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The Review of Student's Share Level Variables and School Level Variables in Mathematics Achievement based on TIMSS Data 2007

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ABSTRACT: The current study is aimed at review on the relationship among mathematics and some students' level variables and school as well as variance percent in each of levels in interpretation of mathematics performance. For this purpose, some data were used, which have been gathered based on Trends in International Mathematics and Science Study (TIMSS, 2007) from students in fourth grade, in Iran. This analysis is focused on an Iranian sample including 3981 students (1786 females and 2195 males). The employed variables in this analysis have been selected at two levels: Student's level (gender, socio- economic status, attitude, and self- concept) and level used at school (parental involvement, school climate, and teaching process). In order to discover the relationship among mathematics performance and analysis predictors, Hierarchical Linear Model (HLM) was utilized. The results indicated that all variables of gender, socio- economic status, self- concept, and attitude are significantly related to mathematics performance at student's level; however, there was no significant relationship among variable of parental involvement and mathematics performance. Similarly, the findings suggest that in comparison with variable of students' variables, variable of school level may predict greater variance than educational performance.
Keywords: Socio- Economic Status, Attitude, Self- Concept, Parental Involvement, School Climate, Teaching Process, TIMSS 2007, Hierarchical Linear Models (Multi- level Techniques)

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INTRODUCTION

Mathematics achievement in students has been one of the main concerns for educational policy makers and teachers. Many researchers maintain that mathematics achievement is one the predictors for economic long run growth in a country (quoted from Salvin et al, 2009). In many countries, the results came from international comparisons are very important like PIRLS and TIMSS studies since they argue that students' performance in mathematics and natural science lessons is extremely paramount for competitive power for a country in the future. For this reason, importance of enjoying strong background and basis in mathematics has been well identified as a prerequisite for admission by higher education institutions in many educational disciplines and natural science and mathematics lessons have drawn attention most of teachers and parents. Trends in International Mathematics and Science Study (TIMSS) is one of the foremost and most extended studies which have been carried out by International Association for Evaluation of Educational Achievement in which more than 60 countries have so far participated. By 1991, Iran has started cooperation with this association and it has participated in TIMSS studies at 1995, 1999, 2003, 2007, and 2011 (Karimi, 2008). Iran is ranked as 28 among 36 participant countries in mathematics of fourth grade (with average score 402 compared to international average 500). This study is intended to examine level variables of students' share (gender, socio- economic status, attitude, and self- concepts) and school level (parental involvement, school climate, and teaching process) over mathematics performance among fourth grade students based on TIMSS data (2007).

There are many effective factors for determining students' educational achievement in the field of education and training. These factors are related to general areas like students, teachers, family, and curriculum etc. (Kabiri and ShavandGharbi, 2010). Some of the effective factors on fourth grade students' mathematics achievement have been reviewed at students' and school levels in this survey.

Factor of gender is the first studied factor at student's level. Role of gender is one of the factors, which have been considered by researchers and teachers, in learning of mathematics. This literature has shown that females generally acquire lower scores than males in standard mathematics achievement tests (Cleary, 1992; Gallagher and Kaufman, 2005) and greater number of males than females are placed at the end points of scores ranges. In their analysis, Wang and Maxey (1995), Willingham and Cole (1997),

and Beller and Gafni (1996) indicated that male students are better than female students in mathematics performance among different countries. Also Engelhard (1990) showed that among students at age 13, boys have better performance than girls and this difference might become more complicated at mathematics content level. Nevertheless, the study conducted by Alkhateeb (2001) showed that among high school students of UAE, girls acquired higher scores than boys in mathematics achievement tests.

Despite of research evidences regarding superiority of males in mathematics achievement, some of these studies reflected that there is no difference among two genders in mathematics achievement. For examples, with reference to research implications, quoted from Kiamanesh and Mahdavi (2008) showed that there is no difference in gender in terms of ability for mathematical reasoning in primary school. Based on international study done by IEA, there was no great difference among boy and girl students in fourth and eighth grades between countries (Mullis et al, 2008). Findings from two TIMSS (1999 & 2003) studies in Iran also showed that there is no significant difference among girls and boys in mathematic achievement. The resultant data from these studies indicated significant reduction in boys' mathematics achievement scores and a significant improvement in scores of mathematics achievement among girls in TIMSS 1999 (Kiamanesh, 2006).

Factor of socio- economic status is the second factor, which has been studied at students' level. In his study, Williams (1999) came to this conclusion that in comparison with other, scores of American learners at ages 16- 25, whose parents had studies more than 14 years at least had the better performance. Nevertheless, scores of American learners, whose parents had lower education, were considerably lower than scores of other learners from the participant countries except for Netherlands.

In most of educational studies regarding the review of effective factors on students' educational achievement, socio- economic status has been considered as control variable since studies have shown that there is a relationship among these two variables (Coleman, 1998; Jenks et al., 1972; quoted from Hansson and Gustafsson, 2010). For instance, it has been indicated that socio- economic status might effect on selection of school and educational discipline and these two factors may, in turn, greatly influence in student's educational achievement level. The level of relationship among educational achievement and socio- economic status was approximately 0.3 for student's level and about 0.6-0.8 at class level (Gustafsson, 1998; White, 1982). A noticeable reduction has been observed in relationship between both variables at international level during recent decades (Sirin, 2005). But in some countries like Sweden, this correlation has been increased and schools' level has become more homogeneous, based on students' immigration and social backgrounds (Gustafsson, 1998, quoted from Hansson & Gustafsson, 2010). Sirin (2005) concluded that among all studied variables in the conducted meta- analyses, economic status of family is one of the factors, which has affected on student's level with educational performance with the greatest correlation and thus correlation might even become stronger at school level. Parental position in structure of socio- economic status may have the maximum impact on educational achievement of students directly (preparation of sources in home) and indirectly (preparation of social capital that is essential for achievement in school) (Coleman 1988, Hansson and Gustafsson, 2010).

Third studied factor at student's level is attitude. Attitude toward mathematics and mathematics achievement are directly related together (e.g. Hembree, 1992; Mullis et al., 2008). Attitude toward mathematics is a multi- dimensional structure which dimensions are self-confidence, mathematics value, enjoyment of mathematics and motivation (Tapia & Marsh, 2005). Self- reliance means the perceived ease and difficulty in learning mathematics. Enjoyment of mathematics includes emotional, exciting, and behavioral reactions regarding like or dislike to mathematics. Mathematics value means that student's beliefs about this matter may contribute to his/ her professional or educational performance.

Several studies (Mettas et al, 2006; Papanastasiou, 2002) have shown positive relationship among attitude and educational achievement. This belief in that positive attitude may lead to achievement is very commonplace but alternately some studies have shown that attitudes and beliefs are not related to mathematics achievement (Fraser & Butts, 1982). Papanastasiou argues that individual's attitude and belief may not be adapted for predication of educational achievement. Other researchers also consider a relationship among attitude toward mathematics and mathematics achievement as a mutual relation.

Self- concept is the fourth factor that has been studied at student's level. Also due to its relation to educational achievement, self- concept is one of the important structures in educational system (Byren, 1984; Valentine et al, 2004). Nevertheless, general self-concept is not possible to be restricted only toward educational orientation (Skaalvik and Skaalvik, 2006). Some researchers like Shavelson et al. (1976) codified a hierarchical model that has divided general self-concept into two educational and non- educational

components. The recent studies have indicated that there is a causal relationship among educational self-concept and subsequent achievement and this relation is bilateral in nature (Lau et al, 1998). This mutual relationship may be interpreted in this way that while the better achievement in student may lead to improving self- concept also positive self- concept may contribute to increasing student's achievement (Byren and Shavelson, 1986; Craven et al., 2003). By conducting analysis on data from TIMSS study in 16 countries, Wilkins et al (2004) showed that there is a direct relationship among self- concept and mathematics achievement.

In the following, we explain about variables at school level. The amount of parental involvement in their children's educational and training activities is the first studied factor at school level so that one of the effective factors on educational low results is related to the relationship among home and school. Teachers complain from rowing distance between students and their parents and lack of their supervision while parents are complaining from careless teachers, who let disorder to be governed over their classroom. The studies have shown that parent- teachers' relationship may greatly effect on learners' growth.

School climate is the second factor which studied at school level. One of the relatively fixed aspects in school environment is school climate (Brown et al, 2004) that considered as a group of intrinsic characteristics, which separates one school from another and effects on behavior of school members. These intrinsic features refer to quality of interpersonal relations between students and teachers, rate of security and peace in school, amount of students' involvements, parents, and school members in participatory decision makings and rate of expectation at high level for learning in students. Generally, school climate is the psychological field in which teachers are working and teaching. School climate may be positive or negative. The school that has a positive climate is considered as a favorable place where there are respectful relations among individuals. In Such an environment, students are encouraged for progress. Lehr (2010) and Stewart (2008) express that sense of correlation in school is the strongest predictors for students' educational achievement. When students have sense of commitment and correlation they will have educational achievement at higher level. On the other hand, school negative climate may be followed by exactly reverse consequences.

Teaching process is third studied factor at school level. Teachers should pay attention to main elements of education. They should understand and use application of materials in educational courses and try to implement grouping processes including skillful learning, ability classification, and participatory learning. These educational quality elements have been described clearly as special effective variables in Creemers' model. Creemers has considered this point that in order to discover rate of students' learning and particularly identifying differences in learning outcomes, we should do this task by means of a basic process at classroom level. These processes directly effect on time of working and the used opportunity on learning by students and indirectly on achievements among students (Creemers, 1994).

MATERIALS AND METHODS

Statistical population of this study includes all Iranian students in fourth grade of primary schools at academic year 2006-7, who have participated in TIMSS 2007 study. Like former studies of TMSS (1995, 1999, and 2007), in TIMSS 2007, two- stage classified cluster sampling method (1) is used to make sure that sampled data represent national students' population (i.e. share of each of 2 clusters in sample is proportional to its size in population). In addition, by benefitting from sampling weight 3 including classroom weight, school weight, students' weight, and total and final weights, it could be assured that the resultant statistical parameters from sample introduce the given population. At first step, schools were sampled by means of the appropriate probability technique with size 4. Then inside any sampled school, all fourth grade classrooms were listed and afterwards one class was systematically selected by random technique and finally all students from sampled classes were chosen with equal probability. Only one classroom is selected from any school in Iran at school level i.e. level 2; thus, number of schools is the same as quantity of classes. Number of samples in TIMSS 2007 is 3881 students (1786 females and 2195 males).

The primary goal in TIMSS is evaluation of achievement in mathematics and natural science lessons. To approach to this objective, some enriched information has been collected regarding educational field of teaching and learning of mathematics and natural science lessons. There are three questionnaires in TIMSS for gathering information about educational field of teaching and learning of mathematics and natural science lessons: (1) Student's questionnaire that is used for data collection regarding familial background of students and their learning experiences of mathematics and natural science lessons; (2) Teacher's questionnaire, which is adopted to gather information about teachers of mathematics and natural science lessons concerning to their fields, readiness, and occupational growth;

and (3) School questionnaire that is used to collect information about the existing field and sources for teaching of mathematics and natural science lessons. Two questionnaires of student and school have been employed to data collection in this plan.

Mathematics achievement of fourth grade students is dependent variable in this study. Independent variables, which have been used also at two levels, are at student's level including variables of socio-economic status, gender, self- concept, and attitude and at school level including variables if parental involvement, school climate, and teaching process.

Multi- level analysis (two levels) has been adopted by means of HLM software in this research. Multi- level model is more advanced model than one- level linear variance models since it can distinguish among levels in variance. For example, Hierarchical Linear Model (HLM) may separate variance of students' mathematics achievement at student's level from class and school (quoted from Lau, 1998). The key hypothesis in one- level models like normal regression is in that observations are independent from each other and this not true usually where there is a nest-like (embedded) structure and when school is embedded in population, class is embedded in school, and student is embedded in classroom. Under such circumstances, the observed person (student) inside a group (class) tends to be similar to other member in his/ her group than other person in other group. This homogeneity is required as a violation from independent error hypotheses for regression traditional model where heterogeneity is accepted. This homogeneity is characterized as a statistical dependence, which is interpreted by Inter- Class Correlation 1 (ICC) i.e. variance share among groups. TIMSS data have hierarchical structure since students are embedded inside classroom, school, and countries. All variables at all levels (student, classroom, school, countries) may be related to mathematics achievement in fourth grade students. For example, variables at student's level may include age, motivation, and school assignments. Moreover, students inside school where school climate and policy and curricula are important attributes related to students' performance. At last, national variables including several factors like national culture and educational programs may be deemed important for interpretation of learning and teaching results. Then, the variables effect on students' performance at different levels and HLM may separate variance at several levels.

RESULTS

Descriptive parameters including mean, standard deviation, minimum and maximum values of research variables are given in the following table.

Initially, an unconditional HLM analysis (one- way ANOVA model with random effects 1) is done (Model A). This analysis is aimed at separation of student's performance variance at different levels (here, student and classroom) as well as review this fact that whether students' performance varies between classrooms or not. This model provides an approximation from ratio of variance among classes in performance that is inter class correlation (ICC) coefficient.

With random effects, one- way ANOVA presents useful primary information about way of variances in latent consequences in and between schools and reliability of each of them out sample mean value of schools as an approximation from their mean population.

Table 1. Descriptive parameters of research variable

Variables	M	SD	Min	Max
Mathematics Achievement	2087.486	409.450	834.751	3441.621
Student's Socio-economic Status	7.2570	1.719	1	10
Self- Concept	10.593	02.91	1	15
Attitude	10.667	2.768	1	15
Parental Involvement	5.209	0.896	1	6
School Climate	29.950	4.186	20	39
Teaching Process	13.353	1.777	8.684	18.857

Table 2. One way ANOVA results (Model A)

Positive Effects	Coefficients	SE		
Average Mean Areas γ_{00}	2060.59	19.874		
Random Effects	Variance Component	Df	X2	P- value
School Mean	82194.253	223	3870.66	0.001
Student's level effect	85710.259			

In one way ANOVA model, random effects of correlation coefficient among schools were derived as 0.489 with respect to the following formula: . Thus, school interpret about 49% of mathematics

performance variance and with respect to this point that the derived value is at significant level so it could be implied that average values of students' mathematics achievement in several schools differ from each other significantly.

The variance of

Reliability coefficients are 1-0. To what extent does higher reliability coefficient differ from performance among schools? Reliability value 1 for 0.925 shows the mean value of the given sample is reliable and it may be considered as a parameter from mean values in real classrooms.

In the following, in order to examine how much variance of fourth grade students' mathematics achievement is related to student's level factors including socio- economic status, gender, self-concept, and attitude, the Model b was used i.e. intercept random model 2 with variables at students' level. Since there is no former hypothesis about difference between schools and predictor variables in this research therefore random part from slops is not dependent. In other words, only intercept value varies in all schools. But other coefficients remain as concept at student's level.

Table 3. ANCOVA model results with random effects (Model B)

Fixed effect			b	SE	P- value
	First Level				
	Intercept Approximation		2157.647	41.328	0.001
	Gender		-63.959	41.328	0.007
	Socio- economic Status		31.724	3.479	0.001
	Self- concept		30.697	1.703	0.001
	Attitude		18.784	1.788	0.001
Random Effect	**Variance Component**	**df**	**Chi- Square**	**P-value**	
School Mean	83186.550	223	4726.347	0.001	
Effect at first level	70150.429				

As it observed in above table (Model B), socio-economic status, self- concept, and attitude as well as gender variable have positive significant relationship with mathematics performance at levels 0.001 and 0.01 respectively. After adding these four variables at first level, variance of student's level was derived as 70150.429 that reduced in contrast to model one i.e. one way ANOVA (85710.259).

While unconditional model is used as baseline for calculation of variance share in present and next models it may interpret parameter of reduced variance share for rate of growth at student's level in comparison with component variance in model A and all unconditional models. For this reason, it may be implied that values (85710.259- 70150.429/85710.259 = 0.1815) of these four variables (gender, socio-economic status, self- concept, and attitude) can interpret 18.15% variance at student's level in mathematics performance.

And finally in order to examine how much of variance for variable of mathematics achievement in Iranian fourth grade students is related to school factors such as parental involvement, school climate, grouping, and teacher's teaching method, the other model was implemented namely intercept random model and random slopes with variables at student and school levels or Model C. variables were analyzed in this model at two levels i.e. student and school.

Table 4. Regression model results as consequence (Model C)

Fixed effect			b	SE	P- value
	Second Level				
	Intercept Approximation		23134.689	35.209	0.001
	Parental Involvement		-16.945	17.98	0.323
	School Climate		18.460	3.773	0.001
	Teaching Process		77.203	9.154	0.001
	First Level				
	Gender		-49.216	21.912	0.025
	Socio- economic Status		31.72	3.59	0.001
	Self- concept		30.698	1.958	0.001
	Attitude		18.750	1.70	0.001
Random Effect	**Variance Component**	**Df**	**Chi- Square**	**P-value**	
School Mean	57229.969	220	3227.776	0.001	
Effect at first level	70178.781				

In the above model (Model C), the results indicated that there is a significant relationship among variables of school climate and teaching process with students' mathematics performance at school level (0.001) but

variable of parental involvement is not related to mathematics performance significantly. There is a significant relationship among variables of socio-economic status, self- concept, and attitude at student's level (0.001) and among gender and students' mathematics performance at level 0.05. Variance values were at student's level (70178.781) and school level (57229.969) where it indicates the interpreted variance value(s) after including variables of student's level as well as school level. Thus, value of Inter Class Correlation (ICC) coefficient is. Since ICC coefficient value has been reduced from 48.9 to 44.9 then it could be implied that predictors at school level may interpret greater variance than predictors at student's level.

DISCUSSION

Given that TIMSS data have nest- like (embedded) nature (students inside classrooms and classrooms inside schools and schools inside countries) and their data are also derived in multi- stage form by means of multi- level analysis in order to achieve more accurate information regarding effective factors on students' achievement so it is suggested that when multi- level attribute in these data are ignored the results may be acquired in different way so they could not reflect an appropriate image of the reality (Naghsh & Moghadam, 2012) therefore the present research is intended to employ appropriate methods for national data analysis at wide level. For this purpose, multi-level techniques was adopted for review the relationship between variables of student and school levels and to determine variance of each of levels. The results of two- level analysis in this study indicated that there was significant relationship among all variables at first level i.e. gender and socio- economic status and attitude with mathematics performance.

Findings about relation among gender and socio-economic status with mathematics performance also shows that there is a significant relationship among gender and educational achievement (e.g. Cleary 1992; Gallaher & Kaufman 2005). Similarly, variable of socio-economic status has been characterized as one of the paramount variables in educational achievement as well (Williams, 1999). The relationship among mathematics self- concept and educational achievement has been studied by many researchers so that results of these researches. Pahlavan Sadegh 2005) are in line with findings from the current study. The results of findings for variable of attitude toward mathematics from studies done by Papanastasiou (2002) indicate the significant relationship among attitude toward mathematics and mathematics educational achievement (Quoted from Pahlavan Sadegh, 2005) so that this relation was also found significant in this investigation. At the same time findings came from study by Kiamanesh (2004) indicate that mathematics self-concept and attitude toward mathematics are some factors that effect on students' educational achievement in mathematics and accordingly the findings of the present study for variables of self- concept and attitude toward mathematics are complied with findings from Kiamanesh (2004). Findings from this study indicated that variables of school level, school climate, and teaching process are significantly related to mathematics achievement while variable of parental involvement had no significant relation with mathematics performance. Similarly, the importance of teaching process in mathematics achievement has been confirmed by some researchers like Creemers (1994). It seems that type of parental involvement and its quality is more important than the restricted relationship between parents and school.

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