in natural and humane areas	3
			Evaluating maps, graphs, and tables	2
			Spatial concepts	1
		Skills	Designing maps on GIS	2
			Thinking in 2 and 3 dimensions	2
			Using a map	2
			Giving directions	2
			Perceiving change and continuity	2
			Virtual orienteering	1
		Values	Love of nature	2

Table 20 shows that all focus groups have indicated that they achieved gains in three categories—knowledge, skills, and values—through spatial thinking skills training. Students with high, average, and low scores commonly expressed that in the knowledge category, they gained an understanding of relationships in natural and human-made areas (f=7), evaluating maps, graphs, and tables (f=6), and spatial concepts (f=6). In the skills category, they mentioned gaining skills in designing maps with GIS (f=8), thinking in 2D and 3D (f=7), giving directions (f=7), map usage (f=6), virtual orienteering (f=6), and perceiving change and continuity (f=5). In the value category, high and average-score groups expressed gains in environmental sensitivity (f=7) while low-score group mentioned learning love of nature (f=2)

During the discussions conducted with high, average, and low scoring students, some students expressed their opinions as follows:

Participant SHS1: *"We learned new things in the class. We learned new words in the class. For example, I had never heard the words 'hierarchy' and 'diffusion' before. We examined natural events together with my friends. For instance, we studied the changes in glaciers on maps. It is really sad to see the negative impact on the climate due to the decrease in glaciers after all those years."*

Participant SAS6: *"You told us to find suitable places for human life and build a city in our class. I really liked that. I do similar things when playing games on my computer... We thought about how we can establish a balance between nature and humans."*

Participant SlS8: *"I found my own place on the map. Trying to visualize the location in my mind, I attempted to find the target... I realized how natural elements change over time due to human intervention and that we need to protect them."*

It has been determined that student gains in all groups fall into the categories of knowledge, skills, and values. For all groups, the common and most frequently expressed aspects across the categories of knowledge, skills, and values were "relationships in natural and human-made areas", "designing maps with GIS", and "environmental sensitivity" respectively.

Table 21 displays the findings regarding the difficulties Muğla BİLSEM 5th grade ITR program students faced during spatial thinking skills training in the social studies course.

Tablo 21. Findings Regarding the Gifted Students' Opinions about the Difficult Parts of the Instructional Module on Spatial Thinking Skills

Focus Group	Theme	Category	Codes	f
The Focus Group with a High Score	Materials and tools	Using GIS program	Creating data on GIS program	3
The Focus Group with an Average Score	Content	Topic	Types of scales	4
The Focus Group with a Low Score	Materials and Tools	Using GIS program	Creating data on GIS program	3

Table 21 shows that focus groups with high and low scores struggled the most when using the GIS program (f=6) in the materials and tools category. On the other hand, the focus group with an average score found the types of scales (f=4) in the content category most difficult.

During the discussions conducted with high, average, and low scoring students, some students expressed their opinions as follows:

Participant SHS1: *"I didn't really struggle with anything. But when using GIS, I mixed up data about areas and lines. Maybe because it was the first time we did such an application."*

Participant SAS6: *"I generally didn't struggle much in the lessons, but sometimes it gets confusing to classify scales as large and small. Maps were different from each other, but deciding on the scale type was sometimes challenging."*

Participant SLS8*: "I only had difficulty with trees and forested areas. More specifically, I couldn't be sure whether to use points or areas."*

In the research, all students who received high and low scores struggled the most when using the GIS program. Students with average scores, on the other hand, found types of scales most difficult.

Table 22 shows the findings regarding Muğla BİLSEM 5th grade ITR program students' opinions as to the integration of spatial thinking skills training into the social studies course.

Table 22. Findings Regarding the Gifted Students' Opinions about the Integration of Spatial Thinking Skills Training into the Social Studies Course

Focus Group	Theme	Category	Codes	f
The Focus Groups with a High Score	Should be integrated	Feelings	Being motivated	3
			Feeling good	2
			Enjoying the topics	2
		Instruction	Being practical	3
			Life based	1
		Skills	Thinking skills	2
The Focus Group with an Average Score	Should be integrated	Feelings	Being motivated	2
			Enjoying the topics	2
			Interested	1
		Instruction	Being practical	3
The Focus Group with a Low Score	Should be integrated	Feelings	Being motivated	3
			Enjoying the topics	2
		Skills	Thinking skills	2

According to Table 22, focus groups with high, average, and low scores unanimously agreed on the inclusion of spatial thinking skills training into the social studies course. All focus groups expressed a desire for spatial thinking skills training to be a part of the social studies course because they felt motivated (f=8). Focus groups with high and average scores specifically wanted spatial thinking skills training in the social studies course due to its practical application (f=6) and its support for thinking skills (f=2).

During the discussions conducted with high, average, and low scoring students, some students expressed their opinions as follows:

> ***Participant SHS2:*** *"It's better when there are activities and games in a lesson. I come to class with enthusiasm because learning different and new things always motivates me."*
>
> ***Participant SAS5****: "I don't like it when there are too many topics in classes, but I liked the topics in this class. This is how our social studies class captures my interest."*
>
> ***Participant SLS9:*** *"In my opinion, we saw different perspectives in the class. Actually, it was a mixture of all the lessons. I tried to think creatively about how to find solutions to problems."*

All groups have expressed positive opinions about the inclusion of spatial thinking skills training into the social studies course. Looking at the students' views, a common expression is that they are motivated by the class.

Discussion and Conclusion

At the end of the research, IMSTS has been determined effective in developing spatial concepts of the gifted students. Cohen's d value greater than 0.8 indicates a high level of impact on the development of spatial concepts through education (Kılıç, 2014).

The relevant body of literature includes various studies conducted to develop spatial concepts of teachers and students (Alyamâni et al., 2021; Jo, 2011; Katsuhiko, 2016; Özdemir, 2011; Tarwana, 2016). Jo (2011) conducted a workshop with teacher candidates and found a significant difference between pre and post-test scores as regards spatial concepts, with Cohen's d value of 2.45. Şanlı (2020b) examined the cognitive structures of geography teacher candidates concerning spatial concepts. The study revealed misconceptions in the sentences of teacher candidates as regards advanced spatial concepts. In their study, Alyamâni et al. (2021) prepared a visual and graph-based training program for the development of certain spatial and temporal concepts in preschool children. The experimental group differed significantly by the end of their study. Literature review yields that instructional programs are designed in some studies to develop spatial concepts while activities are carried out within the scope of a course through various methods and techniques in others. Among these methods and techniques, web-based GIS applications are notable. Studies have shown that GIS-based activities are effective in the development of spatial concepts (Jo & Hong, 2020; Oda, 2012). These data indicate that systematically implemented programs, workshops, or activities in different study groups are effective in developing spatial concepts. All these results are consistent with the findings of the current research, suggesting that planned activities or instructional processes can enhance spatial concepts. An analysis of the Social Studies Curriculum for BİLSEM 2021 shows that the concepts of location and direction at the basic level and change at the simple level are included within the program whereas no concepts at the complex level has been covered in terms of spatial thinking skills. The instructional module developed for the present research includes the concepts that comprise spatial thinking skills across all levels.

The gifted students in the research scored the lowest average in the pre-test of spatial concepts test for the complex-level concepts such as "diffusion, pattern, and correlation." Complex-level concepts can be more abstract and challenging for students in terms of their developmental stage. Generally, complex-level concepts are acquired at the secondary education level. The Curriculum for the Geography Course (9th, 10th, 11th, and 12th grades) published by the MoNE the Board of Education in 2018 includes concepts such as correlation, distribution, and hierarchy. In this regard, the students' struggle with complex-level concepts should be deemed natural. After the IMSTS, students' achievements related to complex-level concepts increased significantly. This result has also been reflected in students' journals, with concepts such as "hierarchy, diffusion, and pattern" being the most frequently noted ones in terms of what the students learned. Additionally, during focus group discussions, the students across all score levels underlined that they learned "spatial concepts" in spatial thinking skills training.

This research concludes no significant difference in terms of gender and location with respect to what the students knew and learned about spatial concepts. The absence of a noteworthy difference between male and female students may be attributed to their ages since the period between 7 and 11 is the time when gender-related developmental differences are minimal as noted by Tunalı and Emir (2017). Regarding the location variable, the absence of a difference between the students living in urban and rural areas may be attributed to the settlement geography characteristics of Muğla province because tourism activities in Muğla increased, especially in coastal areas, between 2000 and 2012. With the rapid population growth in coastal areas, these settlements have acquired an urban character (Kahraman, 2018), which may account for the lack of a significant difference between the students in terms of the location variable.

A significant difference was noted between the pre and post-test scores the gifted students got on the spatial thinking skills test. According to the results, the instructional module on spatial thinking skills has had a high level of effectiveness in improving the participants' spatial thinking skills. The relevant body of studies is populated with research endeavors aiming to enhance individuals' spatial thinking skills through various training programs, workshops, courses, methods-techniques, or activities across variegated samples (Hawes, Moss, Caswell, Naqvi, & MacKinnon, 2017; Jo, 2011; Kızıl, 2021; Lane & Sorby, 2022; Lowrie, Logan, & Hegarty, 2019; Özdemir, 2011; Petty & Rule, 2008; Plummer et al., 2022; Rafi, Samsudin, & Said, 2008; Samsudin et al., 2011; Sorby & Baartmans, 2000; Tığcı, 2003).

The studies using technology and web-supported tools to improve spatial thinking skills have a significant impact on student achievement (Aktürk et al., 2013; Aydoğan, 2020; Azevedo, Osório, & Ribeiro, 2019; Brainin, Shamir, & Eden, 2021; Hollenbeck, 2018; Jo et al., 2016; Keskin, 2018; Kim, 2011; Lin & Chen, 2016; Merç, 2017; Ridha, Annaba, & Wahab, 2020; Sönmez, 2019; Yang & Chen, 2010; Yayla, 2019). For instance, Brainin et al. (2021) used a robot-assisted educational tool to enhance spatial thinking skills in preschool students and found that the intervention group excelled in spatial relations and mental rotation skills.

Examination of research studies utilizing different teaching methods and techniques to better spatial thinking skills reveals a notable effect in terms of developing spatial skills (Akengin & Ayaydın, 2017; Güllühan & Emral, 2021; Kızıl, 2021; Seyhan, 2019). Kızıl (2021) demonstrated that instruction conducted with a synchronic approach in the 8th grade History of Revolution and Kemalism course was effective in upgrading students' synchronic and spatial thinking skills. Taking significant steps for the development of spatial thinking skills, the NRC (National Research Council) published a report in 2006 stating that these skills need to be worked on at school through a planned and systematic process. In their meta-analysis research covering a total of 217 studies on improving spatial thinking skills, Uttal, Miller, and Newcombe (2013) concluded an effect size of 0.47 for these studies. This result implies that a carefully planned and implemented instructional process can very well increase students' spatial thinking skills. The findings of the current research are consistent with the results cited in the literature.

The research samples of national and international studies on spatial thinking skills generally consist of students and teachers at the middle school, high school, and university levels. Gifted students have taken part in studies targeting to better their spatial skills across science, mathematics, and geometry courses. This indicates that there is limited research conducted specifically for gifted students in the field of social studies. Lubinski (2010) and Andersen (2014) emphasize the importance of considering not only verbal and numerical elements but also spatial skills in identifying gifted children, which posits that spatial skills are crucial in STEM (Science, Technology, Engineering, and Mathematics) education and should be incorporated into the education for the gifted. In this research, an instructional module was developed for the gifted students, and the results show a high level of effectiveness with regards to improving these students' spatial thinking skills, which demonstrates that planned educational processes can enhance spatial thinking skills of the gifted students.

In this study, no statistically significant difference was found between male and female gifted students in terms of spatial thinking skills, which can be attributed to the advantages of 21st century technology and the variety of materials and tools used in educational environments. Additionally, it may be plausible to assert that male and female students are in touch with technology-supported applications equally, such as smartphones, the internet, and maps (Collins, 2018; Contreras et al., 2020). Hence, students are exposed to more information, spatial areas, and visual stimuli through internet-based activities and technological tools.

Contrary to the results obtained in this study, there are others concluding that spatial thinking skills vary according to gender. Especially in studies conducted before the year 2000, male participants were more successful in spatial thinking skills (Carroll, 1993; Linn & Petersen, 1985). Voyer, Voyer, and Bryden (1995) conducted a meta-analysis to determine whether there is a gender-based difference in spatial thinking skills, noting a significant difference in spatial thinking skills between boys and girls. However, other studies conducted from the 2000s onwards have shown a decrease in gender-based differences in spatial thinking skills (Contreras et al., 2020; Hyde, 2005; Lizarraga & Ganuza, 2003; Metoyer & Bednarz, 2017; Mulyadi & Yani, 2021; Roberts & Bell, 2000; Rodán et al., 2016; Serinci, 2022). For example, Gold, Pendergast, Ormand, Budd, and Mueller (2018) provided online education to undergraduate students in the geology department to improve their spatial skills, and gender was not determined as a factor. Korkmaz (2017) reported that there was no gender difference in terms of spatial orientation and spatial visualization skills among preschool students. Similarly, Serinci (2022) found no significant difference in terms of gender when examining the spatial thinking skills of 9th and 12th grade students. In their study, Metoyer and Bednarz (2017) stated that they expected males to be more successful than females, but contrary to their expectations, there was no difference between pre and post-test score averages for men and women.

The gender variable has been subjected to various analyses in studies on spatial thinking. These studies suggest that the reason for the emergence of differences in terms of gender is connected to the perspective that views these skills as male abilities (Neuburger, Ruthsatz, Jansen, Heil, & Quaiser-Pohl, 2013), and the anxiety created by this perception affects skills between genders (Heyden, Atteveldt, Huizinga, & Jolles, 2016). For example, Moè and Pazzaglia (2006) conducted a study with 107 female and 90 male high school students aged between 16 and 18 and found that manipulation had an effect over spatial skills. In this regard, the acceptance that either males or females are more successful in spatial thinking skills or the cultural perception that spatial thinking is a male skill (Devlin, 2001) may influence achievement levels of genders.

In terms of the location variable, there was no significant difference between the pre and post-test scores of the gifted students, but an increase was observed on the average scores. According to this result, although there is an increase in the average scores of the students' spatial thinking skills, there is no difference in terms of the location variable. No impact of the location variable on spatial thinking skills is linked to the geographical and population characteristics of the province of Muğla. Being an active province in terms of tourism potential, Muğla exhibits similar spatial diversity in rural and urban areas. Contrarily, Tomaszewski et al. (2015) concluded that the students living in the city center had better spatial thinking skills than students living in rural areas. Purwanto et al. (2021) conducted a similar study and noted that the students studying in urban areas had more developed spatial thinking skills than those studying in rural areas, which can be explained by the fact that urban living spaces are more complex and can affect spatial ability by offering various experiences (Purwanto et al., 2021). According to Bednarz and Lee (2019), the influence of location on spatial thinking skills varies according to the culture and geographical characteristics where individuals reside. Similarly, Newcombe et al. (1983) and Yang and Chen (2010) report that individuals' experiences with the social environment in which they live affect their spatial thinking skills. In a study with 8th grade middle school students, Collins (2018) found a relationship between spatial thinking skills and past travel experiences.

The opinions of the gifted students regarding the instructional module were gathered following the implementation of the IMSTS. All student groups (with high, average, and low scores) compared the spatial thinking skills training administered during this research with the social studies course conducted at BILSEM in terms of content and instruction. The greatest difference in terms of gains was observed in topographic maps. Topographic maps emerged as an important representational tool in developing spatial thinking skills. The findings revealed that the gifted students held the comparison between the two courses with respect to the representational tools. Based on the interviews with the gifted students, Bodur (2019) concluded that there were differences in terms of teaching methods and content between the STEM Education, Science and Engineering Applications Education, and Workshop-Based Science Education approach module series he developed and the BILSEM Science Course Teaching Program published by the Ministry of National Education (MoNE) in 2018. This result implies that similar research samples may share similar opinions.

Especially web-based activities are a priority when providing spatial thinking skills training to the gifted students. One of these activities is orienteering conducted in a virtual environment. The students compared the two courses in terms of activities and stated that the virtual orienteering activity was different. Virtual orienteering can be carried out in an online environment using web-based map applications. In this study, Google Maps was utilized. The game screen was divided into two parts to allow students to see both the real image of the location and the map. The upper part showed the actual image of the location while the lower part displayed the map. The students were paired, one serving as the guide giving directions and the other as the player trying to reach the targets. Orienteering is a sport that involves using maps and compasses, aiming to mentally visualize the surroundings and find the shortest and most accurate route. It activates various spatial skills. It enables individuals to see the world from different perspectives by moving away from a self-centered point of view (Di Tore, Corona, & Sibilio, 2015). An effective and fun form of training conducted in real-life settings, orienteering contributes to the development of spatial thinking skills. In the literature, there are studies on orienteering activities aiming to enhance spatial thinking skills (Ayuldeş, 2020; Sezgin, 2020; Şengör, 2018; Yiğit & Karatekin, 2021). These studies demonstrate that skills such as spatial thinking, spatial reasoning, and map literacy are gained through orienteering activities. González, Martín-Gutiérrez, Domínguez, HernanPérez, and Carrodeguas (2013) conducted orienteering training for freshman engineering students in both real and virtual environments to improve their spatial skills. The results showed that there was no significant difference between the trainings conducted in two environments, pointing that spatial thinking skills can be developed through orienteering activities. Developed for the research, the instructional module on spatial thinking skills included virtual orienteering activities to better the students' skills such as spatial visualization, map reading, and giving directions.

The gifted students expressed gains across the categories of knowledge, skills, and value through spatial thinking skills training. In all focus group discussions, the participants mentioned that they learned how to design maps using Geographic Information Systems (GIS) in the skills category. GIS is a significant information technology used to store, correct, update, recreate, map, and perform comparative analyses to manage geographic data (Artvinli, 2010). Activities were prepared through GIS to enhance students' spatial thinking skills. No expression or concept related to GIS was detected in the BILSEM 2021 Social Studies Course Curriculum and the 2018 Social Studies Course Curriculum. Using GIS as a different tool in social studies course can be an important opportunity to develop students' spatial thinking skills (Şimşek, 2008). Dependent on spatial thinking, GIS is based on modeling spatial data, whether perceived, observed, or measured, in a computer environment (Çabuk & Çabuk, 2011). The use of GIS in education is important to offer students opportunities with respect to problem-solving, decision-making, high-level thinking, and project management skills (Artvinli, 2009; Artvinli & Martinha, 2014). It is an effective tool for the correct perception, analysis, and evaluation of spatial characteristics. Numerous studies have been conducted emphasizing GIS as a crucial tool in developing spatial thinking skills (Keskin, 2018; Lee & Bednarz, 2009; Sönmez & Akbaş, 2019). The cumulative results of these studies pinpoint that GIS is an effective tool for the development of spatial skills, which is consistent with both quantitative and qualitative data analyzed in this research.

The participants expressed that they gained values such as environmental awareness and love of nature through the training. This underlines that the acquired gains are not limited to only the knowledge category but also expand to the category of values. It is possible to state that the instructional module used in this research produced gains in terms of knowledge, comprehension, skills, and affective domains. The BILSEM directive emphasizes that students' abilities should be developed in harmony across social and emotional domains (MoNE, 2016). When considered together with the present results, this explanation implies that support was provided for students' cognitive, affective, and psychomotor development through the module used in this research.

Another qualitative finding of the study underscores that both high and low-scoring students faced difficulties in using the GIS program while average-scoring students experienced conceptual difficulties with respect to map scales. No content about GIS was detected after analyzing the 5th, 6th, 7th, and 8th grade Social Studies Curriculum and the BILSEM 5th grade ITR program. Moreover, the lack of computers with GIS software in schools further complicates this experience. Therefore, it is normal for students to face challenges when using a tool they see for the first time. In a similar study, Jo (2011) found that teachers also experienced some challenges when using GIS tools, which signifies that difficulties in using GIS prevail across various groups.

According to another result of the research, the gifted students expressed a need for spatial thinking skills training. The fact that this training enhances higher-order thinking skills, that it has a practical orientation, and that it motivates the students are provided as the rationale behind the students' willingness to integrate this training into their curriculum.

Suggestions

- In the context of the results obtained in the study, BILSEM social studies teachers can use the instructional module or activities developed for this research to improve the spatial thinking skills of the gifted students in their classes.
- The research found no significant difference in spatial thinking skills in terms of the gender variable. While various studies in the literature support the idea that there is no difference in spatial thinking skills in terms of the gender variable, there are also others that conclude just the opposite. Future studies could be conducted with different research samples to investigate either all or some of the sub-dimensions of spatial thinking skills, and differences in terms of the gender variable could be explored.

According to the findings of the research, there is no significant difference in the spatial thinking skills of the students in urban and rural areas. However, international studies have shown differences in individuals' spatial thinking skills based on location. Individuals' spatial concepts or thinking skills can be examined based on variables such as travel status, spatial experiences, or social environments in future studies.

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