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The Comparative Analysis of Mathematical Achievement, Self-Efficacy, and Self-Concept Based on the Perceived Classroom Climate Among Male and Female Students

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Background: Mathematics is one of the essential and effective subjects that dominate students' educational performance and occupational future.
Objectives: The current study aimed to comparatively analyze the mathematical achievement, self-efficacy, and self-concept based on the perceived classroom climate among the male and female students.
Patients and Methods: The study included 400 students (222 males and 178 females) as respondents from the third grade high school selected by cluster sampling technique considering educational regions, high schools, classrooms, and students. The participants answered the questions derived from three questionnaires, the so called WIHIC, mathematical self-efficacy, and mathematical self-concept description.
Results: The results of route analysis indicated that mathematical self-efficacy rate was 8% and 7% among male and female students, respectively. The variance of mathematical self-concept based on the expressed perceived classroom climate was higher in female than male students (32% versus 26%). However, based on the internal variables in this model, the mathematics score was found to be higher among male than in female pupils (27% versus 13%).
Conclusions: The findings of the route analysis showed that these differences are adjustable by variables such as mathematical self-efficacy.

*Keywords:*Mathematics; Achievement; Self-Efficacy; Self-Concept; Climate; Students

1. Background

The importance of mathematics is so high that UNESCO (United Nations Educational, Scientific and Cultural Organization) named the year 2000 as the year of mathematics. Mathematics is one of the essential and effective subjects that dominate students' educational performance and occupational future. Its instinctive beauty and different applications, has greatly attracted global attention. The international Association for Evaluation of Educational Achievement (IEA) has explored the students' mathematics performance from many countries around the world using the Trend in International Mathematics and Science Study (TIMSS) test. As a member state of IEA association, Islamic Republic of Iran has participated in this test in 1995, 1999, 2003, 2007, and 2011, and has achieved the 38th rank among 41 countries, the 31st rank among 33 nations, the 31st rank among 46 countries, the 29th rank among 49 countries, and the 32nd rank among 42 countries, respectively (1). Kiamanesh emphasized on the Iranian students' mathematical under-achievement with respect to TIMSS findings. An important and significant implication of the teaching and learning processes is the poor performance of the Iranian students during five EIA examinations (2). In this regard, one can refer to the studies by Pahlavan Sadegh (3), and Nasr Isfahani (4). Mathematical self-efficacy may be expressed as an important factor on mathematical performance. In their studies, Pahlavan Sadegh (3), Nasr Isfahani (4), Kabiri (5), Pajares et al. (6), Pirhosseinloo (7) and Wilkins et al., (8) reported direct and indirect effect of mathematical self-efficacy on mathematical achievement. Mathematical self-efficacy could be defined as evaluation of individuals' confidence in their abilities to successful performance or completion of duty or solving a certain mathematical problem (9, 10). Mathematical self-concept is an important variable in mathematical achievement. Several independent investigations conducted by, Pahlavan Sadegh

(3), Nasr Isfahani (4), Wilkins (8), Pajares et al. (6), confirmed the effective role of mathematical self-concept on mathematical achievement (10). It may be implied that learning and educational achievement among individuals are governed by the complex conditions composed of various elements with specific impacts. The existing individual and gender-related differences are considered as elements that play their roles in learning mathematics and personal learning environment. Learning climate, also occasionally called learning situation (1) and learning context (2), is a general term referring to several aspects of training centers. Classroom learning climate refers to an area or situation in which learners and teacher may interact with each other using various information tools and sources in order to pursue their learning activities (11). At present, many studies regarding perceived learning climate show the positive perception toward learning context. This may improve cognitive outcome, create positive attitude in classroom, and increase learners' satisfaction (12, 13). Some of these studies focused on cognitive classroom environment, measurement of effective cultural factors on classroom learning, learning context in the countries with enriched technology, as well as surveys carried out on different learning contexts in various countries (12, 13). Many studies concerned the role of students` gender in the studied variables; some suggested no association (3), while some others reported a relationship between them (4). The Nasr Isfahani indicated that in primary schools, male and female showed the same level of confidence, but regarding high schools, the male students showed higher degree of confidence than female ones (4). In his study, Razavieh concluded that mathematical educational performance was better among female than male students. In his survey, Keramati reported a positively significant relationship between mathematical self-efficacy and benefiting from mathematics lesson, but no significant difference was observed regarding gender. Other study indicated that mathematical self-efficacy expectations in male academic students are stronger than those of their female counterparts and in another study, they found that male students acquired higher scores in self-efficacy. Compared to females, male students evaluated mathematics as more helpful and showed better attitude toward mathematics and were more confident about their capabilities in mathematics. According to Wakins and Slocum, investigation on the role of gender in ideas about mathematical and computer self-efficacy suggested that the rate of beliefs in the mathematical and computer perceived self-efficacy was higher among male teens than in female adolescents (14).

On the other hand, Pajares and Graham (10) stated that in general, a difference could be found between the sense of self-efficacy and the field of mathematics on one hand, and natural sciences in both genders especially across racial minorities on the other hand. In this regard, blacks compared to Caucasians and also female to male exhibited a lower sense of self efficacy (10). Geary studied the relationship between social support and self-efficacy and research habits in the natural sciences subject and their comparison among female and male students. The result showed a positive significant relationship between the elements of research habits (cohesiveness, control, and memorizing contents) and educational self-efficacy in the natural sciences subject plus subscale of social support (family and others) (15). The studies conducted on self-concept and genders produced different results. Several investigations showed that male academic and school students in primary and high schools exhibited higher level of mathematical self-concept than their female fellows (6). Similarly, the studies by Mull, Scott, Martin, and Khalili indicated that female acquire higher scores in mathematics self-concept than male, a condition encouraging female students further by their teachers. Additionally, female are more sociable than male and are influenced more than male. Consequently, their self-concept is more affected by classroom climate than male. The results of surveys by Rohani showed a higher self-concept in female than male (16). Likewise, other studies suggested no difference between genders in mathematical self-concept. Of these studies, one could refer to the investigation by Pajares and Graham, who found no difference in mathematical self-concept among female and male at the end of academic year (10). Over the past two decades, gender related differences have been the major subject of the studies. The studies mainly indicated that male's mathematical achievement was higher than those of the female. The reason for this difference was higher self-efficacy among the male than female students (17). On the contrary, another study indicated that female were superior to male regarding the mathematical achievement score (4). Many studies considered male' superiority over female regarding their confidence to learn mathematics and this difference might be still observed even when female presented better reason for the feeling of confidence based on their performance (18). Other study examined gender-related differences in documents, self-efficacy, and mathematical achievement in sample contained 62 fourth graders. The findings of this investigation showed a significant difference in the variable of mathematical achievement in favor of male, while there was no significant difference in the variable of self-efficacy between male and female. In a similar study carried out by Davis et al. on gender differences in language/math self-concept and achievement among the adults by means of route analysis method, no significant difference was observed among the two variables of mathematical self-concept and mathematical achievement between the two genders (18). In another investigation, no significant difference was observed among the female and male in terms of mathematical self-efficacy and achievement (19).

2. Objectives

The interrelated nature and inevitable complexity of

researches in the field of behavioral sciences doubles the necessity to consider the multiple effects of variables. Thus, the present study tends to discuss the existing differences between female and male students regarding variables of mathematical performance, self-concept, and -self-efficacy based on the perceived classroom climate.

3. Patients and Methods

The current employed the non-experimental (descriptive) method. The design of the present research was of correlation type by means of route analysis technique. The statistical population included female and male students of the third grade high school in the field of math-physics, attending public high schools in Tehran, Iran, during 2012-2013 academic year. Kukran formula was also adopted to select the sample size of 400 participants through cluster sampling technique. Primarily, a series of adjusted questionnaires were distributed among several mathematics classrooms (third grade). The questionnaires were then processed by cooperation with Tehran City Training and Educational Organization (Area No. 5). The recommendation letter obtained from the foregoing area referred to the given high school by the administrator to select one or two classrooms consistent with the classified sampling in the concerned area, and questionnaire forms were distributed among the students. Furthermore, the required explanations were presented to them regarding the research goal. Before administration of the questionnaire the mathematics classes were recommended to carefully answer the questions and mark only one choice when responding to the multiple choice questions. Finally since research aimed to predict the students' educational performance in mathematics the students' end of the year (2012-2013) mathematical score lists was taken from the schools. Next, the students were informed about the research goal and the questionnaires distributed among them. They were asked to select only one choice in each question and complete the questionnaire regarding their mathematics classes. Consistent with the research goal, the students' final examination scores in the last academic year was obtained from schools. To analyze data SPSS software version 19was employed. The following tools were used for data collection.

3.1. Mathematical Self-Efficacy Measurement Tool

The mathematical self-efficacy questionnaire was prepared by Shirali Pouraghdam Yamchi, derived from Pajares scale the respondents should mark their ability rate for any question according to a 11-degree scale ranging from zero (I can't do it at all) to 10 (I can perfectly do it). This questionnaire consists of 13 questions. The construct validity of this questionnaire was examined by Shirali Pouraghdam Yamchi (20). Based on his study the rate of internal consistency for mathematical self-efficacy questionnaire was 0.91 according to Cronbach Alpha coefficient. Also, the obtained Cronbach alpha coefficient rate in the current study was 0.86.

3.2. Mathematical Self-Concept Measurement Tool

This scale was extracted from Marsh's model by means of mathematical-related factor analyses and constructed based on Marsh and Shavelson's multiple and hierarchical self-concept model (20). According to this model, it is assumed that self-concept has seven separated and independent dimensions consisting of physical ability and potential, physical characteristics and features, relationship with parents, verbal self-concept, mathematical self-concept, and self-concept for other lessons in school. The questionnaire related to this model included 12 questions in Likert scale reported by Shirali Pouraghdam Yamchi as appropriate psychometric features for Iran (20). Pourasghar reported the reliability of this questionnaire as 0.89 in terms of Cronbach Alpha coefficient scale. Others also reported higher levels of Cronbach alpha coefficient for this questionnaire (11). In the current analyses, Cronbach alpha coefficient for the total scale was 0.81. There was also reasonable reliability coefficient for the subscales of mathematical interest (0.70) and perceived math capability (0.76).

3.3. Perceived Classroom Climate Measurement Tool

A questionnaire on what is happening in this classroom (WIHIC) was utilized to measure the perceived classroom climate. This scale included 56 questions in seven subscales, adjusted within five scales Likert spectrum and ranged from almost never (1) to always (5). Each subscale may be counted separately (21). The subscales were also translated and used in Iran, by Nikdel (22). Fraser, Fisher, and Mac Robbie reported appropriate Cronbach alpha coefficient rate for each subscale of this questionnaire. In the analysis conducted by Nikdel, the obtained coefficient values of these subscales were from 0.89 to 0.95 which indicated a very high reliability. In this research, the obtained Cronbach alpha coefficient of 0.89 for this questionnaire confirmed its reliability (21, 22).

3.4. Mathematical educational Achievement

The final examination scores in mathematics lesson, obtained from school head office, were considered as mathematical educational achievement of the students.

4. Results

Are mathematical achievement, self-efficacy and self-concept based on the perceived classroom climate different among female and male students? In order to test this hypothesis in the assumed model, the variables were tested separately by means of data obtained from female and male students. Table 1 shows fitting parameters of route model for female and male groups.

Table 1. Fitting Parameters of General Route Model in Female and Male Students [a]

Gender	RMSEA	AGFI	CFI	X^2/df	df	X^2
Female	0.01	0.99	1	0.98	1	0.98
Male	0.01	0.99	1	1.13	1	1.13

[a] Abbreviations: RMSEA, root mean square of errors approximation; AGFI, adjusted goodness of the fit index; CFI, comparative fit index.

Table 2. The Coefficients of Direct, Indirect, and Total Value of Route Model and Interpretation Coefficients for Female and Male Students ($P < 0.05$)

Routes	Direct Effect		Indirect Effect		Total Effect		Interpretation Coefficient	
	Female	Male	Female	Male	Female	Male	Female	Male
Mathematical self-efficacy	0.27	0.27	-	-	0.27	0.27	0.07	0.08
Perceived classroom climate on mathematical self-efficacy	0.46	0.28	0.06	0.10	0.52	0.28	0.32	0.26
Mathematical self-efficacy on Mathematical self-concept	0.22	0.35	-	-	0.22	0.35	-	-
Perceived classroom climate	-	-	0.18	0.21	0.18	0.21	0.13	0.27
Mathematical self-efficacy on mathematical achievement	0.22	0.20	0.06	0.14	0.28	0.34	-	-
Mathematical self-concept on mathematical achievement	0.23	0.40	-	-	0.23	0.40	-	-

All the fitting parameters of this model were at appropriate level (female and male). The coefficients of direct, indirect, and total values along with the interpreted coefficient for any endogenous variable are shown in Table 2. The values for the female are indicated in grey and those of the male in white backgrounds.

According to Table 2, mathematical self-efficacy was interpreted as 7% in female and 8% in male. The higher percentage of variance for mathematical self-efficacy was interpreted among female than in male (32% vs. 26%); while the mathematical achievement score in male was higher than female (27% vs. 13%). A statistically significant coefficient of direct, indirect, and total effect was found in both groups. In addition, the positive direction effect throughout all routes was observed in both groups. Against the acquired direct effects in girls` model compared to that of male, the total models of coefficients were comparable in both groups. However, few differences existed in this context; the rate of perceived classroom climate effect on mathematical self-efficacy in female (0.46) was higher than that of male (0.28). The effective rate of mathematical self-efficacy on mathematical self-concept was greater among male (0.35) than female (0.22). The impact rate of mathematical self-efficacy on educational achievement was approximately comparable in the groups, but the effect of self-concept on mathematical achievement in male (0.40) was evidently stronger than that of female (0.23). As noted, the direct effect of perceived classroom climate on educational achievement was not significant in the two groups. Also indirect effects of the model were almost the same in the two groups. The indirect effect of perceived classroom climate on mathematical self-concept in female was slightly lower (0.06) than that of male (0.10). This effect in female was significant only at level 0.05. The indirect effect of mathematical self-efficacy on educational achievement in male (0.14) was greater that of the female (0.06). In addition, this effect among female was significant at level 0.05.

5. Discussion

The results of the current study suggested that based on the perceived classroom climate, mathematical self-efficacy in female was lower than male, which was consistent with the results of the studies by Wakins and Slocum (14),

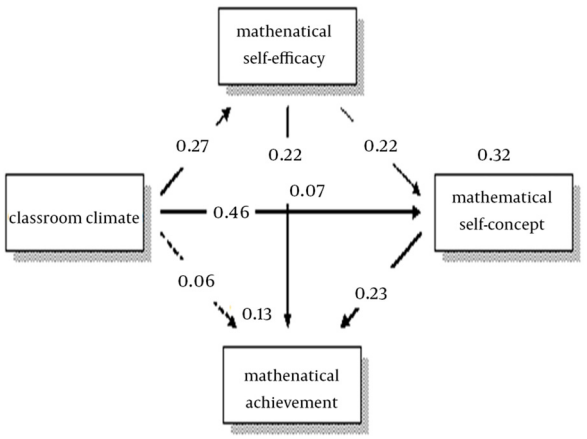

Figure 1. Fitted Routes Model With Standard Coefficients in Female Students

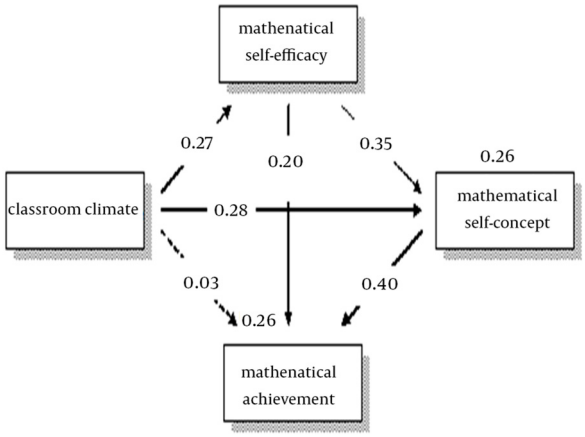

Figure 2. Fitted routes Model With Standard Coefficients in Male Students

and Pajares et al. in which male had greater confidence in mathematical skills compared to female (6). Also the current study findings indicated higher rate of interpreted mathematical self-concept in female than in male, based on the perceived classroom climate. The other studies showed that female obtained higher scores in self-concept than male. This highlights the fact that female are further affected by the persons who play important roles in their lives; they are more encouraged by teachers and are also more sociable and influenced by the others compared to male. As a result, their self-concept is more than those of male and they will be affected by classroom climate (23, 24). The results of the current study indicated that the effective coefficient of the mathematical self-concept on mathematical achievement was stronger in male than in female. This finding was in line with the results of some other investigations (6, 24, 25). These results indicated that male students in primary schools and high schools reported greater rate of mathematical self-concept than their female counterparts in such institutions. Similarly, mathematical achievement score was higher in male than female, based on parameters inside the model. Hide, Garnet regarding gender differences in 1990 analyzed the results of mathematical capability in 100 studies and concluded that male students generally had better performance than female (26). The direct, indirect, and total coefficients were significant in the two groups. Direction of effective coefficients in the two groups was positive for all routes. There was noticeable difference among effect coefficients in female and male including indirect effects of the perceived classroom climate on mathematical self-concept, and mathematical self-efficacy on mathematical achievement. These effects were significant in female and male while both effects were stronger in male's group.

5.1. Limitations of Research

One of the limitations of this study was the difficulty of sample collection in a large community of students and generalization the research findings to the general population. Another restriction was poor cooperation of high school principals.

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