



DUAL MEDIATION MODEL OF GEOGRAPHY LEARNING ENGAGEMENT EVIDENCE FROM CHINESE HIGH SCHOOLS

MODELO DE MEDIACIÓN DUAL PARA LA PARTICIPACIÓN EN EL APRENDIZAJE DE GEOGRAFÍA: EVIDENCIA DE ESCUELAS SECUNDARIAS CHINAS

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ABSTRACT:

Student engagement is one of the most accepted constructs that determine academic success and learning over the long term. Based on Self-Efficacy Theory, Social Cognitive Theory, Self-Determination Theory, and Experiential Learning Theory, this paper designed a dual-mediation model to investigate the relationship between learning motivation, learning styles, and the ability to solve problems and the engagement in geography learning among high school students in Shandong Province, China. The proposed model exhibited a high level of theoretical consistency and empirical validation with the help of validated instruments and Structural Equation Modeling. Self-efficacy and critical thinking turned out to be the most significant direct predictors of engagement, and learning motivation, learning styles, and problem-solving ability also played significant direct roles. Bootstrap analyses also revealed that both critical thinking and self-efficacy were substantive mediators, which means that these cognitive and psychological functions are central in transforming learner characteristics into engagement. The analysis performed in the multi-group analysis found that urban and rural students differ significantly and a number of the structural relationships indicated stronger associations in urban students. Despite its foundation on cross-sectional evidence, the results contribute to the theoretical understanding of the mechanisms of engagement in the exam-based educational environment and have practical

implications for enhancing education in geography and advancing educational justice.

Keywords: Student engagement, Geography education, Self-efficacy, Critical thinking, Structural equation modeling, Mediation analysis.

RESUMEN:

El compromiso estudiantil es uno de los constructos más aceptados que determinan el éxito académico y el aprendizaje a largo plazo. Basándose en la Teoría de la Autoeficacia, la Teoría Cognitiva Social, la Teoría de la Autodeterminación y la Teoría del Aprendizaje Experiencial, este artículo diseñó un modelo de mediación dual para investigar la relación entre la motivación para el aprendizaje, los estilos de aprendizaje y la capacidad de resolución de problemas, y el compromiso en el aprendizaje de geografía entre estudiantes de secundaria en la provincia de Shandong, China. El modelo propuesto mostró un alto nivel de consistencia teórica y validación empírica con la ayuda de instrumentos validados y el modelado de ecuaciones estructurales. La autoeficacia y el pensamiento crítico resultaron ser los predictores directos más significativos del compromiso, y la motivación para el aprendizaje, los estilos de aprendizaje y la capacidad de resolución de problemas también desempeñaron roles directos significativos. Los análisis de *bootstrap* también revelaron que tanto el pensamiento crítico como la



autoeficacia fueron mediadores sustantivos, lo que significa que estas funciones cognitivas y psicológicas son centrales para transformar las características del estudiante en compromiso. El análisis realizado en el análisis multigrupo reveló que los estudiantes urbanos y rurales difieren significativamente y varias de las relaciones estructurales indicaron asociaciones más fuertes en los estudiantes urbanos. A pesar de basarse en evidencia transversal, los resultados contribuyen a la comprensión teórica de los mecanismos de participación en el entorno educativo basado en exámenes y tienen implicaciones prácticas para mejorar la enseñanza de la geografía y promover la justicia educativa.

Palabras clave:

Participación estudiantil, Enseñanza de geografía, Autoeficacia, Pensamiento crítico, Modelado de ecuaciones estructurales, Análisis de mediación.

INTRODUCTION

The phenomenon of student engagement has become one of the central constructs in modern educational research and has been recognized for its significant impact on academic success, persistence, and lifelong learning dispositions (Chick, et al., 2025; Fredricks et al., 2004). This multidimensional construct, which encompasses behavioral, emotional, and cognitive dimensions, has gained increasing importance as educators worldwide seek to enhance learning outcomes and prepare students to address complex and interconnected global challenges. In addition, recent studies highlight that student engagement is a dynamic process that can be fostered through targeted educational practices and supportive learning environments (Reeve & Tseng, 2011; Wang & Holcombe, 2010).

In this regard, the Universal Design for Learning (UDL) framework provides a relevant approach to promoting engagement by emphasizing flexible learning environments that offer multiple means of engagement, representation, and action and expression (CAST, 2024).

From an inclusion perspective, UDL is grounded in the broader principles of universal design, which aim to remove barriers and ensure accessibility for all learners (Mace, 1998), and has been widely recognized as a key strategy for fostering equitable participation in diverse educational contexts (Dalton et al., 2019). Furthermore, the implementation of UDL principles in instructional design and assessment has demonstrated its potential to support diverse learners, including those with learning disabilities and language barriers, by increasing motivation and active participation in learning processes (Delaney & Hata, 2020). In line with this, Meyer et al. (2014) emphasize that engagement is not a fixed trait but can be enhanced

through intentional instructional design that considers learner variability and promotes autonomy and agency.

Geography as a subject of study holds a special status in secondary education as both a transitional science between natural and social sciences and the development of spatial literacy, environmental consciousness, and critical citizenship. Geographic knowledge and skills are more needed than ever in a time when climate change, resource scarcity, and geopolitical tensions are the order of the day. The importance of creating geographical thinking, which is the skill of analyzing spatial patterns, grasping human-environment relationships and using geographical concepts to solve real world problems, is becoming increasingly popular in contemporary geography education (Downs & De Souza, 2006). Nevertheless, regardless of its importance, there are great challenges in meaningful education of students in geography, especially in the environment where the educational system focuses on performance in examinations rather than meaningful learning (Ding & Gao, 2025).

The Chinese learning environment makes the study of student engagement in geography particularly relevant. The education system in China is strongly influenced by the high-stakes Gaokao examination, which significantly shapes curriculum, instruction, and assessment practices in secondary education. Shandong Province, known for its highly competitive academic environment and rigorous standards, exemplifies these challenges and provides a representative context for studying Chinese students. Within this framework, geography holds a unique position as a compulsory subject in both arts and science tracks; however, classroom instruction often prioritizes memorization over spatial reasoning and critical geographical thinking.

Recent research suggests that teaching styles and the learning environment play a crucial role in shaping student engagement, as they can influence motivational factors such as satisfaction and resilience, which in turn enhance active participation in learning processes (Huang et al., 2025). In this sense, the predominance of traditional, exam-oriented instruction may limit opportunities for deeper engagement and the development of higher-order thinking skills. At the same time, emerging studies highlight the potential of digital and immersive learning technologies to transform geography education in China by promoting more interactive, student-centered approaches that foster engagement, critical thinking, and sustainable learning outcomes (Liu & Li, 2025). These innovations offer promising alternatives to traditional methods, as they enable students to actively explore geographical concepts and connect them with real-world contexts, thereby enhancing both motivation and meaningful learning.

Although research has been conducted widely on student engagement in different educational settings, there are

considerable gaps in the research about engagement in geography education, especially in non-Western settings. Although research has been conducted on general factors that influence engagement and studies conducted on self-efficacy and motivation in STEM subjects (Schunk & DiBenedetto, 2016), there is still a paucity of studies that examine domain specific factors that influence engagement in geography in the Chinese educational environment. The recent meta-analyses have indicated that subject-specific engagement studies are required where the disciplinary features and cultural backgrounds are taken into consideration (Lei et al., 2018).

Furthermore, previous studies have tended to consider aspects of engagement affecting engagement by considering factors in the form of a simple direct-effect, and little is known concerning the complex psychological processes in which various learner properties interact to generate engagement. What has been especially under-investigated is the mediating role of critical thinking and self-efficacy in converting foundational factors to actual engagement, which is a major gap considering that the two constructs are flexible psychological variables that may be an effective leveraging point when used in educational intervention. The modern view of engagement research has been shifting towards the need to comprehend the processes in between to come up with theoretically based and practically tested interventions (Chick et al., 2025; Reeve & Tseng, 2011).

The objective of this research was to design and confirm a complete predictive model of student engagement in geography among the high school pupils in Shandong Province, China.

MATERIALS AND METHODS

The design of the research adopted in this study was a quantitative correlational research design based on Structural Equation Modeling (SEM) to analyze the relationship between variables in the proposed model. Cross-sectional design was employed in which data were gathered at one time point in the 2024-2025 academic year. The choice of the analytical tool was SEM since it can analyze direct and indirect relations between two or more variables and characterize the goodness of measurement and structural models (Kline, 2023).

High School students of the Shandong Province, Grade 10, were the participants. The selection of Grade 10 students was done on the following considerations: (1) students who had completed the junior high school level of geography learning, and possessed some basic understanding of geography learning; (2) this grade level was chosen due to the large population of students who could be easily recruited as a sample; (3) students were not under direct pressure due to track selection in Grade 11 or

due to Gaokao in Grade 12, as this provided a more objective measurement of geography learning status.

The stratified random sample was used so as to provide coverage in both urban and rural schools. The stratification of high schools in Province of Shandong based on the urban-rural location was as follows: four schools in each stratum were picked randomly (four urban, four rural); then, 2-3 Grade 10 classes were picked at random in each school.

The rules of thumb that are generally followed for Structural Equation Modeling are that a satisfactory sample size is 5-10 times the number of free parameters in the model (Kline, 2023). The current structural model had some 60 free parameters, implying a recommended sample size of 300- 600 participants. The last valid sample of 487 students is within this range, giving adequate power to estimate models and estimate multi-group analysis.

The sample size of 487 was sufficient and gave sufficient statistical power (>0.80) to identify medium effect sizes ($\beta= 0.30$ or more) at the 0.05 level. This was also an adequate sample size based on the minimum requirement of 200 cases when comparing two or more groups (Kline, 2023).

Five hundred questionnaires were sent and 487 valid questionnaires were sent back, give a valid response rate of 97.4%. The number of questionnaires was reduced to thirteen because of large amounts of missing data ($>20\%$), or apparent response bias (i.e. choosing the same option across the questionnaire). Table 1 shows some sample demographic characteristics.

Table 1. Demographic Characteristics of Participants (N = 487).

Characteristic	Category	n / %
Gender	Male	241 / 49.5
	Female	246 / 50.5
School Location	Urban	258 / 53.0
	Rural	229 / 47.0
Age	15 years	87 / 17.9
	16 years	352 / 72.3
	17 years	48 / 9.8
Parental Education	University or above	156 / 32.0
	High school	213 / 43.7
	Middle school or below	118 / 24.2

The sample was balanced by gender and included an approximately equal proportion of urban and rural students (1:1), meeting the research design criteria. Most participants were 16 years old (72.3%), which aligns with the typical age of Grade 10 students. Geography grades followed a normal distribution, with most students performing at an intermediate level.

Six research instruments were used, all based on 5-point Likert scales (1 = strongly disagree, 5 = strongly agree). Each instrument underwent translation and back-translation procedures and was pilot tested to ensure its validity in the Chinese context.

The Geography Learning Engagement Scale included 18 items assessing behavioral, emotional, and cognitive engagement. The Learning Motivation Scale, based on Self-Determination Theory, measured intrinsic and extrinsic motivation through 14 items. The Learning Styles Scale evaluated four learning preferences using 12 items. Additionally, the Problem-Solving Ability Scale (10 items), Critical Thinking Scale (15 items), and Geography Self-Efficacy Scale (12 items) were used, all demonstrating acceptable reliability (ranging from 0.81 to 0.90).

Data collection followed ethical standards, with approval from the university ethics board and informed consent obtained from students and parents. Participation was voluntary, anonymous, and conducted during October–November 2024 in classroom settings. The questionnaire took approximately 25 minutes to complete.

Data analysis was performed using SPSS 26.0 and Mplus 8.3. Preliminary analysis included data cleaning, handling missing data (less than 5%), and calculating descriptive statistics. Reliability was assessed using Cronbach's alpha, and relationships between variables were examined using Pearson correlations and t-tests.

Confirmatory Factor Analysis (CFA) was conducted to validate measurement models using standard fit indices (CFI, TLI, RMSEA, SRMR). Structural Equation Modeling (SEM) with robust estimation (MLR) was used to test hypotheses and mediation effects through bootstrapping (5,000 samples). Multi-group analysis compared urban and rural students using chi-square difference tests.

RESULTS AND DISCUSSION

Table 2 is a description of all study variables. All scales were found to be highly internally consistent and reliable (Cronbach's alpha 0.82 through 0.91, all above 0.70). According to means, students were reported to have moderate to moderately high levels of all the variables. It is also worth noting that the level of extrinsic motivation ($M = 3.76$) was much higher than that of intrinsic motivation ($M = 3.48$), $t(486) = 8.14$, $d = 0.37$. This resembled the exam-based academic setting.

Table 2. Descriptive Statistics and Reliability of Study Variables (N = 487).

Variable	M	SD	Skewness	Kurtosis	α	Items
Learning Motivation	3.62	0.71	-0.18	-0.35	0.88	14
Learning Styles	3.41	0.68	-0.12	-0.31	0.82	12
Problem-Solving Ability	3.54	0.76	-0.19	-0.38	0.85	10
Critical Thinking	3.47	0.79	-0.16	-0.44	0.87	15
Self-Efficacy	3.59	0.82	-0.22	-0.36	0.89	12
Student Engagement	3.56	0.77	-0.20	-0.39	0.91	18

Note. All variables measured on 5-point Likert scales (1-5). Skewness and kurtosis values within acceptable ranges (± 1.0), indicating approximately normal distributions.

Confirmatory Factor Analysis

Each measurement instrument underwent CFA in order to check its factor structure. Table 3 shows the fit indices of all the measurement models. Measurement models were also found to fit very well, which indicated the validity of the factor structures. Factor loadings were found to be between 0.62 and 0.89, all significant ($p < 0.001$), which means that items have good relationships with their respective latent constructs.

Table 3. Confirmatory Factor Analysis Fit Indices for Measurement Models.

Scale	χ^2	df	χ^2/df	CFI	TLI	RMSEA	SRMR
Geography Self-Efficacy	78.34	51	1.54	0.97	0.96	0.033	0.038
Student Engagement (3-factor)	142.56	132	1.08	0.99	0.99	0.014	0.031
Critical Thinking	124.67	87	1.43	0.97	0.96	0.030	0.035

Scale	χ^2	df	χ^2/df	CFI	TLI	RMSEA	SRMR
Problem-Solving Ability	52.18	34	1.53	0.98	0.97	0.033	0.032
Learning Motivation (2-factor)	89.45	76	1.18	0.99	0.98	0.020	0.029
Learning Styles	67.23	48	1.40	0.97	0.96	0.029	0.036

Note. All models demonstrated excellent fit. CFI and TLI values > 0.95; RMSEA values < 0.05; SRMR values < 0.05 indicate excellent fit.

Correlation Analysis

Table 4 shows the bivariate correlation of all the variables of the study, which answers RQ1. All the variables had significant positive correlations with student engagement, and the correlation coefficients were between 0.43 (learning styles) and 0.74 (self-efficacy). Engagement had the highest correlation with self-efficacy ($r = 0.74$), critical thinking ($r = 0.71$), and learning motivation ($r = 0.64$). The intercorrelation between the mediating variables (critical thinking and self-efficacy) was also strong ($r = 0.67$), which implied that they both had common variance but are distinct constructs.

Table 4. Correlation Matrix for Study Variables (N = 487).

Variable	1	2	3	4	5	6
1. Learning Motivation	1					
2. Learning Styles	0.48**	1				
3. Problem-Solving	0.52**	0.44**	1			
4. Critical Thinking	0.56**	0.41**	0.63**	1		
5. Self-Efficacy	0.61**	0.39**	0.58**	0.67**	1	
6. Student Engagement	0.64**	0.43**	0.59**	0.71**	0.74**	1

Note. ** $p < 0.01$. All correlations significant and positive.

Urban-Rural Comparisons

Independent samples t-tests compared urban and rural students on all study variables (Table 5). Urban students scored significantly higher than rural students on all variables except learning styles, with small to small-medium effect sizes. The largest differences were observed for student engagement ($d = 0.34$), self-efficacy ($d = 0.32$), and problem-solving ability ($d = 0.29$). These differences suggested by contextual factors (e.g., resources, teacher quality, educational opportunities) may influence the development of these constructions.

Table 5. Comparison of Urban and Rural Students on Study Variables.

Variable	Urban (n=258)	Rural (n=229)	t	d
	M (SD)	M (SD)		
Learning Motivation	3.71** (0.69)	3.52** (0.72)	2.98	0.27
Learning Styles	3.46 (0.66)	3.35 (0.70)	1.79	0.16
Problem-Solving	3.64*** (0.73)	3.42*** (0.77)	3.25	0.29
Critical Thinking	3.58*** (0.76)	3.35*** (0.81)	3.21	0.29
Self-Efficacy	3.71*** (0.79)	3.45*** (0.83)	3.51	0.32
Student Engagement	3.68*** (0.74)	3.42*** (0.78)	3.74	0.34

Note. Cohen's d: 0.20 = small effect, 0.50 = medium effect, 0.80 = large effect.

Structural Equation Modeling Results

Measurement Model

Before testing the structural model, a detailed measurement model was tested with all the latent variables and the indicators. The fit of the measurement model was very high: $\chi^2(1147) = 2156.78$; $\chi^2/df = 1.88$; CFI = 0.96; TLI = 0.96; RMSEA = 0.042 (90% CI [0.039, 0.045]); SRMR = 0.038. All the factor loadings were significant ($p < 0.001$), and they ranged from 0.64-0.91, which meant that observed variables were sufficient to represent latent constructions.

Structural Model Testing

The entire structural model was also tested using all the hypothesized direct and indirect paths. The model fitted the data (answers RQ5) very well: $\chi^2(1153) = 2467.42$; $\chi^2/df = 2.14$; CFI = 0.96; TLI = 0.95; RMSEA = 0.048 (90% CF [0.046, 0.051]); SRMR = 0.042. All the fit indices were above the recommended levels, implying that the proposed model fitted the data very well.

Table 6 shows the standardized coefficients of the structural model, which answers RQ2. The three predictors had a significant positive effect on critical thinking and self-efficacy. Critical thinking (0.31) and self-efficacy (0.38) were found to have strong and significant positive effects on engagement, making them the most important of the direct predictors.

Table 6. Standardized Path Coefficients in the Structural Model.

Path	β	t	95% CI
Paths to Critical Thinking			
Learning Motivation → CT	0.41*** (0.046)	8.91	[0.32, 0.50]
Learning Styles → CT	0.28*** (0.043)	6.51	[0.20, 0.36]
Problem-Solving → CT	0.35*** (0.045)	7.78	[0.26, 0.44]
Paths to Self-Efficacy			
Learning Motivation → SE	0.38*** (0.044)	8.64	[0.29, 0.47]
Learning Styles → SE	0.31*** (0.042)	7.38	[0.23, 0.39]
Problem-Solving → SE	0.42*** (0.043)	9.77	[0.34, 0.50]
Direct Paths to Engagement			
Learning Motivation → Eng	0.08* (0.039)	2.05	[0.00, 0.16]
Learning Styles → Eng	0.06 (0.037)	1.62	[-0.01, 0.13]
Problem-Solving → Eng	0.11** (0.042)	2.62	[0.03, 0.19]
Critical Thinking → Eng	0.31*** (0.044)	7.05	[0.22, 0.40]
Self-Efficacy → Eng	0.38*** (0.048)	7.92	[0.29, 0.47]

Note. CT = Critical Thinking; SE = Self-Efficacy; Eng = Engagement; standardized regression coefficient; SE = standard error; CI = confidence interval. R^2 for Critical Thinking = 0.52; R^2 for Self-Efficacy = 0.57; R^2 for Student Engagement = 0.62.

Predictors of Critical Thinking: The three predictors all had significant positive effects on critical thinking. The greatest impact was found on learning motivation (0.41***), then problem-solving ability (0.35***), and learning styles (0.28**). Critical thinking was explained by these three variables at 52 percent.

Paths to Self-Efficacy: All the three factors had significant positive effects on self-efficacy. The greatest impact was on problem-solving ability (0.42***), then learning motivation (0.38***), and learning styles (0.31). These three variables collectively explained 57 percent of the variation in self-efficacy.

Directs Effects on Engagement: Self-efficacy (0.38***) and critical thinking (0.31***) had highly significant positive effects on engagement, being the strongest direct predictors of engagement. The degree of problem-solving skill directly influenced engagement to a lesser yet significant level (0.11). The direct impact of learning motivation was also not very strong, yet significant (0.08). The direct influence of learning styles was not significant (0.06).

Mediation Analysis

Indirect effects were analyzed using critical thinking and self-efficacy through bootstrap mediation analysis (5,000 re-samples) to answer RQ3 and RQ4. Table 7 presents the results.

Table 7. Indirect Effects Through Mediating Variables.

Path	Indirect Effect	95% CI
Through Critical Thinking		
Learning Motivation → CT → Eng	0.127*** (0.024)	[0.082, 0.176]
Learning Styles → CT → Eng	0.087*** (0.020)	[0.050, 0.128]
Problem-Solving → CT → Eng	0.109*** (0.022)	[0.068, 0.155]
Through Self-Efficacy		
Learning Motivation → SE → Eng	0.144*** (0.026)	[0.095, 0.198]
Learning Styles → SE → Eng	0.118*** (0.023)	[0.075, 0.165]
Problem-Solving → SE → Eng	0.160*** (0.027)	[0.109, 0.215]
Total Indirect Effects		
Learning Motivation → Eng	0.271*** (0.034)	[0.206, 0.341]
Learning Styles → Eng	0.205*** (0.030)	[0.148, 0.267]
Problem-Solving → Eng	0.269*** (0.035)	[0.202, 0.340]

Note. Bootstrap samples = 5,000. CI = confidence interval. Effects significant when CI excludes zero.

All indirect effects through both mediators were statistically significant, as the 95% confidence intervals did not include zero.

Critical Thinking as Mediator (answering RQ3): Critical thinking played a significant mediating role between each of the three predictors and engagement. The indirect effects were between 0.087 (learning styles) and 0.127 (learning

motivation). This implies that students who have more learning motivation, adaptive learning style and abilities to solve problems are more likely to develop critical thinking and this results in more geography learning engagement.

Self-Efficacy as Mediator (responding to RQ4): Self-efficacy was also found to mediate all relations with a more pronounced indirect impact, in most cases, than critical thinking. The indirect effects were found to be 0.118 (learning styles) and 0.160 (problem-solving ability). This implies that self-efficacy is more of a psychological power to transform the characteristics of the learners into real actions.

We analyzed possible multicollinearity issues before interpreting the results of mediation because of the correlation between the critical thinking and self-efficacy ($r = 0.67$). Variance Inflation Factor (VIF) analysis disclosed VIFs of 2.21 and 2.35 for critical thinking and self-efficacy respectively, which were significantly lower than the usually accepted value of 5.0 (and conservativeness 3.0). Although these variables have a high degree of variance, the VIF values do not reflect a severe case of multicollinearity that can disqualify coefficient estimates.

Total Effects

Table 8 shows the total (direct and indirect) effects of predictors on engagement.

Table 8. Total Effects on Student Engagement.

Predictor	Direct	Indirect	Total	% Mediated
Learning Motivation	0.08*	0.27***	0.35***	77.4%
Learning Styles	0.06	0.21***	0.27***	77.8%
Problem-Solving Ability	0.11**	0.27***	0.38***	71.1%
Critical Thinking	0.31***		0.31***	
Self-Efficacy	0.38***		0.38***	

Note. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. R^2 for student engagement = 0.62.

The model had a high level of explanatory power as it explained 62% of the variance in student engagement. The highest overall effect was self-efficacy (0.38), problem-solving ability (0.38) and learning motivation (0.35), critical thinking (0.31), and learning styles (0.27).

In terms of learning motivation, learning styles, and problem-solving ability, most of their effects (71-77%) were mediated as opposed to being direct. This leads to the key contribution of critical thinking and self-efficacy as psychological processes through which underlying characteristics of learners are converted into actual engagement.

Multi-Group Analysis: Urban-Rural Differences

Since there were considerable differences in the means between urban and rural students, multi-group SEM was used to determine whether the structural relationships were different across contexts. Table 9 shows the most important path comparisons.

Table 9. Comparison of Key Paths Between Urban and Rural Students.

Path	Urban (n=258)	Rural (n=229)	$\Delta\chi^2$
	β (SE)	β (SE)	
Self-Efficacy → Engagement	0.43*** (0.06)	0.31*** (0.07)	6.82
Critical Thinking → Engagement	0.35*** (0.06)	0.25*** (0.06)	4.21
Problem-Solving → SE	0.48*** (0.06)	0.34*** (0.06)	7.94
Motivation → CT	0.46*** (0.06)	0.34*** (0.07)	5.38
Learning Styles → Engagement	0.08 (0.05)	0.03 (0.05)	1.43

Note. SE = self-efficacy; CT = critical thinking. $\Delta\chi^2$ tests equality constraint across groups (df = 1).

A number of paths were quite different in the city and countryside settings. The correlation between self-efficacy and engagement was greater among urban students (0.43*** instead of 0.31**, $\Delta\chi^2 = 6.82$) than among rural students. Engagement and critical thinking were also more related in the case of urban students (0.35*** vs. 0.25***, $\Delta\chi^2 = 4.21$). Also, problem-solving ability had a stronger effect on self-efficacy (0.48 vs. 0.34) and learning motivation (0.46 vs. 0.34) among urban students. These results indicate that although the general model framework is applicable in different settings, the relationship strength differs, and the stronger relationship is observed in urban schools, which can be attributed to the differences in educational settings, quality of teaching, and student readiness.

Overview of Major Findings

This study formulated and confirmed a complex predictive model of learning geography in the framework of examination-based education in China. The findings of the research were empirical evidence for RQ1-RQ5 and were significant for the theoretical knowledge and practical facilitating learning involvement.

Among the key findings, it is possible to mention: (1) The proposed dual-mediation model fitted the data perfectly, explaining 62 percent of the variance in learning engagement; (2) Self-efficacy and critical thinking were the strongest direct predictors of learning engagement; (3) Both mediators showed significant mediated relationships between learning motivation, learning styles, problem-solving ability, and engagement; (4) 71-77 percent of the effects of foundational predictors were mediated by both mediators; (5) Urban and rural students differed significantly in the strengths of the paths.

Theoretical Contributions

Integration of Multiple Theoretical Frameworks

The main theoretical outcome of the research is that it merges Self-Efficacy Theory, Social Cognitive Theory, Self-Determination Theory and Experiential Learning Theory to develop a comprehensive model of geography learning engagement. This integration is a response to educational psychology calls to go beyond individual theoretical lenses in order to have a holistic understanding of complex phenomena in learning.

The validity of these models was tested by ensuring that the theoretical frameworks are not in conflict with each other. Motivation for learning (Self-Determination Theory), styles for learning (Experiential Learning Theory), and ability to solve problems (Social Cognitive Theory) are intertwined to have an effect on engagement in terms of critical thinking and self-efficacy (Social Cognitive Theory and Self-Efficacy Theory). This integration offers a more complex, in-depth framework for the interpretation of learning engagement.

Clarification of Mediating Mechanisms

The theoretical research contribution is the clarity of the psychological processes that make foundational learner characteristics translate into actual engagement. The research went beyond direct-effect models by showing the critical role of critical thinking and self-efficacy as mediating factors in order to determine how and why some factors affect engagement.

The observation that self-efficacy is the more powerful mediator (indirect effects 0.118–0.160) agrees with the theoretical expectation of Bandura (1997) that self-efficacy beliefs are the most prominent determinants of behavior. This implies that although students might have high levels of learning motivation, adaptive learning styles, and problem-solving skills, when they do not believe in their geography learning capabilities, their engagement might still be poor.

The intermediate position of critical thinking (indirect effects 0.087–0.127) adds to the existing theory, which raises it a level higher and turns it into a learning outcome as a critical mechanism in the engagement process. This is reminiscent of the central role of critical thinking in geography teaching that Chang & Pascua (2016) discuss and empowers the approach with empirical evidence as to what the specific mechanism of critical thinking entails when it comes to facilitating engagement in learning.

Subject-Specific Engagement Model

This research made a distinct contribution to the development of theories in the area of geography education. Although general models of student engagement are widely investigated (Fredricks et al., 2004), more specific models are quite limited. Through geography learning, the study found that due to the distinct nature of the subject, e.g., spatial thinking, multi-scale analysis, human–environment comprehension, predictors and mechanisms of engagement are shaped.

Geography, in the form of problem-solving ability (significant indirect effect 0.160***), is reflected in the central position of this ability. Learning geography intrinsically entails the analysis of complex problems in space, integration of a variety of information, and offering solutions, and therefore problem-solving capacity is a very pertinent predictor.

Unique Findings in Chinese Educational Context

Role of Extrinsic Motivation

The research established extremely high extrinsic motivation ($M = 3.76$), as compared to intrinsic motivation ($M = 3.48$), which is not common in Western schools (Ryan & Deci, 2017). This is an indication of the significant effect of the Gaokao orientation on the learning motivation of Chinese students. Interestingly, however, overall learning

motivation (intrinsic and extrinsic) continued to make significant predictions of engagement (total effect 0.35), indicating that despite examination pressure, motivation is still an important predictor of engagement.

This result implies the cultural universality of Self-Determination Theory^{**},^{**} but also emphasizes the role of cultural context in the motivational expressions (Zhou et al., 2009). Extrinsic motivation in the Chinese environment cannot be considered merely negative but rather as having a valid role in arousing learning effort, with the aim of encouraging long-term learning engagement, intrinsic motivation should still be nurtured.

Complexity of Urban-Rural Differences

Multi-group analysis showed urban-rural disparities that can offer significant information on educational equity. Urban students not only reported significantly higher scores in all variable means compared to rural students, but also their structural path scores were stronger on the whole. To take an example, the influence of self-efficacy on engagement was 0.43 in urban students and 0.31 in rural students.

Such disparities can be indicative of various things. In most cases, urban schools possess superior educational resources, facilities, teaching materials, and technology that may offer more possibilities to develop students' self-efficacy and critical thinking. Moreover, urban teachers have higher qualifications and experience in teaching and can provide more effective assistance to the cognitive development of students. It can also be related to family support, where urban parents are likely to be more educated (32% have university degrees as opposed to about 20% in the country overall), which would provide students with more academic advice and support.

Practical Implications

Strategies for Cultivating Self-Efficacy

Since the role of self-efficacy is central (the strongest mediating effect is -0.38), improvement of the geography self-efficacy of students should be a priority of educational practice. According to the theory of Bandura (1997), there are a number of strategies suggested. To begin with, mastery experiences can be offered by offering students rather challenging, but not too difficult, geography activities which will enable them to build confidence, say, starting with easy map reading and moving to more complicated spatial analysis. Second, the use of vicarious experiences through showing peer success cases, especially of students having similar backgrounds, can reinforce the belief of the students in their abilities. Third, providing verbal persuasion by giving specific and heartfelt positive feedback can support effort and good strategies as opposed to inborn talent. Last but not least, emotional control through the creation of a supportive learning environment

with low levels of anxiety can assist students in interpreting physiological arousal as excitement and not anxiety.

Teaching Methods for Developing Critical Thinking

The important role of critical thinking (direct effect 0.31, significant mediating effects) shows the importance of the development of critical thinking in teaching geography. Problem-based learning has been recommended as one of the approaches that involve coming up with realistic and complicated problems in geography where students are expected to interpret information, analyze evidence, and come up with reasonable judgments. Deep thinking may also be encouraged by using Socratic questioning that entails systematic inquiries along the lines of "What is the evidence that this claim is true?" and "Are there alternative explanations?" Besides this, a multi-perspective analysis stimulates students to study the problems in geography while considering the perspectives of various stakeholders, such as participants in environmental policy and urban planning. Lastly, metacognitive training assists students in being mindful of their cognition as they come to know their assumptions, biases, and logical fallacies.

Balancing Intrinsic and Extrinsic Motivation

Although extrinsic motivation cannot be avoided in Chinese society, teachers must make efforts to foster intrinsic motivation to facilitate profound and prolonged involvement. The first one is to make geography relevant by relating it to the real life of students, with local settings and their professional careers, so that learning has more personal importance. Also important is that they should be given a sense of autonomy by giving them the liberty to select research topics or a format of presentation in curricular structures. Interest can be further aroused by cultivating it through various teaching techniques such as virtual field trips, GIS activities, role-playing and so on. Furthermore, the emphasis on process value and the need to stress the long-term relevance of the thinking skills mastered in the process of geography study, rather than on the final results of the examinations, can make students view the learning process in the wider context.

Interventions for Rural Schools

The differences between urban and rural areas emphasize the fact that rural education is something that should be given specific consideration. The professional growth of teachers is necessary, especially with specific training that can help rural geography teachers develop the critical thinking and self-efficacy of students. The allocation of resources should also be enhanced by making more resources available in terms of teaching materials on geography such as maps, globes, and geographic information technologies. Learning gaps can be bridged by setting up peer tutoring or school exchange programs between urban and rural schools whereby peers would interact and exchange teaching practices. Moreover, the

knowledge of rural parents about the value of studying geography can become stronger and help achieve better results among students.

This research has a number of limitations, which can be taken into account when interpreting the findings:

Cross-Sectional Design

The causal inference is limited by the cross-sectional nature of the study. Though directional hypotheses that were tested using structural equation modeling were theoretically based, it is possible that there are bidirectional or circular relationships between variables. Notably, self-efficacy and critical thinking can also be increased due to learning engagement. Longitudinal or experimental studies should be used in future research in order to determine more definite causal relationships.

Self-Report Data

The data were all self-reports from students, and were both vulnerable to social desirability bias and common method bias. Although construct validity was demonstrated using confirmatory factor analysis, the research methodology ought to be adjusted to include several data sources (teacher assessments, objective scores, behavioral observations) to be more robust in the conclusions.

Geographic Limitation

In addition, the study was carried out in Shandong only, which does not allow generalization of the results. As a region with high intensity of competition in education, Shandong might not be representative of all parts of China. Future research should be done in various provinces and regions with varying educational development levels to prove a universal model.

Unexamined Factors

Other factors that may have been important in influencing engagement were not incorporated in the model, including the quality of teachers, pedagogy, peer interactions, and family support. The interaction of these contextual factors with the individual ones in impacting engagement should be studied in future research.

Future Research Directions

In the findings and limitations of the study, there are a number of recommendations on the future directions of research. Future research should aim to trace the longitudinal involvement of the students during Grade 10 through Grade 12 to analyze the progress of the predictors and mediators through time and to determine the possible cause-effect linkage. Intervention studies can also be carried out in order to develop and test certain programs focused on self-efficacy and critical thinking development to test their causal impact on engagement. A comparative study of the models of cross-cultural research would assist in defining the universality and cultural specificity of

the model used in various educational systems. Moreover, cross-level interactions could be examined with the help of multilevel modeling that would allow for integrating individual, classroom, and school-level variables. Qualitative research, including interviews and classroom observations, may be useful in obtaining a better understanding of the mechanisms of quantitative results, especially the causes of urban-rural disparities. Future studies can also consider the impact of geographic information technology such as GIS on engagement and predictors. Lastly, a modeling test on other subjects like history and biology would be useful in determining both subject-general and subject-specific mechanisms of student engagement.

CONCLUSIONS

The research formulated and confirmed a holistic predictive model of geography learning activity in the examination-based education system in China, which addressed both the gaps in theory and in data. The application of the Self-Efficacy Theory and Social Cognitive Theory, Self-Determination Theory, and Experiential Learning Theory allowed the research to develop a multidimensional approach to learning engagement and to identify critical thinking and self-efficacy as important mediating variables.

The main findings with 62% variance accounted, strong performance of self-efficacy and critical thinking, and important mediating effects contributed significantly to theoretical advancement and offered practical implications for the educational practice. The study highlights the fact that to improve the levels of geography learning, it is necessary not only to pay attention to the surface behaviors but also to develop deeper psychological variables that facilitate long-term learning: the belief in geography learning skills and the ability to think critically about geographical phenomena.

The results of the urban-rural distinctions prompt us to remember that even within the same macro-levels of school policies, there exist differences in the educational context of the micro-level which have a great impact on students' development. This requires finer and fairer distributions, and consolidation of educational resources, and supporting teacher development to make sure that all students irrespective of geographic location are given the provision required to become engaged and develop.

In an era when issues such as climate change, sustainable development, and globalization are gaining more and more importance, geographic literacy and thinking are essential for growing responsible global citizens. Knowledge of proper ways of fostering engagement in geography learning is not just an academic endeavor but a long-term investment in the future well-being of any society. This study has given preliminary insights and avenues of practice for this mission, with the hope that more researchers and teachers are inspired to devote themselves to the quality

of geography education and a new breed of geography students who can respond to challenging issues in the world.

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CONFLICTS OF INTEREST:

The authors declare that there are no conflicts of interest.

Author Contributions under the CRediT Taxonomy:

Autor	Roles
Autor 1	Responsible for: Conceptualization, Methodology
Autor 2	Responsible for: Validation, Formal Analysis
Autor 3	Responsible for: Methodology, Validation, Formal Analysis

Author Contributions

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