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Discerning the Intervening Roles of Students Mathematical Resilience and Academic Emotions between the Relationship of Home-School Ecological Structures and Achievement

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This study is mainly anchored on the theory of Urie Bronfenbrenner, surrounding ecological theory assumptions regarding the effect of different environmental structures upon achievement. The intervening role of students' mathematical resilience, and academic emotions upon the link between ecological system structures, and mathematics achievement was examined among 850 selected junior high school students in the Province of Pampanga. The Academic Emotions Questionnaire (Pekrun, Goetz, & Frenzel, 2005), and the Mathematical Resilience Scale (Janice Kooken, 2015) were used to assess how the resiliency of the students, and their positive and negative emotions mediated the effect of the ecological structures, and mathematics achievement. The results showed that the students' home environment, and their relationship with their parents under the home microsystem, predicts their achievement. Further, their teachers' instructional competence, mathematics learning environment, attitude towards school, positive affect, and self-perceived competence under the school microsystem structures are associated to their performance. The dimensions under the home-school mesosystem structure showed no impact upon students' achievement. Moreover, mathematical resilience, and positive academic emotions (enjoyment, hope, and pride) have a significant relationship to achievement,

but negative emotions (anger, anxiety, shame, hopelessness, and boredom) were negatively correlated with achievement. The students' mathematical resilience, and academic emotions partially and completely mediated the effects of the link of several ecological structures upon achievement.

Keywords: *Home-school ecological structures, mathematical resilience, academic emotions, Mathematics achievement.*

INTRODUCTION

Previous studies conducted on environmental factors, which include home, school, and the community environment, focused on its direct association to students' achievement, but little was known regarding how these factors may be influenced indirectly by several other constructs based upon educational theories.

Improving these theories of a mathematics education requires identifying the constructs that are most predictive of students' long-term learning. Mathematics avoidance, mathematics anxiety, a negative affect towards mathematics, and learned helplessness were some of the constructs developed upon educational research. Each of these factors focusses on the negative aspects and consequences associated with learning mathematics. The literature surrounding these constructs offers ideas and suggestions for treatment once a problem has developed, but typically, does not concentrate explicitly on the ways in which mathematics can be learned that do not result in the growth of such negative constructs. According to Johnston-Wilder and Lee (2010), there is a positive construct which would enable learners to develop a positive affect towards mathematics, and they call this construct, 'mathematical resilience'. There are few research studies which concern this variable and its effect upon mathematics achievement. This reality forms the basis for why the researcher considered this construct in his study.

As defined by Johnston-Wilder et al. (2010), mathematical resilience is an ability that allows students to deal with difficult situations, which may affect them negatively. It includes adverse situations that may arise when students are faced with a problem, which made them give up in the learning process. The situation may be related to problems that arise when the learning process occurs or also relates to the environmental situation that negatively affects their learning effectiveness. Resilience allows students to find and use 'adaptive results' when dealing with the situation. These 'adaptive results' provide defensive properties when faced with a negative situation, turning a negative situation into a situation that supports them, even changing the students into resilient students against future problems that may arise.

Moreover, resilient learners know that whilst learning mathematics requires a struggle, appropriate support can be found and positive emotions, which come from success, can be experienced. Teaching for mathematical resilience enables learners to use mathematics effectively, and to acquire new mathematical skills when needed, to empower their day to day lives and careers.

Nardi and Stewart (2013) stated that the construct of 'mathematical resilience' describes the positive attributes that learners require in order to be prepared to engage with, learn, and use mathematics, both at school and, perhaps, more importantly, beyond. It is needed because of the negative emotions and exclusion which have been seen to be engendered by many traditional approaches to teaching mathematics.

Another construct to consider in this study is the academic or achievement emotions. This is anchored on the control-value theory of achievement emotions. Pekrun (2006) defined academic emotions as those tied directly to achievement activities or achievement outcomes. The enjoyment arising from learning, boredom experienced in classroom instruction or anger when dealing with difficult tasks, were a few examples of activity-related achievement emotions. The outcome emotions pertained to the outcomes of these activities, which include prospective, and anticipatory emotions (e.g., anxiety of failure), as well as retrospective (e.g., pride or shame experienced after feedback of achievement) (Pekrun, 2006).

In psychology, learner emotions, specifically within the context of classroom instruction and achievement, are referred to as academic emotions (Pekrun et al., 2002). The emotions related to achievement are defined as achievement emotions and are measured by using the achievement emotions questionnaire. Academic emotions are explained by referring to the control-value theory. This theory describes emotions as sets of interrelated psychological processes composed primarily of affective, cognitive, motivational, and physiological dimensions. The theory appraises subjective control, and value. The appraisal of subjective control relates to the perceived control of achievement-related actions, and outcomes. By contrast, the appraisal of subjective value pertains to the subjective importance of achievement-related activities, and outcomes. (Pekrun et al., 2011).

Research has shown that academic emotions influence students' learning, and achievement. This influence has been demonstrated in relation to students' motivation. In the study of Villavicencio and Bernardo (2012), it was revealed that enjoyment and pride were both positive predictors of grades. More importantly, both moderated the relationship between self-regulation and grades. For students who report higher levels of both positive emotions, self-regulation was positively associated with grades. However, for those who report lower levels of pride, self-regulation was not related to grades; and, for those who reported lower levels of enjoyment, self-regulation was negatively related to grades. The results of their study also discussed how positive emotions

indicate positive appraisals of task or outcome value, and thus, enhance the positive links between cognitive or motivational variables, and learning. This construct will be also tested if it has an intervening role to the predictor variable concerning the ecological system structures surrounding the students, and the outcome variable, which is their achievement.

The ecological system structure referred to in this study is divided into three sub-structures. Firstly, the home microsystem structure consists of students` parental education, socio-economic status, home environment, and parent-child relationship. Secondly, the school microsystem structure is composed of teachers' instructional competence, the mathematics learning environment, school environment, attitude towards school, positive affect towards mathematics, teacher-student relationship, and self-perceived competence in mathematics. Third, and lastly, is the home-school mesosystem structure, which includes the parental academic support, and parent-school interaction.

Jeynes (2010) classified parental involvement as overt or subtle, and stated that both forms are crucial in understanding the trajectories in which parental involvement affects mathematics achievement. The relationship between overt parental involvement, and academic achievement has recently been called into question.

Previous studies showed that family contexts that are less exciting and involved in their children's education are manifested in less positive attitudes toward school, lower resilience levels (Abreu et al., 2006), and have a higher probability of dropping out of school, once they feel less support from their family, and community (Rumberger, 2011). Moreover, they tend to believe that having studies and completing a school course are not important to having a job or maintaining a career.

In the studies concerning the dimensions under the school microsystem structures, specifically, teachers' instructional competence, Tope (2012) has noted that competent teachers are a critical piece in improving students' achievement, and closing the achievement gap. Better teacher-student relations promote increased student academic performance and improve the classroom climate by reducing disruptive student behaviour (Marzano, 2003).

The attitude towards school is one of the structures of the school microsystem in which, according to Lewy (2012), this construct is being defined as the subject's behaviours, their feelings of expression relative to affection and judgments, favourable or unfavorable, and for the school and school experiences. A positive attitude opens the door for children to do well but does not guarantee that they will; that also depends on other factors. There is a strong association between individuals' attitudes towards education, and their academic performance and commitment. Students who have negative attitudes towards education activities are found to exhibit challenging behaviour, including anti-social and off-task behaviour (Awang et al., 2013).

Another variable to consider in the school microsystem structure is the students' school environment. According to Mick Zais (2011), the school environment means the extent to which school settings promote student safety and student health, which may include topics such as the physical plant, the academic environment, available physical and mental health supports and services, and the fairness and adequacy of disciplinary procedures, as supported by relevant research and an assessment of validity. The result of the study of Usaini and Abu Bakar (2015) indicated that students from a school with adequate facilities, good teachers, and a favourable environment perform well compared to those from schools with fewer facilities, unqualified teachers, and a less enabling environment. However, in the study of Lawrence (2012), it was revealed that the school environment has no significant relationship upon students' academic achievement.

With respect to the teacher-student relationship variable, the results of a previous study showed that a supportive teacher-student relationship was positively related to the social self-concept, school adjustment, and grade, whereas it was negatively associated with externalising behavioural problems, internalised symptoms, and school dropout (Baker, 2006). The students were more behaviourally and emotionally engaged when they had positive relationships with their teachers, and this further contributed to their academic achievement (O'Connor & McCartney, 2007).

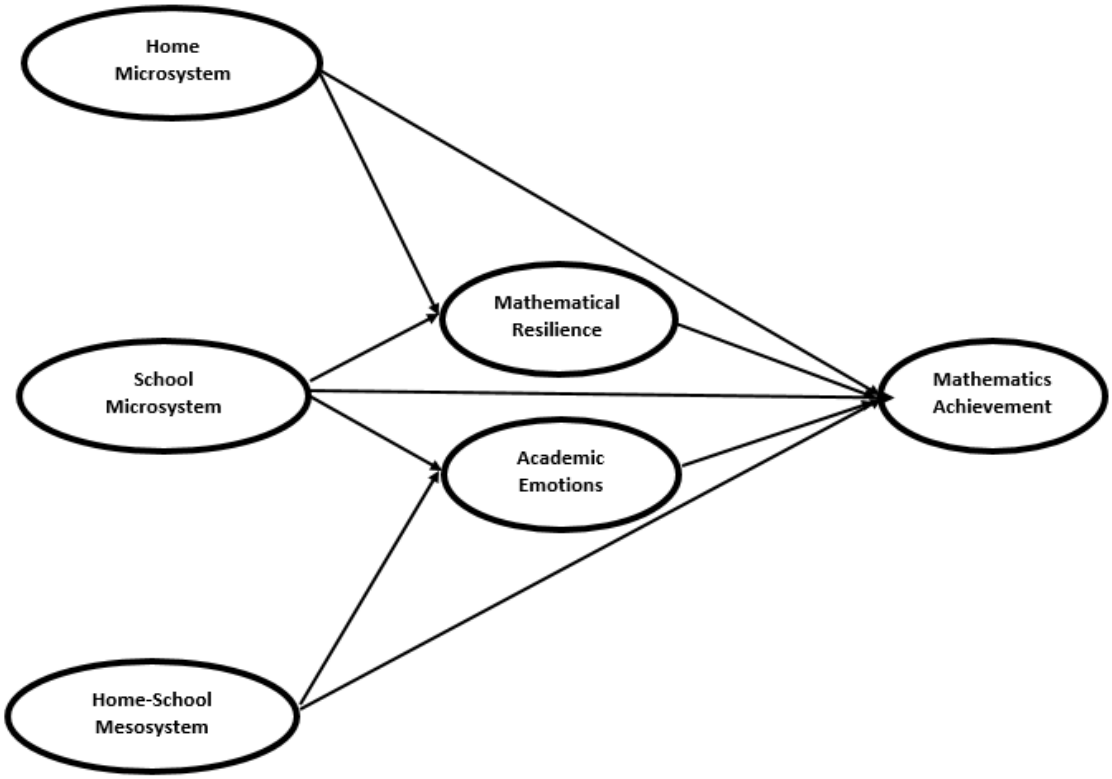
Finally, the last structure in this study is the home-school mesosystem. This includes parental support, and parent-community interaction. The research suggests that a strong home–school mesosystem is significant to a student's development and success in school (Garbarino et al., 1992). However, one cannot look at the role and impact of a student's mesosystem without first considering its microsystem components. In this instance, the student's home–community microsystem, and the student's school microsystem. Furthermore, any question of a child's development should also consider the children themselves. That is, the characteristics of the child which may influence their experiences and interactions in other systems.

Numerous studies have examined the direct links between microsystem factors and students' achievement, and in a variety of contexts. Fewer, however, have considered the influence of mesosystem factors upon achievement (Galindo & Sheldon, 2012), and fewer still, upon the influence of both microsystem, and mesosystem factors (Benner et al., 2008). However, none of the studies noted have considered several other factors that may influence their effect upon students' achievement. Thus, this research sought to examine the intervening role of mathematical resilience and academic emotions in the relationship between Bronfenbrenners' microsystem and mesosystem ecological structures, and the mathematics achievement of junior high school students.

OBJECTIVES

The current study aims to determine how students' mathematical resilience, and their academic emotions intervene between the link of ecological system structures, and mathematics achievement. Specifically, it determined the significant relationship existing between and among the variables used in this study. A significant effect of the predictor variables on the intervening and outcome variables was also investigated. The paradigm of the study is shown in Figure 1.

Figure 1
Conceptual Model Depicting the Intervening Roles of Students` Mathematical Resilience and Academic Emotions on the Relationship of Ecological Factors to their Mathematics Achievement



METHODS

Participants

The sample was drawn from different public junior high schools in the different municipalities of Pampanga. A total of 850 Grade 7 and 8 students participated in the study. The sample size was calculated using a power analysis with the accepted minimum level of significance (α) of 0.05, and the expected power β of 0.80, which is the accepted minimum level of power for the test (Polit & Hungler, 1999). The effect size of 0.25 was estimated based on previous related studies. All

participants gave their informed consent to participate in the study and allow researchers to access their final grade for their course.

Measures

Ecological System Structures: the researcher based the items of the ecological system structure questionnaire from different authors' instruments, which will fall under the dimensions of the home-school ecological structure. These items were validated by three experts, considering their relevance to the construct. Modifications and revisions of the instruments were undertaken following the suggestions of the experts. Some items were omitted because they were too abstract and complicated using the Analysis of Moment Structure (AMOS) software, particularly the factor analysis on the item loadings. The reliability of the instrument reached the desired Cronbach alpha coefficient of 0.87.

Academic Emotions: Eight emotions of enjoyment, hope, pride, anger, anxiety, boredom, shame, and hopelessness were assessed using the Achievement Emotions Questionnaire (AEQ-M) (Pekrun, Goetz, & Frenzel, 2005).

Mathematical Resilience: To assess the students' resiliency in taking mathematics, the Mathematical Resilience Scale developed by Janice Kooken (2015) was utilized.

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***Mathematics Achievement*:** Students` mathematics achievement was assessed in terms of the previous final grade in mathematics.

Procedure

A letter was addressed and sent to the schools' division superintendent of Pampanga to ask for permission to conduct a survey within the selected schools in the Division of Pampanga. Upon the approval of the Superintendent, the researcher administered the questionnaires to gather first-hand information needed in this study, in the selected schools.

The data gathered was tallied, tabulated, processed, and treated using different statistical treatments. The students' levels in different areas were described using mean, and standard deviation. The correlations among the variables were also determined. A hierarchical regression analysis was conducted to examine the mediating effects of negative academic emotions. The method which was outlined by Baron and Kenny (1986) and Frazier, Tix, and Barron (2004) was followed in testing the mediational hypothesis of the study. The Sobel test, an interactive calculation tool for mediation, was also conducted to test whether a mediator carries the influence of an independent variable to a dependent variable.

RESULTS AND DISCUSSIONS

Relationship between Home-School Ecological Structures and Mathematics Achievement

The means, standard deviation, and correlations coefficient of all the variables under study are shown in Table 1.

Table 1

Correlations between Ecological Structures and Mathematics Achievement

Ecological Structures	Independent Variables	Mean	SD	Coefficient
Home Microsystem	Parental Education	2.53	0.98	0.092
	Socio-economic Status	2.15	1.01	0.004
	Home Environment	3.29	0.49	0.149*
	Parent-Child Relationship	3.29	0.47	0.201**
School Microsystem	Teachers` Instructional Competence	3.65	0.42	0.155*
	Mathematics Learning Environment	3.30	0.52	0.140*
	School Environment	3.32	0.50	0.056
	Students` Attitude towards School	3.51	0.47	0.278**
	Students` Positive Affect towards Mathematics	3.26	0.80	0.151**
	Teacher-Student Relationship	3.16	0.65	0.121
	Self-perceived Competence in Mathematics	2.96	0.72	0.154*
Home-School Mesosystem	Parental Academic Support	3.14	0.69	0.056
	Parent-School Interaction	3.10	0.67	0.120

**Significant at p<0.05* ***Highly Significant at p<0.01*

It can be gleaned on the table that only the home environment, and parent-child relationship dimension under the home microsystem structure were significantly correlated with achievement, with a correlation coefficient of 0.149, and 0.201, respectively. Furthermore, the teachers' instructional competencies, mathematics learning environment, attitude towards school, positive affect, and self-perceived competence in mathematics, have a significant relationship on students' mathematics achievement.

Table 2

Correlations of the Intervening Variables on Achievement

Intervening Variables	Mean	SD	Coefficient
Mathematical Resilience	**3.33**	**0.05**	**0.272****
Positive Academic Emotions	**3.65**	**0.64**	**0.200****
Enjoyment	3.38	0.76	0.144*
Hope	3.22	0.76	0.163*
Pride	3.43	0.64	0.057**
Negative Academic Emotions	**2.38**	**0.75**	**-0.206****
Anger	2.37	0.87	-0.114
Anxiety	2.49	0.93	-0.170*
Shame	2.70	0.79	-0.069
Hopelessness	2.41	1.09	-0.241**
Boredom	1.94	0.98	-0.208**

**Significant at p<0.05* ***Highly Significant at p<0.01*

The data in Table 2 reveals that the students' mathematical resilience was significantly related to their achievement. It can be observed that the positive academic emotions, such as enjoyment, hope, and pride, were positively correlated to the students' achievement, which implies that the more the students exercise positive emotions in mathematics, it will yield to better performance in mathematics. The negative emotions, such as anxiety, hopelessness, and boredom, are significantly correlated to the students' performance. The results show that the five negative academic emotions (anger, anxiety, shame, boredom, and hopelessness) were negatively associated with achievement, whereas the critical thinking strategy was positively associated with achievement. In general, positive emotions correlated positively with self-regulated learning, and negative emotions correlated negatively with such components.

Significant Effect of Ecological Structures on Students' Mathematical Resilience

The test for a significant effect of ecological structures upon students' mathematical resilience is shown in Table 3.

Table 3

Regression Analysis of Predictors of Students' Mathematical Resilience

Intervening Variables	β	Std. Error	t	p
Parental Education	-0.072	0.036	-1.993	0.047
Socio-economic Status	-0.041	0.035	-1.171	0.243
Home Environment	0.273	0.070	3.880	0.000**
Parent-Child Relationship	0.325	0.073	4.442	0.000**
Teachers` Instructional Competence	0.599	0.076	7.883	0.000**
Mathematics Learning Environment	0.465	0.060	8.264	0.000**
School Environment	0.326	0.008	4.806	0.000**
Students` Attitude towards School	0.555	0.066	8.361	0.000**
Students` Positive Affect towards Mathematics	0.391	0.036	10.769	0.000**
Teacher-Student Relationship	0.420	0.047	8.915	0.000**
Self-perceived Competence in Mathematics	0.438	0.040	10.904	0.000**
Parental Academic Support	0.251	0.049	5.150	0.000**
Parent-School Interaction	0.453	0.044	10.231	0.000**

Highlighted dimensions will be removed in the model **Significant* ***Highly Significant*

Table 3 reveals that all the dimensions under the school-microsystem structures, and home-school mesosystem structures predict the students' achievement in mathematics. Only the socio-economic status under the home-microsystem structure showed no significant impact upon the students' achievement. This only implies that being resilient in mathematics has nothing to do with the learners' economic status in life.

Significant Effect of Ecological Structures on Students' Mathematical Resilience

Table 4 shows the test for the significant effect of ecological structures on students' academic emotions. The results of the hierarchical regression analyses showed that all of the dimensions under the ecological structures significantly affect the students' academic achievements in mathematics. This implies that students' enjoyment, hope, and pride in learning mathematics has something to do with the environment he or she is exposed to, such as having supportive parents, teachers, and peers; a very good home, school, and classroom environment; rapport between teachers and parents; competent teachers; and so on.

Table 4

Regression Analyses of Ecological Structures on Students' Positive and Negative Academic Emotions

Intervening Variables	Positive Academic Emotions			Negative Academic Emotions		
	β	**t**	**p**	**B**	**t**	**p**
Parental Education	-0.293	-4.599	0.000**	0.056	0.989	0.324
Socio-economic Status	-0.160	-2.444	0.015*	0.224	3.465	0.001**
Home Environment	0.201	3.090	0.002**	-0.073	-1.107	0.270
Parent-Child Relationship	0.215	3.320	0.001**	0.028	0.424	0.672
Teachers` Instructional Competence	0.523	9.253	0.000**	-0.208	-3.212	0.002**
Mathematics Learning Environment	0.453	7.659	0.000**	-0.097	-1.468	0.143
School Environment	0.154	2.345	0.020*	0.076	0.150	0.251
Students` Attitude towards School	0.295	4.657	0.000**	-0.048	-0.730	0.466
Students` Positive Affect towards Mathematics	0.768	18.054	0.000**	-0.275	-4.313	0.000**
Teacher-Student Relationship	0.521	9.188	0.000**	-0.144	-2.195	0.029*
Self-perceived Competence in Mathematics	0.709	15.142	0.000**	-0.013	-0.201	0.841

Highlighted dimensions will be removed in the model **Significant* ***Highly Significant*

Furthermore, results revealed that the socio-economic status of the students has an impact to their negative academic emotions in mathematics, such as anxiety, hopelessness, and boredom. The students' assessment of their teachers' instructional competence and positive affect towards mathematics have significant influences their negative academic emotions. This only shows that students who have incompetent math teachers can lead to their negative academic emotions towards mathematics. Moreover, students` attitude towards mathematics causes also their negative academic emotions.

Significant Effect of the Ecological System Structures on Students' Mathematics Achievement

Table 5 features the hierarchical regression analysis of the predictor variables on students` mathematics achievement.

Table 5

Regression Analysis of the Effect of the Independent Variables on Respondents' Achievement

Intervening Variables	β	Std. Error	t	p
Parental Education	0.411	0.296	1.386	0.167
Home Environment	1.323	0.585	2.263	0.025*
Parent-Child Relationship	1.877	0.606	3.094	0.002**
Teachers` Instructional Competence	0.577	0.695	0.829	0.048*
Mathematics Learning Environment	1.174	0.550	2.136	0.034*
School Environment	0.490	0.578	0.847	0.397
Students` Attitude towards School	2.581	0.592	4.357	0.000**
Students` Positive Affect towards Mathematics	0.822	0.358	2.296	0.023*
Teacher-Student Relationship	0.827	0.441	1.875	0.402
Self-perceived Competence in Mathematics	0.937	0.398	2.355	0.019*
Parental Academic Support	0.353	0.411	0.847	0.398
Parent-School Interaction	0.787	0.432	1.822	0.070

Highlighted dimensions will be removed in the model **Significant* ***Highly Significant*

As shown in Table 5 above, only the home environment, and parent-child relationship under the microsystem structure predict students' achievement. For the school microsystem structures, the school environment and teacher-student relationship have no significant influence upon the mathematics achievement. The teachers' instructional competencies, mathematics learning environment, attitude towards school, positive affect towards mathematics, and self-perceived competence in the said subject, predict achievement. Furthermore, all the dimensions under the home-school mesosystem structures have no significant effect on achievement. This only implies that students' mathematics achievement does not depend upon their parental education, school environment, their good relationship to their teachers, parental academic support, and parent-school interaction.

Significant Effect of Students' Mathematical Resilience and Academic Emotions in their Mathematics Achievement

The test for a significant effect of the intervening variables, namely the mathematical resilience, and academic emotions, is presented in Table 6.

Table 6

Regression Analysis of the Effect of the Intervening Variables on Respondents' Mathematics Achievement

Intervening Variables	β	Std. Error	t	p
Mathematical Resilience	**2.214**	**0.519**	**4.264**	**0.000****
Positive Academic Emotions	**1.354**	**0.440**	**3.074**	**0.002****
Enjoyment	0.834	0.381	2.188	0.030*
Hope	0.939	0.380	2.472	0.014*
Pride	1.681	0.439	3.826	0.000**
Negative Academic Emotions	**-1.195**	**0.378**	**-3.164**	**0.002****
Anger	-0.572	0.332	-1.721	0.087
Anxiety	-0.800	0.309	-2.584	0.010**
Shame	-0.383	0.367	-1.042	0.298
Hopelessness	-0.970	0.260	-3.731	0.000**
Boredom	-0.926	0.290	-3.196	0.002**

Highlighted dimensions will be removed in the model **Significant* ***Highly Significant*

Results show that the students' resilience in mathematics, and positive academic emotions, such as enjoyment, hope, and pride in mathematics, predict their achievement. Moreover, negative emotions such as students' anxiety, hopelessness, and boredom in taking the said subject have significant impacts on their achievement. Moreover, emotions like anger, and shame, have no effect on their performance in mathematics.

The Intervening Role of Mathematical Resilience on the Link between Home Microsystem Structures and Mathematics Achievement

The mediating effect of resilience on the link of the home environment, and parent-child relationship to the mathematics achievement was shown in Table 7, and Figures 1, and 2.

Table 7

Mathematical Resilience as Mediator of Home Microsystem Structures and Mathematics Achievement

Intervening Variables	β	Std. Error	t	p
Home Environment and Mathematical Resilience	0.249	0.070	3.880	0.000**
Mathematical Resilience and Mathematics Achievement	0.272	0.519	4.264	0.000**
Home Environment and Mathematics Achievement	0.149	0.585	2.263	0.025*
Home Environment, Mathematical Resilience, and Mathematics Achievement	0.086	0.586	1.305	0.193
	B	**Std. Error**	**T**	**P**
Parent-Child Relationship and Mathematical Resilience	0.325	0.073	4.442	0.000**
Mathematical Resilience and Mathematics Achievement	0.272	0.519	4.264	0.000**
Parent-Child Relationship and Mathematics Achievement	0.201	0.606	3.094	0.002**
Parent-Child Relationship, Mathematical Resilience, and Mathematics Achievement	0.135	0.537	2.041	0.042*

Figure 2

Resilience as Mediator between Home Environment and Mathematics Achievement

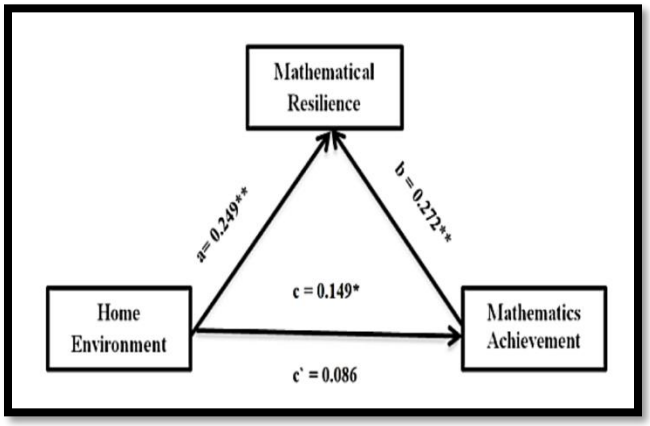
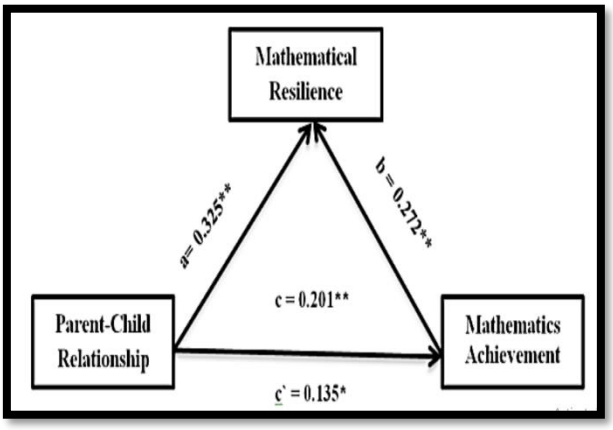


Figure 3

Resilience as Mediator between Parent-Child Relationship and Mathematics Achievement



The results clearly showed that the home environment, and parent-child relationship dimensions of the home microsystem predict the students' mathematical resilience, and achievement, where mathematical resilience predicts achievement. However, the relationship between the home environment of the students, and their achievement controlling math resilience (path c'), was no longer significant. This illustrated a complete mediation, as shown in Figure 2

The mediated effect of mathematics resilience on the relationship between the parent-child relationship, and achievement was shown in Figure 3. The conditions for mediation were all met. The determination of the relationship between the parent-child relationship, and achievement controlling students' resilience (path c') remained significant, illustrating a partial mediation.

This only implies that a positive home environment for learning mathematics has something to do with students' toughness in facing difficulties within the subject. A good interaction between the parents, and students makes them more resilient in learning mathematics, thus, achieving a high final grade. This supports the results obtained in the case study of Goodall and Johnston-Wilder (2015), parental engagement can alleviate students mathematical helplessness (Russell, 2002). However, the prevalence of mathematics anxiety, and learned helplessness in children, and in the adults around them, presents a fundamental barrier to significant improvements in the attainment of outcomes. These core issues will be addressed through the development of 'mathematical resilience' (Johnston-Wilder & Lee, 2010), which enables learners, and the adults around them, to overcome levels of learned helplessness, which may affect their performance in mathematics.

Table 8

Sobel Test of Mediated Effects of Mathematical Resilience between Home Microsystem Structures and Mathematics Achievement

Independent Variables (Home Microsystem Structures)	**Sobel Test of Mediating Effects**						
	a	**b**	**Sa**	**Sb**	**t**	**SE**	**p-value**
Home Environment	1.323	2.214	0.585	0.519	2.00	1.47	0.040*
Parent-Child Relationship	0.585	2.214	0.606	0.519	2.51	1.66	0.012*

a = Raw coefficient for the association between Home Microsystem Structures and Mathematical Resilience
s_a = Standard Error of *a*.
b = Raw coefficient for the association between the Mathematical Resilience and Mathematics Achievement (when the Home Microsystem Structures are also predictors of Mathematics Achievement).
s_b = Standard Error of *b*.
SE = Standard Error of the test

The results of Sobel test of mediated effects showed that the indirect effect of students' mathematical resilience upon the link between the home environment and achievement, and between the parent-child relationships, were significant, as shown in Table 8. The students' mathematical resilience was shown to be a complete or full mediator between the home environment factors, and achievement. This implies that the students' level of performance in mathematics depends on the quality of their environment at home. One can conclude that a positive home learning environment might increase the students' achievement, but only through the toughness of the student in facing difficulties in learning the subject.

Furthermore, the mediating effect of the students' mathematical resilience between their relationship with their parents, and their achievement, was found to be partial. Hence, it can be concluded that a high level of mathematics achievement can be attained and enhanced by being more resilient in learning the subject.

Mathematical Resilience on the Link between School Microsystem Structures and their Achievement

Table 9
Mathematical Resilience as Mediator of School Microsystem Structures and Achievement

Intervening Variables	**β**	**Std. Error**	**t**	**p**
Teachers` Instructional Competence and Mathematical Resilience	0.599	0.076	7.883	0.000**
Mathematical Resilience and Mathematics Achievement	0.272	0.519	4.264	0.000**
Teachers` Instructional Competence and Mathematics Achievement	0.599	0.695	0.829	0.048*
Teachers` Instructional Competence, Mathematical Resilience, and Mathematics Achievement	0.019	0.585	1.368	0.208
	β	**Std. Error**	**t**	**p**
Mathematics Learning Environment and Mathematical Resilience	0.465	0.060	8.264	0.000**
Mathematical Resilience and Mathematics Achievement	0.272	0.519	4.264	0.000**
Mathematics Learning Environment and Mathematics Achievement	0.140	0.550	2.136	0.034*
Mathematics Learning Environment, Mathematical Resilience, and Mathematics Achievement	0.012	0.611	0.168	0.867
	β	**Std. Error**	**t**	**p**
Attitude towards School and Mathematical Resilience	0.555	0.066	8.361	0.000**
Mathematical Resilience and Mathematics Achievement	0.272	0.519	4.264	0.000**
Attitude towards School and Mathematics Achievement	0.140	0.550	2.136	0.000**
Attitude towards School, Mathematical Resilience, and Mathematics Achievement	0.012	0.611	0.168	0.009**
	β	**Std. Error**	**t**	**p**

Positive Affect towards Mathematics and Mathematical Resilience	0.391	0.036	10.769	0.000**
Mathematical Resilience and Mathematics Achievement	0.272	0.519	4.264	0.000**
Positive Affect towards Mathematics and Mathematics Achievement	0.151	0.358	2.296	0.023*
Positive Affect towards Mathematics Positive Affect towards Mathematics, Mathematical Resilience, and Mathematics Achievement	-0.012	0.429	-0.148	0.882
	β	**Std. Error**	**t**	**p**
Self-perceived Competence in Mathematics and Mathematical Resilience	0.438	0.040	10.904	0.000**
Mathematical Resilience and Mathematics Achievement	0.272	0.519	4.264	0.000**
Self-perceived Competence in Mathematics and Mathematics Achievement	0.154	0.398	2.355	0.019*
Self-perceived Competence in Mathematics, Mathematical Resilience, and Mathematics Achievement	-0.008	0.479	-0.101	0.919

The data revealed that the teachers' instructional competence, learning environment in mathematics, attitude towards school, positive affect, and self-perceived competence in mathematics under the school microsystem structure predict the students' resilience in learning mathematics, as well as their performance in the said subject. Subsequently, their mathematical resilience predicts their achievement. This implies that all the conditions in performing the mediation analysis were met. The relationship of the teachers' instructional competence, mathematics learning environment, positive affect, and self-perceived competence in mathematics impacts upon the students' achievements were no longer significant after introducing the intervening variable on the model. It can be reflected that the students' mathematical resilience served as a full mediator on the link of the stated predictor variables upon the outcome variable. Moreover, the students' mathematical resilience partially mediated the association between their attitude towards school, and achievement since the relationship between the said variables remained significant after including the effect of the mediating variable.

The effects of the teachers' instructional competencies, learning environment, positive affect, and self-perceived competencies in mathematics upon a final grade outcome are completely mediated by the students' persistence in the face of difficulty, and a willingness to solve problems in the said subject. This showed that students' achievement in mathematics can be improved through the resilience of the students in learning the subject, and such toughness in facing difficulties regarding the subject can be developed more by the competencies of the teachers in teaching the subject, a conducive classroom environment, positive attitude, and the belief that they can do good in the

subject. The students' good attitude towards school caused a satisfactory performance in the subject, but this impact is mediated by the students' mathematical resilience, and several other factors. For clearer representation of the intervening effects of the students` mathematical resilience between their school microsystem ecological structures and mathematics achievement, the following figures are presented.

Figure 4
Resilience as Mediator between Teachers` Instructional Competencies and Mathematics Achievement

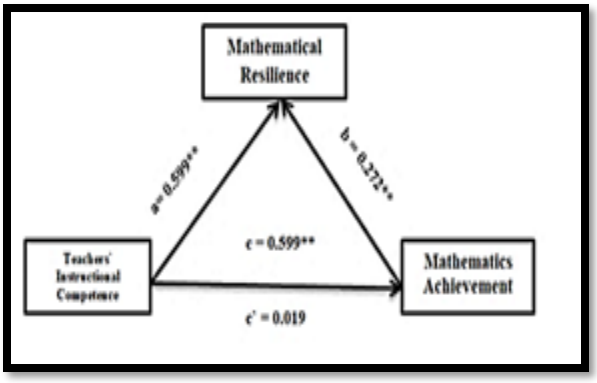


Figure 5
Resilience as Mediator between Mathematics Learning Environment and Mathematics Achievement

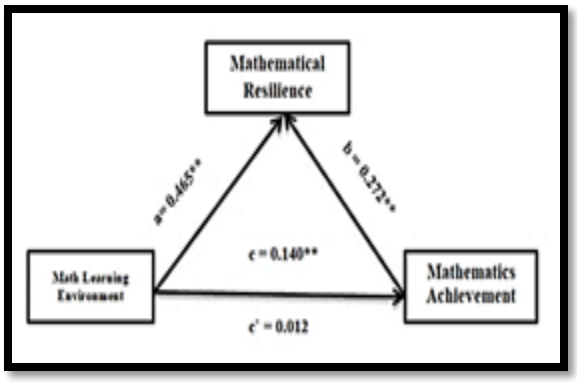


Figure 6
Resilience as Mediator between Attitude towards School and Mathematics Achievement

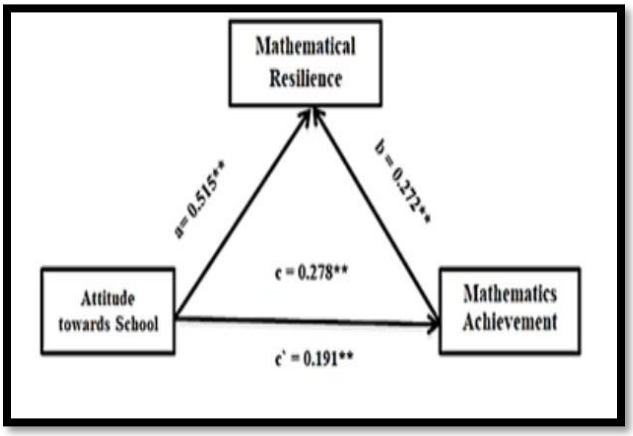


Figure 7
Resilience as Mediator between Positive Affect towards Mathematics and Mathematics Achievement

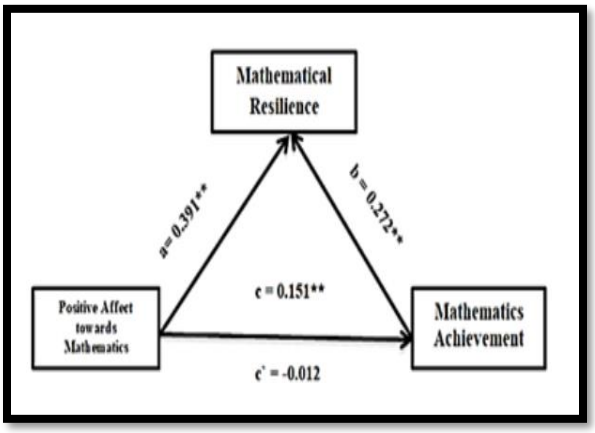
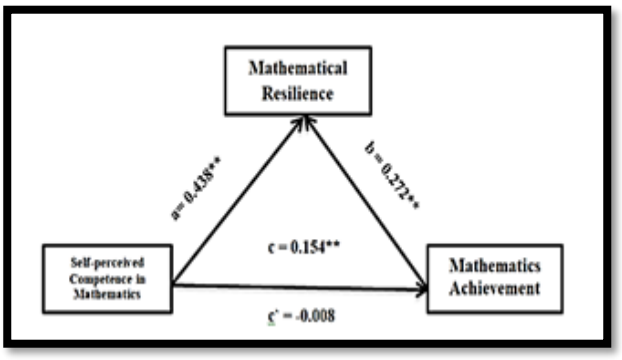


Figure 8
Resilience as Mediator between Self-Perceived Competence in Mathematics and Mathematics Achievement



The results of the Sobel test of the mediated effects is illustrated in the previous table and figures is shown in Table 10.

Table 10
Sobel Test of Mediated Effects of Mathematical Resilience between School Microsystem Structures and Achievement

Independent Variables (School Microsystem Structures)	Sobel Test of Mediating Effects						
	a	b	Sa	Sb	t	SE	p-value
Teachers' Instructional Competencies	0.599	2.214	0.076	0.519	3.75	0.35	0.000**
Mathematics Learning Environment	0.465	2.214	0.060	0.519	3.74	0.28	0.000**
Attitude Towards School	0.555	2.214	0.066	0.519	3.80	0.32	0.000**
Positive Affect towards Mathematics	0.391	2.214	0.036	0.519	3.97	0.22	0.000**
Self-perceived Competence in Mathematics	0.438	2.214	0.040	0.519	3.99	0.24	0.000**

The data above revealed that the indirect effect of students' mathematical resilience on the link between the stated school microsystem structures, and achievement was significant. This only shows that the school microsystem structures such as the instructional competence of teachers, learning environment, attitude towards school, positive affect, and self-perceived competence in mathematics predict students` math achievement because of their resiliency in the subject and some other factors.

Positive Academic Emotions on the Link between Home Microsystem Structures and Achievement

Table 11
Positive Academic Emotions as Mediator of Home Microsystem Structures and Achievement

	β	Std. Error	t	p
Home Environment and Positive Emotions	0.201	0.086	3.090	0.002**
Positive Emotions and Achievement	0.200	0.440	3.074	0.002**
Home Environment and Achievement	0.149	0.585	2.263	0.025**
Home Environment, Positive Emotion and Achievement	0.113	0.589	1.708	0.809
	β	**Std. Error**	**t**	**p**
Parent-Child Relationship and Positive Emotions	0.215	0.089	3.320	0.001**
Positive Emotions and Achievements	0.200	0.440	3.074	0.002**
Parent-Child Relationship and Achievements	0.201	0.606	3.094	0.002**
Parent-Child Relationship, Positive Emotion and Achievements	0.166	0.614	2.520	0.012**

Figure 9
Positive Academic Emotions as Mediators between Home Environment and Mathematics Achievement

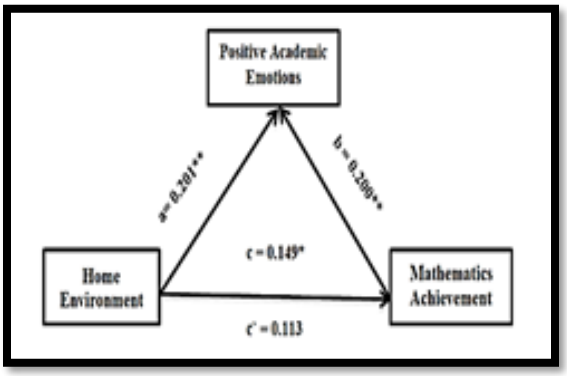
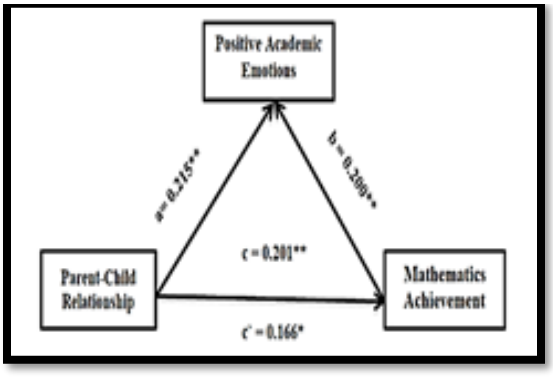


Figure 10
Positive Academic Emotions as Mediators between Parent-Child Relationship and Mathematics Achievement



Figures 9 and 10 illustrate the role of the students' positive academic emotions on the association of their home environment, and their relationship to their parents upon their achievement. The results show that the condition of the students' home environment, and their good relationship with their parents, affects their positive emotions in learning the subject, such as enjoyment, hope, and

pride. These also predict their achievement, and the said positive emotions predict their performance in mathematics.

An analysis of the data in Table 11 showed that the students' positive emotions towards mathematics significantly mediated the relationship between the home environment, and mathematics achievement, as well as the association between the parent-child relationship, and achievement. The students' rapport with their parents partially mediated the link between the predictor, and outcome variables. This finding indicated that the students' condition of their home environment affects their positive emotions, which in turn, affects their mathematics achievement. Based on Baron and Kenny (1986), the mediation effect of the students' positive emotions on the relationship between the said variables is partial since the direct effect is still significant ($c` = 0.166$, $p<0.05$). Furthermore, positive emotions served as full mediators for the relationship of their home environment conditions, and their achievement, since the said link was found to be insignificant after the inclusion of the intervening effect of the mediators.

Table 12
Sobel Test of Mediated Effects of Positive Academic Emotions between Home Microsystem Structures and Achievement

Independent Variables (Home Microsystem Structures)	**Sobel Test of Mediating Effects**						
	a	**b**	**Sa**	**Sb**	**t**	**SE**	**p-value**
Home Environment	0.264	1.354	0.086	0.440	2.17	0.16	0.03*
Parent-Child Relationship	0.296	1.354	0.089	0.440	2.26	0.18	0.03*

Table 12 revealed that the indirect effect of students' positive emotions, such as their enjoyment, hope, and pride in dealing with mathematics on the link of home environment and parent-child relationship to their achievement was significant.

Positive Academic Emotions, School Microsystem Structures, and Mathematics Achievement

Table 13 presents the results of the mediating effects of the students' positive academic emotions, which are enjoyment, hope, and pride, upon the relationship between school microsystem structures, and achievement in mathematics

Table 13

Positive Academic Emotions as Mediator of School Microsystem Structures and Achievement

	β	**Std. Error**	**t**	**p**
Teachers' Instructional Competence and Positive Emotions	0.523	0.088	9.253	0.000**
Positive Emotions and Achievement	0.200	0.440	3.074	0.002**
Teachers' Instructional Competence and Achievement	0.599	0.695	0.829	0.048*
Teachers' Instructional Competence, Positive Emotions and Mathematics Achievement	-0.068	0.801	-0.895	00.372
	β	**Std. Error**	**t**	**p**
Mathematics Learning Environment and Positive Emotions	0.453	0.073	7.659	0.000**
Positive Emotions and Achievement	0.200	0.440	3.074	0.002**
Mathematics Learning Environment and Achievement	0.140	0.550	2.136	0.034
Mathematics Learning Environment, Positive Emotions, and Achievement	0.063	0.611	0.858	0.392
	β	**Std. Error**	**t**	**p**
Attitude towards School and Positive Emotions	0.295	0.087	4.657	0.000**
Positive Emotions and Achievement	0.200	0.440	3.074	0.002**
Attitude towards School and Achievement	0.278	0.592	4.357	0.000**
Attitude towards School, Positive Emotions and Achievement	0.129	0.449	3.614	0.000**
	β	**Std. Error**	**t**	**p**
Positive Affect towards Math and Positive Emotions	0.768	0.034	18.054	0.000**
Positive Emotions and Achievement	0.200	0.440	3.074	0.002**
Positive Affect towards Math and Achievement	0.151	0.358	2.296	0.023*
Positive Affect towards Math, Positive Emotion and Achievement	-0.007	0.555	-0.068	0.946
	β	**Std. Error**	**t**	**p**
Self-perceived Competence in Mathematics and Positive Emotions	0.709	0.042	15.142	0.000**
Positive Emotions and Achievement	0.200	0.440	3.074	0.002**
Self-perceived Competence in Mathematics and Achievement	0.154	0.398	2.355	0.019*
Self-perceived Competence in Mathematics, Positive Emotions and Achievement	0.026	0.861	0.277	0.782

Figures 11 to 15 below illustrated the significant impact of the teachers' instructional competence, the mathematics learning environment, attitude towards school, positive affect, and self-perceived competence in mathematics upon their positive academic emotions, and achievement.

Figure 11
Positive Academic Emotions as Mediators between Teachers` Instructional Competencies and Mathematics Achievement

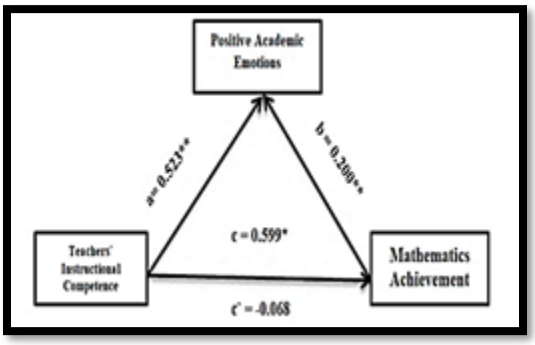


Figure 12
Positive Academic Emotions as Mediators between Mathematics Learning Environment and Mathematics Achievement

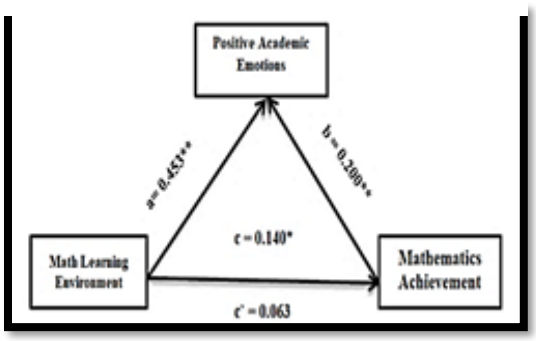


Figure 13
Positive Academic Emotions as Mediators between Attitude towards School and Mathematics Achievement

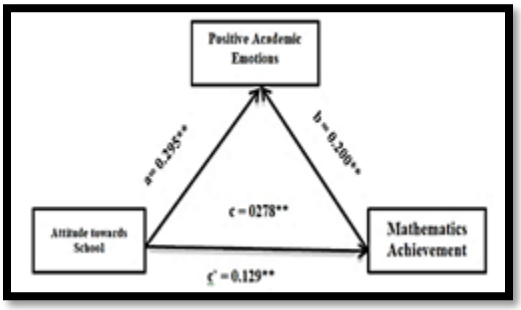


Figure 14
Positive Academic Emotions as Mediators between Positive Affect towards Mathematics and Mathematics Achievement

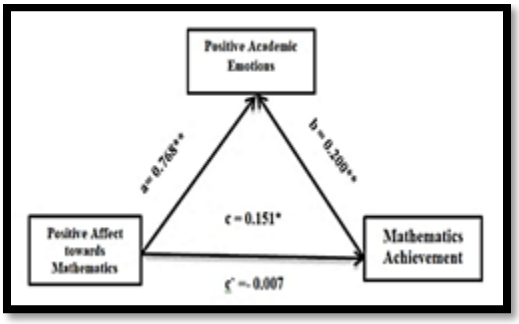


Figure 15
Positive Academic Emotions as Mediators between Self-Perceived Competence in Mathematics and Mathematics Achievement

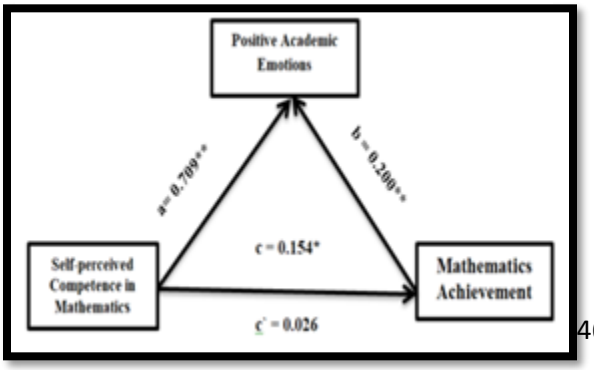


Table 13 and Figures 11 to 15 showed that the students' positive academic emotions predict their achievement. Among the dimensions of school microsystem structures, only the relationship of the students' attitude towards school to their performance was completely mediated by their positive academic emotions. Complete or full mediation means that the school microsystem structures of the students affect their mathematics achievement only because of their attitude towards school. It can be found out also in the result that the students' enjoyment, hope, and confidence in taking the subject were affected by their teachers' competence in teaching the subject, the mathematics learning environment, a positive attitude towards school and mathematics, and their beliefs that they can do well in the subject. Further, result revealed that the link of students` mathematics achievement on other microsystem structures excluding attitude towards mathematics were partially mediated by their positive academic emotions. This only means that these ecological structures impact students` mathematics achievement because of their positive academic emotions and other factors. The significance of the mediating effect of the positive academic emotions on the said connection between the predictor and outcome variables was also tested using Sobel Test.

Table 14

Sobel Test of Mediated Effects of Positive Academic Emotions between School Microsystem Structures and Achievement

Independent Variables (Home Microsystem Structures)	**Sobel Test of Mediating Effects**						
	a	**b**	**Sa**	**Sb**	**t**	**SE**	**p-value**
Teachers' Instructional Competencies	0.811	1.354	0.088	0.440	2.92	0.38	0.004**
Mathematics Learning Environment	0.560	1.354	0.073	0.440	2.86	0.27	0.0044**
Attitude towards School	0.405	1.354	0.087	0.440	2.57	0.21	0.010**
Positive Affect towards Mathematics	0.619	1.354	0.034	0.440	3.03	0.28	0.002**
Self-perceived Competence in Mathematics	0.635	1.354	0.042	0.440	3.02	0.29	0.000**

The Sobel test result revealed that the indirect effects of the predictor variables of the school microsystem structure upon the students' mathematics achievement, when intervened by positive academic emotions, were found to be significant. This implies that the positive emotions of students, such as enjoyment, hope, and pride, mediate the relationship of the competencies of their math instructor, conducive learning environment, attitude towards school, positive affect, and self-perceived competence in mathematics, in their achievement.

Negative Emotions, Teachers' Instructional Competence, and Positive Affect towards Mathematics

The test results are shown in Table 15 for the mediating effect of the students' negative academic emotions, such as anxiety, hopelessness, and boredom, upon the association between teachers` instructional competence, and achievement; and the link between the positive affect towards mathematics and achievement.

The data reflected on Table 15 and Figures 16 to 17 revealed that the teachers' instructional competence and students' positive affect towards mathematics have significant effects on the students' negative emotions, and achievement in mathematics. Also, the students' negative emotions in the said subject, such as anxiety, hopelessness, and boredom, negatively influenced their performance. This supported extant theories (Linnenbrink & Pintrich, 2000; Pekrun, 1992) that negative emotions could interfere with the cognitive processing needed to do the academic task, thus, inhibiting achievement.

Table 15
Negative Academic Emotions as Mediators of School Microsystem Structures and Achievement

	β	**Std. Error**	**t**	**p**
Teachers' Instructional Competence and Negative Emotions	-0.208	0.136	-3.212	0.002**
Negative Emotions and Mathematics Achievement	-0.240	0.378	-3.164	0.002**
Teachers' Instructional Competence and Mathematics Achievement	0.599	0.695	0.829	0.048**
Teachers' Instructional Competence, Negative Emotions and Mathematics Achievement	0.030	0.688	0.461	0.645
	β	**Std. Error**	**t**	**p**
Positive Affect towards Mathematics and Negative Emotion	-0.275	0.610	-2.631	0.039*
Negative Emotion and Mathematics Achievement	-0.240	0.378	-3.164	0.002**
Positive Affect towards Mathematics and Achievement	0.151	0.358	2.296	0.023*
Positive Affect towards Math, Negative Emotions and Mathematics Achievement	-0.119	0.358	1.811	0.072

Figure 16
Negative Academic Emotions as Mediators between Teachers` Instructional Competence and Mathematics Achievement

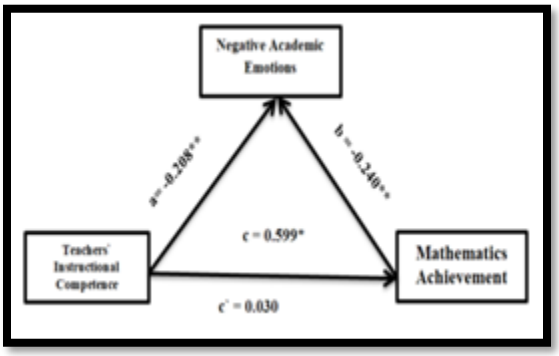
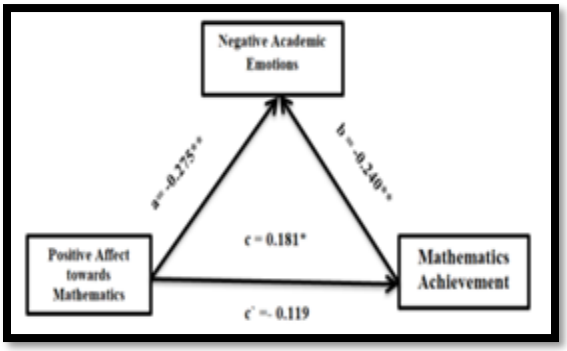


Figure 17
Negative Academic Emotions as Mediators between Positive Affect towards Mathematics and Mathematics Achievement



The negative feelings of anxiety, hopelessness, and boredom completely mediated the relationship between the instructors' competence, and achievement, as well as the relationship between the students' positive affect towards the subject, and their achievement. It was expected that the students who have a competent math instructor, and possess a positive attitude towards the subject, have a deeper level of engagement, and a positive approach to perform the academic tasks. In doing so, they became less anxious, hopeless, and bored about the academic tasks they are completing, thus, achieving a high final grade. The Sobel test on the mediating effect of negative academic emotions on the said association of school microsystems structures to students` mathematics achievement was said to be significant as evident on the results illustrated on Table 16 below.

Table 16
Sobel Test of Mediated Effects of Negative Academic Emotions between School Microsystem Structures and Achievement

Independent Variables (Home Microsystem Structures)	**Sobel Test of Mediating Effects**						
	a	**b**	**Sa**	**Sb**	**t**	**SE**	**p-value**
Teachers' Instructional Competencies	-0.436	-1.195	0.136	0.378	2.25	0.23	0.024*
Positive Affect towards Mathematics	-0.299	-1.195	0.069	0.378	2.55	0.14	0.011*

CONCLUSION AND RECOMMENDATION

This research highlighted that the learners' environment has something to do with the way they face difficulties and problems, and how they will avoid experiencing negative emotions and maintain positive emotions in their academic studies. The results of this study showed that the students' resilience, and academic emotions play important roles in the direct effect of ecological system structures in their mathematics achievement. Although the students experiencing a conducive classroom, competent teachers, and supportive parents may not guarantee that the educators will achieve academic success, the students' resiliency, and their emotions in dealing with the subject, must be taken into consideration.

Furthermore, this study contributes to the research of emotions, and educational psychology. The empirical evidence on the influence of the ecological system structures on the resilience, and academic emotions which affect the achievement of Filipino students can be very useful in understanding how a teacher's instructional competence, and classroom environment can be shaped in emotionally sound ways. Parents and teachers should work hand-in-hand in order for the students to develop their resilience in the subject, turn negative attitudes and emotions into positives, and improve their self-perceived competence in mathematics.

Lastly, teachers and parents should provide encouraging academic support to the students, which may lead to the development of their resiliency in the subject, attainment of positive emotions, and leaving no room for negative emotions, which can affect their achievement in mathematics. The cross-sectional nature of this study makes it difficult to be generalised among all students. To enrich these findings, future research may consider longitudinal studies, and other programs to elucidate more clearly the causal chain linking ecological system structures, resilience, emotions, and achievement.

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