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The Relationship between Geographical Self-Efficacy and Academic Achievements in Geography: A Moderated Mediating Model

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Abstract: There are limited studies on the impact of domain-specific self-efficacy on academic achievements. The geospatial thinking ability is paramount to understand the relationship between geographical self-efficacy and academic achievements in geography. This study aims to explore the mediating effect of geospatial thinking on the relationship between geographical self-efficacy and academic achievements, and the moderating role of gender and attendance type. A total of 749 Chinese high school students, working as participants, anonymously completed a questionnaire covering topics like geographical spatial thinking, geographical self-efficacy, academic achievements in geography, gender, attendance type, and place of residence. The analysis using MPLUS 8.3 software indicates that geographical self-efficacy significantly predicts academic achievements in geography. Geospatial thinking plays a significant mediating role in this pathway, with gender and type of attendance having moderating effects. This study enhances the understanding between domain-specific self-efficacy and academic achievements, providing crucial guidance for educational practices, such as emphasizing geospatial thinking training for high school students, focusing on encouraging female students, and properly scheduling rest times for boarders, which will significantly contribute to the sustainable development of geography education.

Keywords: geographical self-efficacy; academic achievements in geography; geospatial thinking ability; gender; attendance type; moderated mediation

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1. Introduction

In the face of an escalating global environmental crisis, education for sustainable development is more crucial than ever. UNESCO urges countries to promote education for sustainable development in its Sustainable Development Goals [1]. Sustainable education entails transferring knowledge and skills, and fostering positive values and attitudes towards lifelong learning that contribute to sustainable development [2]. Geography education plays a significant role in cultivating learners' understanding and abilities related to sustainable development, making it a key component of sustainable development education [3]. On one hand, geography education effectively enhances awareness and responsibility towards environmental protection while disseminating knowledge about sustainable development [4]. On the other hand, geography education also promotes learners' capacity for sustainable development by improving regional participatory processes [5].

The academic achievement in geography, as a significant manifestation of the outcomes of geography education, has always been a topic of interest to geographers, psychologists, and educators. In the field of cognitive science, academic achievement is often seen as behavior driven by cognitive factors [6]. With the development of cognitive science, many detailed theories can be used to explain the relationship between academic motivation and academic achievements, such as self-efficacy theory [7,8], achievement goal theory [9], and attribution theory [10,11]. Among them, self-efficacy theory is a significant theoretical

foundation of social learning study in the 1970s. Its explanation about the influence of individual self-ability evaluation on motivation and behavior has ignited wide discussions about whether self-efficacy can predict students' academic achievements [12]. However, there are relatively few studies on the prediction of domain-specific self-efficacy in relation to specific subject performance, particularly within the field of geography.

Some studies indicate that students' motivations vary with personal and environmental factors [13]. This implies that other mechanisms might affect the relationship between geographical self-efficacy and academic achievements. Recent years have witnessed an increase in studies examining the factors influencing students' academic performance in geography [14]. Among these studies, individual factors such as self-efficacy, gender, learning attitude, and geospatial thinking ability are deemed to be closely related to geographical academic achievements [15,16]. Moreover, external environmental factors such as family capital, place of residence, teacher quality, and teaching strategies are believed to significantly influence academic achievements in geography [17,18]. However, most studies have only discussed the direct impact relationship of individual factors and external environmental factors on geographical academic achievements, neglecting the possible mediating and moderating roles of some factors in the relationship between geographical self-efficacy and geographical academic achievements. Therefore, it is necessary to further study the predictive role of geographical self-efficacy in regard to academic achievements and its influence.

Exploring the world from the perspective of space is a unique cognitive way of geography, and geospatial thinking is a unique cognitive approach formed in the process of exploring spatial laws in geography [19]. Therefore, geospatial thinking ability is vital for geography and is considered to be the key factor influencing students' academic achievements [20]. The study indicates that students with higher geospatial thinking abilities often achieve greater success in geography [21].

This study employs geospatial thinking ability as a mediator, with gender and attendance type serving as a moderator, and place of residence as a covariate, to explore the intricate mechanisms influencing the relationship between geographical self-efficacy and academic achievements in geography (Figure 1). Based on the extensive sample data across eight provinces in China, this study attempts to empirically validate this mediating and moderating relationship. The purpose of this study is to explore the complex relationship between self-efficacy and academic achievements, so as to effectively guide educational practices of strengthening high school students' geospatial thinking abilities, amplify geography education for female students, and organize adequate rest time for boarders. These efforts will effectively facilitate the sustainable development of geographical education.

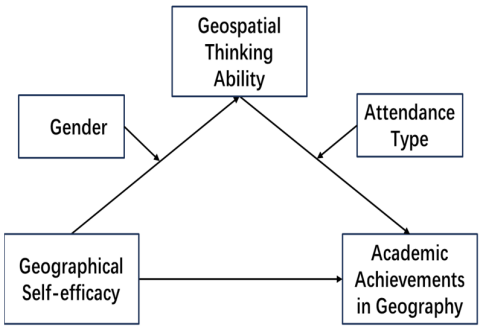

Figure 1. Theoretical model diagram.

2. Theoretical Basis and Hypothesis

2.1. Geographical Self-Efficacy and Academic Achievements in Geography

Self-efficacy largely reflects individuals' expectations and beliefs about the outcomes of their behaviors, and a high level of self-efficacy may inspire confidence in successfully completing tasks and exhibit extraordinary task performance [22,23]. The self-efficacy

during the middle school holds a crucial significance in an individual's life, which may affect students' academic achievements and future career success as well as social integration [24]. Academic achievement is an assessment of an individual's level of knowledge and skills within a certain timeframe, typically encompassing criteria such as grades, academic honors, and academic abilities [25,26]. Numerous studies have confirmed the importance of self-efficacy in relation to academic achievements, and a high level of self-efficacy often implies having higher academic achievements [27–30].

In recent years, studies on the relationship between self-efficacy and academic achievements has gradually permeated into different academic disciplines. For instance, studies on mathematics show that effective feedback and mathematics self-efficacy significantly affect academic achievements in mathematics [31]. Similarly, studies on language disciplines demonstrate that students with high academic self-efficacy outperform those with low self-efficacy in reading achievements [32]. Studies in science have shown that students' scientific self-efficacy is highly correlated with academic achievements. [33]. Although the influence of self-efficacy will be better understood when the evaluation of self-efficacy focuses on specific fields [34], there are few measurements and studies specifically targeted at geographical self-efficacy currently. Therefore, the study of geography self-efficacy's impact on geographical academic achievements becomes highly meaningful.

Based on the above literature analysis, it is found that there might be a close relationship between geographical self-efficacy and geographical academic achievements; thus, the following hypothesis is proposed: Geographical self-efficacy can positively predict geographical academic achievements (H1).

2.2. The Mediating Role of Geospatial Thinking

Spatial thinking has become essential thinking for global governance in the 21st century, which is paramount to advancing global sustainable development [35]. Spatial thinking ability is defined as the ability to visualize and solve problems spatially [36]. Geospatial thinking ability is often considered a part of spatial thinking ability, which has a closer relationship with the spatial and geographical knowledge aspects involved in geography. Hence, it is believed to be a vital way of thinking in geography and determines geography academics' success to a great extent [37]. Increasing interventions show that enhancing students' spatial thinking ability can improve geographical academic performance [38,39]. However, studies have found that the effectiveness of such interventions is influenced by students' beliefs (e.g., self-efficacy) and enthusiasm [40].

According to social cognitive theory, self-efficacy may be influenced by environmental and personal factors, which will lead to changes in geographical academic achievements [41]. Among these factors, existing studies have found that the high level of self-efficacy can enhance students' motivation and interest to continue learning geography and further improve their performance in spatial thinking ability tests. Students who are active in geospatial thinking often stand out in their geographical academic achievements [42], whereas low levels of self-efficacy could impact students' confidence in using spatial thinking abilities to solve spatial problems. It is revealed that spatial thinking ability forms the basis for students' understanding and reasoning about scientific phenomena [43,44], and students with lower levels of spatial thinking abilities would find it challenging to excel in their geographical academic achievements.

Given the above findings, the following hypothesis is proposed: Geographical self-efficacy has an indirect impact on the academic achievements of high school students through the mediating effect of geospatial thinking capabilities (H2).

2.3. The Moderating Role of Gender

As early as the 1970s, studies showed that factors such as age, gender, and family background significantly affect geospatial thinking ability [45]. With further study, the relationship between gender and geospatial thinking ability has become more complex. A few researchers believe that gender has no influence on geospatial thinking ability. This

is because with the development of information technology, both males and females can equally access schema conducive to the development of spatial thinking abilities through smartphones and internet map applications [46]. Another study showed that, compared to family capital, gender does not significantly impact geospatial thinking ability [47]. However, more studies have proven that geospatial thinking ability are influenced by gender, and different researchers have varying interpretations of this.

The influence of gender on spatial thinking ability can be divided into direct and indirect aspects. Some researchers believe that gender indirectly affects geospatial thinking ability by influencing the sense of place [48]. Other scholars elaborate the direct effect of gender differences on geospatial thinking ability through specific examples [49]. Some studies on gender differences have yielded conflicting results. In an intervention experiment, a female student in the experimental group valued spatial information and spaces more than other experimenters [50]. Conversely, another study found that males scored higher than females in a geospatial test [51].

From the above literature analysis, it is found that gender possibly moderates the relationship between geography self-efficacy and academic achievements by influencing geospatial thinking ability. Therefore, we hypothesized that the mediating effect of geographical spatial thinking ability on geographical self-efficacy is moderated by gender (H3).

2.4. The Moderating Role of Attendance Type

An individual's behavior and cognition are closely related to their surroundings. Studying at day schools and boarding schools are two different ways to attend class, which often signify differences in family factors and cognitive environments for students. Boarders replace their families with schools, which can compensate for the negative impacts that the original family environment brings [52]. However, if boarders cannot adapt to the school environment, they will suffer mental adaptability disorders and a series of behavioral problems [53]. Therefore, under different cultural backgrounds, there may be various results regarding the academic achievements of boarders and externs. In the Western traditional elite boarding system's context, most of the existing studies on the impact of boarding on academic achievements has been positive [54]. However, in China, the impact of boarders on academic achievements is different [55]. Another study on boarder self-efficacy suggested that boarders are associated with higher peer attachment and greater self-efficacy, and they participate less in violent crimes [56].

Regarding geospatial thinking ability, many studies have shown that family factors such as parents' economic income, educational level, social status, family environment, and social experience can positively predict geospatial thinking ability [57]. Although there are few studies that directly state that attendance type has an impact on students' spatial thinking abilities, we believe that students' different attendance types can lead to differences in students' study time, study atmosphere, and even study process. These differences may influence geospatial thinking abilities. Consequently, we hypothesize that the moderating effects of the attendance type affect the mediating effect of geospatial thinking ability on geographical academic achievements (H4).

3. Method

3.1. Procedures

This study received approval from the Ethics Review Committee of Shaanxi Normal University. Prior to data collection, class head teachers in each school contacted students and their parents and obtained their consent. Before the formal test, geography experts evaluated the content of the questionnaire and thought that the questionnaire could effectively reflect the study content. The questionnaire was also pre-tested with 30 students, who evaluated the fluency and comprehensibility of the content of the questionnaire and the results of the pre-test were good. The survey was conducted through two paper questionnaires. The first questionnaire contained demographic information and a geospatial thinking ability test (the completion time was 35 min), and the second questionnaire was a

geographical self-efficacy questionnaire (the completion time was 20 min). The questionnaires of each school were arranged to be completed in two geography classes within one week (May–June, 2023). During the data collection period, adhering to the principle of voluntarism, the geography teacher provided the participating students with an informed consent form and emphasized that the filling in of this questionnaire would not affect the evaluation of the students in their schools. Students were encouraged to complete the questionnaire independently. The questionnaires completed by the students were anonymized to ensure their privacy.

3.2. Participants

To test this hypothesis on a national scale, high school students from eight public schools across eastern, central, and western China were selected to participate in this study, with a total of 1060 students participating in the survey. After eliminating invalid responses, 970 valid questionnaires remained for the geospatial thinking ability test and 749 for the geography self-efficacy questionnaire. Only students who completed all parts were included in the study (n = 749, retention rate 70.66%). In the final sample, 49.4% of the respondents were female (n = 370), 50.6% of the respondents were male (n = 379), 59.15% of the respondents lived in urban areas (n = 443), and 40.85% of the respondents lived in rural areas (n = 306).

3.3. Measures

The data for this study consisted of four parts: demographic information, a geospatial thinking ability test, a geography self-efficacy scale, and geographical academic achievements. The demographic information included the participant's gender, residence, and attendance type. Gender included both male and female categories; residence included both rural and urban categories; and attendance type refers to the way in which the student attends school, which is categorized into three types: boarders, those who rent rooms, and externs. Among them, boarders were those who eat and sleep at school on study days except for holidays. Externs are the opposite of boarders: they eat and sleep in their own homes in general, except during class time. Rental students are in between externs and boarders: they eat and sleep in the rented place except for class time and are generally less constrained by their families and schools.

3.3.1. Geospatial Thinking Ability Test

This study uses the Spatial Thinking Ability Test (STAT) developed by Lee and Bednarz to assess students' geospatial thinking ability levels. The STAT contains 16 test questions covering eight components of spatial thinking ability [58]. It consists of two equivalent forms and can not only measure students' spatial thinking abilities but also compare them before and after interventions. One of the STAT's advantages is its reliability and standardization as an assessment tool for thinking abilities [59], which has been widely used in various studies in different regions [60]. The full score of this test is 16, and the higher the score, the stronger the geospatial thinking ability. Since the respondents in the survey spoke Chinese, the English questionnaires were translated into Chinese. To ensure the accuracy and faithfulness of the translation, the back-translation method was used to minimize study errors caused by translation [61]. This process involved first translating the English questionnaire into Chinese, then re-translating the Chinese questionnaire back into English, and finally comparing the differences between the two. If there were no inconsistencies in expression, we considered the translated version to be trustworthy. In this study, the Cronbach α coefficient for this scale in the study was 0.64, and the McDonald ω coefficient for this scale in the study was 0.81, which are reliable results [62].

3.3.2. Geography Self-Efficacy

This study develops a Geography Self-Efficacy questionnaire by adapting the Mathematics Self-Efficacy questionnaire from the 30th Student Questionnaire in the 2012 Program

for International Student Assessment (PISA). Self-efficacy is a belief that one can achieve desired outcomes in any task and is a crucial part of Bandura's social cognitive theory [63,64]. Self-efficacy can be general or specific to a particular field. The General Self-Efficacy Scale developed by Schwarzer and Jerusalem is a universally applicable instrument to measure general self-efficacy [65]. However, general scales cannot cover the specificity of a particular field, leading researchers to develop many scales specific to their areas of expertise. In fact, self-efficacy specific to a field tends to predict outcomes in a particular area better than general self-efficacy [66]. The Geography Self-Efficacy questionnaire developed in this study covers areas in geography such as confidence in understanding maps, orientation, three-dimensional space, and spatiotemporal patterns. It consists of eight questions such as "I can quickly navigate and plan routes in unfamiliar places using maps or other geographical objects" and "I can imagine 3D terrain in my mind just from a two-dimensional topographic map". The scale, using a 4-point Likert scale (1 = very unconfident, 4 = very confident), assesses respondents' geography self-efficacy, with a higher total score indicating higher geographical self-efficacy. The Cronbach α coefficient for this scale was 0.88, and the McDonald ω coefficient for this scale was 0.88, indicating reliability.

3.3.3. Geographical Academic Achievements

Academic achievement is a crucial aspect of measuring students' progress in school [67]. To assess the level of geography knowledge and skills mastered by students, the study takes the geography subject scores from the latest mid-term test as a representative of the sampled students' geographical academic performance. The sample schools selected for this study are all located in provinces that have implemented China's New High School Entrance Examination policy, a series of reform policies on the high school stage education examination enrollment system issued by the Ministry of Education of China in 2021. The policy aimed at promoting quality education development and promoting education fairness [68]. Under the New High School Entrance Examination policy, the curriculum standards and scoring systems for geography are uniform, ensuring the comparability of geography scores among the sample schools. As such, many researchers have conducted studies on students' academic performance using academic scores in school [69–71].

3.4. Data Analysis

This study used SPSS 27.0 for descriptive statistical analysis and correlation analysis, SPSS 27.0 and JASP0.18.1.0 software for reliability testing and validity testing, and Mplus 8.3 to test the mediation and moderation effects in the research hypotheses. Firstly, the Harman single-factor test was used to check whether there is a common method deviation between the data of geospatial thinking ability questionnaire and geographical self-efficacy questionnaire. The results showed that, of the total factors, six exhibited eigenvalues surpassing 1 with the first factor constituting a mere 19.53%, a rate significantly lower than the critical threshold of 40%, thereby affirming the credibility of impending data interpretation [72]. Secondly, we used SPSS 27.0 to calculate Cronbach α to evaluate the reliability of the questionnaire. We used JASP to test the reliability and validity to ensure that the reliability and validity of the questionnaire were acceptable for the samples used in this study. Given that the dependent variable (geographical academic achievements) and the moderator variables (gender and attendance type) were all variables measured via a single question, this study only tested the reliability and validity of the mediator variable (geospatial thinking ability) and the independent variable (geographical self-efficacy). Again, the Pearson correlation coefficient was used to measure the degree of linear association between continuous variables. Finally, mediation and moderation effects were explored using Mplus 8.3 software to test the four hypotheses proposed in this study.

4. Results

4.1. Confirmatory Factor Analysis and Validity

The factor structure in this study was confirmed by confirmatory factor analysis. Only the Geospatial Thinking Abilities questionnaire and the Geographical Self-Efficacy questionnaire were tested in the confirmatory factor analysis. Due to the weak loading of dimension 6 of the Geospatial Thinking Abilities questionnaire (0.21), it was removed from the model, and the removed model fit well (CMIN/DF = 2.66, $p < 0.001$, CFI = 0.97, TLI = 0.96, RMSEA = 0.04, SRMAR = 0.04). In addition, the Geographical Self-Efficacy questionnaire had a composite reliability (CR) of 0.88 and an average variance extracted (AVE) of 0.48, the Geospatial Thinking Abilities questionnaire had a composite reliability of 0.82 and an average variance extracted of 0.59 (Table 1), and the square root of the AVE for each factor was greater than the correlation between the factors (Table 2), suggesting that the scales had appropriate discriminant validity. Overall, the validity of the scale in this study was acceptable.

Table 1. The results for validity.

Factors	Indicator	Item	Loading	AVE	CR
Factors 1				0.48	0.88
	GSES1	I can quickly navigate unfamiliar places using maps or other geographical tools to plan routes	0.68		
	GSES2	I can find the spatial and temporal changes of geographical elements in maps or graphs	0.76		
	GSES3	I can choose the optimal location based on the given spatial characteristics (such as land use, elevation, and population density) and the superposition of these elements	0.73		
	GSES4	I can map out the slope and section of some places from the terrain	0.70		
	GSES5	I can identify the spatial correlation (positive or negative) of certain geographical elements in the map.	0.70		
	GSES6	I can visualize 3D terrain in my mind based on 2D topographic maps	0.73		
	GSES7	I can imagine what some shapes (triangles, squares, etc.) look like when rotated, deformed, and superimposed	0.54		
	GSES8	I can use various legends to understand geographical features (e.g., bus routes to judge traffic conditions)	0.70		
Factors 2				0.59	0.82
	STAT1	navigating using direction and location information	0.74		
	STAT2	detecting map patterns	0.41		
	STAT3	understanding map layers	0.42		
	STAT4	interpreting a topographic map	0.43		
	STAT5	identifying spatial correlation	0.68		
	STAT7	converting verbal and symbolic information to spatial information	0.82		
	STAT8	understanding map overlays and dissolves	0.81		

Table 2. Discriminant validity of variables.

Variables	Factor 1	Factor 2
Factor 1	0.69	
Factor 2	0.13	0.76

4.2. Descriptive Statistics and Correlation Analysis

The descriptive analysis results of all variables in this study are shown in Table 3. There was a positive correlation between the variables used for mediation analysis: geospatial thinking ability, geographical self-efficacy, and geographical academic achievements. First, there is a significant positive correlation between geospatial thinking ability and geographical self-efficacy (r = 0.14, $p < 0.001$). Second, there is a significant positive correlation between geospatial thinking ability and geographical academic achievements (r = 0.16, $p < 0.001$). Lastly, there is a significant positive correlation between geographical self-efficacy and geographical academic achievements (r = 0.09, $p = 0.011$). The two moderating variables, gender and attendance type, show a weak correlation with other variables. The relationship between these variables provides support for subsequent hypothesis testing.

Table 3. Descriptive statistics and correlation analysis among the study variables.

Variables	Mean	SD	a	b	c	d	e	f
a. Geographical Self-efficacy	21.70	5.06	1					
b. Geospatial Thinking Ability	12.04	2.24	0.14 ***	1				
c. Academic Achievements in Geography	64.59	9.94	0.09 *	0.16 ***	1			
d. Gender	1.49	0.50	−0.22 ***	−0.03	0.01	1		
e. Mode of Reading	2.38	0.81	0.05	0.05	−0.13 ***	−0.05	1	
f. Residence	1.25	0.44	−0.07	−0.10 **	0.03	0.03	−0.40 ***	1

Note: N = 749. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4.3. Mediation Analysis

Given the significant correlation between geographical self-efficacy, geospatial thinking ability, and geographical academic achievements, a path analysis model from MPLUS is used to describe their relationships. The results (Figure 2 and Table 4) show that geographical self-efficacy significantly and positively predict geospatial thinking abilities and geographical academic achievements (β = 0.14, SE = 0.04, t (747) = 3.70, $p < 0.001$; β = 0.08, SE = 0.04, t (747) = 1.98, $p = 0.048$), and geospatial thinking ability significantly predicts academic achievements (β = 0.15, SE = 0.03, t (747) = 4.61, $p < 0.001$). The effect size of mediation analysis is shown in Table 5.

Table 4. Testing the mediation effect of Geographical Self-efficacy on Academic Achievements in Geography.

Variables	M: Geospatial Thinking Ability			Y: Academic Achievements in Geography		
	β	SE	t	β	SE	t
Geographical Self-efficacy	0.14	0.04	3.70 ***	0.08	0.04	1.98 *
Geospatial Thinking Ability				0.15	0.03	4.61 ***
Residence	−0.09	0.04	−2.48 *	0.06	0.04	1.51
R-sq	0.03 *			0.03 **		

Note: Analyses conducted using Mplus8.3. N = 749. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. SE, standard error. All variables are standardized.

Table 5. The effect size of mediation analysis.

	Effect Size	Relative Effect Size
Total effect	0.10	
Direct effect	0.08	78.52%
Indirect effect	0.02	21.48%

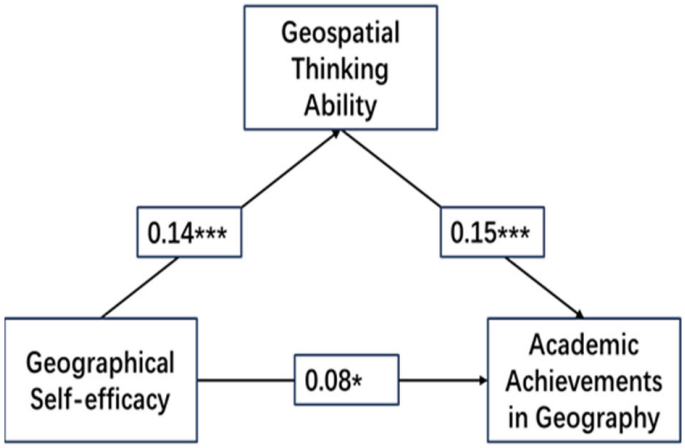

Figure 2. Mediation model with geospatial thinking as the mediator. * $p < 0.05$, *** $p < 0.001$.

4.4. Moderated Mediation Analysis

To test whether gender and attendance type moderate the established mediating pathways, the current study applied MPLUS software to perform a moderated mediation analysis. Since gender and attendance type are categorical variables, binary dummy coding (W1 = Male; W2 = Female) and tertiary dummy coding (V1 = Boarder; V2 = Rent rooms; V3 = Extern) were applied to gender and attendance type, respectively. In the moderating analysis of gender, males were taken as the reference group, and in the moderating analysis of attendance type, and borders were taken as the reference group. The results, as shown in Table 6, indicate that gender significantly moderates the pathway through which geography self-efficacy influences geospatial thinking abilities (β = 0.17, SE = 0.07, t (745) = 2.35, $p = 0.019$), and attendance type significantly moderates the influence path of geospatial thinking abilities on geographical academic achievements (β = −0.27, SE = 0.11, t (743) = −2.46, $p = 0.014$; β = −0.25, SE = 0.09, t (743) = −2.88, $p = 0.004$). Different moderating effects were found at different values of each moderator (Table 7), with more significant moderation effects in the pathway of geospatial thinking abilities on geographical academic achievements for the female group of externs and boarders compared to the male group.

Table 6. The moderated mediating effect analysis of geographical self-efficacy on academic achievements in geography.

Variables	M: Geospatial Thinking Ability			Y: Academic Achievements in Geography		
	β	SE	t	β	SE	t
Geographical Self-efficacy	0.07	0.05	1.26	0.08	0.04	2.15 *
Gender	0.01	0.07	0.12			
Residence	−0.22	0.09	−2.59 *	0.00	0.09	0.05
Geographical Self-efficacy x Gender	0.17	0.07	2.35 *			
Geospatial Thinking Ability				0.35	0.08	4.58 ***
Rent Rooms				−0.18	0.12	−1.44
Extern				−0.35	0.11	−3.36 **
Geospatial Thinking Ability x Rent Rooms				−0.27	0.11	−2.46 *
Geospatial Thinking Ability x Extern				−0.25	0.09	−2.88 **
R-sq	0.04 **			0.17 **		

Note: Analyses conducted using Mplus8.3. N = 749. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Male (W1 = 1; W2 = 0), Female (W1 = 0; W2 = 1); Boarder (V1 = 1; V2 = 0; V3 = 0), Rent rooms (V1 = 0; V2 = 1; V3 = 0), Extern (V1 = 0; V2 = 0; V3 = 1). SE, standard error. All variables are standardized.

Table 7. Indirect effect of mediating models under different conditions.

Group	Effect	SE	Boot LLCI	Boot ULCI
Male				
Boarder	0.02	0.02	−0.01	0.07
Rent rooms	0.01	0.01	−0.00	0.04
Extern	0.01	0.01	−0.00	0.02
Female				
Boarder	0.08	0.03	0.04	0.15
Rent rooms	0.02	0.02	−0.01	0.06
Extern	0.02	0.01	0.01	0.05

4.5. Simple Slope Analysis

Simple slope tests show, in Figures 3 and 4, compared to the male group, that as geographical self-efficacy increased, the female group showed a significant upward trend in geospatial thinking ability, and the upward trend was more significant than that of the male group (β = 0.24, SE = 0.05, t (745) = 4.58, $p < 0.001$). For externs, as geospatial thinking skills improve, there is a significant upward trend in academic achievements in geography (β = 0.10, SE = 0.04, t (743) = 2.30, $p = 0.022$). For rental students, the influence of geospatial thinking ability on academic achievements in geography is not significant (β = 0.08, SE = 0.08, t (743) = 1.07, $p = 0.28$). For boarders, as geospatial thinking ability improves, there is a significant upward trend in academic achievements in geography (β = 0.35, SE = 0.08 t (743) = 4.58, $p < 0.001$), and this trend is even more prominent than for non-resident students.

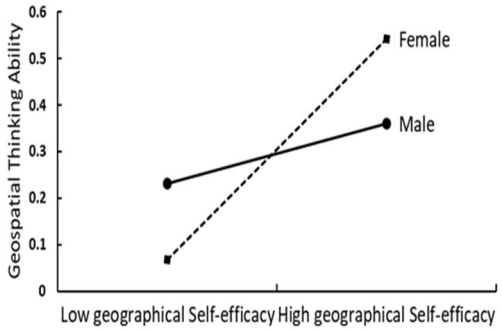

Figure 3. Moderating effect of gender on the prediction of geospatial thinking ability from geographical self-efficacy.

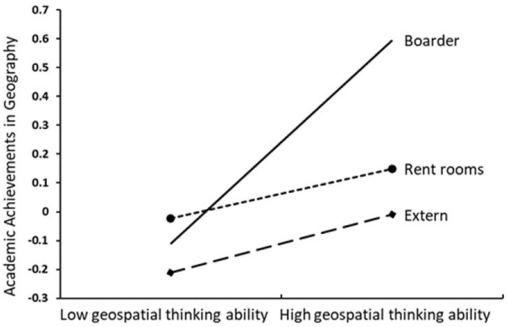

Figure 4. Moderating effect of attendance type on the prediction of academic achievements in geography from geospatial thinking ability.

5. Discussion

Geography education plays a crucial role in promoting education for sustainable development, and the outcomes of geography teaching even have an impact on the process of sustainable development to some extent [73]. Regrettably, research on the mechanism of how geography academic achievement influences this process is still in its infancy, posing a significant challenge to the sustainable development of geography education. To address this deficiency, this study explored the influence of geographical self-efficacy on academic achievements in geography and its underlying mechanisms. Through the construction of a reliable structural model for moderated mediation effect analysis, the results show that geographical self-efficacy could positively predict geographical academic achievements through the mediating role of geospatial thinking abilities, and gender magnifies the positive impact of geographical self-efficacy on geospatial thinking abilities, while the attendance type strengthens the positive impact of geospatial thinking abilities on geographical academic achievements. These findings contribute to the existing studies of literature on the relationship between self-efficacy and academic achievements and explore the relationship between geographical self-efficacy and academic performance. Moreover, the study confirms the heterogeneous characteristics of individual attributes, such as gender and attendance type, in this mechanism.

5.1. Impact of Geographical Self-Efficacy on Academic Achievements in Geography

The study found that geographical self-efficacy can positively predict academic achievements in geography, supporting previous cross-sectional studies [74]. According to social cognitive theory, self-efficacy plays a vital role in an individual's cognitive, behavioral, and emotional operations. It is a key factor in achieving goals, tasks, and challenges and affects an individual's life and learning in various ways [75].

Early studies have found that personal achievement is closely related to self-efficacy [76–78]. Later studies further confirmed that self-efficacy can not only predict personal achievements positively but also predict personal academic achievements in school positively [79–81]. Additionally, self-efficacy is closely related to an individual's experience in specific academic fields [82,83]. A study showed that students' self-efficacy in geography is higher than in math, and there is a correlation between biology and geography, and between math, physics, and chemistry [84]. In fact, in certain subjects, the self-efficacy of high school students can largely predict academic achievements in that subject [85]. It has been found in existing studies that self-efficacy in English, math, and reading can predict academic achievements in these subjects [86–88]. In geography, it has been found that general self-efficacy can predict academic achievements in geography positively [89]. It is worthwhile to note that although the measures of self-efficacy in specific subjects are different in each study, these study results are consistent with our findings. Therefore, our conclusion that geography self-efficacy positively predicts geographical academic achievements is reliable.

5.2. Mediating Role of Geospatial Thinking Ability

The study identified that geospatial thinking ability plays a mediating role between geographical self-efficacy and academic achievements in geography. That is, geographical self-efficacy relates not only directly to high school students' academic achievements in geography but also indirectly through students' geospatial thinking ability. This supports and expands previous cross-sectional studies, which suggest that the relationship between self-efficacy and academic achievements is not necessarily direct and can be influenced by other factors and mechanisms [90]. Moreover, the indirect effects identified in this study suggest that the relationship between geographical self-efficacy and academic achievements might be stronger for high school students with high spatial thinking capabilities. In fact, other study evidence indicates that incorporating Web GIS into classroom instruction stimulates students' self-efficacy, which further drives their motivation to study geography, effectively enhancing their spatial thinking skills. Enhanced spatial thinking ability might potentially aid students in acquiring subject-specific knowledge [91,92]. Especially in the

STEM fields, students with high spatial thinking capabilities tend to have higher STEM scores [93,94]. As a result, there is a growing consensus among researchers to intensify interventions on spatial thinking ability in the classroom [95–98]. Enhancing the self-efficacy of teachers and students is one such intervention direction [99]. Thus, educational practices should place greater emphasis on guiding teachers' objectives and encouraging students, thereby providing a conducive atmosphere for their development in geospatial thinking ability, which in turn promotes the holistic development of students.

5.3. Moderating Role of Gender

This study discovered that gender can moderate the direct impact of geographical self-efficacy on geospatial thinking ability. That is, the spatial thinking ability of female students is more susceptible to the influence of geographical self-efficacy compared to their male counterparts. The reasons are as follows: on one hand, gender differences might be prevalent in high school students' geographical self-efficacy. A study has shown that under certain circumstances, females tend to exhibit higher self-efficacy in reading and writing, while males are often more confident in their reasoning and computational skills [100,101]. Given that females typically display weaker spatial skills compared to males, they might possess lower geographical self-efficacy. Those constantly doubting themselves struggle to articulate and interpret intricate spatial relationships through maps and graphical representations [102], which also implies that their potential in spatial thinking might be significantly hampered. On the other hand, gender differences might also play a role in the development of spatial thinking. A study has found that males often outperform females in spatial tasks like mental rotation and spatial perception [103]. Moreover, in geographical academic performance, which is closely tied to spatial thinking capabilities, males typically excel over females [104]. Therefore, fostering higher geographical self-efficacy in females can significantly boost their spatial thinking, necessitating a heightened emphasis on encouraging educational approaches for females. While it is evident that gender plays a pivotal role in the interplay between self-efficacy, spatial thinking, and academic achievements, many studies have overlooked the significance of gender. Although some studies have explored the possibility of bridging the gender gap between self-efficacy and high school academic achievements [105], the topic of gender differences in self-efficacy, spatial thinking ability, and academic achievements remains contentious. Many scholars contend that there are no gender differences in the development of self-efficacy, spatial thinking ability, and academic achievements [106,107]. Despite contrasting with our findings, this offers room for further study.

5.4. Moderating Role of Attendance Type

This study also unveils that attendance type could moderate the direct impact of geographical spatial thinking on academic achievements in geography. Specifically, boarders show a stronger predictive power between spatial thinking abilities and geographical academic achievements compared to externs. Existing studies have shown that geospatial thinking skills influence academic achievements in geography by aiding students in understanding and acquiring geographical knowledge. However, this process, multifaceted in nature, might be shaped by numerous factors, with the attendance type being one of them. Empirical studies have shown that boarding has a positive impact on students' academic achievements [108,109], as it saves commuting time, allowing students to spend more time on their studies [110]. Meanwhile, boarders often benefit from increased interactions with peers and teachers [111]. The rise in school-based extracurricular activities also enhances boarders' emotional connection and identification with the school [112]. Such environmental attachment, combined with peer support and school identification, greatly benefits academic achievements [113,114].

In addition, boarding can be particularly advantageous for vulnerable students [115,116]. Bass noted that boardings of vulnerable students expose themselves more to social and

educational capital [117]. Nonetheless, certain studies highlighted that the positive effects do not persist indefinitely and might turn adverse with prolonged boarding durations.

Emotional distress occurring from continuous boarding for over four weeks can hinder students' adjustment and affiliation with the school [118], potentially undermining the positive impact of boarding on academic achievements [119]. Therefore, to maximize the advantages of the boarding experience on academic achievements, schools should prudently schedule relaxation periods for boarders to optimize their boarding experience [120].

6. Conclusions

Overall, our findings successfully corroborate our hypotheses: geographical self-efficacy can significantly predict academic achievements in geography positively, with geospatial thinking playing a significant mediating role, and gender and attendance type also serving as moderators in the mediating path of geospatial thinking ability. These findings have deepened the understanding of the relationship between domain-specific self-efficacy and academic achievements. In terms of educational significance, this study shows the importance of geographical self-efficacy for the improvement of high school students' academic achievements in geography. In daily teaching, educators should emphasize enhancing students' geographical self-efficacy and strengthening their geospatial thinking ability training. It is essential to pay particular attention to encouragement-focused education for female students to boost their motivation to study geography. In the process of management, schools should try their best to encourage students who rent rooms to board in schools and guide parents to strengthen the discipline of externs. In addition, schools should schedule appropriate relaxation periods for borders to ensure their holistic well-being. By doing so, students can improve their academic performance in geography and establish a strong foundation for the sustainable advancement of geography education.

7. Limitation and Future Directions

Indeed, there remain a few limitations in the study. Firstly, this study is constrained by its cross-sectional design, reflecting only the relationship between geographical self-efficacy and academic achievements in geography under specific conditions. Future studies could adopt a longitudinal approach to explore the mechanisms by which geographical self-efficacy influences academic performance in different periods. Secondly, the study focuses on high school students, whose geographical self-efficacy and geospatial thinking might generally be stronger than those of middle and elementary school students. This specific sample may limit the generalizability of our findings. Future studies could expand the sample size across different educational stages to test the universality of our results. Lastly, the study only controls for a covariate "place of residence," which might lead to deviations in the research outcomes. Subsequent studies could control for other factors such as grade level and whether geography is taken as an elective to ensure the accuracy of the results.

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