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The Effect of Spatial Self-Efficacy and Anxiety on Preservice Geography Teachers' Teaching Dispositions

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Spatial thinking refers to basic skills in geography teaching, which enables students to understand spatial relationships, analyze geographical information, and develop a holistic understanding of the world. Teacher dispositions play a critical role in helping students acquire these skills. Despite their importance, our knowledge about teachers' dispositions to teach spatial thinking is quite limited. This research aimed to examine the effect of preservice geography teachers' spatial self-efficacy and spatial anxiety on their dispositions to teach spatial thinking. It was conducted using a descriptive survey research design. The sample consisted of 585 students studying geography at state universities in Türkiye. The data were collected using the Spatial Ability Self-Report Scale, the Teaching Spatial Thinking through Geography Disposition Inventory, and the Spatial Anxiety Scale. The data were analyzed using the Pearson correlation and structural equation modeling. The analysis results yielded a significant positive correlation between spatial self-efficacy and dispositions to teach spatial thinking. As preservice teachers' spatial self-efficacy increased, their dispositions to teach spatial thinking also increased. There was also a negative correlation between spatial anxiety and dispositions to teach spatial thinking. When preservice teachers' spatial anxiety increased, their dispositions to teach spatial topics decreased. These results showed that spatial self-efficacy and spatial anxiety play an important role in preservice geography teachers' dispositions to teach spatial thinking. Accordingly, training programs and experimental work aimed at increasing spatial self-efficacy and reducing spatial anxiety would help improve preservice teachers' dispositions to teach spatial thinking.

Introduction

Spatial thinking (ST) is among the indispensable basic skills of geography teaching. The value of ST in geography teaching is that it enables students to understand spatial relationships, analyze geographical information, and shape a holistic worldview. ST allows students to recognize better the concepts of place and space, the distribution of geographical phenomena, and the connections between these phenomena. It also improves students' analytical and creative thinking abilities to solve problems and enables them to use geographic information technologies effectively and generate innovative solutions to real-world problems. ST refers to "a constructive amalgam of three elements: concepts of space,

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tools of representation, and processes of reasoning" (NRC, 2006, p. ix). Students need to master spatial skills to form spatial concepts, understand representations, and engage in spatial reasoning (Jo & Bednarz, 2014a; Lee et al., 2018). In this sense, geography teachers are primarily responsible for teaching spatial skills to students.

Geography teachers should have essential skills and knowledge to teach ST, such as spatial terminology, using spatial representations and geographic information systems, map reading and interpretation, critical thinking, problem-solving, and communication. However, teachers' knowledge and skills do not guarantee their disposition to teach (Almerico et al., 2011; Bercaw et al., 2012; Borko et al., 2007; Davis & Stewart, 2005; Diez, 2007; Dottin, 2009; Eberly et al., 2007; Jo & Bednarz, 2014b). If a geography teacher has sufficient knowledge and skills about ST, but has a low level of dispositions to teach, it will be hard for students to acquire ST (Jo & Bednarz, 2014b). Thus, teacher dispositions play a critical role in performances such as transferring knowledge and skills related to ST, employing spatial technologies, preparing teaching materials, and motivating students. Teacher dispositions are as valuable as teacher knowledge and skills, and well-structured teaching methods, materials, and curricula to succeed in the teaching and learning of ST (Jo & Bednarz, 2014b). However, our knowledge about geography teachers' dispositions towards teaching ST is still limited to a few studies (Lee et al., 2018; Şanlı & Jo, 2020). These studies have examined dispositions towards ST teaching among preservice geography teachers in terms of demographics. Thus, this indicates a need for research that investigates how teachers are affected by psychological factors such as spatial self-efficacy (SSE) and spatial anxiety (SA), which affect their teaching dispositions. Against this background, the present research attempts to fill a gap by examining the effect of preservice geography teachers' SSE and SA on their dispositions towards teaching ST. In this research, SSE is accepted as teachers' beliefs in their capacity to fulfil spatial tasks, and SA is accepted as anxiety and stress felt in the face of such tasks. The research results will add to the efforts to support preservice teachers' professional development. ST is today considered a strong predictor of skills in science, technology, engineering, and mathematics (STEM) subjects (Gagnier & Fisher, 2017; Safadel, 2016; Uttal & Cohen, 2012); thus, improving preservice teachers' ST skills may also help increase their STEM achievement. The research results could also guide in determining how geography teacher training programs can be improved and revised. Thus, preservice teachers who graduate from revised undergraduate programs can help students develop spatial skills once they begin their professional careers.

Spatial Self-Efficacy

Self-efficacy, introduced by Bandura (1977), refers to people's belief in their ability to plan and execute actions to handle different situations effectively. Within Bandura's (1986) broader theory of self-efficacy 1986, spatial self-efficacy (SSE) focuses explicitly on how confident individuals feel about their skills to successfully perform spatial tasks and overcome spatial difficulties. In essence, SSE is about how much someone believes in their capabilities when dealing with spatial tasks and challenges (Kuznetcova et al., 2022; Pajares, 1996; Safadel, 2016). SSE supports teachers' ability to think creatively and innovatively in the teaching process. Self-confident teachers could be more courageous in generating new ideas and solutions. Teachers' SSE also affects their willingness to try out different strategies and generate alternative solutions when faced with spatial tasks (Kuznetcova et al., 2022; Pazzaglia et al., 2017; Power et al., 2016). SSE is positively related to individuals' success, motivation, and persistence in spatial tasks (Coxon et al., 2016; Pazzaglia et al., 2018; Penna et al., 2014). Additionally, SSE affects "one's motivations, learning outcomes, engagement,

and ultimately performance on spatial tasks" (Arıkan & Çetin, 2024, p. 2). Relevant research in geography education has reported that preservice geography teachers' SSE influences performances such as accomplishing spatial tasks, devoting more effort to spatial operations, showing perseverance in challenging tasks, and controlling emotional reactions in the face of obstacles (Jo & Bednarz, 2014b; Lee et al.,2018; Sanlı & Jo, 2020). Therefore, measuring teachers' SSE and taking necessary steps are critical for the successful teaching of ST.

Various instruments are used to measure SSE (Arıkan & Çetin, 2024; Kuznetcova et al., 2022; Safadel et al., 2023; Turgut, 2015). However, these instruments cannot measure all aspects of spatial skills, rather they measure one aspect of spatial skills or a few spatial skills due to the complex nature of ST. Kuznetcova et al. (2022) developed the Visuospatial Self-Efficacy Scale with a sample of university students to measure SSE related to five spatial skills (i.e., "Rotation and Symmetry", "Isometric and Orthographic Views", "Folding Flat Patterns", "Real-Life Tasks: "Implicit VS [visuospatial] Skill Use", and "Real-Life Task: Explicit VS Skill Use") (pp. 418-419). More recently, Arıkan and Çetin (2024) developed the "Spatial Skills Self-Efficacy Scale" to evaluate self-efficacy related to four spatial skills (i.e., "intrinsic static", "intrinsic dynamic", "extrinsic static", and "extrinsic dynamic"). The "Spatial Ability Self-Report Scale" (SASRS) developed by Turgut (2015) measures university students' spatial skills. The present research also investigated preservice geography teachers' using SASRS.

Spatial Anxiety

Anxiety is a state of worry and uneasiness about a situation that a person is experiencing or is likely to experience. Anxiety emerges as a reaction specific to a particular context or task. SA refers to the feelings of fear, concern, and stress caused by spatial processing, such as mental manipulation, navigation, and visualization (Geer, 2019; Geer et al., 2024; Kremmyda et al., 2016; Lawton, 1994; Lawton, et al.,2016; Lyons et al., 2018; Meneghetti, et al; 2021; Ramirez et al., 2012; Vieites et al., 2020). SA is specific to each task (Lourenco & Liu, 2023). Navigation anxiety, for example, differs from anxiety arising from imagery or manipulation (mental rotation) (Alvarez-Vargas et al., 2020; Blajenkova, et al.,2006; Lyons et al., 2018; Malanchini et al., 2017). This is because there are multiple causes of SA. According to Lynch (1960), the experience of getting lost is a state of anxiety associated with an individual's emotional sense of security. Walkowiak et al. (2015) found that lack of information causes anxiety, especially in spatial tasks such as navigating (Lawton & Kállai, 2002; Malanchini et al., 2017) or reaching a route (Maloney et al., 2014; Oliver et al., 2024). Gender stereotypes (such as prejudices that girls are less successful in spatial tasks) cause SA (Nazareth et al., 2019; Vieites et al., 2020). Delage et al. (2022) reported that women had higher anxiety than men in a series of spatial tasks, especially for manipulation tasks. According to Lourenco and Liu (2023), SA is caused by previous negative experiences or failures related to spatial tasks. This situation is often caused by a decline in confidence in one's own spatial skills (i.e., SSE). SA is also associated with the lack of participation and practice in activities that require spatial skills in early childhood (Anticich et al., 2012; Ramirez et al., 2012). This is why children are encouraged to participate in activities that require spatial skills, especially in early childhood. Thus, it seems unlikely to define a single factor that causes SA. Therefore, researchers have recently drawn attention to the use of multidimensional anxiety scales (Geer et al., 2024; Oliver et al., 2024) instead of unidimensional anxiety scales (Lawton, 1994; Ramirez et al., 2012) to assess SA. Lyons et al. (2018) developed the "Spatial Anxiety Scale" for imagery, navigation, and mental manipulation, relying on the taxonomy of spatial skills introduced by Uttal et al. (2013).

Imagery anxiety occurs when an individual tries to mentally visualize objects or situations, mental manipulation anxiety occurs during spatial tasks such as manipulation and imagery, and navigation anxiety refers to negative thoughts and emotional reactions that emerge when an individual tries to reach from one place to another or follow a specific route (Lyons et al., 2018). Recent research has found stronger correlations between these components of SA and skills (i.e., object manipulation, spatial navigation, and visual memory) (Geer, 2019; Geer et al., 2024; Kremmyda et al., 2016; Lyons et al., 2018; Oliver et al. 2024). The mechanisms of navigation and mental manipulation anxiety are linked to mechanisms of navigation and mental manipulation skills (Geer et al., 2024). Accordingly, the present research examined preservice geography teachers' SA that emerges from spatial tasks related to imagery, mental manipulation, and navigation.

Dispositions Toward Teaching Spatial Thinking

Dispositions to teach ST refer to teachers' willingness to teach spatial skills. Teacher dispositions are driven by factors such as the view that all students can learn, the employment of effective teaching strategies in the classroom, and commitment to a safe and supportive learning atmosphere (Borko et al., 2007; Cano, 2005; Schommer-Aikins, 1993; Schraw & Olafson, 2003). Teachers' teaching dispositions also influence student motivation, learning time, self-efficacy, and student achievement (Chan, 2003; Chan & Elliott, 2004; Paulsen & Feldman, 1999; Johnson, 1992; King & Kitchener, 2002; Letina, 2022; Schommer-Aikins, 2004). Geography teachers' positive dispositions towards teaching ST improve their performances in terms of including more spatial tasks in their classes, using spatial concepts and technologies effectively, and guiding students in solving spatial problems (Jo & Bednarz, 2014a, 2014b). A geography teacher who is highly disposed to teach ST may be expected to compare the change in the water level of a lake over the years by using spatial software (such as Google Earth) or analyze the distribution of settlement areas in a city by using GIS. Teachers willing to teach ST are more likely to plan various teaching methods and activities in out-of-school learning environments to help students better understand spatial concepts and relationships. They can, for example, teach spatial concepts through games or simulations or plan fieldwork and orienteering to give students an active learning experience in nature (Şanlı & Jo, 2020). In this sense, teacher dispositions to teach ST are of critical importance to build and foster ST skills in students.

Along with the growing importance attached to teaching ST over the last decade, there has been a focus on geography teachers' dispositions. The first study in the literature was an inventory developed by Jo and Bednarz (2014b). Şanlı and Sezer (2019) adapted this inventory to Turkish and tested its validity and reliability. The effect of demographics on teacher dispositions to teach ST was investigated by Lee et al. (2018) administering the original inventory to Chinese and Korean preservice geography teachers and by Şanlı and Jo (2020) using the adapted Turkish version Turkish with a sample of preservice geography teachers. The researchers reported that the instruments are valid and reliable in determining preservice geography teachers' teaching dispositions. The Turkish version of the scale adapted by Şanlı and Sezer (2019) consists of five subscales. The subscale of "teaching thinking skills" deals with "teachers' beliefs in teaching thinking skills and their willingness to help students develop thinking skills using various teaching strategies". The subscale of teaching ST skills deals "with the awareness, understanding and value of ST and the importance of its teaching in schools". The subscale of ST in geography deals with teachers' willingness "to teach spatial thinking in geography classes". The subscale of "explicit teaching of spatial concepts" deals with how explicitly teachers teach spatial concepts Lastly,

the subscale of "adopting spatial representations and geospatial technologies in instruction" deals with "teachers' understanding of using GISs and spatial representations such as maps and globes in classrooms" (p. 2074). The "Teaching Spatial Thinking through Geography Disposition Inventory" was used in this research to investigate the effects of SSE and anxiety on preservice geography teachers' dispositions to teach ST.

The Purpose and Significance of the Research

The purpose of this research is to examine the effect of preservice geography teachers' SSE and SA on their dispositions to teach ST. SSE is a decisive factor in performing spatial tasks. SSE has been found to be positively linked to individuals' performance, success, motivation, and patience in spatial tasks. Penna et al. (2014) found that confidence in one's spatial skills affects performance on statistical reasoning tasks. Likewise, Coxon et al. (2016) found that the level of SSE affects success in spatial tasks (especially navigation). Pazzaglia et al. (2018) reported a positive correlation between SSE and the development of spatial skills. Gagnier et al. (2022) also concluded that SSE affects motivation in people's efforts to face obstacles and achieve goals. Duffin et al. (2012) observed that teachers' high self-efficacy in ST directly impacts their teaching strategies and practices to develop their students' skills. On a similar note, several studies have reported that preservice geography teachers' SSE affects their effort and success in completing spatial tasks, their perseverance in challenging tasks, and controlling emotional reactions in the face of obstacles (Jo & Bednarz, 2014b; Lee et al., 2018; Şanlı & Jo, 2020). Teacher self-efficacy is also tied to openness to new teaching methods (Berman et al., 1977; De Mesquita & Drake, 1994; Guskey, 1987), fidelity to program implementation (Durlak & DuPre, 2008), effective teaching techniques (Ross, 1994; Woolfolk-Hoy & Burke-Spero, 2005), effective classroom management (Dikmenli & Çifçi, 2016; Tsouloupas et al., 2010), time management (Allinder, 1994), ensuring student motivation (Duffin et al., 2012; Schunk & Mullen, 2012), and academic achievement (Bates et al., 2011; Beilock et al., 2010; Gunderson et al., 2012; Kane & Staiger, 2008). The present research will offer insights into how preservice geography teachers' self-efficacy is reflected in their teaching dispositions. Preservice teachers with high SSE may develop a stronger belief in ST. This may promote their motivation and effort to solve spatial problems in the teaching process. Moreover, preservice teachers with high self-efficacy may feel more comfortable teaching spatial topics and develop more effective teaching strategies. This can help both teachers and students to improve their spatial skills.

Like self-efficacy, SA is also a decisive factor in individuals' performance of spatial tasks. Earlier studies have shown that SA affects self-efficacy, successful performance, focus, motivation, problem-solving strategies, and time management in spatial tasks. Lawton (1994) argued that individuals with high levels of SA feel less competent. Similarly, Ramirez et al. (2012) found that mental rotation is negatively affected by high SA. Lyons et al. (2018) reported that increased SA leads individuals to avoid spatial tasks. Dursun (2010) also found that preservice teachers with high SA had a low level of spatial visualization ability. Similarly, Rocha et al. (2022) found that high SA weakened teachers' mental rotation ability for mental manipulation tasks. Teachers' SA is likely to be reflected in students' ST. Gunderson et al. (2012) noted that high SA in teachers led to a poor spatial performance in students. According to Gagnier and Fisher (2020), teachers who are more anxious about ST offer their students fewer opportunities to develop their spatial skills. Low SA enhances teachers' SSE. It was discovered that primary school teachers who experienced less anxiety when tackling spatial problems tended to develop a greater confidence in their ability to enhance these skills through consistent practice (Gagnier et al., 2022). Moreover, teachers'

high SA are linked to the frequency of performing spatial tasks in their classes (Gagnier & Fisher, 2020; Gunderson et al., 2012), time allocated to teach ST (Levine et al., 2012), the nature of the spatial tasks performed (Gagnier & Fisher, 2020), teachers' use of strategies to improve spatial skills and their motivation in the teaching process (Bursal & Paznokas, 2006), and the likelihood of using process-oriented teaching methods. Taken together, these findings indicate the potential effects of high SA on preservice geography teachers' spatial skills; thus, they provide insights into how SA is reflected in their teaching dispositions. In other words, an increase in SA may cause preservice teachers to feel more stress while performing spatial tasks. This may cause them to avoid activities and applications related to spatial topics (e.g., GIS, navigation applications, maps, etc.) or to be timid in performing such tasks. In this sense, identifying teachers with high SA helps design specific training for them so that they can overcome their anxiety and improve their performance through structured training (Lyons et al., 2018).

Given the theoretical background and the relevant literature, there seems to be a correlation between preservice geography teachers' ST teaching dispositions and their SSE and SA. The following two hypotheses were formulated accordingly:

H1: SSE positively affects dispositions towards teaching ST in geography courses.

H2: SA negatively affects dispositions towards teaching ST in geography courses.

Methods

Research Design

The research used a correlational survey design aimed at investigating relationships between multiple variables (Büyüköztürk, et al., 2020). SSE and SA were treated as the independent variables, while dispositions to teach ST were treated as the dependent variable. Structural equation modelling (SEM) was used to analyze correlations between the variables in greater depth. The model was aimed at finding out how preservice geography teachers' SSE and SA affect their dispositions to teach ST.

Research Sample

The research recruited a sample of 585 students studying in the geography departments of 10 state universities in Türkiye. Geography departments in Türkiye were initially established to train scientists in geography. However, over the years, students studying geography have been given pedagogy training as part of their standard undergraduate studies, and they are today entitled to become geography teachers after graduation and accepted as teachers in terms of graduate employment. Thus, the participating students were referred to as preservice geography teachers. The target population includes approximately 13,000 preservice geography teachers. The sample size required to represent the population was calculated using the formula "$n = N.t^2.p.q / d^2.(N-1) + t^2.p.q$". N is the total number of individuals in the target population; n is the required sample size; p is the probability of the event occurring; q is the probability of the event not occurring; t is the theoretical value obtained from the t-table at a specified level of significance; and d is the accepted sampling error based on the event frequency (Yazıcıoğlu & Erdoğan, 2014). For the target population (N), the theoretical t-value was set at 1.96, with a sampling error of 0.05, p

= .5, q = 0.5, and α = 0.05. With these values, the minimum required sample size was calculated to be 370. The number of participants (585) in this research was significantly higher than the minimum required sample size.

Data Collection Instruments

Spatial Ability Self-Report Scale

The SASRS was developed by Turgut (2015) to measure the ST self-efficacy of university students in Turkey. The scale consists of 18 items and is rated on a 5-point Likert-type scale. The Cronbach's alpha was found to be .88 for the total scale. The scale has three subscales: "Object Manipulation Spatial Ability (OMSA), Spatial Navigational Ability (SNA), and Visual Memory (VM)" (p. 1997). The OMSA subscale is related to the perceived ability to mentally rotate, combine, separate, or otherwise manipulate objects; the SNA is related to the belief in skills such as navigating, planning routes, and map out locations; and the VM factor is related to the perceived ability to memorize and use images or locations of objects (Turgut, 2015). Example items include "I can imagine the rotated versions of three-dimensional objects mentally", and "I can find a shorter route to a location if I have been there before". A high score on this scale indicates that preservice teachers have high self-confidence in spatial skills and can use these skills effectively. A low score indicates that they have low self-confidence in spatial skills and may experience difficulties in performing spatial tasks.

Inventory of Teaching ST through Geography Disposition

Jo and Bednarz (2014) created an inventory to assess how prepared future teachers were to teach spatial skills in their classrooms. Later on, Şanlı and Sezer (2019) translated and adjusted this inventory into Turkish. The Turkish version includes 23 items, each rated on a scale of 1 to 5 to gauge agreement. They found that the overall reliability of the inventory was relatively high, with a Cronbach's alpha value of 0.89. The inventory consists of five subscales: "teaching thinking skills, teaching spatial thinking skills, spatial thinking in geography, explicit teaching of spatial concepts, and adopting spatial representations and geospatial technologies in instruction". Example items include "I believe that spatial thinking should be taught in schools", and "I believe that geospatial technologies, such as geographic information systems (GIS) and global positioning systems (GPS)". A high score indicates a high level of teacher dispositions to teach ST in geography classes, while a low score indicates a low level of teacher dispositions. Scores on this scale are subjective as they reflect one's own perception of their spatial abilities and confidence. A high score is not an objective indicator of spatial skills, rather it indicates a high level of confidence in spatial tasks, whereas low scores indicate a low level of confidence in spatial tasks.

Spatial Anxiety Scale

The scale, first developed by Lyons and colleagues in 2018 to measure spatial anxiety in adults, was later translated into Turkish by Poçan and his team in 2020, specifically for university students. When they tested the Turkish version, it showed strong reliability overall, with a Cronbach's alpha coefficient of 0.90. This means that the questions in the scale consistently measured what they were supposed to measure among the Turkish university students who participated in the study. The scale consists of three subscales: "navigation,

mental manipulation, and imagery" (p. 526). The scale consists of 21 items and asks respondents to rate their anxiety on a 5-point Likert-type scale. Example items include "Finding your way to an appointment in an area of a city or town with which you are not familiar", "Trying to get somewhere you have never been to before in the middle of an unfamiliar city", and "Asked to follow directions to a location across town without the use of a map". A high score indicates high anxiety about spatial tasks. This means that the respondent experiences anxiety, stress, or discomfort while performing spatial tasks. Low scores indicate a low level of anxiety about spatial tasks. This means that the respondent can cope with spatial tasks more easily.

Data Collection

An online form was designed to collect data. The form starts with brief information about the research and the principle of voluntary participation. It then proceeds with the above-said three data collection instruments. Ethical approval was received from the Ethics Committee of Pamukkale University (approval no. 68282350/2024/5). The data were collected through the online form between April and May 2024.

Data Analysis

Some assumptions were tested prior to the data analysis. Cook's distances were computed to identify outliers, if any. The results showed that the dataset had no outliers (maximum Cook's distance = 0.71). A skewness and kurtosis range of ±1 suggests that the data distribution approximates normality (Tabachnick & Fidell, 2007). The calculated values ($-0.98 \leq$ skewness ≤ 0.28; $-0.02 \leq$ kurtosis ≤ 0.77) showed that the distribution of the data was approximately normal. The variance inflation factor values less than 3 indicate that there is no multicollinearity problem (Yurt, 2023). The highest VIF value was found to be 1.78, showing no multicollinearity between the variables. To assess the model fit in the SEM analysis, various indices were employed, including the Standardized Root Mean Square Residual (SRMR) (< 0.08), χ^2/df (< 5), Comparative Fit Index (CFI) (> 0.90), Tucker-Lewis Index (TLI) (> 0.90), and Root Mean Square Error of Approximation (RMSEA) (< 0.10) as recommended by Hair et al. (2010). These analyses were conducted using IBM SPSS Amos 24 software.

Findings

Correlation Analysis Results

Prior to conducting SEM analysis, Pearson's correlation coefficients were calculated to examine the relationships between SSE, attitudes towards teaching ST, and SA. The mean and standard deviation values of SSE, SA, and disposition scores were also calculated. Table 1 presents the analysis results.

Table 1. Relationships Between Spatial Self-Efficacy, Dispositions Towards Teaching Spatial Thinking, and Spatial Anxiety

Variables	Mean	SD	1.	2.	3.
1. Spatial Self-Efficacy	10.56	2.69	1		
2. Dispositions Towards Teaching Spatial Thinking	18.49	2.40	.590**	1	
3. Spatial Anxiety	7.44	1.05	-.268**	-.449**	1

**p < 0.01; N = 585

As seen in Table 1, there were significant correlations between SSE and dispositions towards teaching ST (r = 0.590; p < 0.01) and SA (r = -0.268; p < 0.01). As SSE scores increased, teaching disposition scores also increased. On the other hand, as SA scores increased, SSE scores decreased. There was a negative significant correlation between SA and dispositions towards teaching ST in geography classes (r = -0.449; p < 0.01). As SA scores increased, teaching disposition scores decreased.

SEM Analysis Results

The structural equation model shown in Figure 1 was developed and tested to test the research hypotheses. SSE and SA were treated as the independent variables, and dispositions to teach ST were treated as the dependent variable. The model was tested using maximum likelihood estimation. According to the calculated goodness-of-fit values ($\chi 2$ = 112.50; df = 38; $\chi 2$/df = 2.96; p < 0.001; RMSEA = 0.06; SRMR = 0.04; CFI = 0.98; TLI = 0.98), the model showed a good fit to the data (Hair et al., 2010). Table 2 displays path coefficients, standard errors, significance levels, and confidence intervals.

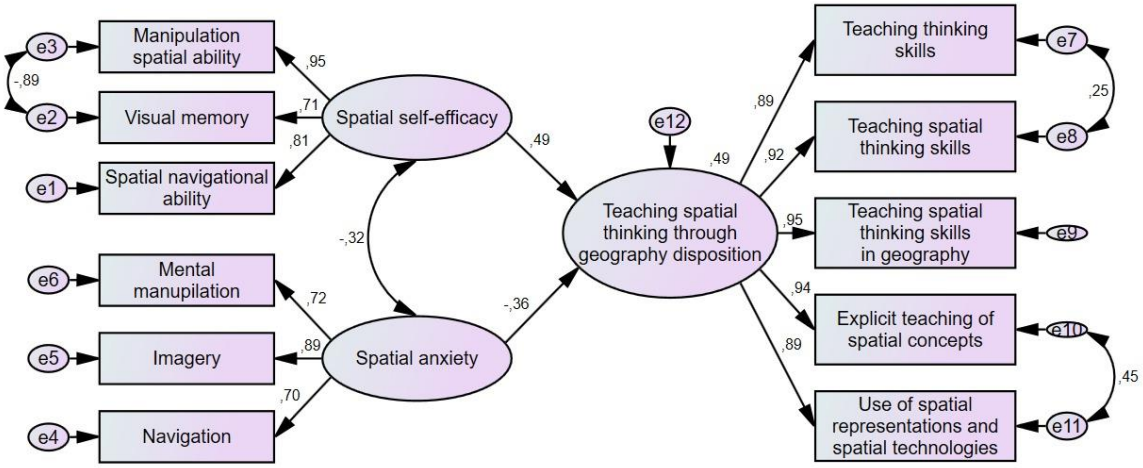

Figure 1. The Tested Structural Equation Model

As seen in Table 2, the predictive power of SSE for dispositions towards teaching ST in geography classes was 0.49 (SE = 0.04; t = 12.96; p < 0.001). As SSE increased, dispositions to teach ST in geography classes also increased. Accordingly, H1 was accepted. The predictive power of SA for dispositions towards teaching ST in geography classes is -0.36 (SE = 0.06; t = -8.89; p < 0.001). As SA increased, dispositions to teach ST in geography classes decreased. Accordingly, H2 was also accepted. ST self-efficacy and SA explained 49% of the variation in dispositions towards teaching ST in geography classes.

Table 2. Standardized Path Coefficients and Significance Levels

Hypothesis	Paths			β	SE	t	p	Note
H1	SSE	--->	DTST	0.49	0.04	12.96	***	Accepted
H2	SA	--->	DTST	-0.36	0.06	-8.89	***	Accepted

***p < 0.001; SSE: Spatial Self-Efficacy, DTST: Dispositions Towards Teaching Spatial Thinking, SA: Spatial Anxiety

Discussion

This research is the first to examine the effect of preservice geography teachers' SSE and anxiety on their dispositions to teach ST. The research sample consisted of preservice geography teachers who play a critical role in teaching ST in the future. The Pearson correlation analysis and SEM were used in the data analysis. In the model designed, SSE and SA were treated as the independent variables, and dispositions to teach ST were treated as the dependent variable. According to the analysis results, preservice geography teachers' SSE and anxiety had a significant effect on their dispositions to teach ST.

According to the first research finding, as SSE increased, dispositions to teach ST increased. Accordingly, H1 was accepted. This result shows that the high self-efficacy of preservice geography teachers towards spatial tasks (object manipulation, visual memory, and spatial navigation) positively affects their teaching dispositions. Research shows that when people believe in their abilities (self-efficacy), they tend to approach challenges with optimism and determination (Bandura, 2001a, 2001b). This is especially true for teachers, as studies have consistently found that those with solid self-efficacy are more effective in their roles (Henson, 2001; Hoy et al., 2009; Moore & Esselman, 1992; Takahashi, 2011). However, there needs to be more understanding of how self-efficacy in spatial tasks affects teachers' attitudes toward teaching. Nevertheless, numerous studies have linked high spatial self-efficacy with better performance in spatial tasks (Coxon et al., 2016; Gagnier et al., 2022; Geer, 2019; Hegarty et al., 2002; Lee et al., 2018; Pazzaglia et al., 2018; Penna et al., 2014; Power et al., 2016; Safadel, 2016; Towle et al., 2005). A high sense of self-efficacy improved people's performance on spatial tasks, encouraging them to exert more effort in performing spatial tasks (Power et al., 2016). The better people performed on mental rotation tests, the more willing they were to complete these tasks (Towle et al., 2005). Additionally, high levels of SSE led to successful performance in mental rotation tests in virtual reality (Coxon et al., 2016). The development of spatial skills positively impacts the development of analytical thinking skills (Geer, 2019). Given the results of relevant research, high self-efficacy positively affects individuals' performance in spatial tasks, motivates them to deal with spatial tasks and put more effort into completing spatial tasks, and is a predictor of success, patience, and fidelity in spatial operations. Accordingly, it seems that the high SSE of preservice geography teachers will increase their teaching dispositions such as covering spatial concepts more often, guiding students in solving spatial problems, and organizing activities that encourage ST. High SSE is directly related to preservice geography teachers' ability to use spatial technologies and tools. Several researchers have emphasized that the use of these technologies in teaching ST increases preservice teachers' dispositions (Lee & Bednarz, 2009; Lidstone & Stoltman, 2006; Ratinen & Keinonen, 2011). This shows that technology holds a prominent place in teaching ST. The results of the present research are in accord with the self-efficacy theory (Bandura, 1977) and the results of earlier studies. However, further research and more data are needed to confirm these relationships.

According to the second research finding, as SA increased, dispositions to teach ST decreased. Accordingly, H2 was accepted. This result shows that high levels of anxiety

towards spatial tasks (object manipulation, visual memory, and spatial navigation) negatively affect preservice geography teachers' teaching dispositions. No study has been found that reveals the relationship between SA and dispositions to teach ST. However, a great deal of research has reported a negative significant relationship between SA and performances related to spatial skills (Bell & Fox 2003; Bursal & Paznokas, 2006; Dursun, 2010; Geer, 2019; Geer et al., 2024; Kremmyda et al., 2016; Lauer et al., 2018; Lawton, 1994; Lyons et al., 2018; Ramirez et al., 2012; Ramirez et al., 2018; Rocha, et al., 2022; Viaud-Delmon et al., 2002). Lawton (1994) argued that high levels of SA led to impairment of adaptive navigation strategies in adults. Additionally, high SA negatively affected visualization ability (Dursun, 2010) and mental rotation ability (Ramirez et al., 2012). It is also known that increased anxiety is linked to decreased performance on navigation tasks (e.g., navigational ability) (Kremmyda et al., 2016). High SA causes individuals to avoid spatial tasks (Lyons et al., 2018). Teachers with high SA avoided implementing spatial activities in their classrooms (Gunderson et al., 2012). This avoidance stems from the fact that high levels of SA cause individuals to be reluctant to perform spatial tasks due to the stress it causes in visuospatial working memory (Geer et al., 2024). It is also claimed that teachers with high SA are discouraged from teaching ST due to their reduced confidence in their spatial skills (especially mental manipulation), and they lose time in performing spatial tasks (Rocha et al.,2022). The results of the relevant studies clearly demonstrate that high levels of SA negatively affect an individual's performance in spatial tasks. It is also apparent that as teachers' SA decreases, they believe in the malleability of ST skills and make an effort to teach them. Atit and Rocha (2021) stated that primary school teachers' low levels of anxiety while solving spatial problems enable them to believe that they can improve spatial skills with practice and provide motivation for teaching. It seems that the high SA of preservice geography teachers will cause them to avoid spatial tasks in geography classes, cover spatial concepts less often, hesitate about using spatial concepts and representations, and be less willing to solve spatial problems encountered by students. Thus, it seems that this situation will negatively affect preservice teachers' dispositions to teach ST, making it hard to integrate these skills into classes and impart them to students. Preservice teachers who avoid using spatial concepts effectively are likely to fail to develop students' ST skills. This situation may make it harder to teach ST skills through geography, thereby causing students' ST skills not to develop properly. Therefore, reducing SA may positively affect preservice geography teachers' dispositions towards and performances in teaching ST. All in all, the results of the present research are in accord with earlier observations.

According to the last research finding, ST self-efficacy and SA explained 49% of the variation in dispositions towards teaching ST. In other words, these two variables explain a significant part of preservice geography teachers' dispositions to teach ST. This result predicts that when preservice geography teachers' SSE is increased, and their SA is under control, their dispositions to teach ST will improve. The combination of these two factors encourages preservice geography teachers to participate more actively and willingly in the teaching process. Moreover, this result revealed that preservice geography teachers' performance in teaching ST is not only related to cognitive abilities but also to affective factors. Thus, it is apparent that teacher dispositions have a crucial role in teaching students ST. Therefore, raising preservice geography teachers' SSE and reducing their SA will positively affect their dispositions to teach ST. This will improve the teaching process of ST skills through geography classes, thus enabling students to acquire ST skills more effectively. Research on teaching ST has demonstrated that spatial skills can be shaped and developed through education and practice (Uttal et al., 2013). In this context, the combination of high self-efficacy and low anxiety is indicative of the importance of incorporating strategies that

improve self-efficacy and reduce anxiety into teacher training programs in order to hone spatial skills.

Limitations

This research has some limitations. It focused on the effect of SSE and anxiety levels on preservice geography teachers' dispositions to teach ST. However, ST has a versatile structure; thus, this research could not include many factors (such as level of technology literacy, receiving additional training, and GIS competencies) that affect the realization of spatial tasks. Future research might consider such factors. This research was descriptive and used a correlational survey design. Although this design allows researchers to reveal correlations between variables, causal inferences cannot be made. Thus, there is a need for further research to explain causal relationships. The cross-sectional data collection approach used in this research only provides an understanding of complex relationships at a specific point in time. Therefore, longitudinal studies would offer further insights. Finally, this research revealed the effect of preservice geography teachers' own beliefs and affective states on their dispositions to teach ST. Future studies could examine the impacts of student self-efficacy and anxiety on teachers' teaching dispositions.

Conclusion and Recommendations

This research concludes that SSE and SA occupy an important place in preservice geography teachers' dispositions to teach ST. Accordingly, a combination of high self-efficacy and low anxiety increased preservice geography teachers' teaching dispositions. Preservice teachers with high self-efficacy beliefs and low anxiety levels can be more effective in transferring their knowledge and skills to students and enriching students' learning experiences. Moreover, these characteristics may encourage preservice teachers to be more optimistic about their careers and invest more in their professional development. Thus, a reasonable recommendation could be to explore ways and means to support preservice geography teachers' SSE and incorporate practices that improve SSE and reduce SA into geography teacher training undergraduate programs. The very examples here may include writing project proposals using GIS, examining different geographical regions using Google Earth and Google Maps, engaging in virtual and real fieldwork, drawing and analyzing topographic maps, using simulations for geophysical phenomena such as earthquakes, floods, and landslides.

References

Allinder, R. M. (1994). The relationship between efficacy and the instructional practices of special education teachers and consultants. *Teacher Education and Special Education,17*(2), 86-95. https://doi.org/10.1177/088840649401700203

Almerico, G., Johnston, P., Henriott, D., & Shapiro, M. (2011). Dispositions assessment in teacher education: Developing an assessment instrument for the college classroom and the field. *Research in Higher Education Journal*, *11*, 1-19. Retrieved April 25, 2024, from https://www.aabri.com/manuscripts/10665.pdf

Alvarez Vargas, D., Abad, C., & Pruden, S. M. (2020). Spatial anxiety mediates the sex difference in adult mental rotation test performance. *Cognitive Research: Principles and Implications, 5*(1), 1-17. https://doi.org/10.1186/s41235-020-00231-8

Anticich, S. A. J., Barrett, P. M., Gillies, R., & Silverman, W. (2012). Recent advances in intervention for early childhood anxiety. *Australian Journal of Guidance and Counselling*, *22*(2), 157-172. https://doi.org/10.1017/jgc.2012.24

Atit, K., & Rocha, K. (2021). Examining the relations between spatial skills, spatial anxiety, and K-12 teacher practice. *Mind, Brain, and Education*, *15*(1), 139-148. https://doi.org/10.1111/mbe.12274

Arıkan, A., & Çetin, T. (2024). Psychometric properties of the spatial skills self-efficacy scale: A validity and reliability study. *Thinking Skills and Creativity*, *52*, 1-18. https://doi.org/10.1016/j.tsc.2024.101555

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215. https://doi.org/10.1037/0033-295X.84.2.191

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Prentice-Hall.

Bandura, A. (2001a). Social cognitive theory of mass communications. In J. Bryant & D. Zillman (Eds.), *Media effects: Advances in theory and research* (2nd ed.) (pp. 121-153). Lawrence Erlbaum.

Bandura, A. (2001b). Social cognitive theory: An agentic perspective. *Annual Review of Psychology, 52,* 1-26. https://doi.org/10.1146/annurev.psych.52.1.1

Bates, T., Swennen, A., & Jones, K. (2011) Teacher educators a professional development perspective. In T. Bates, A. Swennen, & K. Jones (Eds.), *Professional development of teacher educators* (pp. 7-19). Abington/New York: Routledge.

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers' math anxiety affects girls' math achievement. *Proceedings of the National Academy of Sciences of the United States of America*, *107*(5), 1860-1863. https://doi:10.1073/pnas.0910967107

Bell, M. A., & Fox, N. A. (2003). Cognition and affective style: Individual differences in brain electrical activity during spatial and verbal tasks. *Brain Cognition, 53*(3), 441-451. https://doi:10.1016/s0278-2626(03)00216-1

Bercaw, L. A., Summers, D. G., Colby, S. A., & Payne, M. (2012). Mirror images: Teacher candidates' perceptions of disposition development. *Action in Teacher Education, 34*(5-6), 514-525. https://doi.org/10.1080/01626620.2012.729481

Berman, P., McLaughlin, M. W., Bass, G., Pauly, E., & Zellman, G. (1977). *Federal programs supporting educational change: Factors affecting implementation and continuation* (Vol. 7). Santa Monica, CA: The Rand Corporation.

Blajenkova, O., Kozhevnikov, M., & Motes, M. A. (2006). Object-spatial imagery: A new self-report imagery questionnaire. *Applied Cognitive Psychology*, *20*(2), 239-263. https://doi.org/10.1002/acp.1182

Borko, H., Liston, D., & Whitcomb, J. (2007). Genres of empirical research in teacher education. *Journal of Teacher Education, 58*(1), 3-11. https://doi:10.1177/0022487106296220

Bursal, M., & Paznokas, L. (2006). Mathematics anxiety and preservice elementary teachers' confidence to teach mathematics and science. *School Science and Mathematics 106*(4), 173-180. https://doi:10.1111/j.1949-8594.2006.tb18073

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2020). *Bilimsel araştırma yöntemleri [Scientific research methods]* (29th ed.). Ankara: Pegem Akademi.

Cano, F. (2005). Epistemological beliefs and approaches to learning: Their change through secondary school and their influence on academic performance. *British Journal of Educational Psychology*, *75*(2), 203-221. https://doi.org/10.1348/000709904X22683

Chan, K.W. (2003). Hong Kong teacher education students. epistemological beliefs and approaches to learning. *Research in Education, 69*(1), 36-50. https://doi.org/10.7227/RIE.69.4

Chan, K.W., & Elliott, R. G. (2004). Relational analysis of personal epistemology and conceptions about teaching and learning. *Teaching and Teacher Education*, *20*(8), 817-831. https://doi.org/10.1016/j.tate.2004.09.002

Coxon, M., Kelly, N., & Page, S. (2016). Individual differences in virtual reality: Are spatial presence and spatial ability linked?. *Virtual Reality*, *20*, 203-212. https://doi.org/10.1007/s10055-016-0292-x

Davis, S., & Stewart, P. (2005). Developing dispositions of preservice teachers through membership in professional organizations. *Journal of Authentic Learning, 2*(1), 37-46.

De Mesquita, P. B., & Drake, J. C. (1994). Educational reform and the self-efficacy beliefs of teachers implementing nongraded primary school programs. *Teaching and Teacher Education, 10*(3), 291–302. https://doi:10.1016/0742-051x(95)97311-9

Delage, V., Trudel, G., Retanal, F., & Maloney, E. A. (2022). Spatial anxiety and spatial ability: Mediators of gender differences in math anxiety. *Journal of Experimental Psychology: General, 151*(4), 921-933. https://doi.org/10.1037/xge0000884

Diez, M. E. (2007). Looking back and moving forward: Three tensions in the teacher dispositions discourse. *Journal of Teacher Education, 58*(5), 388-396. https://doi.org/10.1177/0022487107308418

Dikmenli, Y., & Çifçi, T. (2016). Geography teachers' attitudes and beliefs regarding classroom management. *The International Journal of Higher Education, 5,* 283-291. http://dx.doi.org/10.5430/ijhe.v5n2p283

Dottin, E. S. (2009). Professional judgment and dispositions in teacher education. *Teaching & Teacher Education, 25*(1), 83-88. http://dx.doi.org/10.1016/j.tate.2008.06.005

Duffin, L. C., French, B. F., & Patrick, H. (2012). The teachers' sense of efficacy scale: Confirming the factor structure with beginning preservice teachers. *Teaching and Teacher Education, 28*(6), 827-834. https://doi.org/10.1016/j.tate.2012.03.004

Durlak, J.A., & DuPre, E.P. (2008). Implementation matters: a review of research on the influence of implementation on program outcomes and the factors affecting implementation. *American Journal of Community Psychology*, *41*, 327-50. http://dx.doi.org/10.1007/s10464-008-9165-0

Dursun, Ö. (2010). *The relationships among preservice teachers' spatial visualization ability, geometry self-efficacy, and spatial anxiety* [Master's thesis]. Middle East Technical University Graduate School of Social Sciences.

Eberly, J. L., Rand, M. K., & O'Connor, T. (2007). Analyzing teachers' dispositions towards diversity: Using adult development theory. *Multicultural Education, 14*(4), 31-36.

Gagnier, K., & Fisher, K. (2017). Spatial thinking: A missing building block in STEM education. Technical Report produced by the Science of Learning Institute for the Johns Hopkins University Institute for Education Policy.

Gagnier, K. M., & Fisher, K. R. (2020). Unpacking the black box of translation: A framework for infusing spatial thinking into curricula. *Cognitive Research: Principles and Implications, 5*(1), 1-19. https://doi.org/10.1186/s41235-020-00222-9

Gagnier, K. M., Holochwost, S. J., & Fisher, K. R. (2022). Spatial thinking in science, technology, engineering, and mathematics: Elementary teachers' beliefs, perceptions, and self-efficacy. *Journal of Research in Science Teaching*, *59*(1), 95–126. https://doi.org/10.1002/tea.21722

Geer, E. A. (2019). *The development and construct validation of the revised spatial anxiety scale* [Doctoral dissertation, Florida State University]. ProQuest Dissertations and Theses Global.

Geer, E. A., Barroso, C., Conlon, R. A., Dasher, J. M., & Ganley, C. M. (2024). A meta-analytic review of the relation between spatial anxiety and spatial skills. *Psychological Bulletin, 150*(4), 464-486. https://doi.org/10.1037/bul0000420

Gunderson, E. A., Ramirez, G., Beilock, S. L., & Levine, S. C. (2012). The relation between spatial skill and early number knowledge: The role of the linear number line. *Developmental Psychology, 48*(5), 1229-1241. https://doi.org/10.1037/a0027433

Guskey, T. R. (1987). Context variables that affect measures of teacher efficacy. The *Journal of Educational Research*, *81*(1), 41–47. https://doi.org/10.1080/00220671.1987.10885795

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis*. New Jersey: Pearson Prentice Hall.

Hegarty, M., Richardson, A. E., Montello, D. R., Lovelace, K., & Subbiah, I. (2002). Development of a self-report measure of environmental spatial ability. *Intelligence, 30*(5), 425-447. https://doi.org/10.1016/S0160-2896(02)00116-2

Henson, R. K. (2001). The effects of participation in teacher research on teacher efficacy. *Teaching and Teacher Education, 17*(7), 819-836. https://doi.org/10.1016/S0742-051X(01)00033-6

Hoy, A. W., Hoy, W. K., & Davis, H. A. (2009). Teachers' self-efficacy beliefs. In K. R. Wenzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp.627-653). Routledge/Taylor & Francis Group.

Jo, I. & Bednarz, S.W. (2014a). Developing preservice teachers' pedagogical content knowledge for teaching spatial thinking through geography, *Journal of Geography in Higher Education, 38*(2), 301-313. http://dx.doi.org/10.1080/03098265.2014.911828

Jo, I., & Bednarz, S. W. (2014b). Dispositions toward teaching spatial thinking through geography: conceptualization and an exemplar assessment, *Journal of Geography, 113*(5), 198-207. https://doi.org/10.1080/00221341.2014.881409

Johnson, K. E. (1992). The relationship between teachers‟ beliefs and practices during literacy instruction for non-native speakers of English. *Journal of Reading Behavior, 14*(1), 83-108. https://doi.org/10.1080/10862969209547763

Kane, T. J., & Staiger, D. O. (2008). Estimating teacher impacts on student achievement: An experimental evaluation. NBER Working Paper Series, No. 14607

Kremmyda O, Hüfner K, Flanagin V. L, Hamilton D. A, Linn J, Strupp M., Jahn, K. &

Brandt, T. (2016). Beyond dizziness: Virtual navigation, spatial anxiety and hippocampal volume in bilateral vestibulopathy. *Frontiers in Human Neuroscience, 10*(139), 1-12. https://doi.org/10.3389/fnhum.2016.00139

King, P. M., & Kitchener, K. S. (2002). The reflective judgment model: Twenty years of research on epistemic cognition. In B. K. Hofer & P. R. Pintrich (Eds.), *Personal epistemology: The psychology of beliefs about knowledge and knowing* (pp. 37–61). Lawrence Erlbaum Associates Publishers.

Kuznetcova, I., Porter, C., Peri, J. & Glassman, M. (2022). The construction and validation of the visuospatial self-efficacy (VSSE) scale. *Journal of Science Education and Technology, 31*, 414-427 (2022). https://doi.org/10.1007/s10956-022-09964-1

Lauer, J. E., Esposito, A. G., & Bauer, P. J. (2018). Domain-specific anxiety relates to children's math and spatial performance. *Developmental Psychology*, *54*(11), 2126-2138. https://doi.org/10.1037/dev0000605

Lawton, C. A. (1994). Gender differences in way-finding strategies: Relationship to spatial ability and spatial anxiety. *Sex Roles: A Journal of* Research, *30*, 765-779. https://doi.org/10.1007/BF01544230

Lawton, C. A., & Kállai, J. (2002). Gender differences in wayfinding strategies and anxiety about wayfinding: A cross-cultural comparison. *Sex Roles, 47*(9/10), 389-401. https://doi.org/10.1023/A:1021668724970

Lawton, C. A., Czarnolewski, M. Y., & Eliot, J. (2016). Laterality, sex, and everyday spatial behaviours: An exploratory analysis. *Laterality: Asymmetries of body, Brain and*

Cognition, 21(4-6), 745-766. https://doi.org/10.1080/1357650X.2015.1081919

Lee, J., & R. S. Bednarz. (2009). The effect of GIS learning on spatial thinking. *Journal of Geography in Higher Education, 33*(2), 183-198. http://dx.doi.org/10.1080/03098260802276714

Lee, J., Jo, I., Xuan, X., & Zhou, W. (2018). Geography preservice teachers' disposition toward teaching spatial thinking through geography: a comparison between China and Korea. *International Research in Geographical and Environmental Education, 27*(2), 135-148. https://doi.org/10.1080/10382046.2017.1320898

Letina, A. (2022). Teachers‟ epistemological beliefs and inclination towards traditional or constructivist teaching. *International Journal of Research in Education and Science (IJRES)*, *8*(1), 135-153. https://doi.org/10.46328/ijres.1717

Levine, S. C., Ratliff, K. R., Huttenlocher, J., & Cannon, J. (2012). Early puzzle play: A predictor of preschoolers' spatial transformation skill. *Developmental Psychology, 48*(2), 530-542. https://doi.org/10.1037/a0025913

Lidstone, J. & Stoltman, J. (2006) Editorial: Searching for, or creating, knowledge: The roles of google and GIS in geographical education. *International Research in Geographical and Environmental Education, 15*(3), 205-209. https://10.2167/irgee153ed.0

Lourenco, S. F., & Liu, Y. (2023). The impacts of anxiety and motivation on spatial performance: Implications for gender differences in mental rotation and navigation. *Current Directions in Psychological Science, 32*(3), 187-196. https://doi.org/10.1177/09637214231153072

Lynch, K. (1960). *The image of the city*. Harvard University Press.

Lyons, I. M., Ramirez, G., Maloney, E. A., Rendina, D. N., Levine, S. C., & Beilock, S. L. (2018). Spatial anxiety: A novel questionnaire with subscales for measuring three aspects of spatial anxiety. *Journal of Numerical Cognition*, *4*(3), 526-553. https://doi.org/10.5964/jnc.v4i3.154

Malanchini, M., Rimfeld, K., Shakeshaft, N. G., Rodic, M., Schofield, K., Selzam, S., Dale, P. S., Petrill, S. A., & Kovas, Y. (2017). The genetic and environmental aetiology of spatial, mathematics and general anxiety. *Scientific Reports, 7*(1), 1-11. https://doi.org/10.1038/srep42218

Maloney, E. A., Sattizahn, J. R., & Beilock, S. L. (2014). Anxiety and cognition. *WIREs Cognitive Science, 5*(4), 403-411. https://doi.org/10.1002/wcs.1299

Meneghetti, C., Miola, L., Toffalini, E., Pastore, M., & Pazzaglia, F. (2021). Learning from navigation, and tasks assessing its accuracy: The role of visuospatial abilities and wayfinding inclinations. *Journal of Environmental Psychology*, *75*, 101614. https://doi.org/10.1016/j.jenvp.2021.101614

Moore, W. P., & Esselman, M. E. (1992, April 20-24). *Teacher efficacy, empowerment, and a focused instructional climate: Does student achievement benefit?* [Conference presentation]. Annual Conference of the American Educational Research Association, San Francisco, CA, United States.

NRC. (2006). *Learning to think spatially*. Washington, DC: National Academy Press.

Nazareth, A., Killick, R. C., Dick, A. S., & Pruden, S. M. (2019). Strategy selection versus flexibility: using eye-trackers to investigate strategy use during mental rotation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *45(2)*, 232–245. https://doi.org/10.1037/xlm0000574

Oliver, A., Wildschut, T., Sedikides, Parker, O. M., Wood A.P. & Redhead, E.S. (2024). Nostalgia assuages spatial anxiety. *Journal of Experimental Social Psychology, 112*, 1-12. https://doi.org/10.1016/j.jesp.2023.104586

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research, 66*(4), 543-578. https://doi.org/10.2307/1170653

Paulsen, M.B., & Feldman, K. A. (1999). Student motivation and epistemological beliefs. *New Directions for Teaching and Learning, 78*, 77-80. https://doi.org/10.1002/tl.7802

Pazzaglia, F., Meneghetti, C., & Ronconi, L. (2018). Tracing a route and finding a shortcut: The working memory, motivational, and personality factors involved. *Frontiers in Human Neuroscience, 12*(225),11-11. https://doi.org/10.3389/fnhum.2018.00225

Pazzaglia, F., Meneghetti, C., Labate, E., & Ronconi, L. (2017). Are wayfinding self-efficacy and pleasure in exploring related to shortcut finding? A study in a virtual environment. In T. Barkowsky, H. Burte, C. Hölscher & H. Schultheis (Eds.) *Spatial cognition X. Spatial cognition KogWis 2016. Lecture notes in computer science*, (pp 55-68). Springer, Cham. https://doi.org/10.1007/978-3-319-68189-4_4

Penna, M. P., Agus, M., Peró-Cebollero, M., Guàrdia-Olmos, J., & Pessa, E. (2014). The use of imagery in statistical reasoning by university undergraduate students: A preliminary study. *Quality & Quantity*, *48*, 173-187. https://doi.org/10.1007/s11135-012-9757-5

Poçan, S., Açıkgül, K. & Sad, S.N. (2020). The adaptation of spatial anxiety scale into Turkish: validity and reliability studies *Mediterranean Journal of Educational Research, 14*(34), 64-83. https://doi:10.29329/mjer.2020.322.3

Power, J., Buckley, J., & Seery, N. (2016). Visualizing success: Investigating the relationship between ability and self-efficacy in the domain of visual processing. The 70th ASEE Engineering Design Graphics Division Midyear Conference, At Embry-Riddle Aeronautical University, Florida, USA.

Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2012). Spatial anxiety relates to spatial abilities as a function of working memory in children. *Quarterly Journal of Experimental Psychology, 65*(3), 474-487. http://dx.doi.org/10.1080/17470218.2011.616214

Ramirez, G., Hooper, S. Y., Kersting, N. B., Ferguson, R., & Yeager, D. (2018). Teacher math anxiety relates to adolescent students' math achievement. *AERA Open*, *4*(1), 1-3. http://dx.doi.org/10.1177/2332858418756052

Ratinen, I., & Keinonen, T. (2011). Student-teachers' use of Google Earth in problem-based geology learning. *International Research in Geographical and Environmental Education, 20*(4),345-358. https://doi.org/10.1080/10382046.2011.619811

Rocha, K., Lussier, C. M., & Atit, K. (2022). What makes online teaching spatial? Examining the connections between K-12 teachers' spatial skills, affect, and their use of spatial pedagogy during remote instruction. *Cognitive Research: Principles and Implications, 7(*25), 1-19. https://doi.org/10.1186/s41235-022-00377-7

Ross, J.A. (1994, June). *Beliefs that make a difference: The origins and impacts of teacher efficacy* [Conference presentation]. The annual meeting of the Canadian Association for Curriculum Studies. Ontario Institute for Studies in Education Trent Valley Centre, Ontario. https://files.eric.ed.gov/fulltext/ED379216.pdf

Safadel, P. (2016). *Examining the effects of augmented reality in teaching and learning environments that have spatial frameworks* [Doctoral dissertation, Texas Tech University].

Safadel, P., White, D & Kia, A. (2023). Spatial self-efficacy and spatial ability: an analysis of their relationship, *New Review of Hypermedia and Multimedia, 29*(2),114-150. https://doi.org/10.1080/13614568.2023.2248057

Schommer-Aikins, M. (1993). Epistemological development and academic performance among secondary schools. *Journal of Educational Psychology, 85*(3), 406-411. https://psycnet.apa.org/doi/10.1037/0022-0663.85.3.406

Schommer-Aikins, M. (2004). Explaining the epistemological belief system: Introducing the embedded systemic model and coordinated research approach. *Educational Psychologist, 39*(1), 19-29. http://dx.doi.org/10.1207/s15326985ep3901_3

Schraw, G., & Olafson, L. (2003). Teachers' epistemological world views and educational practices. *Journal of Cognitive Education and Psychology*, *3*(2), 178-235. https://doi.org/10.1891/194589503787383109

Schunk, D. H., & Mullen, C. A. (2012). Self-efficacy as an engaged learner. In S. L. Christenson, A. L. Reschly & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 219–235). Springer Science + Business Media. https://doi.org/10.1007/978-1-4614-2018-7_10

Şanlı, C., & Jo, I. (2020). Examining preservice geography teachers' dispositions to teach spatial thinking skills. *International Journal of Eurasian Education and Culture, 11*(5), 2069-2102. https://doi.10.35826/ijoecc.240

Şanlı, C., & Sezer, A., (2019). Teaching spatial thinking through geography disposition inventory: A validity and reliability study on its Turkish adaptation. *Egean Geographical Journal, 26/28*(2), 213-225.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics.* Boston, MA: Allyn & Bacon/Pearson Education.

Takahashi, S. (2011). Co-constructing efficacy: A communities of practice perspective on teachers' efficacy beliefs. *Teaching and Teacher Education*, *27*(4), 732-741. https://doi.org/10.1016/j.tate.2010.12.002

Towle, E., Mann, J., Kinsey, B., O'Brien, E. J., Bauer, C. F., & Champoux, R. (2005). Assessing the self-efficacy and spatial ability of engineering students from multiple disciplines. *Proceedings Frontiers in Education 35th Annual Conference*, S2C-15. http://dx.doi.org/10.1109/FIE.2005.1612216

Tsouloupas, Costas N., Carson, Russell L., Matthews, Russell, Grawitch, Matthew J., & Barber, Larissa K. (2010). Exploring the association between teachers' perceived student misbehaviour and emotional exhaustion: The importance of teacher efficacy beliefs and emotion regulation. *Educational Psychology, 30*(2), 173-189. http://dx.doi.org/10.1080/01443410903494460

Turgut, M. (2015). Development of the spatial ability self-report scale (SASRS): Reliability and validity studies. *Quality & Quantity: International Journal of Methodology, 49*(5), 1997-2014. http://dx.doi.org/10.1007/s11135-014-0086-8

Uttal, D. H., & Cohen, C. A. (2012). Spatial thinking and STEM education: When, why, and how? In B. H. Ross (Ed.), *The psychology of learning and motivation: Vol. 57. The psychology of learning and motivation* (pp.147-181). Elsevier Academic Press. https://psycnet.apa.org/doi/10.1016/B978-0-12-394293-7.00004-2

Uttal, D. H., Miller, D. I., & Newcombe, N. S. (2013). Exploring and enhancing spatial thinking: Links to achievement in science, technology, engineering, and mathematics?. *Current Directions in Psychological Science*, *22*(5), 367-373. http://dx.doi.org/10.1177/0963721413484756

Viaud-Delmon I., Berthoz A., & Jouvent R. (2002). Multisensory integration for spatial orientation in trait anxiety subjects: Absence of visual dependence. *European Psychiatry*, *17*(4),194-199. https://doi:10.1016/S0924-9338(02)00667-3

Vieites, V., Pruden, S. M., & Reeb-Sutherland, B. C. (2020). Childhood wayfinding experience explains sex and individual differences in adult wayfinding strategy and anxiety. *Cognitive Research: Principles and Implications, 5*(1), 1-16. https://doi.org/10.1186/s41235-020-00220-x

Walkowiak, S., Foulsham, T., & Eardley, A. F. (2015). Individual differences and personality correlates of navigational performance in the virtual route learning task. *Computers in Human Behavior*, *45*, 402-410. https://doi.org/10.1016/j.chb.2014.12.041

Woolfolk Hoy, A. & Burke Spero, R. (2005) Changes in teacher efficacy during the early years of teaching: a comparison of four measures. *Teaching and Teacher Education, 21*,

343-356. http://dx.doi.org/10.1016/j.tate.2005.01.007

Yazıcıoğlu, Y., & Erdoğan, S. (2014). *SPSS uygulamalı bilimsel araştırma yöntemleri [Applied scientific research methods with SPSS]*. Ankara: Nobel

Yurt, E. (2023). *Sosyal bilimlerde çok değişkenli analizler için pratik bilgiler: SPSS ve AMOS uygulamaları [Practical knowledge for multivariate analysis in social sciences: SPSS and AMOS applications].* Ankara: Nobel.