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The Correlation Between Students' Academic Self-Efficacy and Classroom Environment in STEM Lessons: A Study Among Grade 7th to 12th International School Students in Mainland China

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Abstract

Academic self-efficacy is a significant predictor of students' academic performance and learning outcomes. And a positive classroom environment that is conducive to student learning has also been found to be crucial in improving students' learning experience. However, there are few studies on the relationship between the two variables, especially in STEM courses. To figure out this question, the present study involved 247 Chinese secondary students from Grade 7 to 12 to complete an online anonymous survey. The Individualized Classroom Environment Questionnaire (ICEQ), which consists of five sub-scales including personalization, participation, investigation, independence, and differentiation, was used in this survey to measure their perception of the classroom environment. And the Academic Self-Efficacy Scale (ASS) was used to assess students' STEM academic self-efficacy. Correlation analysis revealed that there was a positive weak correlation between students' STEM academic self-efficacy and the overall classroom environment (r=.189, p<0.01). The highest correlation was found between self-efficacy and investigation (r=.303**, p<0.01), followed by participation(r=.230**, p<0.01), differentiation(r=.228**, p<0.01) and personalization(r=.187**, p<0.01). But a negative weak correlation existed between self-efficacy and independence (r=-.220**, p<0.01). (175 words).**

Keywords

Academic Self-Efficacy, Classroom Environment, Correlation analysis, STEM Education.

1. Introduction

1.1. Research background: STEM education is booming in China

Originating in the United States, STEM education has developed rapidly over the past 20 years and has been promoted in many countries and regions [1]. Since STEM education has been found to be an effective way to nurture students' comprehensive qualities and support their whole-person development in many other countries, the Chinese government also began to promote STEM education in recent years by releasing a series of official policy documents.

STEM education has a relatively short history in China, so there is a lack of enough practice in public schools [2]. However, many international schools in China adopting foreign teaching systems, which provide some Chinese students with relatively mature STEM experiences, which has also become the starting point for the promotion of STEM education in China.

1.2. Statement of problem

STEM education usually adopts an interdisciplinary approach that aims to train students to use multiple approaches of conceptualization to solve authentic problems. Meanwhile, this interdisciplinary learning mode also puts forward higher requirements for students' knowledge construction and practical skills, especially for students with insufficient basic knowledge and skills [1]. Those students who fail to complete a certain task in their courses tend to have lower confidence, which may further lead to lower motivation and less persistence in STEM learning [3].

Researchers also found that a supportive and inclusive classroom environment that focuses on engaging all students, emphasizing students' hard work and their progress can enhance their confidence in STEM learning [4]. While in an interdisciplinary learning environment, how can teachers create a better learning experience for students? And whether there is a correlation between the classroom psychological environment and students' academic self-efficacy in STEM courses?

This research tries to focus on students' academic self-efficacy and the classroom environment to explore their associations and then provides some empirical evidence for STEM educators to adjust their curriculum design or the way they teach.

1.3. Significance

Although there have been various studies on the relationship between mathematics or English classroom environment and students' academic self-efficacy in the past, few studies aimed to investigate the factors that affect students' self-efficacy in STEM classrooms, especially in mainland China. In fact, classroom environment and self-efficacy have been widely studied, but few studies have focused on the connections between the two variables. From the theoretical perspective, this study was aimed at enriching the research results related to STEM education in China.

From the perspective of practice, this research specifically analyzes the relationship between different dimensions of classroom psychological environment and students' academic self-efficacy. These data analysis results remind teachers of some details that need to be paid attention to in real teaching, thus could improve the teaching skills of educators and the outcomes of STEM education.

2. Literature Review

2.1. Academic self-efficacy in STEM learning

Self-efficacy, which was proposed by the American psychologist Bandura, refers to "people's confidence or belief in their ability to achieve behavioral goals in a specific field" [5].

Correspondingly, academic self-efficacy refers to an individual's evaluation and confidence in his/her abilities to complete academic tasks and achieve expected learning outcomes[6]. Consistent with self-efficacy, Schunk believes that students evaluate their academic self-efficacy through four dimensions including "performance, observational experiences, forms of persuasion, and physiological responses"[6]. Some research findings have claimed that academic self-efficacy has positive correlations with learning motivation [7], task persistence, and performance [8].

In the field of STEM education, students' STEM academic self-efficacy has also been found to be a positive predictor of better performance and persistence in STEM lessons [9]. In addition, girls with higher academic self-efficacy in STEM are more likely to choose STEM-related majors and jobs after they grow up [10].

2.2. Classroom environment

Classroom environment, also referred to as classroom climate, is a comprehensive concept that includes the physical (e.g., location, facilities, and light...) and psychological (e.g., teacher-student relationship, peer interaction, discipline...) aspects of the classroom [11]. Studies on the classroom environment began to flourish after psychologist Lewin developed the psychodynamic field theory, which emphasized that human development largely depends on

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the interaction between the individual and the environment. Studies over the past decades have found that the way the teacher manages the classroom shall contribute to a safe and positive atmosphere that is conducive to students' learning [12].

To better evaluate an educational environment and its impact on individuals, Moos proposed that three aspects including relationship, personal development, system maintenance/change should be considered[13]. Then, most of the classroom environmental measurement instruments have been developed based on Moos's three dimensions for studying the classroom environment, like Learning Environment Inventory and My Class Inventory [14].

Baek and Choi studied Korean college students and compiled the "Classroom Environment Scale". Through empirical analysis, they stated that the classroom environment and students' academic performance showed a significant correlation [15]. Shernoff pointed out that the best learning environment usually involves the complexity of teaching materials, high teacher expectations, good teacher-student relationship, clear student learning goals, and teacher supervision and evaluation systems[16].

In this study, the Individualized Classroom Environment Questionnaire (ICEQ) developed by Fraser with five subscales including personalization, participation, independence, investigation, and differentiation was used to investigate the perception of secondary school students about the classroom environment[17]. It contains 25 items and it is developed to "differentiate conventional classrooms from individualized ones involving either open or inquiry-based approaches".

2.3. Academic self-efficacy and classroom environment

Students' academic self-efficacy beliefs can be affected by the classroom environment. For example, Bleeker and Jacobs found the belief of teachers and peers in a student's STEM abilities can have an impact on a student's interests and even academic goals [18]. Research also found that positive feedback from other students or teachers increased the impact on academic self-efficacy through social persuasion [19].Moreover, students regularly observe their classmates succeed or fail at a task, it can be a vicarious experience of academic self-efficacy.

An empirical study involved 1055 Australian secondary students found that the classroom environment is related to student academic self-efficacy in mathematic classes [20].At the same time, Dorman also pointed out that classroom environment factors such as student cohesion and teacher support, task orientation has a significant impact on students' sense of academic self-efficacy in mathematic classes [20].

A medium correlation was also found between the classroom environment and students' self-efficacy when Zedan and Bitar studied 900 high school students in Israel. Participants were required to complete the classroom atmosphere questionnaire and the mathematical self-efficacy questionnaire in the math class. The research results also pointed out that the dimension of classroom atmosphere explains 50% of the variance of mathematical self-efficacy. And regression analysis shows that mathematics self-efficacy can effectively predict mathematics performance [21].

Daemi and Zafarghandi examined 200 English as foreign language learners and explored the relationship between the classroom environment and academic self-efficacy, the results highlighted the connection between the Participants need to complete what happened in class? (WIHIC) and self-efficacy table (SELF-A). The Spearman rank-order correlation was run to analyze the data. They found that self-efficacy was significantly correlated with task orientation and student cohesion, while the correlation with cooperation was low [22].

2.4. Theoretical framework

It is believed that academic self-efficacy is linked to perceptions of the classroom environment. Lorsbach and Jinks stated "unlike most belief systems, which can be highly personal, academic

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self-efficacy is generally a belief that is addressable in a classroom context"[23]. Thus the classroom environment and students perceived academic self-efficacy are directly related and cannot be considered separately. We try to analyze the possible connections between them from the classification of the theoretical basis of the classroom environment and the sources of self-efficacy, which is shown in Figure 1.

The Classroom Environment Questionnaire we used in this study follows Moos's scheme for classifying human environments. Moos's three basic types of environment dimensions including

1. Relationship dimensions: it is an indicator which "identifies the nature and intensity of personal relationships within the environment and assess the extent to which people are involved in the environment and support and help each other".

2.Personal development dimension: it "assesses basic directions along which personal growth and self-enhancement tend to occur".

3.System maintenance and system Change dimension: it refers to the definition "which involves the extent to which the environment is orderly, clear in expectations, maintain control, and is responsive to change" [24].

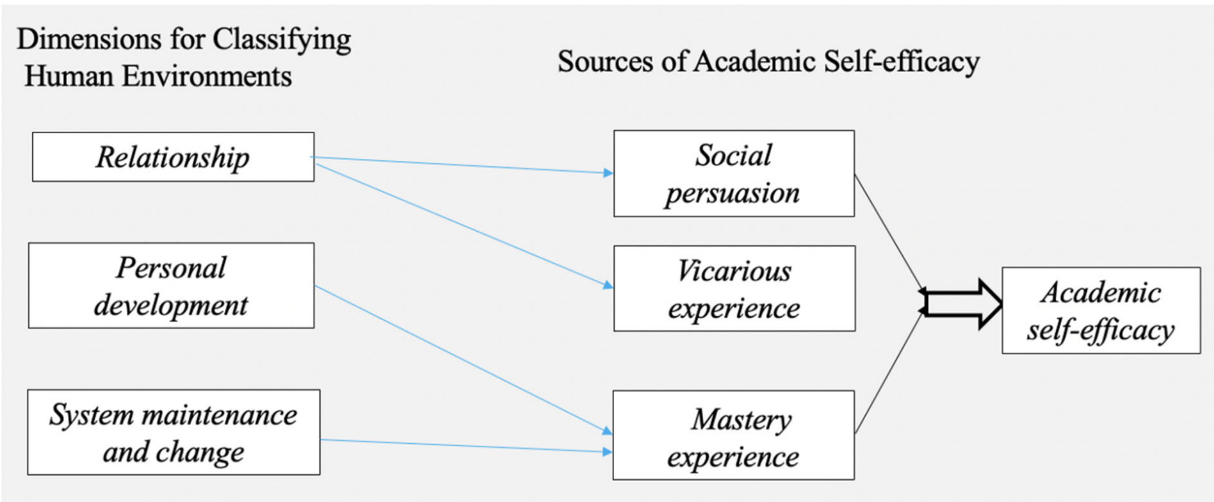

Figure 1. The Interaction Between Classroom Environment and Academic Self-eefficacy [5,13,23].

As is showed in Figure 1, among the five dimensions of the Personalized Classroom Environment Questionnaire we used in this study, Personalization and Participation belong to the Relationship dimension, Independence and Investigation belong to the Personal Development dimension, and Differentiation belongs to the System maintenance and change dimension according to Moos's scheme for characterizing human environments[25]. The blue arrows between the dimensions for classifying human environments and the sources of self-efficacy indicate items that may influence each other according to Lorsbach and Jinks, who believe that the concept of self-efficacy is an "important component of all three of Moos's dimensions (relationship, personal development, system maintenance, and change) for classifying human environments" and provided profound argumentation in the article [23]. For example, Students regularly observing their classmates succeed or fail at a task that belongs to the relationship dimension in the classroom environment can be a vicarious experience of academic self-efficacy. Thus it can be predicted that students' perceptions of the classroom environment and academic efficacy are correlated.

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3. Research Design: A Correlation Study

3.1. Quantitative approach

Based on the review of previous literature, there have been some studies on academic self-efficacy and classroom environment in the field of education, but few studies on the relationship between the two, especially in STEM courses. Therefore, a quantitative approach was adopted in this study to investigate the following three questions:

1. What is the level of secondary students' academic self-efficacy in learning STEM lessons?

2. What are secondary students' perceptions of the STEM classroom environment?

3. Are there correlations between students' academic self-efficacy dimensions and the classroom environment dimensions?

3.2. Sample

Secondary students who were in Grade 7 to Grade 12, attending an international school, and having STEM courses in their curriculum were invited to participate in the survey. From March 30th to June 25th, 2021, data were obtained from 258 students in the form of an online questionnaire, of which 247 valid questionnaires (excluding the cases with incomplete answers and duplicate answers for all items) were collected. In this study, the researcher used the STEM Education Network to spread the links to the questionnaire with the help of principals and some teachers. Students attending international schools in mainland China in Grade 7 to Grade 12 could access the questionnaire through the links forwarded by teachers and the school's official website. Table 1 shows the demographic information of the sample: participants include students from Grade 7 to Grade 12 (Male=141, Female=106) with a mean age of 14.52, and most of them come from big cities like Shenzhen, Beijing, Shanghai, Guangzhou.

Table 1. Demographic Information of Sample (N=247)

Item		n	Percentage
Age	12	10	4.0%
	13	60	24.3%
	14	71	28.7%
	15	40	16.2%
	16	42	17.0%
	17	11	4.5%
	18	13	5.3%
Grade	Grade 7	46	18.6%
	Grade 8	78	31.6%
	Grade 9	35	14.2%
	Grade 10	41	16.6%
	Grade 11	27	10.9%
	Grade 12	20	8.1%
Gender	Male	141	57.1%
	Female	106	42.9%
School Location	Beijing	39	15.8%
	Shanghai	31	12.6%
	Shenzhen	84	34.0%
	Guangzhou	21	8.5%
	Other Cities	72	29.1%

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3.3. Instruments

3.3.1. Demographic information

Studies showed that classroom psychosocial environment students perceived vary according to year level and subject area [26]. Gender differences have also been observed in STEM academic self-efficacy [6]. Therefore, the demographic information we surveyed includes age, grade, gender, location of the school.

3.3.2. Assessment of classroom environment

The "Individualized Classroom Environment Questionnaire" was used to assess the STEM classroom environment [25]. It has five subscales (viz. Personalization, Participation, Independence, Investigation, Differentiation) with 5 items for each subscale. Each item used a five-point response format (viz. Almost Never, Seldom, Sometimes, Often, Very Often) by scoring 1, 2, 3, 4, and 5, respectively. Therefore, the total score of the questionnaire ranges from 25 to 125, the higher the total score, the better the classroom environment.

Additionally, Table 2 shows the item number corresponding to each dimension and the classification of each dimension according to Moos's three general categories for conceptualizing dimensions characterizing diverse psychosocial environments[13]. (viz. Relationship, Personal Development, and System Maintenance and System Change).

Table 2. Descriptive Information for Five Classroom Environment Dimensions

Dimension	Description	Sample item	Moos' s schema
Personalization (Q1,6,11(R),16,21)	The extent to which the teacher helps, befriends,trusts and is interest in students	The STEM teacher takes a personal interest in each student.	Relationship
Participation (Q2,7(R),12,17,22)	The extent to which students have attentive interest, participate in discussions, do additional work and enjoy the class.	Students give their opinions during discussions.	Relationship
Independence (Q3(R),8,13(R),18(R),23(R))	The extent to which the related activities in STEM class such as where to seat, partners are determined by students	Students choose their partners for group work.	Personal Development
Investigation (Q4(R),9,14,19,24)	The extent to which skills and processes of inquiry and their use in problem solving and investigation are emphasized.	Students carry out investigations to test ideas.	Personal Development
Differentiation (Q5,10(R),15,20,25(R))	The extent to which students are taught differently in STEM class.	Different students use different books, equipment and materials.	System Maintenance and System change

Note: Item number marked R needs to be scored in the reverse direction.

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In this study, the item analysis was conducted to test the reliability of the Individualized Classroom Environment Questionnaire. Outcomes show that the questionnaire has high reliability (Cronbach's α = .915). The five subscales also has relatively acceptable reliability: (1) Personalization (Cronbach's α =0.686); (2) Participation (Cronbach's α =0.654); (3) Independence (Cronbach's α =0.668); (4) Investigation: (Cronbach's α =0.789); (5) Differentiation: (Cronbach's α =0.778).

3.3.3. Assessment of academic self-efficacy

The "Academic Self-efficacy Scale" developed by Gafoor was used to assess perceived academic competence at STEM classwork [27].

It has 16 items with five dimensions (viz., Learning process, Comprehensive, Utilization of resources, Goal orientation, Adjustment) and some items were modified to elicit a response to the academic efficacy of STEM lessons. Participants respond to each item on a five-point scale from "exactly false" (scoring as 1) to "exactly true"(scoring as 5). The total score of the scale ranges from 16 to 80, the higher the total score, the higher the academic self-efficacy.

Table 3. Item Number of Each Dimension in Academic Self-efficacy Scale

Dimension	Item number
Learning process	Q1,15
Comprehensive	Q10(R),26(R)
Utilization of resources	Q3(R),7(R),11
Goal orientation	Q4(R),9
Adjustment	Q5,8(R),12,13(R),14,16(R)

Note: Item number marked R needs to be scored in the reverse direction.

In this study, the item analysis was conducted to test the reliability of the Academic Self-efficacy Scale. Results show that the scale has high reliability (Cronbach's α = .962). The five subscales also has relatively good reliability: (1) Learning Process (Cronbach's α =0.864); (2) Comprehensive (Cronbach's α =0.728); (3) Utilization of Resources (Cronbach's α =0.729); (4) Goal orientation: (Cronbach's α =0.665); (5) Adjustment: (Cronbach's α =0.931).

3.4. Data collection and analysis

This study used an online questionnaire to collect data, students could get access to the questionnaire by clicking the link generated by the WenJuanXing or scanning the QR code. The researcher got the cooperation of some principals to place the survey (anonymous web link and QR code) on their official website and students could choose whether to participate voluntarily. Besides, the researcher asked STEM teachers to promote the survey to their students. At the beginning of this survey, a description of the survey and a consent form was shown to students and the survey would begin after participants circle the button "understand and accept". Students could complete this questionnaire on their computers or mobile phones, and it would take about 10-15 minutes to finish it.

The researcher used SPSS 26.0 to analyze the data. Item analysis was first conducted to test the reliability of the instruments. In subsequent analysis, the researcher conducted the descriptive analysis to get a general understanding of the STEM academic self-efficacy of secondary students and the perceived classroom environment of their STEM lessons. The correlations analysis was the core of this study since it helped explore the connection between STEM academic self-efficacy and the five aspects of the STEM classroom environment.

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3.5. Triangulation

Figure 2 shows the measures used to achieve triangulation in this research.

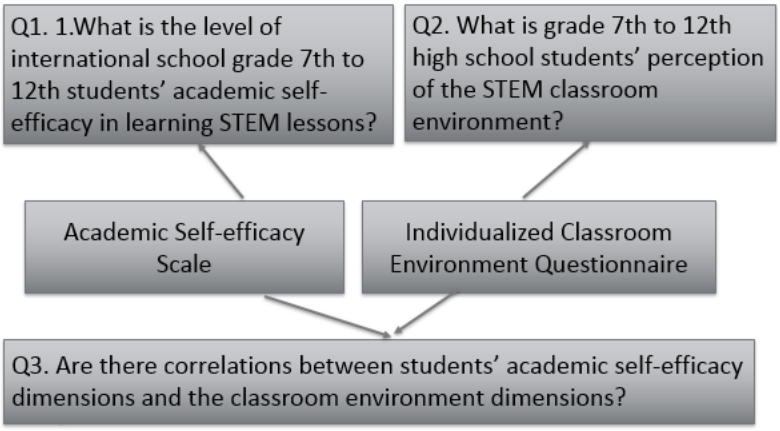

Figure 2. Measures to Achieve Triangulation in the Research

4. Results and Findings

4.1. Descriptive analysis

Table 4 provides an overview of the descriptive outcomes of students' STEM academic self-efficacy and classroom environment. From the table, it could be seen that in general students' STEM academic self-efficacy is at a moderate level (Mean=52.09, SD=14.34, N=247). The average score of each item was 3.26, smaller than 4 (3= Neutral, 4= Nearly True). Specifically, their self-efficacy in the learning process, goal orientation, and adjustment are relatively higher with an average score of each item greater than 3.26.

Regarding the classroom environment, it can be seen that the mean score of the STEM classroom environment is close to 90 (Mean=89.60, SD=14.44, N=247) and the average score of each item was 3.58 (3=sometimes, 4=often). It means in most STEM classrooms teachers are trying to build a positive and inclusive learning environment by adopting some teaching strategies, although not very often in general.

Table 4. Descriptive Analysis Results for Academic Self-efficacy and Classroom Environment

N=247	Mean	SD	Min	Max	Mean for each item
Academic Self-efficacy					
Total Score	52.09	14.34	24	74	3.26
Learning Process	6.76	2.17	2	10	3.38
Comprehensive	9.61	2.65	5	15	3.20
Utilization of Resources	9.58	2.46	4	15	3.19
Goal Orientation	6.58	1.93	2	10	3.29
Adjustment	19.55	6.08	8	29	3.26
Classroom Environment					
Total Score	89.60	14.44	49	120	3.58
Personalization	17.35	3.19	9	24	3.47
Participation	18.21	2.97	12	26	3.64
Independence	17.25	2.36	10	24	3.45
Investigation	18.49	3.76	9	25	3.70
Differentiation	18.31	3.65	9	25	3.66

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4.2. Correlation analysis

Table 4 presents the correlation analysis results between STEM academic self-efficacy outcomes and classroom environment variables. In this table, weak linear relationships can be seen between self-efficacy dimensions and classroom environment dimensions. Overall, academic self-efficacy is positively related to the classroom environment (r=.189**, p<0,01). Respectively, the academic self-efficacy is positively related to personalization (r=.187**, p<0.01), participation (r=.230**, p<0.01), investigation (r=.303**, p<0.01), and differentiation (r=.228**, p<0.01). However, in this research, there is a negative weak linear relationship between the overall academic self-efficacy and independence in the classroom (r= -.220**, p<0.01). Independence means students can choose their seats, partners, or own autonomy in other related learning activities. While such “freedom” fails to enhance students’ academic self-efficacy in this study.

Table 5. The Correlations Among STEM Academic self-efficacy and Classroom Environment

	SE total	*Learning Process*	Comprehensive	Utilization	Goal Orientation	Adjustment	CE Total	Personalization	Participation	Independence	Investigation	Differentiation
SE Total	1											
Learning Process	.873**	1										
Comprehensive	.922**	.752**	1									
Utilization	.914**	.712**	.802**	1								
Goal Orientation	.933**	.812**	.865**	.845**	1							
Adjustment	.978**	.827**	.869**	.877**	.873**	1						
CE Total	.189**	.201**	.091	.034	.158**	.271**	1					
Personalization	.187**	.181**	.109	.034	.176**	.259**	.929**	1				
Participation	.230**	.275**	.151**	.052	.188**	.298**	.906**	.835**	1			
Independence	-.220**	-.194**	-.278**	-.319**	-.188**	-.141**	.758**	.657**	.581**	1		
Investigation	.303**	.337**	.194**	.140**	.239**	.378**	.947**	.836**	.857**	.616**	1	
Differentiation	.228**	.190**	.121	.125**	.192**	.305**	.940**	.836**	.784**	.668**	.892**	1

Note: ** p<0.01; SE Total=the total score of academic self-efficacy; CE Total=the total score of the classroom environment

5. Discussion

5.1. Why weak linear relationships between academic self-efficacy and classroom environment?

The goal of this research was to explore the connection between STEM academic self-efficacy and the classroom environment of international secondary students in mainland China. Although the data analysis showed a correlation between academic self-efficacy and classroom environment in STEM courses, which was consistent to a certain extent with previous findings in other subjects. In this study, however, the correlation coefficients between the two variables and their subdimensions were weak (all coefficients were less than 0.4). The researchers infer that there were two possible reasons for this result.

Firstly, the valid sample size of this study was only 247 secondary school students, which was relatively small compared with other similar studies conducted by other researchers. For example, Dorman invited 1055 Australian secondary school students as participants in his study of the relationship between classroom environment and academic self-efficacy in students' math learning[20]. In statistics, the sample size is directly proportional to Z-score and inversely proportional to the margin of error [28]. Therefore, smaller sample size in this study could reduce the confidence level while increasing the margin of error, leading to less powerful

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statistical significance in data analysis. The small sample size was also one of the limitations of this study. To obtain a stronger correlation coefficient, it is necessary for the researcher to consider extending the duration of the survey or promoting the study by collaborating with more schools and teachers in different cities. When the sample is sufficiently representative, the results of the data analysis may change accordingly.

Secondly, the online survey did not include an item of how long students experienced STEM learning. As STEM education is still in its initial stage of development in China, some students only had STEM courses for a short time. Some of them might not be familiar with the teaching philosophy and learning approach of STEM courses, so they were not able to fully understand all the items in the questionnaire, which might lead students to give answers at random, thereby reducing the validity of the data.

5.2. What are the implications of the correlation results?

In this research, the highest correlation index was found between investigation and academic self-efficacy (r=.303**, p<0.01), which indicated that when students are given more opportunities to do some research and investigations by themselves, they may get higher self-efficacy in learning. Under the guidance of teachers, students can take the initiative to plan, monitor, evaluate and adjust their ongoing learning activities so that they can gain more sense of autonomy and master experience, thus improving their self-efficacy. Students' academic self-efficacy is also positively related to participation (r=.230**, p<0.01), differentiation (r=.228**, p<0.01), and personalization (r=0.187**, p<0.01). If teachers can consciously pay attention to the ability level and characteristics of each student and set individualized tasks and challenges, and create more opportunities for students to be engaged in the learning process, students will feel the inclusiveness and support from teachers and peers. In this way, they can more actively explore their potential and make progress in an open and safe psychological environment of the classroom.

5.3. Why negative weak correlation between academic self-efficacy and independence?

However, in this research, there is a dimension of the classroom environment, the independence is negatively related to academic self-efficacy (r=-.220, p<0.01). This result is inconsistent with the researchers' hypothesis. Based on previous studies and self-efficacy theory, researchers hypothesized that when teachers give more freedom to choose their group teammates, classroom seats, and even determine the length and content of discussions and activities in class, students' self-efficacy will also increase. However, the findings of this study do not support this hypothesis, and the researchers infer that there may be several reasons:

First of all, although independence to some extent means respect for students' personalities and learning styles, excessive independence may also lead teenagers to abuse the freedom given by teachers and make teachers lose their role as the facilitator of learning activities. For example, if students are allowed to choose group members freely in class, adolescents may be more likely to choose peers with whom they have good relationships, which is an important way for them to gain a sense of belonging to a group. As a result, they may spend the time that would otherwise be used for studying discussing gossip or school news, which undoubtedly reduces their effective studying time and the possibility of getting a sense of accomplishment from completing the task.

Secondly, the study was conducted in international schools in China, with most of the participants being students who grew up and received education in China. Many of them have grown accustomed to relying on teachers to make advance arrangements for grouping, class discussion, classroom seating, and so on, preferring to follow the teacher's instructions rather than make decisions on these matters themselves. This may reflect the difference in the cultural

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situation that too much independence may bring students extra stress other than passion. In addition, the existence of a negative correlation may also be due to the insufficient sample size (N=247). Subsequent studies could include a larger sample size or compare participants' attitudes toward independence in different countries.

6. Conclusion

Based on the data analysis of 247 participants in this study, secondary students in mainland China had a moderate level of self-efficacy. There was an overall positive weak correlation between self-efficacy and the classroom environment they perceive. And the academic self-efficacy was also positively and weakly related to four sub-dimensions of the classroom environment, including investigation, participation, differentiation, and personalization. An unexpected negative weak correlation existed between self-efficacy and independence. It seemed that having higher degrees of freedom would lead to the decline of students' self-efficacy, while this finding still needs to be confirmed by further research.

The results of this study, which focused on the STEM learning experience of students in international schools in mainland China, provided some clues for educators and administrators to further improve curriculum design and lesson planning. Although this study only found a positive weak linear relationship between academic self-efficacy and the classroom environment, it still indicated that an open and safe classroom environment in STEM courses could enhance students' academic self-efficacy. Therefore, STEM teachers should create a positive classroom learning environment at multiple aspects to improve students' academic self-efficacy in STEM courses and thus increase the fruits of STEM classroom learning.

References

[1] M. Honey, G. Pearson and H. A. Schweingruber: STEM integration in K-12 education: Status, prospects, and an agenda for research, National Academies Press Washington, DC, Vol. 500 (2014).

[2] Z.-L. An, N. Wang, W. Wan, et al.: The Enlightenment of Chinese Innovation Education—STEM ,International Conference on Social Science, Economics and Education Research (Shanghai, China, March 6-8,2020).Vol.455,p.85-87.

[3] L.V. Charleston, R. Leon: Constructing self-efficacy in STEM graduate education, Journal for. Multicultural Education, Vol. 10 (2016) No. 2, p.152-166.

[4] A. Zollman: Learning for STEM literacy: STEM literacy for learning, School Science and. Mathematics, Vol. 112(2012) No. 1,p. 12-19.

[5] A. Bandura: Self-efficacy: toward a unifying theory of behavioral change, Psychological Review, Vol. 84 (1977) No.2,p.191.

[6] D. H. Schunk, F. Pajares: The development of academic self-efficacy in Development of achievement. motivation.(Academic Press, America 2002), p.15-31.

[7] D. H. Schunk, A. R. Hanson: Peer models: Influence on children's self-efficacy and achievement., Journal of Educational Psychology, Vol. 77(1985) No.3, p.313.

[8] D. H. Schunk: Self-efficacy and achievement behaviors, Educational Psychology Review, Vol.1(1989) No.3,P.173-208.

[9] A. D. Rittmayer, M. E. Beier: Overview: Self-efficacy in STEM, Swe-Awe Casee Overviews, Vol. 1(2008), P.12.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202312_6(12).0010

[10] S. Larose, C. F Ratelle Gu and F. Guay, et al.Trajectories of science self-efficacy beliefs during the. college transition and academic and vocational adjustment in science and technology programs, Educational Research and Evaluation, Vol.1(2006), P.373-393.

[11] B.J. Fraser: Classroom Environment (Routledge ,British 2012),p.125.

[12] J. J. Barr: Developing a Positive Classroom Climate, IDEA Paper Vol.61(2016).

[13] R. H. Moos： Evaluating educational environments,Jossey-Bass San Francisco,(1979).

[14] B. J. Fraser: Assessment of Learning Environments: Manual for Learning Environment Inventory. (LEI) and My Class Inventory (MCI),Third Version(1982).p.235

[15] S.-G. Baek and H.-J. Choi: The relationship between students' perceptions of classroom. environment and their academic achievement in Korea, Asia Pacific Education Review, Vol. 3 (2002) No.1, p.125-135.

[16] D. J. Shernoff: Optimal learning environments to promote student engagement, (2013).

[17] B. J. Fraser: Individualized classroom environment questionnaire,Evaluation News, Vol. 3(1982). No.2, p.72-73.

[18] M. M. Bleeker and J. E. Jacobs： Achievement in math and science: Do mothers' beliefs matter 12. years later? , Vol.96(2004) No.1,p. 97.

[19] N. E. Betz and R. S. Schifano: Evaluation of an intervention to increase realistic self-efficacy and. interests in college women, Journal of Vocational Behavior, Vol.56 (2000) No.1, p.35-52.

[20] J.P. Dorman: Associations between classroom environment and academic efficacy, Learning. Environments Research, Vol.4(2001) No.3, 243-257.

[21] R. Zedan, J. Bitar: Environment learning as a predictor of mathematics selfefficacy and math. achievement[J]. American International Journal of Social Science, Vol.3(2014) No.6,P.85-97.

[22] M. N. Daemi, A. Tahriri and A. M. Zafarghandi: The relationship between classroom environment. and EFL learners' academic self-efficacy, International Journal of Education and Literacy Studies, Vol.5(2017) No.45, p.16-23.

[23] A. Lorsbach, J. J. Jinks: Self-efficacy theory and learning environment research, Learning. Environments Research Vol.2(1999) No.2, P.157-167.

[24] P. M. Insel, R. H. Moos: Psychological environments: Expanding the scope of human ecology. American Psychologist, Vol.29(1974) No.3, P.179.

[25] B.J. Fraser, D. L. Fisher: Using short forms of classroom climate instruments to assess and improve. classroom psychosocial environment,Journal of Research in Science Teaching, Vol.23(1986) No.5, P.387-413.

[26] B.J. Fraser, Classroom environment instruments: Development, validity and applications. Learning environments research, Learning Environments Research,. Vol.1(1998)No.1, p. 7-34.

[27] A.K. Gafoor, M.Ashraf: Academic Self-Efficacy Scale-2006. Department of Education, University of. Calicut. (2016), p.10

[28] C.E. Land: Statistical limitations in relation to sample size. Environmental Health Perspectives, Vol.42(1981),P.15-21.