A Structural Model of Academic Buoyancy, Aptitude, and School Environment on the Mathematics Achievement of Pre-service Teachers

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Abstract

The study determined the direction and magnitude of the relationships of academic buoyancy, aptitude and school environment towards mathematics achievement of the pre-service teachers through Structural Equation Modeling. Maximum Likelihood was used to estimate while Chi-square/degrees of freedom, Goodness of Fit Index, Normal Fit Index, Tucker-Lewis Index, Comparative Fit Index, and Root Mean Square Error of Approximation indices were used to evaluate the goodness of fit of the hypothesized models. The best fit model for the mathematics achievement of pre-service teachers is best anchored on aptitude supported by school environment. Academic buoyancy is necessary but insufficient for mathematics achievement.

Keywords: Structural Equation Modeling; Academic Buoyancy; Aptitude; School Environment; Mathematics Achievement; Pre-service Teachers.

1. Introduction

1.1. Pre-service Teacher

The quality of school and classroom instruction relies heavily upon its teachers. Before entering the teaching profession, the pre-service teachers need to complete at least secondary education of appropriate quality and relevance, so that they may acquire the skills needed to teach their future students and have a sound knowledge of the subjects they will be teaching. In some countries, teachers often enter the profession lacking core subject knowledge because their own education has been poor. A study of pre-service teacher education for lower secondary mathematics teaching in 15 countries, found that they have inadequate training, many newly qualified teachers are not confident that they have the skills necessary to support students with more challenging learning needs (UNESCO Global Monitoring Report, 2014)

1.2. Mathematics Academic Achievement

Researches that have been published in recent years suggest that teaching quality matters in terms of the student's achievement (Sanders, Rivers, & Hall, 1996). It was found that the teachers' mathematical knowledge was significantly related to mathematics achievement gains of students (Hill, Rowan, & Ball, 2005). They emphasized the need to provide highly qualified teachers that demonstrate subject-matter competency to have students with high mathematics achievement.

In terms of mathematics, the students in the Philippines always lag behind other countries in the region. In 2008, even with only science high schools participating in the Advanced Mathematics category, Philippines ranked lowest among ten countries

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(Mullis, Martin, & Loveless, 2016). The results showed that Philippines ranked 34th out of the 38 countries participating in the survey.

1.3. Academic Buoyancy

One of the many factors that influence mathematics academic achievement of students is academic buoyancy. This is the students' ability to successfully deal with academic setbacks and challenges that are typical of the ordinary course of school life such as poor grades, competing deadlines, exam pressure, difficult schoolwork and the like. Students who are highly buoyant will have great ability to overcome daily schooling challenges because academic buoyancy will act as a protective element and can also be the activator of calmness in oneself (Martin and Marsh, 2008).

Academic buoyancy which is considered as a latent variable is assessed by three observed variables namely: self-efficacy, coping skills and anxiety. Self-efficacy is the beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments (Bandura, 1997). In this study, it is the pre-service teachers' beliefs of their abilities to achieve excellence in mathematics, assignments, course, and tests. Coping Skills is a psychological construct defined as "constantly changing cognitive and behavioral efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person"(Lazarus & Folkman, 1984, p. 141). Mathematics Anxiety, on the other hand, is defined by Richardson and Suinn (1972) as a tension that interferes with the manipulation of numbers and solving everyday problems.

1.4. Aptitude

Another factor aside from academic buoyancy that influences the mathematics academic achievement of students is their aptitude. It measures the student's overall performance across a broad range of mental capabilities. Aptitude tests are cognitive measures used to predict future performance in some activities like school learning (Corengia, Pita, Mesurado, & Centeno, 2013). Aptitudes can be measured and are used to predict a person's potential for achievement in a defined area. If a person displays an aptitude for a type of activity by currently showing high specific ability in that field, one may predict that his or her performance will increase significantly with additional training in that area (Reber, Allen, & Reber, 2009).

In this paper, aptitude it is a latent variable defined by numerical reasoning, abstract reasoning and verbal critical reasoning abilities of the pre-service teachers. Numerical ability tests are designed to measure the candidates' capacity to manipulate or use numbers to correctly solve problems according to Olatoye & Aderogba (2011). Verbal Critical Reasoning tests are designed to test the student's ability to take a series of facts expressed in words and to understand and manipulate the information to solve a specific problem, while Abstract reasoning tests are used to test the student's ability to perceive relationships and then to work out any co-relationships using diagrams, symbols or shapes instead of words or numbers. These types of test involve identifying the underlying logic of a pattern and then determining the solution (Newton & Bristoll, 2017).

1.5. School Environment

School environment refers to factors within the school that influence the teaching-learning process. Student's academic achievement is highly dependent on school environment since they spend approximately three-fourths of the conscious part of their weekdays at school. It includes the physical and aesthetic surroundings and the psychological climate and culture of the school that can affect the teaching–learning process. The extent to which students learn could be enhanced depending on what the school environment provides to the learners and the teacher (Eccles, Wigfield, & Schiefele, 1998).

In the present study, this is considered as the third latent variable and is assessed by the following observed variables: Administrative Support, School Facilities and Classroom Social Environment. Administrative Support is the process of integrating the efforts of the school personnel, i.e., the members of the staff, the school administrators and the school heads and utilizing appropriate materials in such a way as to promote effectively the development of students' academic performance (Gigante & Firestone, 2008). School Facilities on the other hand refers to the schools infrastructures that are used by students and teachers in their daily school activities. It includes learner's resources such as equipment, classrooms, laboratories, libraries, playing fields, textbooks among others that enhance the quality and relevance of imparted skills thus creating conducive environment that promote effective teaching and learning (Schneider, 2002). Lastly, Classroom Social Environment is defined by Crosnoe, Monica and Glen (2004) as the general atmosphere in the school. It is related to the interpersonal relations between students and teachers. It is comprised of students' perceptions about how they are encouraged to interact with and relate to others.

1.6. Purpose of the Study

Academic buoyancy, aptitude and school environment form a complex network that are all interrelated and are likely to affect mathematics academic achievement. The study would contribute to the understanding of the complex phenomenon of student achievement in mathematics for both the researchers and the practitioners in the field. The model tested and validated would not only determine the factors that affect pre-service teacher's achievement but also provide a more accurate measure which will advance the research on student's mathematical achievement. The purpose of the study is to develop a structural model that best fit the mathematical academic achievement of pre-service teachers in relation to academic buoyancy, aptitude and school environment.

1.7. Structural Equation Model

Latent variables in Structural Equation Modeling generally correspond to hypothetical constructs or factors, which explanatory variables are presumed to reflect a continuum that is not directly observable. Three different indicators were used to measure academic buoyancy; coping skills, self-efficacy and anxiety. The indicators used to assess the construct of aptitude are numerical reasoning, verbal critical reasoning and abstract reasoning; while, classroom social environment, school facilities and administrative support were the indicators used to assess the construct of school environment. The use of multiple indicators is designed to achieve a better representation of the latent variable, and facilitates assessment of potential measurement errors in the statistical computing. According to Schumacker & Lomax (2012), it is commonly accepted that multiple observed variables are preferred over a single variable in defining a latent variable.

1.8. Study Constructs and Conceptual Model

Table 1 presents the exogenous and endogenous variables used in the study. The independent variables which are being used as measures of academic buoyancy are linked to the dependent variable mathematics achievement.

The four hypothesized structural models are illustrated in Figures 1-4. These models were explored hoping to come up with the best inter-linkages among the variables. The numbers "1" in the diagram indicate that the regression coefficient has been fixed to 1. Coefficients are fixed to a number to minimize the number of parameters estimated in the model.

Table 1. Variables of the study, its roles and measures

VARIABLES	CODE	ROLE	MEASURE
Academic Buoyancy			
Coping	AB-COP	Exogenous	Coping skills Questionnaire
Anxiety	AB-ANX	Exogenous	Anxiety Questionnaire
Self-efficacy	AB-SEF	Exogenous	Self-Efficacy Questionnaire
School Environment			
Classroom Social Environment	SE-CSE	Exogenous	Classroom Social Environment Questionnaire
Administrative Support	SE-ASU	Exogenous	Administrative Support Survey
School Facilities	SE-SFA	Exogenous	School Facilities Survey
Aptitude			
Numerical Reasoning	AP-NRE	Exogenous	Numerical Reasoning Psychometric Test
Abstract Reasoning	AP-ARE	Exogenous	Abstract Reasoning Psychometric Test
Verbal Critical Reasoning	AP-VCR	Exogenous	Verbal Critical Reasoning Psychometric Test
Mathematics Achievement			
Fundamentals of Math	MA-FOM	Endogenous	Fundamentals of Math Test
Plane Geometry	MA-PGE	Endogenous	Plane Geometry Test
Probability and Statistics	MA-PAS	Endogenous	Probability and Statistics Test
Elementary Algebra	MA-EAL	Endogenous	Elementary Algebra Test

1.8.1.1. Hypothesized Structural Model 1

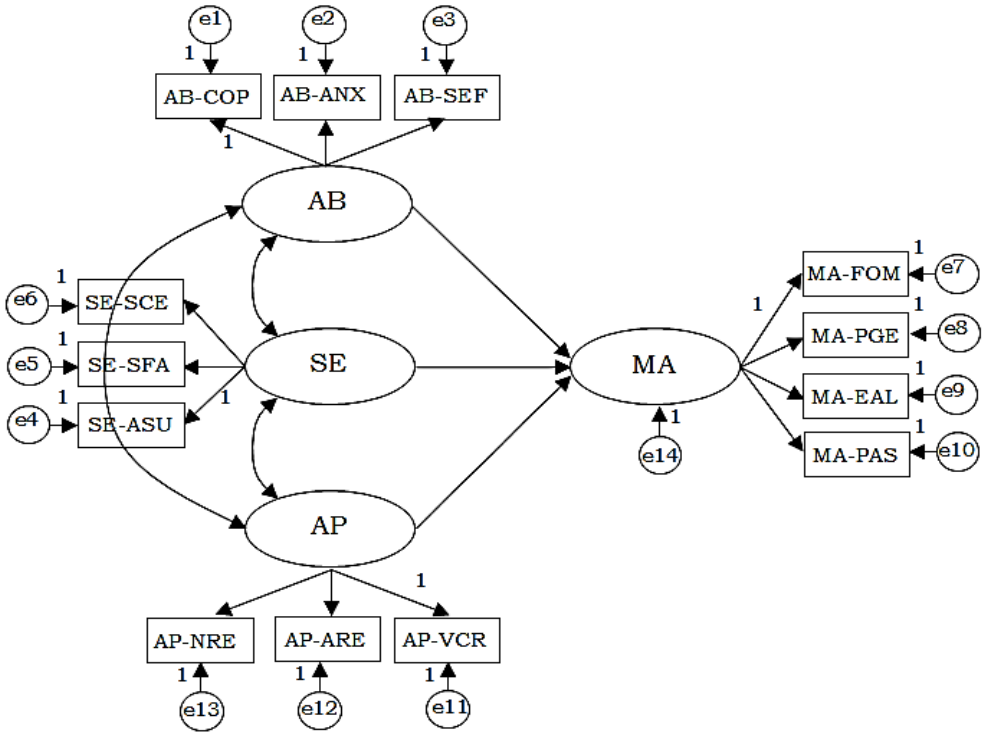

Figure 1 Academic Buoyancy, School Environment, Aptitude and Mathematics Achievement Model (AB-SE-AP-MA Model)

1.8.1.2. Hypothesized Structural Model 2

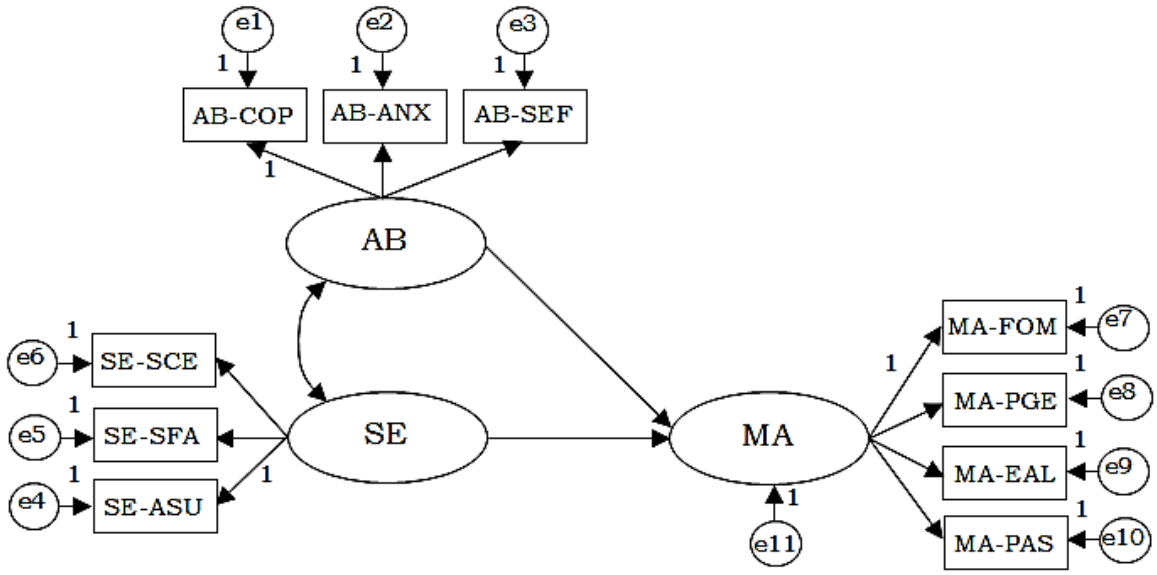

Figure 2. Academic Buoyancy, School Environment and Mathematics Achievement Model (AB-SE-MA Model)

1.8.1.3. Hypothesized Structural Model 3

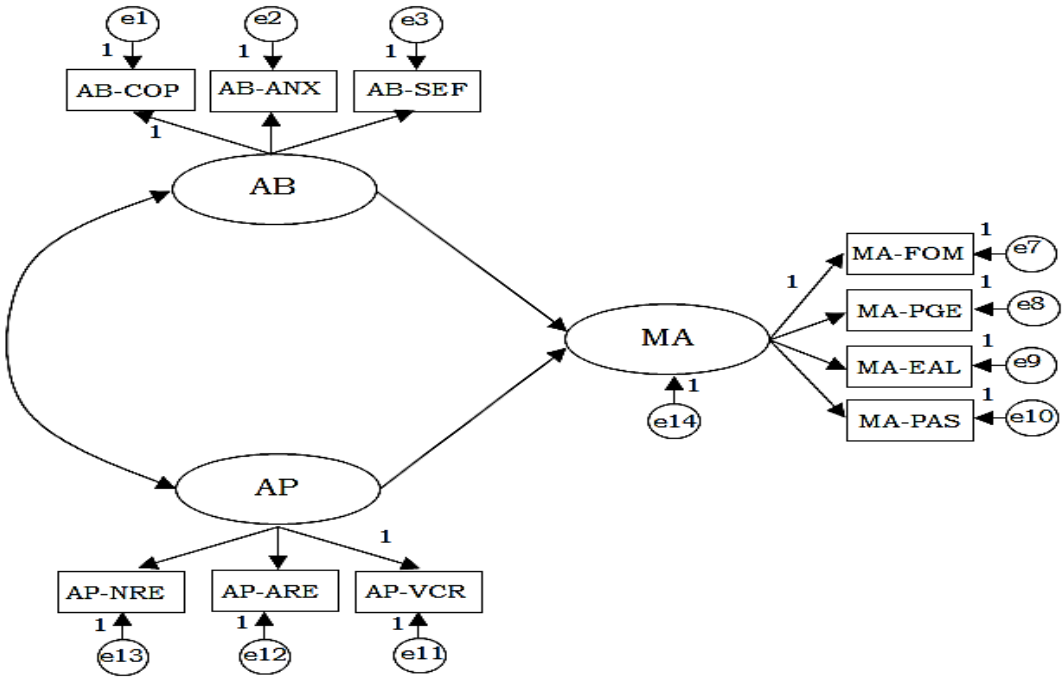

Figure 3. Academic Buoyancy, Aptitude and Mathematics Achievement Model (AB-AP-MA Model)

1.8.1.4. Hypothesized Structural Model 4

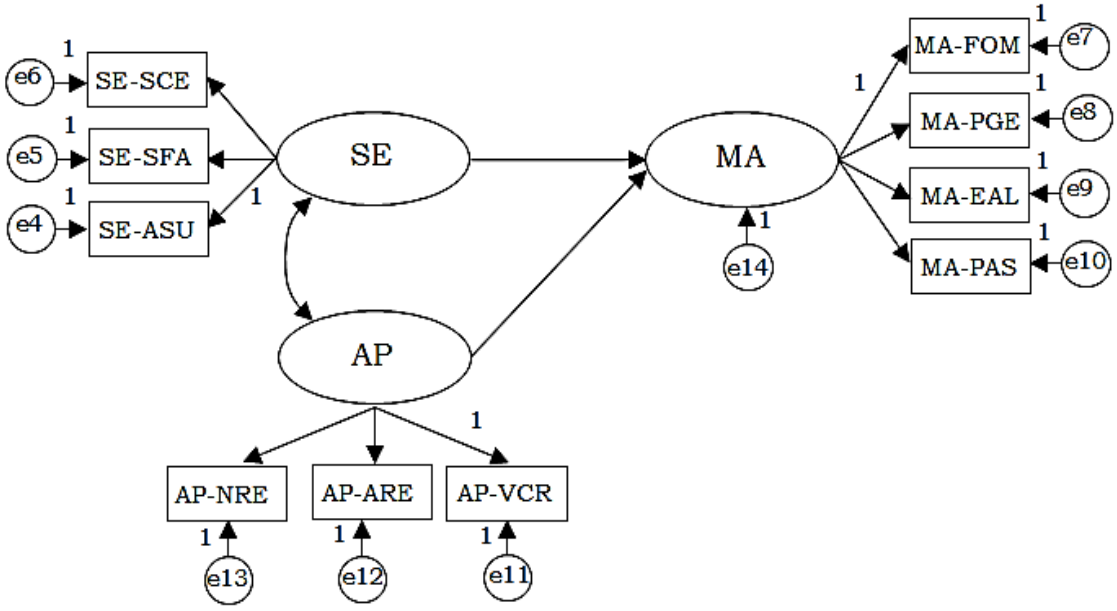

Figure 4. School Environment, Aptitude and Mathematics Achievement Model (SE-AP-MA Model)

1.9. Theoretical Framework

The triadic reciprocal causation (Bandura, 1986) best describes the relationship that associates the academic achievement of pre-service teachers to the different variables considered in this study. In this interdependent causal structure, personal (academic buoyancy and aptitude), behavioral (achievement) and environmental (school environment) factors operate as interacting determinants that influence one another bi-directionally. This reciprocity is not equivalent to equal strength between the three sets of interacting determinants, nor do the mutual influences and their reciprocal effects occur simultaneously as a holistic entity.

The interaction between personal and behavior factors reflects the interaction between academic buoyancy, aptitude and achievement. The student's ability to successfully deal with academic setbacks and challenges that a typical student will encounter and their cognitive ability give shape and direction to the knowledge and skills they develop in math. What students think, believe, and feel, affects how they behave. The natural and extrinsic effects of their achievement, in turn, partly determine their buoyancy and aptitude.

The relationship between environment and personal factors of reciprocal causation is concerned with the interactive relation between academic buoyancy, aptitude and environmental influences. Student's expectations, beliefs, emotional bents and cognitive competencies are developed by the general atmosphere in the school, the interpersonal relations between students and teachers and the students' perceptions about how they are encouraged to interact with and relate to others. Their school environment, in turn, determines the personal characteristics of students.

The reciprocal causation in the triadic system between environment and behavior represents the two-way influence between student's achievement and their school environment. In the transactions of everyday life, behavior alters environmental conditions and is, in turn, altered by the very conditions it creates. The environment is not a fixed entity that inevitably impinges upon individuals. When mobility is constrained, some aspects of the physical and social environment may encroach on individuals whether they like it or not. But most aspects of the environment do not operate as an influence until they are activated by appropriate behavior. Lecturers do not influence students unless they attend their classes, teachers usually do not praise their students unless they do something praiseworthy. The aspect of the potential environment that becomes the actual environment for given individuals thus depends on how they behave. Because of the bi-directionality of influence between behavior and environmental circumstances, people are both products and producers of their environment. They affect the nature of their experienced environment through selection and creation of situations.

2. Methodology

2.1. Research Design

The study used a descriptive-correlational and causal-comparative design. A questionnaire was administered to the pre-service teachers of the different state colleges and universities to gather description and information on their academic buoyancy, aptitude, school environment and mathematics achievement. In addition to data collection, the steps necessary for model testing was used; model specification, identification, estimation, evaluation, and modification (Hoyle, 1997; Kaplan, 2009; Kline, 2011; Schumacker & Lomax, 2012).

Correlational technique was also used to examine the relationships of responses to the questions in survey or several other variables. Multiple regression analysis was used to demonstrate the relationship between multiple predictor variables and a dependent or criterion variable.

2.2. Research Locale

The seven Public Higher Education Institutions (PHEIs) in the region were all members of the Philippine Association of State Colleges and Universities (PASUC) which is under the supervision of the Commission of Higher Education (CHED) Region A. Only five out of the seven state colleges and universities were chosen as participants of the study, since they were the only ones offering education courses.

2.3. Participants of the Study

The participants of the study were all pre-service teachers enrolled during the school year 2016 – 2017 either in the elementary or secondary education program of the participating State Colleges and Universities. Participation in the study was voluntary and the students were informed that they could withdraw from the process at any stage with no penalty to them.

2.4. Research Instrument

Four research instruments were used to answer the problem of the study: (1) multiple choice test that measures the mathematics achievement of the student, (2) aptitude test, (3) academic buoyancy questionnaire, (4) and school environment questionnaire. Prior to the administration of the questionnaire the draft of the instrument was subjected to face and content validation by the panel of experts. The items in the questionnaires were then modified based from their comments and suggestions. Test reliability was done among the 75 pre-service teachers who were non participants of the study and it was found to have a high internal consistency as indicated by their corresponding Chronbach's Alpha.

2.4.1. Mathematics Achievement

The mathematics achievement test was a multiple choice exam made by the researcher and it includes 10 items for each topic which is mathematic competencies found in the Philippines Licensure Examination of Teachers (LET). Topics included were fundamental of mathematics, plane geometry, elementary algebra and probability and statistics. Originally, each topic contained 15 items but were reduced to 10 as suggested by the panel of experts. The items were removed by the researcher in such a way that a desired acceptable Chronbach's Alpha ($\alpha = 0.700$) was achieved.

2.4.2. Academic Buoyancy

Academic buoyancy includes self-efficacy, anxiety and coping skills. The first two subcomponents of academic buoyancy were adopted from the "Mathematics Self-Efficacy and Anxiety Questionnaire" (May, 2009). Originally it contained a total of 29 items but was reduced to 10 items each. Coping skills adopted from Carver and Scheir (1989) were also reduced from 43 to 10 items. Items removed were based from the suggestions of the panel of experts and considering also the reliability of each item. The items were also trimmed in such a way that a desired Chronbach's Alpha ($\alpha = 0.775$) was achieved.

2.4.3. Aptitude

The Aptitude test includes numerical reasoning, abstract reasoning, and verbal critical reasoning. Five (5) items from each subcomponent were included in the test and the Chronbach's Alpha (α) is 0.870. These items were adopted from Psychometric Success sample test by Newton & Bristoll (2017).

2.4.4. School Environment

School environment includes classroom social environment, and the research questions were adopted from Patrick & Ryan (2003). Initially it contained 17 items before it was reduced to 10. School environment also includes school facilities and administrative support and the questions were adopted from McGowen (2007) and from Seed Administrator Evaluation Survey, 2013. Both were reduced to 10 from 20 and 16 items respectively. The items were trimmed based from the suggestions of the panel of experts in such a way that a desired Chronbach's Alpha ($\alpha = 0.900$) was achieved.

2.4.5. Data Gathering Procedure

Following protocol prior to gathering of the data, the State Colleges and Universities included in the study were already identified by the researcher. A request letter for the approval for the conduct of the study to the different HEIs addressed to the different presidents was secured. The researcher then went to the different State Colleges and Universities for the approval of the request letter and to set schedule when the research instrument would be launched. The researcher administered the mathematics achievement test and the aptitude test together with the academic buoyancy and school environment questionnaire in one setting. This was to ensure that each student answers all the items in the research instrument. Each student finished answering the research instrument for an average of one hour and thirty minutes.

2. Results and Discussion

This section presents the four models hypothesized in the study together with the endogenous and exogenous variables. The models were derived from the correlation of the latent variables attributed by several measured variables. As shown in each of the four figures, the latent variables were represented with circles and measured variables were represented with squares. The line with an arrow in one direction shows a hypothesized direct relationship between the two variables; while, the absence of a line indicates no causal relationship between the variables. The arrow originates at the causal variable and point to the variable that was caused. The curved line with an arrow in both directions demonstrates a bi-directional relationship or covariance for exogenous variables. For every endogenous variable, a residual term was added in the model; a circle with the letter "e" written in it that stands for error.

2.1. Structural Model 1

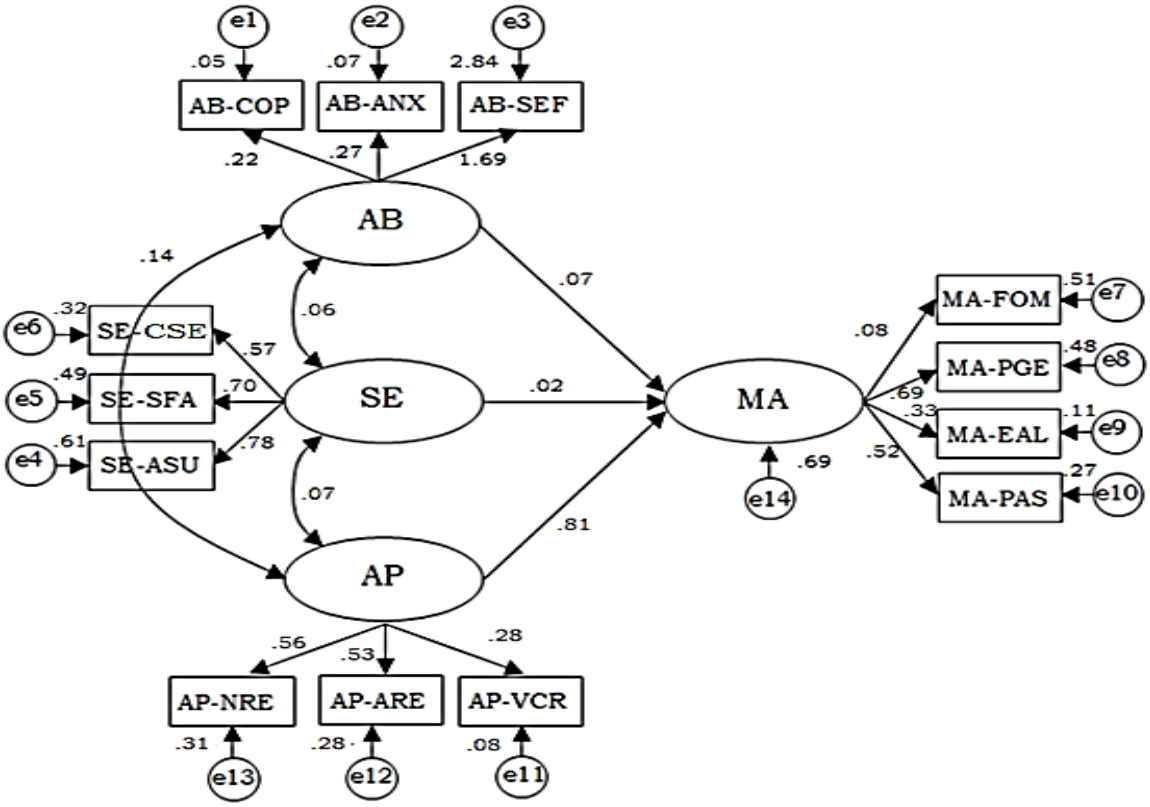

Figure 5. Academic Buoyancy, School Environment, Aptitude and Mathematics Achievement Model (AB-SE-AP-MA Model)

The findings show that if AB were increased by one standard deviation while SE and AP were held constant, MA would be expected to increase by 0.07 standard deviations. On the other hand, if SE was increased by one standard deviation taking into consideration the two other variables, MA would be expected to increase by only 0.02 standard deviations. Lastly, if AP was increased by one standard deviation taking into consideration AB and SE, MA would be expected to increase by only 0.81. The effects of latent to latent variables and between measured and latent variables were estimated to produce regression weights as shown in Table 2.

Table 2. Standardized regression weights of structural model 1

	Variables			β	S.E.	C.R.	βETA	P
MA	←	AB		8.392	2.581	3.252	0.071	0.001
MA	←	SE		0.561	1.121	0.508	0.025	0.603
MA	←	AP		0.878	0.094	9.354	0.814	***

Looking at the p-value, the result shows that only aptitude among the three latent variables in the 1st model was a significant predictor of student's achievement in mathematics. As displayed in Table 3, the goodness of fit of Model 1 was examined using the following indices: chi square/degrees of freedom (CMIN/DF), Root Mean Square of Error Approximation (RMSEA), Norm Fit Index (NFI), Tucker - Lewis Index (TLI), Comparative Fix Index (CFI) and Goodness of Fit Index (GFI). The criterion for each index indicates a good fit and all criterions must be satisfied in order to have a good fit of the model.

Table 3. Standard fit measures of structural model 1

STANDARD INDEX	STANDARD VALUE/ CRITERION	MODEL 1 FIT VALUE
CMIN/DF	0 < CMIN/DF < 2	5.036
P-VALUE	> 0.05	0.000
NFI	> 0.95	0.874
TLI	> 0.95	0.862
CFI	> 0.95	0.896
GFI	> 0.95	0.959
RMSEA	< 0.05	0.063

Clearly, there is a need to find another model since the results showed a poor fit. Only one (GFI=0.959) out of the seven standard value/criterion of the indices were satisfied. The values of the indices CMIN/DF (5.036) together with its P-value (0.000), NFI (0.874), CFI (0.896) and RMSEA (0.063) did not satisfy the set for a good fit model.

2.2. Structural Model 2

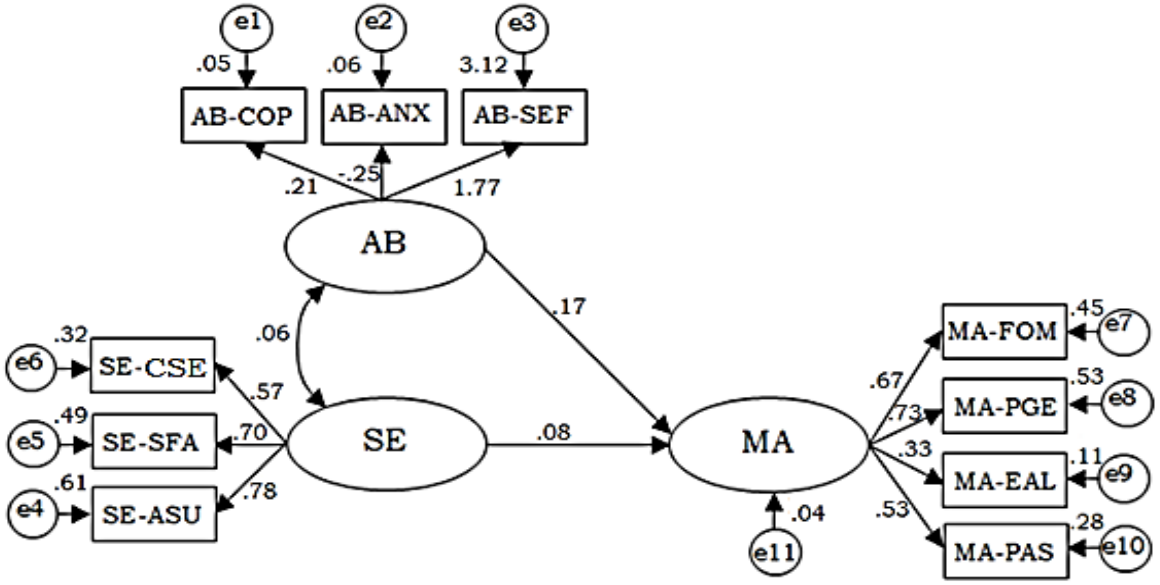

Figure 6. Structural Model 2: Academic Buoyancy, School Environment and Mathematics Achievement Model (AB-SE-MA Model)

From figure, if AB were increased by one standard deviation holding SE constant, MA would be expected to increase by 0.17 standard deviations. On the other hand, if SE was increased by one standard deviation holding AB constant, MA would be expected to increase by only 0.08 standard deviations.

Table 4. Standardized regression weights of structural model 2

Variables			β	S.E.	C.R.	βETA	P
MA	←	AB	18.702	2.726	6.869	0.16	***
MA	←	SE	1.856	1.031	1.807	0.072	0.07

As shown in the table, school environment (SE) with p-value and beta weight is not a significant predictor of academic achievement of pre-service teachers. Only academic buoyancy (AB) had a significant relation to student's mathematics academic achievement. Looking at the first column, the unstandardized estimate of academic buoyancy (AB) to math achievement (MA) means that 1 point increase on the academic buoyancy of students predicts 18.702 point increase on their mathematics academic achievement. Table 5 presents the assessment of the goodness-of-fit of Model 2. The model fit for the two latent variables combined did not assume a true model being fitted to the data.

Table 5. Standard fit measures of structural model 2

STANDARD INDEX	STANDARD VALUE/ CRITERION	MODEL 2 FIT VALUE
CMIN/DF	0 < CMIN/DF < 2	8.126
P-VALUE	> 0.05	0.000
NFI	> 0.95	0.865
TLI	> 0.95	0.830
CFI	> 0.95	0.879
GFI	> 0.95	0.953
RMSEA	< 0.05	0.084

CMIN/DF together with its P-value and RMSEA did not qualify to the standard measures of goodness-of-fit. Notice, the chi-square minimum/degrees of freedom (8.126) is way beyond the value of 2 with p-value (0.000) which was less than 0.05 and root mean square of errors approximation (0.084) greater than 0.05. Also, measures of normed fit index (0.865), Tucker-Lewis index (0.830) and comparative fit index (0.879) were all less than the standard value/criterion, which was 0.95. All indices must be met to justify a good model with reference to the data. Having only goodness of fit index (0.953 > 0.950) that met the value/criterion makes this a poor fit model. Hence there is a need to look for another model.

2.3. Structural Model 3

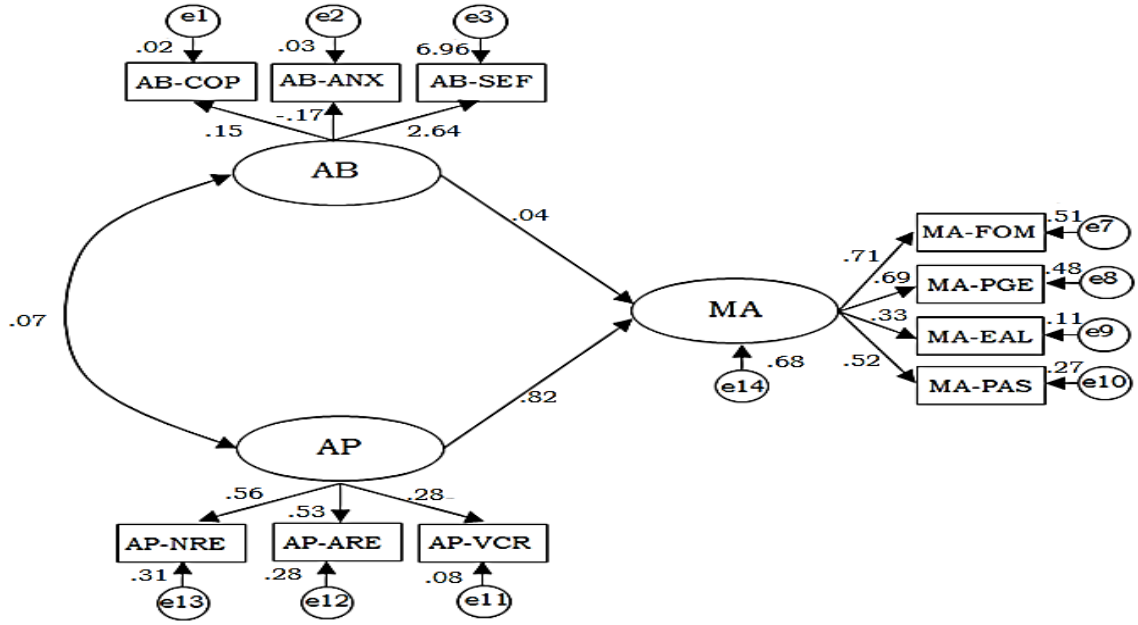

Figure 7. Structural Model 3: Academic Buoyancy, Aptitude and Mathematics Achievement Model (AB-AP-MA Model)

A shared relationship of an endogenous variable mathematics achievement (MA) and two exogenous variables academic buoyancy (AB) and aptitude (AP) is displayed in Figure 7. The total effect assumed by aptitude to mathematics academic achievement of students is way far better compared to the total effect of academic buoyancy. Also, if AB were increased by one standard deviation holding AP constant, MA would be expected to increase by only 0.04 standard deviations. On the other hand, if AP was increased by one standard deviation holding AB constant, MA would be expected to increase by 0.82 standard deviations. As shown in table 6, only aptitude shows a significant relationship with mathematics academic achievement of students as compared to academic buoyancy shown by their beta weight and p-value.

Table 6. Standardized regression weights of structural model 3

Variables			β	S.E.	C.R.	βETA	P
MA	←	AB	6.919	2.307	2.999	0.041	0.003
MA	←	AP	0.888	0.094	9.457	0.823	***

The unstandardized estimate in Table 6 of the beta weights of aptitude (AP) mean that one point increase on the aptitude of students predicts 0.888 point increase in their mathematics academic achievement. Table 7 illustrates the goodness-of-fit for model 3 when the actual values of the endogenous variables were collected with their predicted values.

Table 7. Standard fit measures of structural model 3

STANDARD INDEX	STANDARD VALUE/ CRITERION	MODEL 3 FIT VALUE
CMIN/DF	0 < CMIN/DF < 2	5.123
P-VALUE	> 0.05	0.000
NFI	> 0.95	0.897
TLI	> 0.95	0.880
CFI	> 0.95	0.915
GFI	> 0.95	0.972
RMSEA	< 0.05	0.064

Results reveal that the chi-square (CMIN/DF), which was 5.123 along with its p-value (0.000), did not show an acceptable measure for the fitted values. Only GFI (0.972) met the acceptable measure. Furthermore, NFI (0.897), TLI (0.880), CFI (0.915) were all greater than 0.095 and did not indicate a good fit value together with and RMSEA (0.064). This indicated a poor fit model to the data; therefore, another model have to be tested.

2.4. Structural Model 4

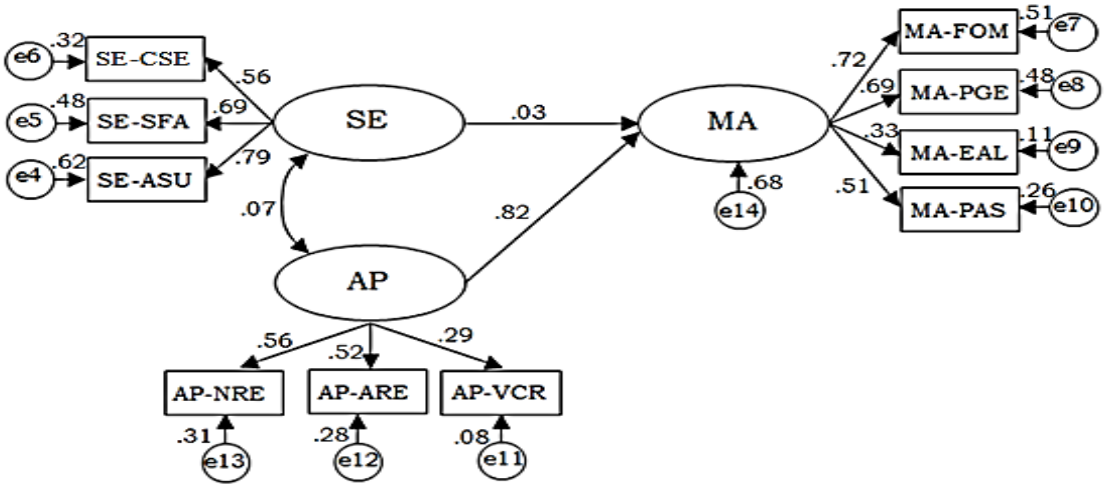

Figure 8. Structural Model 4: School Environment, Aptitude and Mathematics Achievement Model (SE-AP-MA Model)

The standardized total effect of aptitude and school environment to math achievement means that an increase in 1 standard deviation in the aptitude and school environment; while, holding the other variable constant, predicts a 0.82 and 0.03 standard deviation increase, respectively in their mathematics academic achievement.

Table 8. Standardized regression weights of structural model 4

Variables			β	S.E.	C.R.	βETA	P
MA	←	SE	0.657	1.124	0.584	0.026	0.559
MA	←	AP	0.898	0.095	9.444	0.824	***

As shown in the standardized regression weights of structural model 4, only aptitude gave off a significant relationship with pre-service teacher's mathematics achievement. The table also shows that school environment was not a significant predictor of pre-service teacher's mathematics achievement as shown by the beta weight and p-value. Therefore, aptitude of students highly predicted the mathematics academic achievement of pre-service teacher's in this representation. The unstandardized direct effect of aptitude (AP) to math achievement (MA) means that 1 point increase on the aptitude predicts a 0.898 point increase in their mathematics academic achievement.

Table 9 provides detailed illustration to show the goodness-of-fit indices of model 4. It illustrates the best fit of the model as indicated by CMIN/DF which is 1.124 and 0<CMIN/DF<5, with its corresponding p-value (0.288) which is greater than 0.05. Showing also acceptable measures (>0.95), were the indices of NFI (0.978); TLI (0.996); CFI (0.997) and GFI (0.993). Furthermore, the value of RMSEA also satisfied the criterion for a good fit with its value (0.011) greater than 0.05.

Table 9. Standard fit measures of structural model 4

STANDARD INDEX	STANDARD VALUE/ CRITERION	MODEL 4 FIT VALUE
CMIN/DF	0 < CMIN/DF < 2	1.124
P-VALUE	> 0.05	0.288
NFI	> 0.95	0.978
TLI	> 0.95	0.996
CFI	> 0.95	0.997
GFI	> 0.95	0.993
RMSEA	< 0.05	0.011

In general, the direct relationship of school environment and aptitude were declared as the measurement model where all the standard value/criterion for goodness-of-fit are satisfied. The best fit model for mathematics academic achievement of pre-service teachers in Region 10 is best anchored on the aptitude (AP) of students with β=0.824, supported by their school environment (SE) having β=0.026.

In the fit model, latent variable aptitude was estimated by three observed indicators; numerical, abstract and verbal critical reasoning. Among these indicators, AP-NRE had the greatest factor loading on AP, the corresponding standardized path coefficient indicated a relatively large effect size. It is no surprise, then, that aptitude of the students explained about 31.36% of the variance of numerical reasoning. The factor loading of AP-ARE on AP was also high, and 27.04 % of the variance of abstract reasoning is explained by their aptitude. Furthermore, that aptitude of the students explained only about 8.41% of the variance of verbal critical reasoning, as shown by the small factor loading of AP-VCR to AP.

School environment is a latent variable measured by classroom social environment, school facilities and administrative support. SE explains 62.41%, 47.61% and 31.36% respectively of the variance of SE-ASU, SE-SFA and SE-CSE as indicated by their factor loadings of 0.79 for SE-ASU, 0.69 for SE-SFA and 0.56 for SE-SCE. The covariance among two latent variables (AP and SE) in the figure was only 0.07 showing only a minimal relationship between the two; thus, there is little correlation between these two latent variables.

The path coefficient of AP towards MA however was very strong showing that mathematics academic achievement of the students is best anchored on aptitude. This further shows that an increase in 1 standard deviation on aptitude of students while taking into account school environment, the mathematics achievement of students increase by 0.82 standard deviation. Furthermore, mathematics achievement (MA) explained 67.24% of the variance of the aptitude (AP) of the students. The remaining 32.76% of the variance is explained by the measurement error, which represented all unmeasured causes of mathematics achievement and score unreliability. In other words, the variance in the observed variable was explained by the underlying factor and the measurement error.

The minute path coefficient of SE towards MA means that mathematics academic achievement of students was only supported by their school environment. An increase of 1 standard deviation on SE would predict and increase of only 0.03 standard deviation on their achievement.

The result that aptitude is the best predictor of mathematics achievement of students agrees with previous findings (Stump & Stanley, 2002; DeBerard, Spielmans, & Julka, 2004; Sujata, 2005; Aluja & Blanch, 2004). Aptitude is an abstract quality or a psychological characteristic which cannot be measured directly predicted achievement according to Gagné & St Père, (2002). They further claimed that aptitude test, in itself, is nothing more than an achievement test, but it is used not simply as a measure of present performance in the special task but as an index of future performance in other and broader tasks.

The theory that supported the findings of the present study is the triadic reciprocal causation of Bandura (1986). In this interdependent causal structure of Bandura, internal personal factors, behavioral and environmental events operate as interacting determinants that influence one another bi-directionally. In the present model, however, it is only in the directional effect from aptitude (internal factor) towards achievement (behavioral) and another from school environment (environmental) towards achievement (behavioral). Although the interaction between aptitude and school environment was bidirectional, the covariance between these two factors were only minimal.

The theory of multiple intelligences (Gardener, 1999) also supported the results of this study concerning mathematics aptitude and mathematics achievement of pre-service teachers. According to this theory, the specific intelligence called logical-mathematical deals with numbers and logic which is a type of intelligence that includes the ability to reason, sequence, think in terms of cause-and-effect, create hypotheses, look for conceptual regularities or numerical patterns, and enjoy a generally rational outlook on life. A student with high aptitude in mathematics would have high mathematics achievement scores.

Education production function theory, an application of the economic concept of a production function to the field of education, also supported the findings of the study in a sense that there is a significant path coefficient from school environment towards mathematics achievement. Input measures including classroom social environment, school facilities, and administrative support affect a student's mathematics achievement (Hanushek, 2011).

The result showed that aptitude explained the largest proportion of the variance in student's achievement together with their school environment. This means that students with high aptitude specifically on numerical and abstract reasoning would most likely have high academic achievement in mathematics because numerical reasoning ability test is designed to measure the student's capacity to manipulate or use numbers to correctly solve problems. Abstract Reasoning tests are used to test the student's ability to perceive relationships, and to work out any co-relationships using diagrams, symbols or shapes instead of words or numbers both relevant to the content being taught in mathematics (Newton & Bristoll, 2017).

3. Conclusion

Results showed that the best fit model is Structural Model 4: School Environment, Aptitude and Mathematics Achievement Model (SE-AP-MA Model). The best fit model on mathematics academic achievement of pre-service teachers in Region 10 is best anchored on the aptitude of students (β=0.824) supported by their school environment (β=0.026).

The theory generated based on the result of the study is that the academic achievement of students is best anchored on their aptitude supported by their school environment. The better the level of aptitude of the students are specifically in numerical

reasoning and abstract reasoning supported by an conducive school environment, then the better they perform on mathematics achievement tests resulting in high academic achievement. It is probable that academic buoyancy is a necessary but not sufficient condition for mathematics achievement.

Due to the significant role of aptitude in students' mathematics academic achievement, the teachers, educational policy-makers and practitioners as well as parents should endeavor to promote and develop the psychometric attributes of the students. The administrators and teachers may use prior academic achievement measures of the pre-service teachers, especially the preparatory GPA to identify students who need remediation and support. Policy makers may review and evaluate their programs and set up appropriate selection criteria for admission to the education course and consider aptitudes scores, so as to improve the quality of learning and teaching.

The effect of school environment on student's mathematics academic achievement; necessitate for effort to be taken in order to strengthen the school environment. Efforts may be taken to further strengthen the school environment.

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