Research Article

doi: 10.12973/eu-jer.9.2.489

European Journal of Educational Research

Volume 9, Issue 2, 489 - 498.

ISSN: 2165-8714

http://www.eu-jer.com/

Contributing Factors of Secondary Students' Attitude towards Mathematics

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Received: December 13, 2019 ▪ Revised: January 26, 2020 ▪ Accepted: March 3, 2020

Abstract: The research investigated the effect of socioeconomic status, gender, perceived parental influences, teacher affective support, classroom instruction and previous achievement on students' attitude towards mathematics. The comparison of these effects was also done between urban and rural school students. This research employed a cross-sectional quantitative design based on a structural equation modelling approach. The sample consisted of 808 students from ten secondary schools in Sabah, three of which were urban and seven were rural schools. Findings showed positive relationships exist between perceived parental influences (r = .231), teacher affective support (r = .242), classroom instruction (r = .439), and previous achievement (r = .284) with students' attitude towards mathematics. The multigroup analysis for urban and rural students showed similar results as the whole student group. However, for urban students, classroom instruction (r = 0.352) and previous achievement (r = -0.363) had the greatest impact on attitude towards mathematics. For rural students, the highest impact on attitude towards mathematics was from classroom instruction (r = 0.452) and teacher affective support (r = 0.246). The least impact for both groups was perceived parental influence. This study implied that factors affected students' attitude towards mathematics in rural and urban secondary students are different.

Keywords: *Attitude towards mathematics, perceived parental influences, teacher affective support, classroom instruction, previous achievement.*

To cite this article: Davadas, S. D., & Lay, Y. F. (2020). Contributing factors of secondary students' attitude towards Mathematics. *European Journal of Educational Research*, *9*(2), 489-498. https://doi.org/10.12973/eu-jer.9.2.489

Introduction

Positive attitude, beliefs and values are considered as equally important besides strong conceptual knowledge and mathematical knowledge to ensure one's ability to thrive in a demanding globalized world (Tarmizi & Tarmizi, 2010). Kundu and Ghose (2016) stated that mathematics is critical for human civilization and development. Henceforth, mathematics is a subject in the school curriculum from primary to secondary levels in most countries including Malaysia. Students' aptitude and attributes have impact on their achievement and enjoyment of learning mathematics (Mazana et al., 2019). Abdul Gafoor and Kurukkan (2015) stated that students tend to dislike mathematics more than other subjects due to aversive teaching style, difficulty in following the instruction, understanding the subject and remembering the equations in solving problems. Past findings showed that attitude towards mathematics is significantly related to achievement in the subject (Lipnevich et al., 2011; Moenikia & Zahed-Babelan, 2010; Mathai, 2014; Singh & Imam, 2013; Spencer, 2012). In order to address mathematics anxiety, we need to determine whether this concern is due to negative experiences in the classroom or is caused by other factors (Aydin & Aytekin, 2019).

Many studies have been carried out to determine the factors affecting students' attitude towards mathematics (Haladyna et al., 1983; Marchis, 2011; Reyes & Stanic, 1988; Wachira, 2005). Studies showed that parental influences (Mahamood et al., 2012; Nenty, et al., 2016), teacher affective support (Marchis, 2011; Sakiz et al., 2012), classroom instruction (Abu Bakar et al., 2010) and previous achievement (Birgin et al., 2010; Ma & Xu, 2004) were related to students' attitude towards mathematics. Hence, this study examined the influence of these factors on students' attitude towards mathematics and compares the interrelationships of the variables for urban and rural students.

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Literature Review

The term 'attitude towards mathematics' is not easily defined. Kibrislioglu (2015) defines the term as the feeling of liking or not liking the subject that leads to the tendency of either engaging or avoiding participation in mathematical activities; a perception that mathematics is good or bad and being useful or not. In Tahar et al. (2010), attitude towards mathematics is defined as one's emotional disposition whether positive or negative about the subject. Four components of attitude as described in Tapia (1996b) which are value, motivation, confidence, and enjoyment was measured in this research. Aktas and Tabak (2018) carried out a validity and reliability study of the Math and Me Survey which is a scale tool comprising of two factors: mathematics self-perception, and enjoyment of mathematics. According to Aktas and Tabak (2018) students with a high mathematics self-perception believe they have the ability to understand mathematics and to solve mathematical problems while students scoring high on the subscale Enjoyment of mathematics like mathematics and enjoy games, puzzles and problems related to mathematics. Attitudes towards Mathematics in this study consist of four dimensions: enjoyment, general motivation, self-confidence, and value which is measured using the Attitudes Towards Mathematics Inventory, ATMI (Tapia & Marsh, 2002). There are various factors that affect students' attitude towards mathematics.

Studies found that home environment and parental involvement with the student can influence his attitude toward mathematics (Areepattamannil et al., 2015; Jacobbe et al., 2012). Parents mostly recognize the critical need to be involved in their children's education, but it is also commonly acknowledged that many parents felt their inadequacy in helping their children because of their own low confidence with their mathematical ability (Mohr-Schroeder et al., 2017). Drummond and Stipek (2004) claimed that parents are more inclined to help their children with reading but not with mathematics due to their perception that mathematics is less important to everyday life and the low confidence with their mathematical ability. More parental involvement in their child's mathematics education could contribute towards positive attitude towards mathematics in their children and increasing the tendency for the child to pursue a science, technology, engineering and mathematical related career (Rowan-Kenyon et al., 2012). In Cao et al. (2006) and Kerr (2007) children understand that their school achievement is of great importance to their parents, and that their parents' expectations are high. The natural desire of children to please their parents translates into an added incentive for immigrant children to do well in school (Kerr, 2007: 170).

Teachers' affective support has also been identified as a factor influencing students' attitude towards mathematics (Sakiz et al., 2012). Sakiz (2007) explained teacher affective support as teacher being caring, respectful, concern for and have genuine interest in the students, valuing, listening, fair-treatment, encouragement and high expectations. Marchis (2011) found that most of the students in his study think that their teacher likes mathematics and that he or she is a good mathematician. More than half of the students get encouragements from their teacher when having difficulties with mathematics and three-quarter of the respondents agreed that their teacher explains mathematics enthusiastically. Marchis (2011) concludes that the most important factor for attitude toward learning mathematics is the teacher ($r = 0.600$). The second highest factor was self-efficacy ($r = 0.468$). It is imperative therefore, that teachers employ effective instructional methods by developing relationships with the students so that they can experience active and critical engagement (Belbase, 2013; Kaplan, 2013).

Classroom instruction is another factor influencing attitude towards mathematics among students. The choice of instructional strategy influences students' attitude towards mathematics (Hodges & Kim, 2013). Classroom processes are mechanism involving the student and teacher attitude, and the students' achievement-related behavior in the classroom (Reyes & Stanic, 1988). Bilican et al. (2011) found that students in Turkey developed more positive attitudes towards mathematics and perceive themselves as more adept in mathematics in 2007 compared to 1999. Active learning, individual differences and variety of teaching methods were introduced in Turkey during the end of the 90's. This shows that classroom instruction needs to be student-centered, and teachers need to employ cooperative and collaborative learning to support students' attitude towards mathematics (Tessema, 2010).

Previous achievement has also been related to students' attitude towards mathematics (Kibrislioglu, 2015; Dodeen et al., 2014; Mathai, 2014). Previous achievement is linked to the students' belief that positive results from past examinations will help them to learn mathematics (Mazana et al., 2019). Students who struggle with mathematics early in school normally develop an aversion towards the subject (Mathai, 2014: 189). In Ma and Xu's (2004) study of cross-lagged effects between attitude and achievement, achievement demonstrated causal predominance over attitude across their secondary school sample. That is, changes in prior attitude did not result in any significant changes in later achievement, but changes in prior achievement did result in significant changes in later attitude.

Students' gender and their socio-economic status have also been associated with their attitude towards mathematics. In general, male students have a more positive attitude towards mathematics and experience less anxiety (Uzoka-Walker, 2009; Asante, 2012; Tessema, 2010). However, other studies (Birgin et al., 2010; Orhun, 2007) report no gender difference. Socio-economic status which is indicated by the educational achievement, occupation, social class income (Duerr, 2012) of the parents are also linked to students' academic success (Hansson, 2012; Singh & Imam, 2013) but Syyeda (2016) found the relationship insignificant.

The conceptual framework is shown in Figure 1, identifying the research hypotheses that were tested in this study.

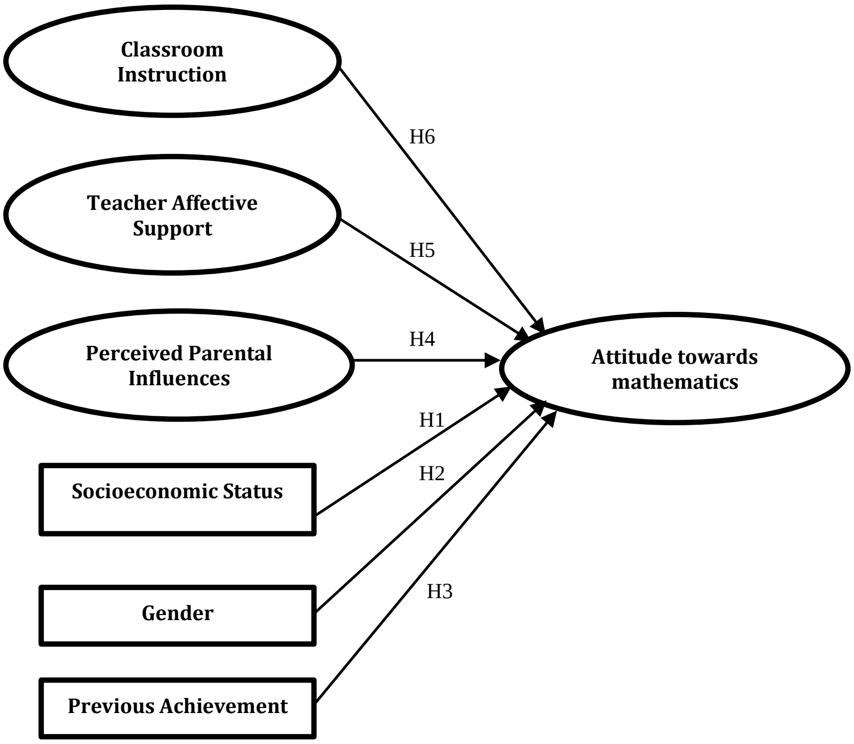

Figure 1. The Conceptual Framework

Six research hypotheses were tested in this research, as listed below:

H1: There is a positive relationship between students' socioeconomic status as measured by parents' occupation, and students' attitude towards mathematics.

H2: There is a positive relationship between gender (male) and students' attitude towards mathematics.

H3: There is a positive relationship between previous achievement and students' attitude towards mathematics.

H4: There is a positive relationship between perceived parental influences and students' attitude towards mathematics.

H5: There is a positive relationship between teacher's affective support and students' attitude towards mathematics.

H6: There is a positive relationship between classroom instruction and students' attitude towards mathematics.

Methodology

This study employed a quantitative and cross-sectional research approach with the use of questionnaire to collect data. Samples of Form Four students were collected from 10 identified secondary schools (three urban and seven rural schools) in Sabah, Malaysia. The number of urban and rural schools have been determined based on the proportion of urban and rural schools in Sabah. A total of 808 questionnaires were collected and used in data analysis. The questionnaire was developed based on existing measurement scales adapted from past studies. The research questionnaire comprises of five sections, based on the hypothesized model. The first section, Section A comprises of six items: student's school district, class, father's occupation, mother's occupation, students' gender, and previous Lower Secondary Evaluation (PMR) Mathematics results. The PMR results are representative of the students' previous achievement (PA) while the father's and mother's occupation is totaled to represent the variable socio-economic status (SES). Section B contains 16 items that is used to measure students perceived parental influences. The items have been used in a previous study (Cao et al., 2006) to measure perceived parental influences (PPI) among students in the United States. Section C consists of nine items measuring students' perception of their teacher affective support (TAS) adopted from Sakiz (2007). Classroom instruction (CI) is measured in Section D using 30 items adapted from Tessema (2010). In Section E, students' attitude towards mathematics (ATM) is measured using the Attitude Towards Mathematics Inventory (Tapia, 1996). Items in the finalised questionnaire are determined based on the results of the confirmatory factor analysis (CFA) performed. The value of RMSEA should be less than 0.08, CFI more than 0.90 and Chisq/df as high as 5.0 is acceptable (Lay & Khoo, 2010; Hair et al., 2014). These scales were translated to Malay using Brislin's (1970) back translation method and contents were validated by a team of expert from among mathematics lecturers and senior teachers. Data were analyzed using structural equation modelling with IBM SPSS AMOS version 23.0. Structural

Equation Modeling (SEM) has not been employed previously to measure the factors in this study. The purpose of using SEM is to quantify the effects of the factors towards the endogenous construct Attitude Towards Mathematics (ATM).

Findings and Discussion

The confirmatory factor analysis (CFA) was carried out to determine the validity and reliability of the measurement scales for attitude towards mathematics, perceived parental influences, teacher affective support and classroom instruction. Table 1 shows the validity and reliability of the research variables. Reliability is accepted when factor loading is more than 0.400, composite reliability (CR) is more than 0.600 and Average Variance Extracted (AVE) is more than 0.500.

Table 1. Reliability and Validity of the Measurement Models

Construct	Sub-Construct	Factor Loading	CR	AVE
ATM	atm_1	0.68	.698	.569
	atm_2	0.964		
	atm_3	-0.465		
	atm_4	0.817		
TAS	tas_1	Single item construct	.893	.583
PPI	ppi_1	Single item construct	.823	.546
CI	ci_1	0.952	.922	.799
	ci_2	0.929		
	ci_3	0.792		

Figure 2 shows the pooled CFA with all constructs as second order except for TAS. The fitness indices indicated by RMSEA, CFI, and Chisq/df to show absolute fit, incremental fit and parsimonious fit respectively are within the accepted limit.

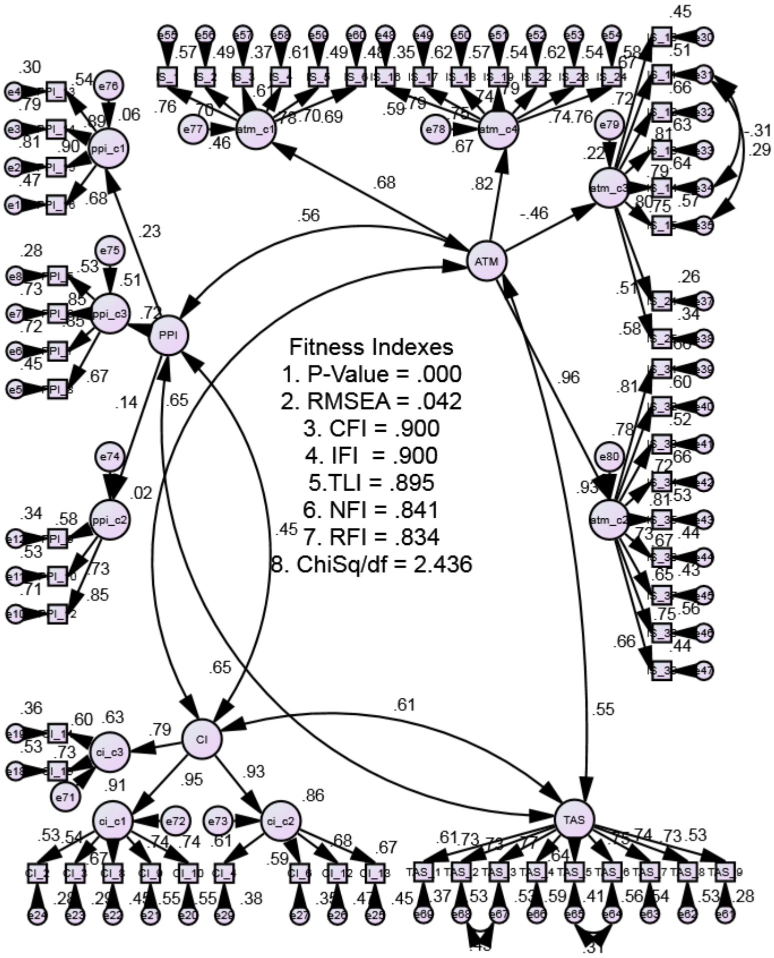

Figure 2. Pooled CFA Result

Table 2 presents the discriminant validity index of the measurement model. All the diagonal values representing square roots of AVE are higher than the correlations of the respective construct, hence indicating acceptable discriminant validity (Awang, 2015).

Table 2. Discriminant Validity Index of the Research Construct

	ATM	TAS	PPI	CI
ATM	**.75**			
TAS	.58	**.76**		
PPI	.56	.56	**.74**	
CI	.67	.68	.66	**.89**

A KMO value of 0.5 and above combined with the Bartlett's test which is significant (.000) indicates that the data is suitable for a factor analysis (Hair et al., 2014: 130). The KMO values for the CI (.795), PPI (.852), TAS (.878) and ATM (.918) construct are above 0.5. During the pilot study, reliability for each of the constructs were measured by the Average Variance Extracted (AVE) and composite reliability (CR). AVE values above 0.5 and CR values above 0.6 (Hair et al., 2014) has been achieved for all the constructs and sub-constructs (Table 1).

Table 3 shows the assessment of normality for each sub-construct. Awang (2015) stated that skewness ranges from -1 to +1. In this study, atm_C4 skewness value has a magnitude of more than 1.0. However, SEM is robust to skewness greater than 1.0 in absolute value if the sample size is large. This study had more than 500 samples which according to Hair et al. (2014) indicated large sample size. Kurtosis below the value of three is accepted (Kline, 2011), which was achieved in this study.

Table 3. Assessment of Normality for Each Sub-Construct

	Min	Max	Skewness	Kurtosis
atm_c1	1.00	10.00	.151	-.819
atm_c2	1.00	10.00	-.074	-.838
atm_c3	1.00	10.00	.635	-.278
atm_c4	2.00	10.00	-1.231	.933
ci_c1	0.20	10.00	-.336	-.406
ci_c2	0.00	10.00	-.290	-.502
ci_c3	0.00	10.00	.013	-.853
ppi_c3	1.00	10.00	-.968	.709
tas_c1	1.00	10.00	-.515	-.470

Table 4 presents the result of the hypotheses testing. The hypothesis is supported when the critical ratio (C.R.) is more than 1.96 and probability value, p is less than 0.05 (Hair et al., 2014). The result shows that two of the research hypotheses were not supported and four others were supported. Socio-economic status (SES) of the students was not significantly related to attitude towards mathematics (ATM) (C.R. = 0.59, p = 0.116). Similarly, gender (Gen) was also not significantly related to ATM (C.R. = -1.61, p = 0.188). However, previous achievement (PA) (C.R. = -5.68, p = 0.000), perceived parental influence (PPI) (C.R. = 9.24, p = 0.000), teacher affective support (TAS) (C.R. = 8.34, p = 0.000), and classroom instruction (C.R. = 15.68, p = 0.000) were all significantly related to ATM. The result also indicated that CI (r = 0.439) has the highest effect on ATM followed by PA (r = -0.284), TAS (r = 0.242) and least, by PPI (r = 0.231).

Table 4. Hypotheses Testing for Direct Effects

	Hypotheses	Estimate, r	S.E.	C.R.	p
H1	ATM← SES	0.042	0.071	0.59	0.116
H2	ATM←Gen	-0.05	0.031	-1.61	0.188
H3	ATM←PA	-0.284	0.05	-5.68	0.000
H4	ATM←PPI	0.231	0.025	9.24	0.000
H5	ATM←TAS	0.242	0.029	8.34	0.000
H6	ATM←CI	0.439	0.028	15.68	0.000

A multigroup analysis was also carried out to determine the differences in the pattern of relationship for urban and rural students. Figure 3 and Figure 4 presents the SEM analysis for urban and rural students respectively. The result shows that for urban and rural students, the absolute fit (indicated by RMSEA, <0.08) and parsimonious fit (indicated by ChiSq/df, <5.0) were met. The incremental fit (indicated by CFI, >0.90) was not met for the SEM of both urban and rural students (Hair et al., 2014). However, Baumgartner and Himburg (1995), and Doll et al. (1994) argued that a CFI value of above 0.8 is still acceptable.

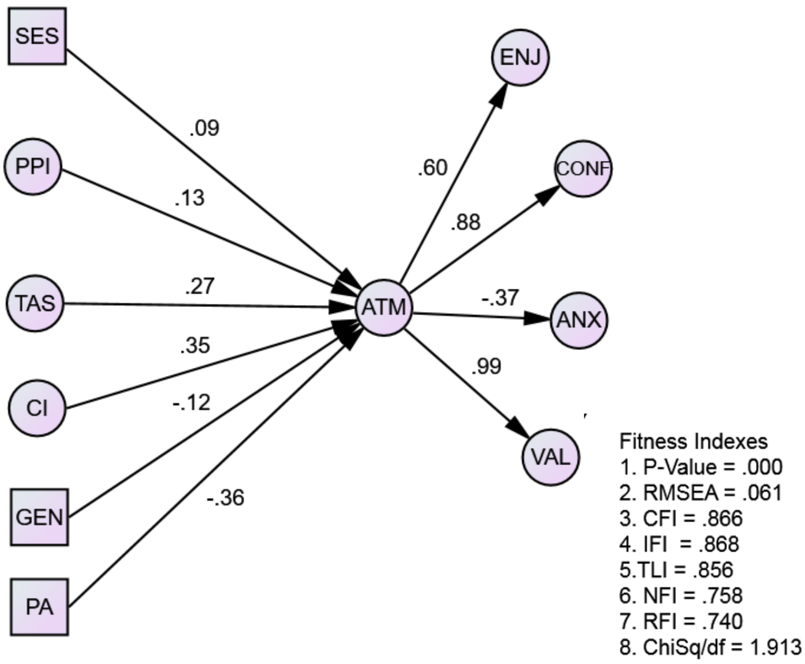

Figure 3. SEM for urban students

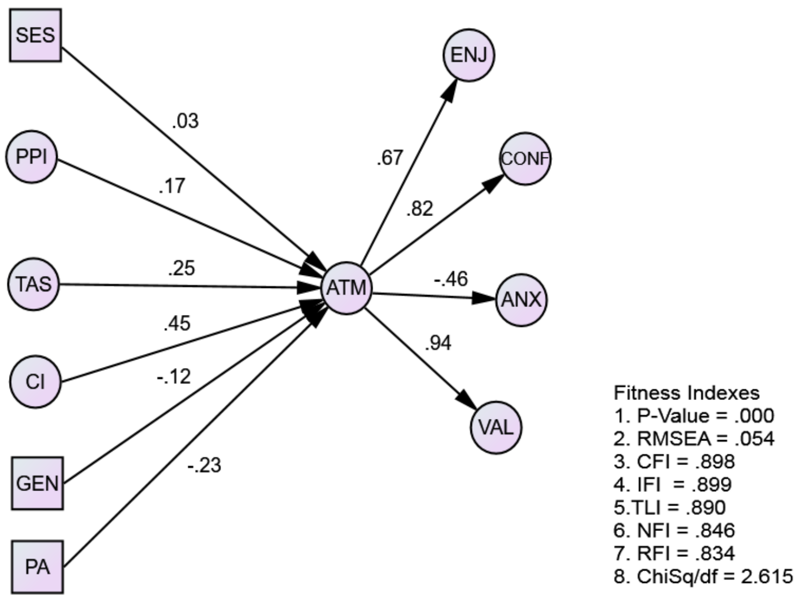

Figure 4. SEM for rural students

Based on the results presented in Table 5 and Table 6 to show the regression weights and significance for urban and rural students respectively, the correlations among the research variables were identified. The result indicated that the relationships of SES and gender with ATM for urban (SES: C.R. = 0.465, p = 0.096; Gen: C.R. = 0.967, p = 0.061) and rural students were not significant (SES: C.R. = 0.034, p = 0.455; Gen: C.R. = 0.186, p = 0.684). The relationships of PA, PPI, TAS and CI with ATM for urban and rural students were all significant. All C.R. values exceeded 1.96 and all p values were less than 0.05 (Hair et al., 2014). For the urban students, PA has the highest effect on ATM (r = -0.363) followed by CI (r = 0.352), TAS (r = 0.266) and least by PPI (r = 0.134). As for rural students, CI has the highest effect on ATM (r = 0.452) followed by TAS (r = 0.246), PA (-0.232) and least by PPI (r = 0.165).

Table 5. Regression Weights and Significance for Urban Students

	Hypotheses	Estimate, r	S.E.	C.R.	p
H1	ATM← SES	0.093	0.020	0.465	0.096
H2	ATM←Gen	-0.119	0.123	0.967	0.061
H3	ATM←PA	-0.363	0.065	5.585	0.000
H4	ATM←PPI	0.134	0.037	3.622	0.000
H5	ATM←TAS	0.266	0.045	5.911	0.000
H6	ATM←CI	0.352	0.049	7.184	0.000

Table 6. Regression Weights and Significance for Rural Students

	Hypotheses	Estimate, r	S.E.	C.R.	p
H1	ATM← SES	0.001	0.029	0.034	0.455
H2	ATM←Gen	-0.016	0.086	0.186	0.684
H3	ATM←PA	-0.232	0.035	6.629	0.000
H4	ATM←PPI	0.165	0.037	4.459	0.000
H5	ATM←TAS	0.246	0.030	8.200	0.000
H6	ATM←CI	0.452	0.032	14.135	0.000

The result shows that SES and gender were not significantly related to attitude towards mathematics among the students, and among urban and rural students. The insignificant relationship of SES with ATM in this study was similar to past findings (Syyeda, 2016). The assessment in PISA 2012 also concluded that the impact of SES on students' performance was inconclusive. Gender was also not significantly related to ATM among the students and among urban and rural students. Similar result was also shown in past studies (LeGrand, 2013; Moenikia & Zahed-Babelan, 2010) although other studies did indicate significant difference (Duerr, 2012; Jacobs et al., 2005; Lipnevich et al., 2011; Van Damme et al., 2004). Hence, the effect of SES and gender on students' ATM is still inconclusive and may be attributed to other related factors such as parents' ATM themselves and their mathematic efficacy. Collaborative learning in the classroom may have contributed to the insignificant difference based on SES and gender as students are equally affected by the situation in the classroom (Laal & Ghodsi, 2012).

This study showed that CI is the main factor influencing ATM for all the students and most prominently for the rural students. PA is the main factor influencing ATM for the urban students. The importance of CI to students' ATM is explained by the Cognitive Load Theory which implied that activities in the classroom can improve students' understanding of the subject and therefore, induce a more positive attitude towards mathematics (Sweller et al., 2011). For the urban students, PA may be a strong influencing factor of ATM due to greater pressure on these students from the family and school to continuously perform well in their subjects. It is also interestingly noted in this study that teacher affective support influences the rural students more compared to urban students. This agrees with the general idea that teachers who are interested in their students can improve their performance (Mensah et al., 2013; Wachira, 2005; Marchis, 2011; Awofala, 2014).

A small but significant effect was observed between perceived parental influence and ATM ($r = .231$). Similar result was found in urban and rural students. This result could be tied to the insignificant relationship between SES and ATM. It also contradicts Rowan-Kenyon, Swan and Creager (2012) but supports Marchis (2011) who shows that teacher affective support is the strongest predictor of students' attitude towards mathematics. Parental involvement with the students consistently occur among those with positive attitude, but the relationship of these variables is weak.

Conclusion

This study concludes that SES and gender were not significantly related to ATM while PPI, TAS, CI and PA were significantly related to ATM. The comparison of urban and rural students indicated that CI and TAS were strongly related to ATM. Thus, this reinforces the need for learning in the classroom to be fun, interesting and supported affectively by the teacher. PA was also a significant motivator to improve students' ATM. PPI was significantly related to ATM as well. These findings presented the importance of all these constructs: PPI, TAS, CI and PA to ensure positive attitude towards mathematics among the students. Future studies need to investigate more on other factors relating to parental influence by exploring the impact of parents' attitude towards mathematics, and their mathematical efficacy. This might lead to greater insights which can assist in the employment of greater collaboration and partnership with the school, and the implementation of more effective educational strategies in school and at home.

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