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STUDENTS' SOCIAL-EMOTIONAL COMPETENCY AND MATHEMATICS ACADEMIC DEVELOPMENT: A CLUSTERING ANALYSIS ON CHINA

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Abstract

More and more countries and regions are concerned about social-emotional competency (SEC) which help students develop positive self-emotion to promote academic and social development. The present study focused on an in-depth and meaningful understanding of different students' social-emotional competency and mathematics academic development. Participants were 6949 grade 4 and 5 pupils in China. The cluster analysis revealed different profiles by social-emotional competency's four sub-dimensions which measured by the Chinese version of Delaware Social-Emotional Competency Scale (DSECS-SCV). MANOVA was conducted to test whether self-confidence, mathematics anxiety, mathematics interest, achievement, teacher-student relationships, and peer relationships significantly differed across the four clusters. The cluster analysis revealed four distinct profiles: high SEC, low SEC, medium SEC (social-communication) and medium SEC (control-responsible). The high SEC profile represented scores high in self-confidence, mathematics interest, achievement, teacher-student relationships and peer relationships, but low level of mathematics anxiety. Statically significant differences in the above variables existed across high, medium and low SEC clusters. However, homogeneity in self-confidence, achievement, teacher-student relationships and peer relationships were also observed in the two medium SEC clusters. This study enables teachers to have better understanding of students' social-emotional competence and the relationships between social-emotional competence and mathematics academic development, so that they can apply appropriate teaching strategies to different types of students in practical teaching and social emotional learning programs to effectively promote students' academic and social development.

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Keywords: Cluster analysis, social-emotional competency, mathematics, academic development.

1.   Introduction

In 1994, Goleman et al. proposed the concept of social-emotional learning (SEL) and set up Collaborative for Academic Social, and Emotional Learning (CASEL). SEL is defined as "children and adults acquire and effectively apply the knowledge, attitudes, and skills necessary to understand and manage emotions, set and achieve positive goals, feel and show empathy for others, establish and maintain positive relationships, and make responsible decisions" (Collaborative for Academic, Social, and Emotional Learning, 2018). There are five core social-emotional competencies (SEC), including self-management, self-awareness, social awareness, relationships skills and responsible decision-making, which can be enhanced by SEL (CASEL, 2018). Self-awareness refers to skills in identifying one's own emotions and thoughts and in understanding how thoughts and emotions impact one's behaviour; Social awareness refers to individuals' ability to understand others' behaviour, take others' perspective, and demonstrate empathy; Self-management refers to skills in effectively regulating one's thoughts, emotions, and behaviours; Relationships skills refer to the ability to form and maintain healthy friendships, listen to others, work cooperatively, handle conflict constructively, and assist others; Responsible decision making refers to the ability to make safe, respectful, and moral decisions about one's behaviour and interactions with others(CASEL, 2018). SEL and SEC can contribute to academic success and socialization (Denham & Brown, 2010). Therefore, SEL and SEC are increasingly valued by governments, schools, teachers and educational researchers.

There have been numerous studies revealing that SEC has a wide impact on the development of students, including achievement, teacher-student relationships, peer relationships and academic emotions and attitude. Several of the more recent and insightful of which are listed here. For instance, DeLay et al. (2016) found that SEL interventions can improve students' writing and math performance by comparing 14 intervention classrooms and 8 control classrooms. SEL interventions could break down barriers of social segregation and these students with high academic performance can help students with low academic performance. Durlak, Weissberg, Dymnicki, Taylor, and Schellinger (2011) conducted a meta-analysis based on universal SEL programs, including 213 schools and 270,034 kindergarten through high school students. For the students in the experimental group, they had an 11% gain in academic achievement on average. Greenberg et al. (2015) revealed that SEL interventions can diminish students' problem behaviours and improve positive interpersonal relationships. Another paper that also researched the effect of SEC on interpersonal relationships is by Zins, Weissberg, Wang, & Walberg (2004). This study found that SEC can promote students to understand and respect others' behaviours and develop good teacher-student relationships and peer relationships. Some researches revealed improving competency of social emotional can effectively reduce students' psychological problems, such as academic anxiety (Durlak & Wells, 1997; Ephremidze, Janashia, & Lagvilava, 2006).

2.   Problem Statement

Although numerous studies have explored the effect of SEC on students' academic achievement, interpersonal relationships, emotions and attitudes, there is no research to understand the learner profiles in terms of varying capabilities for mathematics social-emotional competency's four sub-dimensions. In

order to address this gap, this study categorized students by cluster analysis so that we could know if the different combinations of SEC sub-dimensions can predict the success of mathematics academic development.

3. Research Questions

This paper revealed different distinct learning profiles, and they were compared in association with self-confidence, mathematics anxiety, mathematics interest, achievement, teacher-student relationships and peer relationships.

There are two research questions: Would different clusters show diverse SEC profiles (Question 1)? Would better profiles exhibit greater self-confidence, mathematics interest, achievement, teacher-student relationships, and peer relationships (Question 2)?

4. Purpose of the Study

This paper sought to understand the learner profiles in terms of social-emotional competency's four sub-dimensions. The main goal of the present study was to provide an in-depth and meaningful understanding of different students' social-emotional competency and mathematics academic development.

5. Research Methods

5.1. Participants and Procedures

Data were collected from 6949 students (M=11.26, SD=0.97) studying in 97 primary schools in China. Stratified random sampling method was adopted in the study. The sample consisted of 3620 fifth graders, with 52.8% (n=3669) being male, 47.2% (n=3280) being female.

5.2. Measures

All measures, except mathematics achievement test, used self-report items with a response form of 4-point Likert scale, ranging from 1 (not like me at all or strongly disagree) to 4 (very much like me or strongly agree). The mean of the scores of items that made up a scale was used as the index of the variable measured by that scale. Mathematics achievement scores were transformed into a scale ranging from 0-100.

5.2.1. Social-Emotional Competency

The Chinese version of Delaware Social-Emotional Competency Scale (DSECS-SCV) which was developed by Zhu (2016) was used to measure students' social-emotional competency. This scale assessed four SEC, including self-management, social awareness, relationships skills and responsible decision making.

5.2.2. Academic Achievement

The mathematics achievement test was developed by mathematics teachers and experts in educational measurement, involving the knowledge about space and shape, change and relation, uncertainty, and quantity. The test contained 30 multiple-choice items.

5.2.3. Emotions and attitudes

Mathematics self-confidence scale (7 items), interest scale (4 items) and anxiety scale (5 items) were used to measure academic emotions and attitudes, which were adapted from PISA 2012 (OECD, 2014). An example of the items for self-confidence was "I learn mathematics quickly", for interest was "I do mathematics because I enjoy it", and for anxiety was "I get very tense when I have to do mathematics homework".

5.2.4. Teacher-Student Relationships

Five items of mathematics teacher-student relationships scale was adapted from PISA 2012 (OECD, 2014). An example of the item was "My teacher keeps the class orderly".

5.2.5. Peer Relationships

The peer nomination method (Asher & Dodge, 1986) was used to measure peer relationships. In every class, children needed to circle six classrooms, including three classrooms they liked most and three they liked least. Based on these nominations, every child had a standardized liking (L) and disliking (D) scores. Then, we got a social preference (SP) by using the standard L score to minus the standard D score. In this study, social preference (SP) was used to measure peer relationships.

5.3. Data Analysis Procedures

In the main analyses, cluster analysis was conducted to identify homogeneous groupings of participants with distinct profiles of SEC. The clustering variables were four SEC, namely responsible decision making, relationships skills, self-management, and social awareness. K-means cluster analysis using Ward's method with Euclidean distance as a measure of similarity was conducted. MANOVA was conducted to test whether self-confidence, mathematics anxiety, mathematics interest, achievement, teacher-student relationships, and peer relationships significantly differed across the different clusters.

6. Findings

6.1. Descriptive Statistics and Correlations

Table 3 displays means, standard deviations, and correlations of variables. Social-Emotional competency's four sub-dimensions were positively related to mathematics self-confidence, mathematics interest, mathematics achievement, mathematics teacher-student relationships, peer relationships, and negatively related to mathematics anxiety.

4

Table 01. Descriptive statistics and correlations of variables

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	1									
2	0.48***	1								
3	0.51***	0.52***	1							
4	0.41***	0.52***	0.48***	1						
5	0.28***	0.22***	0.23***	0.25***	1					
6	0.27***	0.29***	0.30***	0.27***	0.20***	1				
7	0.31***	0.33***	0.32***	0.32***	0.24***	0.53***	1			
8	-0.21***	-0.12***	-0.14***	-0.15***	-0.26***	-0.20***	-0.26***	1		
9	0.31***	0.34**	0.31***	0.32***	0.23***	0.39***	0.49***	-0.20***	1	
10	0.11***	0.11***	0.09***	0.13***	0.20***	0.05**	0.10***	-0.08***	0.12***	1
M	3.10	2.96	3.01	3.09	50.66	2.68	3.15	2.14	3.23	0.04
SD	0.62	0.72	0.70	0.67	16.04	0.72	0.74	0.80	0.72	1.38

$*p < 0.05$，$**p < 0.01$，$***p < 0.001$

1= responsible decision making, 2= social awareness, 3= self-management, 4= relationships skills, 5= mathematics achievement, 6= mathematics self-confidence, 7= mathematics interest, 8= mathematics anxiety, 9= mathematics teacher-student relationships, 10= peer relationships

6.2. Profiling of SEC Variables

Table 4 shows the means of four clusters. The first cluster was labelled "high SEC" profile because 2620 students (37.7%) scored high in responsible decision making, social awareness, self-management and relationships skills. In contrast, the second cluster, labelled "low SEC" profile, contained 940 students (14.0%) who reported low scores of social-emotional competency's four sub-dimensions. The third cluster, labelled "medium SEC (social-communication)" profile, comprised of 1725 students (24.8%) with high scores in social awareness and relationships skills, but low level of responsible decision making and self-management. Finally, the fourth cluster, labelled "medium SEC (control-responsible)" profile, included 1630 students (23.5%) with high scores in responsible decision making and self-management, but low level of social awareness and relationships skills.

Table 02. Means of the four clusters

Variable	Cluster 1 "high SEC"	Cluster 2 "low SEC"	Cluster 3 "medium SEC (social-communication)"	Cluster 4 "medium SEC (control-responsible)"
Responsible decision making	0.75	-1.05	0.22	-1.06
Social awareness	0.83	-1.36	-0.22	-0.27
Self-management	0.84	-1.44	-0.34	-0.02
Relationships skills	0.69	-1.41	0.04	-0.36

6.3. Cluster Differences in Various Variables

Table 5 presents the comparison of the four-cluster profiles in association with mathematics achievement, mathematics self-confidence, mathematics interest, mathematics anxiety, mathematics teacher-student relationships and peer relationships. The high SEC profile represented scores high in mathematics self-confidence, mathematics interest, mathematics achievement, mathematics teacher-student relationships and peer relationships, but low level of mathematics anxiety. In contrast, the low SEC profile represented scores low in mathematics self-confidence, mathematics interest, mathematics achievement, mathematics teacher-student relationships and peer relationships but high levels of mathematics anxiety. The various variables' means of two medium SEC profiles were between that of high SEC profile and low SEC profile.

Pairwise comparisons with Tukey's honestly significant difference (HSD) were conducted to uncover an in-depth description of the four clusters. Statistically significant differences existed in for various variables across the four clusters. For mathematics achievement, mathematics self-confidence, mathematics interest, mathematics teacher-student relationships and peer relationships, high SEC profile had the highest scores, followed by two medium SEC profiles, and low SEC profile had the lowest scores. However, medium SEC (social-communication) and (control-responsible) profiles displayed homogeneity. For mathematics anxiety, high SEC profile had the lowest score, followed by medium SEC (control-responsible) profile, medium SEC (social-communication) and low SEC profiles had the highest score. Homogeneity was also observed in both medium SEC (social-communication) and low SEC clusters.

Table 03. Comparison of the four-cluster profiles on various variables

Variable	High SEC		Low SEC		Medium SEC (social-communication)		Medium SEC (control-responsible)	
	M	SD	M	SD	M	SD	M	SD
Mathematics achievement	55.86[a]	15.24	42.49[c]	14.27	48.93[b]	15.35	50.46[b]	16.27
Mathematics self-confidence	2.98[a]	0.69	2.36[c]	0.72	2.56[b]	0.67	2.61[b]	0.67
Mathematics interest	3.50[a]	0.61	2.72[c]	0.77	3.02[b]	0.71	3.07[b]	0.71
Mathematics anxiety	1.93[c]	0.84	2.29[a]	0.72	2.27[a]	0.76	2.16[b]	0.76
Mathematics teacher-student relationships	5.57[a]	0.59	2.83[c]	0.76	3.13[b]	0.68	3.08[b]	0.70
Peer relationships	0.25[a]	1.38	−0.33[c]	1.39	0.07[b]	1.41	0.00[b]	1.25

Means in the same row with different superscript letters differ significantly at p < .01 in the Tukey's HSD comparison

7. Conclusion

The goal of the present study was to provide understanding of the different SEC profiles in terms of mathematics achievement, mathematics self-confidence, mathematics interest, mathematics anxiety, mathematics teacher-student relationships and peer relationships. The current findings answered the two research questions of this study. First, the cluster analyses revealed four distinct learning profiles, with

high SEC profile being the most adaptive profile exhibiting high levels of responsible decision making, social awareness, self-management and relationships skills (Question 1). Second, high SEC profile exhibited greatest mathematics achievement, mathematics self-confidence, mathematics interest, mathematics teacher-student relationships and peer relationships, but low level of mathematics anxiety (Question 2).

This study divided students into 4 categories, including high SEC, low SEC, and two medium SEC. The students belonged to high SEC profile had the highest mathematics achievement, interpersonal relationships, mathematics interest and self-confidence, but the lowest mathematics anxiety. While the students belonged to low SEC profile had the lowest mathematics achievement, interpersonal relationships, mathematics interest and self-confidence, but the highest mathematics anxiety. The students belonging to the two medium SEC had middle scores.

High SEC profile had significantly higher mathematics achievement than low SEC profile. The reason for this might be that these students tend to have higher self-awareness and responsible. They knew they should study hard. What's more, good interpersonal relationships can help students study well. In Chinese culture, students' academic achievements are seen as the most direct indicator of their levels of knowledge skills, and better achievements are the goals of numerous students, parents and teachers. Therefore, students with high SEC had high mathematics achievement is very important.

High SEC profile had significantly higher mathematics teacher-student relationships and peer relationships than low SEC profile. According to the ecosystem theory, the teacher-student relationship formed and developed in the process of teacher-student interaction. The teacher-student relationship is affected not only by the communication situation, but also by the characteristics of teachers and students.

In addition, high SEC profile had significantly higher emotions and attitudes than low SEC profile. The students with high SEC had stronger self-awareness and more confidence to solve mathematics problems. Chinese curriculum reform has been in constant process. Two Basics Teaching, three-dimensional objectives and key competency proposed in recent years. What behind these concepts is people-oriented educational philosophy and the return of the essence of education. It can be seen that the enhancement of knowledge and skills are not the only objectives in Chinese curriculum, and fostering students' academic emotions and attitudes is been increasingly valued. However, neither fostering students' emotions and attitudes which is one of the three-dimensional objectives, nor teaching students how to learn and being responsible which is emphasized by the key competency, is hard to do in traditional classes. This is why Chinese elementary and secondary teachers have difficulty in meeting the requirements proposed by the curriculum reform. However, the results revealed that fostering students' SEC maybe can solve the problem.

Especially, high SEC profile had the lowest mathematics anxiety, followed by medium SEC (control-responsible) profile, medium SEC (social-communication) and low SEC. Homogeneity was also observed in medium SEC (social-communication) and low SEC clusters. This implies that good relationships skills and responsible decision making ability could not alleviate the students' mathematics anxiety.

In summary, the cluster analysis revealed four distinct profiles: high SEC, low SEC, medium SEC (social-communication) and medium SEC (control-responsible). The high SEC profile represented scores

high in self-confidence, mathematics interest, achievement, teacher-student relationships and peer relationships, but low level of mathematics anxiety. This study enables teachers to have better understanding of their students' social-emotional competence and the relationships between social-emotional competence and mathematics academic development, so that they can apply appropriate teaching strategies to different types of students in practical teaching and social emotional learning programs to promote students' academic and social development effectively.

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