Australian Journal of Basic and Applied Sciences, 7(4): 437-442, 2013
ISSN 1991-8178

Path Analysis of the Factors Influencing Students' Achievement in Mathematics

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Abstract: The aim of the present study is to look into the effects of teaching method and teaching practices, students' attitude towards mathematics, students' anxiety, teachers' attribution and their characteristics and the classroom climate on students' achievement in mathematics. This study seeks to test a causal model for the students' achievement in mathematics. Participants consist of 201 students from Libyan school in Kuala Lumpur, Malaysia who completed a questionnaire (comprising of 74 (36.8%) male and 127 (63.2%) female). One hundred and five students (52.2%) are in grade 4-6 th, eighty one students (40.3%) are the 7-9th graders, and fifteen students (7.50%) are from the secondary school. Students were asked to respond to a 5-point Likert scale, on the questionnaire that includes the Teaching Practice scale, teachers' attribution scale, classroom climate scale, students' attitude towards mathematics scale and students' anxiety scale, in addition to the students' mathematics achievement scale. The path analysis of the Structural equation modelling was employed to explore the interaction of these variables in predicting students' achievement in mathematics. The results reveal that teachers' attribution and their characteristics is the strongest predictor of students' achievement in mathematics over and above other variables included in the model. The teaching method and teaching practices directly predict students' achievement but insignificantly and indirectly predict students' achievement via both teachers' attribution and their characteristics and the classroom climate. However, students' attitude towards mathematics and students' anxiety have predicted students' achievement directly and negatively but the correlation is insignificant and weak.

***Key words*:** Path analysis, Students' mathematics achievement, teacher' characteristic, teaching practices

INTRODUCTION

In the recent decades, some extensive literature has examined the effective consequences of education in many countries (Al-Agili et al., 2012; De Maeyer et al., 2010; Teddlie & Reynolds, 2000).

Researchers in mathematics education have come up with many factors which demonstrate some significant relationships with mathematics achievement. These factors, among which are the teaching method and teaching practices (Hamidah Yamat et al., 2011; Maat et al., 2011), students' attitude towards mathematics as a subject (Aranador et al., 1998; Cokadar & Kulge, 2008 ; McLeod, 1992; Stevens et al., 2004), students' degree of anxiety (Akin, 2008; Ashcraft, 2002; Ashcraft & Kirk, 2001; Cates & Rhymer, 2003 ; Woodard, 2004), teachers' attribution and their accompanying characteristics (Ale, 1989), and the classroom climate (J. Hiebert & D.A. Grouws, 2007; Yılmaz & Çavaş, 2008)

Moreover, according to Adeogun and Osifila (2008), there has been a significant impact of inadequate educational resources on students' academic performance. Adeogun and Osifila (2008) have emphasised that teachers' attributions, teaching methods and teaching practices are the most important factors that leave an impact on student learning. However, Current discussions concern whether or not, and the degree to which the teachers can make a difference in student learning relative to other factors that is expected to influence student learning (Arslan & Demirel, 2008; Wong, 1992). In addition, the present talks also dwell into the specific elements of the teaching that can be logically and causally correlated to student achievement (Scriven, 1990).

Teachers' attributes and their demonstration of behaviours in the classroom, contribute to the learning environment of the students, which in turn have an effect on the achievement of the students. There is a common hypothesis establishing the association between the experience of teachers and student achievement, whereby students who are taught by the most experienced teachers tend to achieve better (Wilkins, 2008) To explain this, teachers tend to work at perfecting the content and also have the necessary classroom management skills to handle various kinds of classroom issues. Studies on the inter-relation between teachers' experiences and students' achievement have shown some contradicting findings. A positive and strong relationship formed between teachers' years of teaching, teachers' experiences and students' achievement has been found by Fetler (2001), Darling-Hammond (2000), and Bodenhausen (1988), while Chhinh and Tabata (2003) report a weak, yet positive relationship. Moreover, Klecker (2002) have noted that there are no significant differences in students' achievement through their teachers' experiences.

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The main Instructions related to characteristics of the classroom are the interactions that take place between the teacher, students, and the curriculum. Hiebert and Grouws (2007) have noted that there are some features of teaching that can be more effectively adopted to enhance the efficiency of skills for the purpose of boosting students' conceptual understanding. The findings from the studies have revealed that a review of the instructions that stresses on the development of concepts can facilitate both skill learning and theoretical understanding, besides, when education to promote the struggle with mathematics, the students understanding will increases A similar observation has been noted by Stevenson et al., (1986), that when students are exposed to rigorous mathematical content, their achievement will tend to improve. As found from the experiment, mathematics' anxiety is another factor that appears to affect students' mathematics achievement. According to Ashcraft (2002) mathematics anxiety is all about having the feeling of tension and apprehension, or fear that interferes with one's performance in mathematics. Many studies done on mathematics anxiety consider that there is a weak relationship between mathematics anxiety and mathematics achievement of students, as shown, for example, (Akin, 2008; Ashcraft & Kirk, 2001; Cates & Rhymer, 2003 ; Woodard, 2004). These studies have also outlines clearly the importance of the possible effects that mathematics anxiety have on mathematics performance.

Furthermore, the classroom climate such as the classroom size and students being calm and quiet in the classroom may also affect the achievement of the students. Some researchers have asserted that there are significant impacts of the students-teacher ratio reduction on test scores in some settings (Angrist & Lavy, 1999; Krueger & Whitmore, 2002). In contrast, Banerjee et al. (2004) have pointed out that there is no effect in reducing the proportion of students to teachers that have been achieved through the employment of remedial education teachers for students who stay with the regular teacher.

We hypothesize as shown in the next model that the teaching method and teaching practices, students' attitude towards mathematics, students' anxiety, teachers' attribution and their characteristics, and classroom climate would be associated with students' mathematics achievement.

We also hypothesize that teachers' attribution and their characteristics, and classroom climate would serve as the mediators between the teaching method and teaching practices, students' attitude towards mathematics, and students' anxiety on one hand and students' mathematics achievement on the other hand. This model is provided in its schematic structure in Fig. 1.

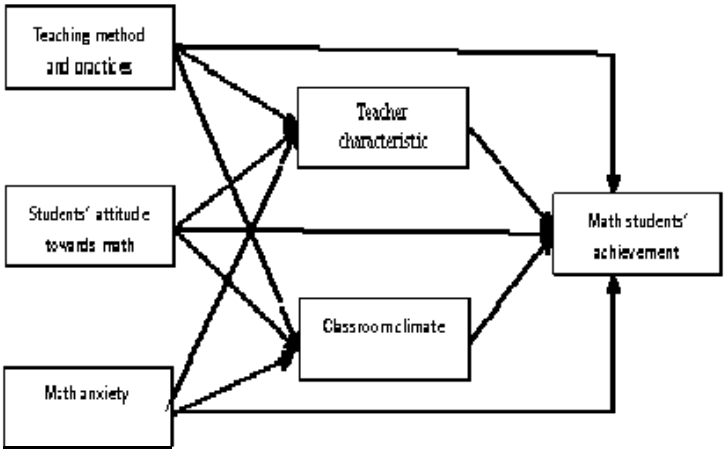

Fig. 1: Initial Theoretical Model.

In this model the including factors are: (1) teaching method and teaching practices, (2) students' attitude towards mathematics, (3) students' anxiety, (4) teachers' attribution and their characteristics, (5) classroom climate, and (6) The students' mathematics achievement. The first one, second, and third are the factors, the fourth and fifth the mediators, and the sixth acts as the endogenous variables.

MATERIALS AND METHODS

Participants:

Participants were 201 students (74 (36.8%) were male and 127 (63.2%) were female) enrolled in Libyan school in Kuala Lumpur, Malaysia. The students provided information on their age, gender, year in school, and GPA. Of the participants, 105 students (52.2%) were in Primary school "grade 4-6", 81 students (40.3%) were in junior school "grade7-9", and 15 students (7.5%) were in secondary school. Their ages range from 1(10 -11) years to 4 (more than 15 years) (M= 1.1, SD=.3) (as shown in

Table 1) and the GPA scores range from 1(excellent) to 5 (weak) (M= 2.17, SD=.87).

Instruments:

The Participants were given a questionnaire contained the students' demographic information and there are 30 items including the teaching method and teaching practices of teachers (TMP), teachers' attribution and their characteristics (TC), classroom climate (CLR), students' attitude towards mathematics (SATM) and students' anxiety (ANXI).

Table 1: Respondents' Demographic.

Type	N	Factor	Frequency	Percentage (%)
Gender	201	Female	127	63.2
		Male	74	36.8
Age	201	"9 - 11"	99	49.3
		"12-14"	86	42.8
		More than 14	16	8.00
Class	201	Class 4-6	105	52.2
		Class 7-9	81	40.3
		Secondary	15	7.50

The students' mathematics achievement (ACHI) was measured via the students' mid-term exams and final exams scores in the first semester 2011. They are asked to answer these 30 items with a 5-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). The instrument was administered by the researcher, and the Participants were given sufficient time to answer all questions in the questionnaire.

However, the number of items had been decreased to 20 items due to the low factor loading during the EFA and CFA processes using SPSS 18.0 and AMOS 18.0, respectively. Eleven items of (TMP), three items of (TC), two items of (CLR), two items of (SATM), and two items of (ANXI) are dealt with in this part of the analysis.

Statistical Analysis:

Path analysis techniques with AMOS 18, through the adoption of the maximum likelihood estimations are used to investigate the direct and indirect effects between variables

The researchers have studied the modification indexes and paths that improve the fit model. In order to measure the goodness-of the fitted model, we have focused on many different types of fit indexes including the index for chi-square test, the relative chi-square = (chi-square/degree of freedom), Comparative Fit Index (CFI), Goodness of Fit Index (GFI), and Root Mean Square of Error Approximation (RMSEA) (Hair, Black, Anderson, Tatham, & Tatham, 2010) To achieve the fitness of the theoretical model to the empirical data, the relative chi-square (CMINDF) must be between 1 and 5, while the CFI, GFI and AGFI values must exceed 0.90. The RMSEA value must be lower than 0.08 to indicate an acceptable fit to the data (Schumacker & Lomax, 2004).

Result:

The data were analyzed at the beginning to explore the descriptive statistics for each variable.

Table 2 shows the Pearson correlation, means and standard deviations of the variables in this study. The variables range from 1 to 5 on a five-point Likert scale. On all variables' measures, the mean varies from 2.09 on students' achievement to 3.82 on students' attitudes towards mathematics.

Table 2: Pearson correlation, means, and standard deviations.

Variables	TPM	TC	CL	SATM	ANX	ACHIEV
TPM						
TC	.591**					
CL	.434**	.305**				
SATM	.250**	.167*	.170*			
ANX	.332**	.278**	.105	.373**		
ACHIEV	.385**	.474**	.322**	.047	.093	
Mean	2.43	2.88	2.43	3.82	3.01	2.09
SD	.811	.954	.903	.862	1.165	.862
** p<0.01, * p<0.05						

Fig. 1 illustrates the Initial Theoretical Model for students' achievement, that represents the data (e.g., whether teaching practices and teaching method influence students' achievement through its influence on teachers' characteristics), then it discusses the goodness of fit statistics that is inadequate for the initial model.

The initial theoretical model is an attempt to improve the fit of the model according to several fit indexes.

Fig. 2 presents the modified model, which fits the data. The model has demonstrated excellent fit (x2 = 1.08, df = 1, p = .299, CFI = 1.000, GFI .998, AGFI = .962, RMSEA = .020). The standardized coefficients in

Fig. 2 obviously highlight that TPM predicts ACHIV positively and insignificantly, and predicts TC and CL significantly, also predicts ACHIV indirectly and positively via TC and CL significantly. On the other hand, SATM has predicted negatively ACHIV and CL, and predicts positively but insignificant TC, also ACHIV indirectly and positively through TC and CL. However ANX has predicted negatively ACHIV and CL, and predicts TC positively and insignificantly, and predicts ACHIV indirectly and positively via TC and CL.

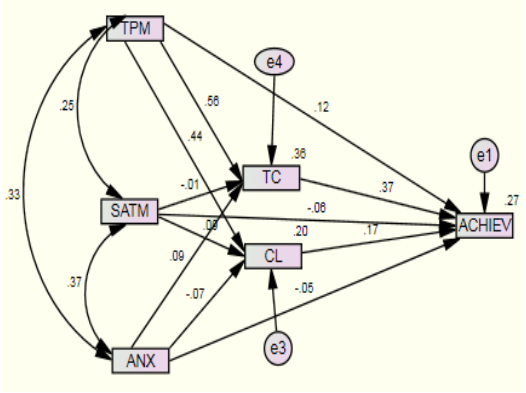

Fig. 2: Final path analysis of six factors model.

Overall, the predictor variables have been able to explain for 27% of the variance in students' achievement. This indicates an average effect size on academic achievement. The key finding reveals that TC has predicted students' achievement over and above other variables. The effect of TC on ACHIEV ($\hat{\beta}$ = .37, p = .000) proves to be the strongest variable effect on students' achievement. The effect of CL on ACHIEV ($\hat{\beta}$ = .17, p = .000). Meanwhile, the lowest variables' effect on students' achievement have been SATM and ANX ($\hat{\beta}$ = -.06, p = .393) and ($\hat{\beta}$ =-.05, p = .486), respectively. TPM also directly influences TC and CL ($\hat{\beta}$ = .56 p = .000) and ($\hat{\beta}$ = .44 p = .000). However both SATM and ANX have directly influenced TC and CL rather weakly and insignificantly.

presents the revised model after the elimination of the insignificant paths, and this shows that TPM has influenced ACHIV positively and indirectly via TC and CL in a significant way.

One finding that is regarded as noteworthy in the revised model lies in the fact that, contrary to expectations, TPM does not have any significant direct effect on the ACHIV. Rather, the effect is mediated by TC and CL. As expected, TPM strongly and directly influences TC and CL ($\hat{\beta}$ = .59, p = .000) and ($\hat{\beta}$ = .43, p = .000) respectively.

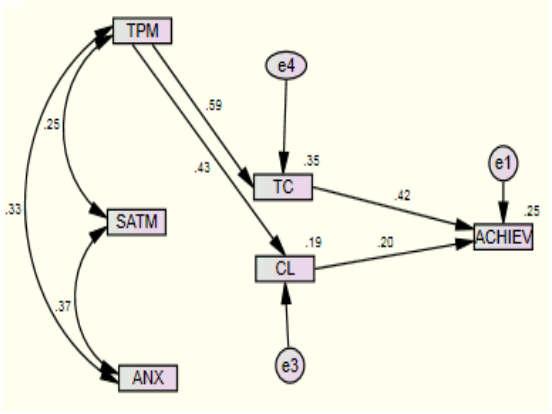

Fig. 3: Revised model of six factors model.

Discussion:

The aim that is intended in the current study is to look into the effects of the teaching method and teaching practices, students' attitude towards mathematics, students' anxiety teacher attribution and their characteristics and classroom climate on students' achievement in mathematics. The fit indexes manage to show that correlations among measures are explained by the model, the path coefficients from TPM to TC, PTM to CL,

TC to ACHEV, and from CL to ACHEV are observed to be significant. For aspects like teachers' attribution and classroom climate, they function as important mediators in linking students' achievement in mathematics and teaching practices and teaching methods, students' attitude towards mathematics, and students' anxiety on mathematics. As predicted, the models delineate that ACHEV has been predicted in a positive light by TPM, TC and CL and negatively by ANX.

Findings of earlier works about the impact of some factors on students' achievement in mathematics are somewhat conflicting. For example, some studies, Wilkins (2008), Fetler (2001), Darling-Hammond (2000) and Bodenhausen (1988) show a strong and positive significant effect of teachers' attribution on students' achievement in mathematics and this altogether, is consistent with this research. Conversely, Chhinh and Tabata (2003) and Klecker (2002) have found a negative effect of teachers' attribution on students' achievement in mathematics. Ashcraft (2002), Cates and Rhymer (2003) and Woodard (2004) discover that math anxiety has a poor impact on students' achievement in mathematics, which is also in accordance with this research. Moreover, in some studies that concentrate on the classroom climate such as students-teacher ratio, a positively significant effect on students' achievement in mathematics has been found, which is deemed compatible with this study (Angrist & Lavy, 1999; Krueger & Whitmore, 2002). However, Banerjee et al. (2007) have pointed out that there is no effect when it comes to reducing of the number of students.

From this study, the researchers further note that as shown in the revised model of
, teaching practices and teaching methods do influence the achievement of students in mathematics rather significantly, through the teachers' attribution and their characteristics, such as the experiences of the teachers and their qualifications and beliefs of the teachers in mathematics, also affecting the students' achievement in mathematics via suitable classroom climate in terms of the number of pupils in the classroom or their level of participation in the classroom and also the division of students into small discussion groups.

Conclusion:

This study carries the purpose of investigating the influence of teaching practices and teaching methods, teachers' attribution, classroom climate, students' attitude towards mathematics, and students' mathematics anxiety on students' achievement in mathematics, where a path analyses have been carried out in this study towards establishing some sound findings. The study elaborates on the fact that students' achievement in mathematics does show some correlations with these factors positively and significantly, also this study has shown that teaching practices and teaching methods indirectly influence students' achievement in mathematics significantly via teachers' attribution and classroom climate. The results of the study enable the teachers to identify the gaps in their instructional methodology and encourage the teachers to place more emphasis on the classroom climate such as in aspects like the participation of students in the math lessons and dividing them into small discussion groups. The findings of this study can also be made as a guide for educational authorities to prepare appropriate and effective educational development programs, particularly those specifically created towards the betterment of teaching effectiveness.

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