Assessing the Factors of Academic Achievement in Mathematics in the Modern World Using Structural Equation Modeling

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Erika Mae P. Asoy[1] and Ronel G. Dagohoy[2]
[1,2]Kapalong College of Agriculture, Sciences and Technology, Davao del Norte, Philippines

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ABSTRACT. In the Philippines, Mathematics in the Modern World plays a crucial role in various aspects of people's lives and shaping how people understand the world. The primary aim of this study was to construct the most suitable model for predicting academic success in Mathematics worldwide by investigating how self-concept, teaching quality, and the learning environment are interconnected. To achieve this, the study employed a descriptive-causal approach and utilized Structural Equation Modeling (SEM). Data were gathered from the 200 higher education students of a public community college in Davao del Norte through stratified random sampling. The results showed that the model developed for academic achievement effectively demonstrated the connection between teaching quality and the learning environment and their direct influence on academic achievement. This signifies that the extent of teaching quality and learning environment could mean higher academic achievement. Higher education institutions may consider the model in advancing the academic achievement of Mathematics in the Modern World.

1.0. Introduction

Academic achievement drives students toward their ultimate aspirations. To achieve this, students fuel their thinking with ideas and experiences, which are transformed into behavior (Abed et al., 2019). Nonetheless, in Germany, Meyer et al. (2019) noted that academic performance suffered because of diminished expectancy beliefs. Parallel to this, negative attitudes contributed to the low mathematics performance of students in the Philippines (Peteros et al., 2019). Consequently, the 2019 Trends in International Mathematics and Science Study (TIMSS) revealed that Filipino students had a significantly low average mathematics achievement. The sudden decline in scores from 358 in 2003 to 297 in 2019 implied that only one percent had reached the advanced benchmark (Bernardo, 2020). Thus, shortcomings and negative factors in the teaching and learning of mathematics contribute to students' failure (Casinillo, 2019).

Effective learning in mathematics was considered to be a mechanism for making rational decisions (Malik & Rizvi, 2018). By the same token, it was regarded as the outcome of developing knowledge and skills (Algani & Alhaija, 2021). In the same way, Snodgrass (2021) agreed that mathematics achievement was an essential factor for students to be prepared for their college choices and career paths. Further, Islam (2018) supported that it was the central criterion for admission and class promotion and thus resulted in personal satisfaction and social recognition. Hence, this suggests that mathematics holds significance in students' everyday lives and overall welfare (Casinillo et al., 2020).

*Correspondence: ronelgdagohoy@gmail.com
Ronel G. Dagohoy, Kapalong College of Agriculture, Sciences and Technology, Davao del Norte, Philippines

Over time, extensive research associated academic achievement with different variables. Susperreguy et al. (2017) conducted research that linked self-concept as a predictor of academic success. It was revealed that a positive view of mathematics is essential in boosting subsequent accomplishments. Meanwhile, another factor of academic achievement was teaching quality. Literature emphasized that teaching quality appeared to enhance effort regulation and, in effect, improved mathematics proficiency (Leon et al., 2017). Also, teachers should strive to motivate students to embrace the new class setup by utilizing suitable platforms and engaging them in meaningful activities (Valenzona et al., 2022). On the other hand, Bakare and Orji (2019) highlighted the need for a suitable learning environment. Active participation allowed students to master their mathematics skills, which were relevant inside and outside the classroom. In summary, Walberg (1980) theorized key factors influencing academic achievement and established aptitude, teaching, and environment as the primary pillars.

Due to the significant challenges posed by this issue, numerous studies have been carried out to identify factors, draw conclusions, and offer recommendations. However, the researcher has not encountered a study encompassing all the variables mentioned above within the realm of higher education curriculum, especially one employing structural equation modeling. Thus, there is a need to conduct the study.

The study aimed to construct a model for predicting academic success in Mathematics within the context of the modern world. Specifically, the study had the following objectives: To assess and describe the students' self-concept levels. To evaluate and describe the quality of teaching provided by teachers. To assess and describe the learning environment in classrooms. To evaluate and describe the levels of academic achievement in Mathematics in the modern world. To identify and establish significant interrelationships between self-concept, teaching quality, learning environment, and academic achievement. To determine which of the external factors has the most substantial influence on academic achievement. To formulate a model that best represents the academic achievement in Mathematics within the modern world. In particular, the model suggested a comprehensive view of how the measured and construct variables correlated and, thus, which factor highly predicted academic achievement in Mathematics in the Modern World. This study is the basis for developing plans for advancing student's academic achievement in Mathematics in the Modern World.

2.0. Literature Review

The study is primarily anchored to the Educational Productivity Theory of Walberg (1980), which asserted that certain factors must be maximized to increase affective, behavioral, and cognitive learning. Among these factors, self-concept, quality of instruction, and school environment were said to be significantly affecting the academic achievement of students. Accordingly, students' ability to progress and function is defined by their intention to conduct activities, solve problems, and actively participate in the lessons. Also of equal importance, the quality of teaching is critical in building and ensuring the learning process. Then, when evaluating student success, another important factor is the environment. Furthermore, when combined with current econometric analysis, the theory serves as a comprehensive beginning stage for observational research and educational policy.

Similarly, Jaiswal and Choudhuri (2017) proposed that there exists a favorable correlation between self-concept and academic success. Therefore, teachers and parents must collaborate in enhancing both self-concept and achievement to foster the sustained growth of students' success. Moreover, it was discovered that instructional clarity, organization and/or preparation, and expressiveness all relate to enhanced course achievement based on students' perceptions of teaching qualities (Brown & Kurzweil, 2017). Furthermore, Ijak et al. (2017) interpreted the necessity for a positive learning environment—because students learn better when they have a constructive perception of their environment—that can positively impact learning outcomes such as academic achievement.

Correspondingly, the study is also rooted in the interrelationships between the exogenous variables. According to Yi and Lee (2017), the high level of instructional quality in every index at all mathematics achievement levels contributed to a higher mathematics self-concept for Singaporean learners, as evidenced in international studies such as PISA and TIMSS. Moreover, a study found substantial variations in students' self-concept following the intervention in the learning environment, wherein self-concept levels were higher in the study group (Elsayed Abdelhalim et al., 2020). Furthermore, Song's (2018) research revealed that instructional design is beneficial in cultivating collaborative problem-solving skills among elementary students within an integrated learning environment.

The hypothetical model depicted in Figure 1 includes two categories of underlying constructs, referred to as exogenous and endogenous variables. The exogenous variables in the study encompass self-concept, teaching quality, and the learning environment. In contrast, the endogenous variable is academic achievement. Since latent variables are not directly observable, they cannot be directly measured. Therefore, each latent construct is associated with multiple measurements or observable variables. Consequently, a key focus of this study was to

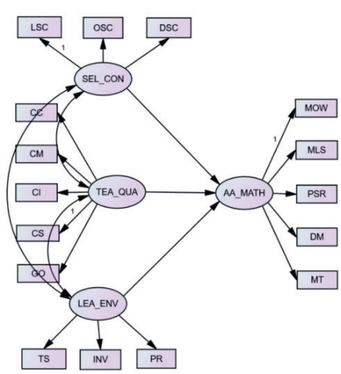

Figure 1. Hypothesized Model Showing the Interrelationships between Variables

determine the strength and direction of the regression lines extending from the latent variables to the observed variables.

The latent self-concept comprises three indicators: *learned self-concept, organized self-concept,* and *dynamic self-concept.* Learned self-concept pertains to how individuals develop beliefs as influenced by surroundings; organized self-concept refers to the consistency of individuals' belief of themselves despite others' perspectives; and dynamic self-concept is identified as the change in beliefs and responses resulting from experiences (Peteros et al., 2019).

The latent variable "teaching quality" is assessed through the following five observable indicators: Classroom climate reflects the quality of the teacher-student relationship; classroom management encompasses the presence of rules, routines, and organized lesson structures; clear instruction which involves the teacher's ability to explain the subject matter effectively and engagingly; Challenging students, which pertains to the teacher's support for higher-order thinking and metacognition among students; Goal orientation which is connected to the teacher's efforts to ensure that lessons are meaningful and purposeful for students (van der Scheer, 2019).

The latent variable "learning environment" comprises three dimensions, or scales: Teacher support, which gauges the degree to which teachers establish meaningful connections with their students. Involvement, which evaluates the range of learning opportunities provided to learners. Personal relevance describes the extent to which the subject matter is connected to students' experiences outside of the classroom (Afari, 2013).

Academic achievement in Mathematics within the context of the Modern World encompasses five distinct domains: Mathematics in our world, which underscores the application of mathematics in understanding natural phenomena and the world around us. Mathematical language and symbols pertain to using mathematical symbols, syntax, and rules for effective communication and problem-solving. Problem-solving and reasoning, which extend beyond numerical calculations and involve critical thinking and logical problem-solving. Data management involves the processing and analyzing of data to make predictions and informed decisions. Mathematics as a tool that relates to the various practical and societal applications of mathematics (Commission on Higher Education [CHED], n.d.).

3.0. Methodology

The study utilized the descriptive-causal research method to measure the extent to which the variables were associated. In correspondence, descriptive-causal research revealed variables that were interacting and the type of interaction that transpired. Then, this enabled the researchers to draw conclusions based on established relationships (Seeram, 2019).

Furthermore, the study employed the Structural Equation Model (SEM). SEM is a data analysis approach rooted in theory, used to test and confirm pre-existing hypotheses regarding causal connections among observable and/or latent variables. In essence, this method assesses how well the data, typically in the form of correlations, aligns with one or more conflicting causal theories in experimental or non-experimental research settings (Hancock et al., 2018). Such a method was used to generate a best fit model on academic achievement in Mathematics in the Modern World of education students considering self-concept, teaching quality, and learning environment as exogenous variables.

The study was conducted at Kapalong College of Agriculture, Sciences, and Technology (KCAST), a local college located at the heart of the Municipality of Kapalong. The study involved third- and fourth-year students of the Academic Year 2021-2022 of the KCAST as they had undergone the course GE 105—Mathematics in the Modern World face-to-face. The sample size for this study was determined using Soper's (2020) online calculator software, which computed the minimum sample size required for the model structure. Initially, based on the number of latent and observed variables in the study, the calculation suggested a minimum of 100 samples. However, following the recommendation of Kyriazos (2018), who emphasized that in a structural equation model, the sample size should ideally be at least 200, the researchers opted for a sample size of 200 participants. This decision aligns with the principle in quantitative research that emphasizes that a larger sample size provides greater statistical power and adheres to the guidance provided by both cited sources regarding SEM sample sizes.

Moreover, the study employed stratified random sampling to determine the distribution of samples. In stratified random sampling, distinct strata are created based on shared characteristics or attributes of the individuals in the population. A random sample is then selected from each stratum, with the size of each sample being proportional to the size of the stratum in relation to the total population (Sharma et al., 2017). In this particular study, the strata were defined by the four programs within the Teacher Education Department of KCAST.

The study utilized three downloadable questionnaires sourced from the internet to assess the exogenous variables. These questionnaires were modified in terms of length for the convenience of the research participants. For self-concept assessment, the instrument was adapted from the study "Factors Affecting Mathematics Performance of Junior High School Students" by Peteros et al. (2019). To measure teaching quality, the questionnaire was derived from van der Scheer et al. (2019) titled "Validity and Reliability of Students' Perceptions of Teaching Quality in Primary Education." For evaluating the learning environment, the instrument was obtained from Afari's study (2013) titled "The Effects of Psychosocial Learning Environment on Students' Attitudes towards Mathematics." Additionally, the instrument for assessing the endogenous variable (academic achievement in Mathematics in the Modern World) was developed by the researchers themselves. This test was designed to align with the domains outlined in the suggested syllabus of the Commission on Higher Education (CHED, n.d.).

The survey research questionnaire underwent a rigorous validation process to guarantee content validity. Initially, the first draft of the research instrument was submitted to the research committee for their input, suggestions, and recommendations to enhance its clarity and effectiveness. Subsequently, the corrections and improvements suggested by the committee were incorporated. Finally, the refined and finalized draft of the questionnaire was presented to the research panel for further examination and fine-tuning. This meticulous review process was undertaken to ensure the instrument's accuracy and appropriateness for the study.

The feedback, corrections, comments, and suggestions provided by expert validators were carefully integrated into the final revision of the questionnaire before commencing data collection. Furthermore, the ratings and assessments from these validators were aggregated to ascertain the overall quality and suitability of the questionnaire. Additionally, the multiple-choice test designed to measure academic achievement in Mathematics in the Modern World underwent a meticulous creation process guided by a Table of Specifications. This test was also subjected to validation by the research panel before the actual study was conducted. In summary, the rigorous validation processes applied to both the questionnaire and the academic achievement test were intended to ensure the reliability and validity of the study's results.

The study employed several statistical tools to analyze the data and test the hypotheses: Mean: Mean was utilized to assess the extent of self-concept, teaching quality, learning environment, and academic achievement. Pearson r: Pearson's correlation coefficient was employed to determine the relationships between self-concept, teaching quality, learning environment, and academic achievement. Multiple Regression Analysis: This method was used to analyze the significant impact of self-concept, teaching quality, learning environment, and academic achievement. Structural Equation Modeling (SEM): SEM was utilized to explore and establish the best-fit model. Factor analysis was also conducted to assess the latent variables. Alternative Model using Analysis of Moment Structure (AMOS): AMOS was employed to generate the best-fit model. To identify the best-fit model, it was essential for all the indices' values to meet the required criteria. These statistical tools collectively enabled the study to analyze the data comprehensively and determine the most suitable model for academic achievement in Mathematics in the Modern World.

The participants in this study were education students, and the researcher took diligent steps to safeguard their safety, rights, and trust throughout the research process, ensuring that ethical principles were upheld. In line with ethical guidelines, Fleming and Zegwaard (2018) outlined four key ethical considerations that were meticulously addressed in this study:

Ethical Expectations: The study adhered to ethical expectations, which encompass a commitment to conducting research in an ethically responsible manner. Informed Consent: Participants were provided with clear and comprehensive information about the study's purpose and procedures, and their informed consent was obtained before their participation. Risk of Harm: Measures were taken to minimize any potential risks or harm to the participants, and their well-being was a top priority. Anonymity, Confidentiality, and Conflict of Interest: The confidentiality of participants' information was rigorously maintained, ensuring their identities and responses remained anonymous and secure. Additionally, any potential conflicts of interest were transparently managed. These ethical considerations were carefully observed to uphold the rights and welfare of the education students involved in the study.

4.0. Results and Discussion

Self-Concept

The analysis and interpretation of the student's self-concept levels are presented below. Table 1 displays the self-concept levels of education students, with mean scores ranging from 3.89 to 4.33. The overall mean score is 4.05, accompanied by a standard deviation of 0.49, which can be characterized as qualitatively high.

Upon examining the data, it is evident that the indicator with the highest mean score is "dynamic self-concept," which received a rating of 4.33, indicating a very high level of self-concept. Conversely, the indicator with the lowest mean score is "organized self-concept," which received a rating of 3.89, signifying a high level of self-concept. The overall result stipulates that the self-concept of education students is often manifested.

Table 1
Level of Self-Concept

Indicators	Mean	SD	Description
Learned Self-Concept	3.93	0.51	High
Organized Self-Concept	3.89	0.58	High
Dynamic Self-Concept	4.33	0.56	Very High
Overall mean	4.05	0.49	High

Legend:
1.00 – 1.79 Very Low 2.60 – 3.39 Average 4.20 – 5.00 Very High
1.80 – 2.59 Low 3.40 – 4.19 High

Teaching Quality

The analysis and interpretation of the teaching quality of teachers are presented below. Table 2 showcases the teaching quality levels of teachers, with mean scores ranging from 4.24 to 4.36. The overall mean score is 4.27, accompanied by a standard deviation of 0.53, indicating a qualitatively very high level of teaching quality.

Upon closer examination of the data, it becomes apparent that the indicator with the highest mean score is "challenging students," which received a rating of 4.36, signifying a very high level of teaching quality. Conversely, the indicators with the lowest mean scores are "classroom climate," "clear instruction," and "goal orientation," each receiving a rating of 4.24, which, although the lowest among the indicators, still qualifies as a very high level of teaching quality. In summary, the results suggest that the teaching quality of teachers is consistently observed at a very high level.

Table 2
Level of Teaching Quality

Indicators	Mean	SD	Description
Classroom Climate	4.24	0.60	Very High
Classroom Management	4.25	0.57	Very high
Clear Instruction	4.24	0.65	Very High
Challenging Students	4.36	0.58	Very High
Goal Orientation	4.24	0.55	Very High
Overall mean	4.27	0.53	Very High

Legend:
1.00 – 1.79 Very Low 2.60 – 3.39 Average 4.20 – 5.00 Very High
1.80 – 2.59 Low 3.40 – 4.19 High

Learning Environment

The analysis and interpretation of the learning environment in classrooms are provided below. As seen in Table 3, the learning environment in classrooms is represented by mean scores ranging from 3.83 to 4.24. The overall mean score is 4.01, with a standard deviation of 0.60, qualitatively indicating a high level of the learning environment.

Upon closer examination of the data, it is evident that the indicator with the highest mean score is "personal relevance," which received a rating of 4.24, signifying a very high level of personal relevance in the learning environment. On the other hand, "involvement" is the indicator with the lowest mean score of 3.83, which is still classified as high. In summary, the results suggest that the learning environment in classrooms is characterized by a high level of personal relevance and overall quality, with even the lowest-rated indicator considered high.

Table 3
Level of Learning Environment

Indicators	Mean	SD	Description
Teacher Support	3.96	0.69	High
Involvement	3.83	0.72	High
Personal Relevance	4.24	0.62	Very High
Overall mean	4.01	0.60	High

Legend:
1.00 – 1.79 Very Low 2.60 – 3.39 Average 4.20 – 5.00 Very High
1.80 – 2.59 Low 3.40 – 4.19 High

Academic Achievement in Mathematics in the Modern World

The level of academic achievement in Mathematics in the Modern World of education students is presented, analyzed, and interpreted hereunder. As demonstrated in Table 4, the academic achievement levels of education students in Mathematics in the Modern World are represented by mean scores ranging from 5.50 to 6.93. The overall mean score is 6.22, and the standard deviation is 0.82, qualitatively indicating a high level of academic achievement in this subject.

The data reveals that the domain with the highest mean score, rated at 6.93, indicating a very high level of achievement, is "problem solving and reasoning." On the other hand, "data management" is the domain with the lowest mean score, rated at 5.50, signifying a high level of achievement. The summary of results means that the academic achievement in Mathematics in the Modern World of education students is very satisfactory.

Table 4
Level of Academic Achievement

Indicators	Mean	SD	Description
Mathematics in our World	5.91	1.25	High
Mathematical Language and Symbols	6.30	1.17	High
Problem Solving and Reasoning	6.93	1.07	Very High
Data Management	5.50	1.50	High
Mathematics as a Tool	6.46	1.16	Very High
Overall mean	6.22	0.82	High

Legend:
0 – 1.60 Very Low 3.21 – 4.80 Average 6.41 – 8.00 Very High
1.61 – 3.20 Low 4.81 – 6.40 High

Correlations Between Variables

Table 5 presents the significance of the relationship between self-concept and academic achievement in Mathematics in the Modern World among education students. The overall correlation coefficient (r-value) is calculated as 0.382, and the corresponding probability value is determined to be 0.000. This probability value is significantly lower than the predetermined significance level of 0.05 set for this study. The results indicate a positive and moderate significant correlation between self-concept and academic achievement in Mathematics in the Modern World. Consequently, the null hypothesis is rejected in this context, implying that there is indeed a statistically significant relationship between self-concept and academic achievement in this subject. Further, in Mathematics in the Modern World, moderate self-concept leads to moderate academic achievement.

As observed, the correlation analysis between various aspects of self-concept and specific domains of academic achievement in Mathematics in the Modern World revealed varying results: The correlation between "dynamic self-concept" and "mathematical language and symbols" yielded the highest r-value of .732, with a p-value of .000. This indicates a positive and highly significant correlation between dynamic self-concept and proficiency in mathematical language and symbols. Conversely, the link between "learned self-concept" and "problem solving and reasoning" resulted in the lowest r-value of .121, with a p-value of .000. This signifies a positive but relatively low level of significance in the correlation between learned self-concept and problem-solving and reasoning skills.

Table 5
Correlation between Self-Concept and Academic Achievement

Self-Concept	Academic Achievement in Mathematics in the Modern World					
	Mathematics in our World	Mathematical Language and Symbols	Problem Solving and Reasoning	Data Management	Mathematics as a Tool	**Overall**
Learned Self-Concept	.433**	.273**	.121*	.471**	.432	.251**
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Organized Self-Concept	.321**	.498	.145*	.669**	.201**	.324**
	(.000)	(.000)	(.040)	(.000)	(.004)	(.000)
Dynamic Self-Concept	.351**	.732**	.159*	.378**	.301**	.624**
	(.000)	(.000)	(.024)	(.000)	(.000)	(.000)
Overall	.439**	.404**	.108*	.393**	.124*	**.382****
	(.000)	(.000)	(.000)	(.000)	(.000)	**(.000)**

**Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 6 shows the significance of the relationship between teaching quality and academic achievement in Mathematics in the Modern World among education students. The overall correlation coefficient (r-value) is calculated as 0.532, and the corresponding probability value is determined to be 0.000. This probability value is substantially lower than the preset significance level of 0.05 established for this study.

These results indicate a positive and significant correlation between teaching quality and academic achievement in Mathematics in the Modern World. Consequently, the null hypothesis is rejected in this context. This implies that, within the context of Mathematics in the Modern World, higher teaching quality is associated with higher levels of academic achievement among education students.

Table 6
Correlation between Teaching Quality and Academic Achievement

Teaching Quality	Academic Achievement in Mathematics in the Modern World					
	Mathematics in our World	Mathematical Language and Symbols	Problem Solving and Reasoning	Data Management	Mathematics as a Tool	**Overall**
Classroom Climate	.200**	.189**	.108	.404**	.416**	.500**
	(.004)	(.007)	(.129)	(.000)	(.000)	(.000)
Classroom Management	.404**	.185**	.209**	.124*	.381**	.189**
	(.000)	(.009)	(.003)	(.039)	(.000)	(.007)
Clear Instruction	.177*	.192**	.143*	.376**	.123*	.189**
	(.012)	(.007)	(.044)	(.000)	(.043)	(.007)
Challenging Students	.180*	.444**	.424**	.400**	.185**	.653**
	(.011)	(.000)	(.000)	(.000)	(.009)	(.000)
Goal Orientation	.290*	.374**	.420**	.368**	.494**	.430**
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Overall	.301**	.379**	.349**	.317**	.272**	**.532****
	(.000)	(.000)	(.000)	(.000)	(.000)	**(.000)**

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

In Table 7, the significance of the relationship between the learning environment and academic achievement in Mathematics in the Modern World among education students is presented. The overall correlation coefficient (r-value) is calculated as 0.339, and the corresponding probability value is determined to be 0.000. This probability value is significantly lower than the predefined significance level of 0.05 set for this study.

These results reveal a positive and moderate significant correlation between the learning environment and academic achievement in Mathematics in the Modern World. Consequently, the null hypothesis is rejected in this context. This implies that a moderate learning environment in the context of Mathematics in the Modern World is associated with moderate academic achievement among education students.

Table 7
Correlation between Learning Environment and Academic Achievement

Learning Environment	Academic Achievement in Mathematics in the Modern World					
	Mathematics in our World	Mathematical Language and Symbols	Problem Solving and Reasoning	Data Management	Mathematics as a Tool	**Overall**
Teacher Support	.132*	.181*	.176*	.509**	.237*	.334**
	(.032)	(.024)	(.013)	(.000)	(.001)	(.000)
Involvement	.292**	.159*	.399**	.355**	.101*	.518**
	(.000)	.024	(.000)	(.000)	(.013)	(.000)
Personal Relevance	.109*	.113*	.170*	.383**	.509**	.372**
	(.025)	(.013)	(.027)	(.000)	(.000)	(.000)
Overall	.245*	.203**	.185**	.364**	.276*	**.339****
	(.001)	(.004)	(.009)	(.000)	(.007)	**(.000)**

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Indeed, the correlation analysis between specific aspects of the learning environment and distinct domains of academic achievement in Mathematics in the Modern World revealed various results: The correlation between "teacher support" and "data management" yielded the highest r-value of .509, with a p-value of .000. This indicates a positive and highly significant correlation between teacher support and proficiency in data management. Similarly, the link between "personal relevance" and "mathematics as a tool" resulted in the highest r-value of .509, with a p-value of .000, signifying a positive and highly significant correlation between personal relevance and using mathematics as a tool. In contrast, the correlation between "involvement" and "mathematics as a tool" resulted in the lowest r-value of .101, with a p-value of .013. This indicates a positive but relatively low level of significance in the correlation between involvement and the application of mathematics as a tool.

The results of the correlational analysis indicate that there is a significant and meaningful association between the latent exogenous variables (such as self-concept, teaching quality, and learning environment) and the latent endogenous variable (academic achievement) in this study. To be precise, it could be deduced that teaching quality and academic achievement in Mathematics in the Modern World have a positive high significant correlation. For self-concept and academic achievement in Mathematics in the Modern World as well as learning environment and academic achievement in Mathematics in the Modern

World, a positive moderate significant correlation exists. Thus, this corroborates the Educational Productivity Theory of Walberg (1980). This study underscores the crucial role of teaching quality as a catalyst for fostering and ensuring the success of the learning process. It emphasizes that when there is a high level of teaching quality, it is associated with a correspondingly high level of academic achievement in Mathematics in the Modern World. In other words, effective teaching quality is seen as a key determinant of academic success in this subject.

Similarly, the findings align with the proposition by Jaiswal and Choudhuri (2017), which supports the idea of a positive association between self-concept and academic achievement. This suggests that efforts from both teachers and parents to enhance self-concept and academic performance can contribute to student success.

Likewise, the research conducted by Brown and Kurzweil (2017) corroborates the importance of instructional clarity in achieving better course outcomes. Their findings emphasize that when instruction is clear and well-structured, it can lead to improved academic achievement. Similarly, Ijak et al. (2017) back the claim for a positive learning environment by which students gain a constructive perception of their environment, thus positively impacting their learning outcomes.

Influence of Exogenous Variables on Academic Achievement

Table 8 presents the combined influence of self-concept, teaching quality, and the learning environment on academic achievement in Mathematics in the Modern World. The analysis reveals an f-value of 27.832, an r-value of .547, an r-squared value of .229, and a p-value of .000. Importantly, the p-value is significantly lower than the pre-established significance level of .05.

These results collectively support the rejection of the null hypothesis in this context. In other words, the exogenous variables (self-concept, teaching quality, and learning environment) exert a significant and meaningful influence on the endogenous variable, which is academic achievement in Mathematics in the Modern World. This underscores the importance of these factors in explaining variations in academic performance in this subject.

Table 8
Influence of Exogenous Variables on Academic Achievement

Exogenous Variables	Academic Achievement in Mathematics in the Modern World			
	B	β	*t*	*Sig.*
Self-Concept	.117	.074	1.587	.114
Teaching Quality	.437	.069	6.328	.000
Learning Environment	.006	.052	0.109	.913
R = .547				
R^2 = .229				
F = 27.832				
P = .000				

The findings from the regression analysis reveal that the three latent exogenous variables, namely self-concept, teaching quality, and learning environment, have a substantial and statistically significant influence on the latent endogenous variable, which is academic achievement in Mathematics in the Modern World. Particularly, teaching quality significantly influences academic achievement in Mathematics in the Modern World, while self-concept and learning environment showed probability values of .114 and .913, respectively. Then, the study of Decristan et al. (2017) validates the results wherein it ensured that each of the three fundamental elements of teaching quality, that is, cognitive activation, supportive climate, and classroom management, improved students' conceptual knowledge. Also, students distinguish between a positive view toward the particular implementation of teaching in subjects and their personal general views toward the subjects. It proved that teaching quality as a specific range of instructional factors and contexts impacting instruction improves student achievement (Klette et al., 2017; Petalla & Madrigal, 2017). Also, Teachers in mathematics need to have positive attitudes since this is found to be imperative to students' performance (Casinillo et al., 2022).

Establishing the Best Structural Model

In this study, five hypothesized models were generated and subsequently tested to assess their validity and suitability in explaining the relationships among the variables under investigation. Even so, before the data was tested for structural equation modeling, assumptions were satisfied, including the normality of distribution. In addition, to avoid under-fitting and over-fitting, completeness of the data was guaranteed, and no missing cases were recognized. The generated models were tested based on their practicality supported by strong theoretical assertions. The six generated models are summarized in Table 9.

To determine the best fit model among the hypothesized models, it is essential to evaluate various fit indices. Here are the criteria for assessing the fit of structural equation models, as you have described: Chi-square/degrees of freedom (χ^2/df): A value less than 2 is generally considered acceptable, with a corresponding p-value greater than 0.05. This indicates that the model is a good fit if the chi-square value is close to the degrees of freedom. Root Mean Square of Error Approximation (RMSEA): An RMSEA value less than 0.05 is considered a good fit. Additionally, the p-close value should be greater than 0.05. Normed Fit Index (NFI), Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), and Goodness of Fit Index (GFI): All of these indices should ideally be greater than 0.95 to indicate a good fit of the model.

Table 9
Summary of Goodness of Fit Measures of the Six Generated Models

Model	P-value (>0.05)	CMIN / DF (<2)	NFI (>0.95)	TLI (>0.95)	CFI (>0.95)	GFI (>0.95)	RMSEA (<0.05)	P-close (>0.05)
1	.000	23.655	.699	.652	.707	.647	.238	.000
2	.000	13.189	.837	.813	.847	.734	.175	.000
3	.000	13.328	.875	.843	.883	.819	.176	.000
4	.000	12.341	.880	.859	.888	.783	.169	.000
5	.000	15.985	.832	.799	.840	.738	.194	.000
6	**.132**	**1.564**	**.961**	**.978**	**.977**	**.956**	**.002**	**.236**

Legend: CMIN/DF – Chi Square/Degrees of Freedom; NFI – Normed Fit Index; GFI – Goodness of Fit Index; TLI – Tucker-Lewis Index; RMSEA – Root Mean Square of Error Approximation; CFI – Comparative Fit Index

The modified model divulges the direct causal link of the latent exogenous variables, teaching quality, and learning environment towards the latent endogenous variable, academic achievement in Mathematics in the Modern World. The sixth generated structural model is inferred to have indices that strongly satisfy a good fit as indicated by its CMIN/DF = 1.564 with a corresponding p-value = .132, RMSEA = .002 with a corresponding p-close = .236, and the indicated indices, namely, NFI = .961, TLI = .978, CFI = .977, and GFI = .956.

The goodness of fit measures results indicate that the model meets the criteria for a good fit: The Chi-square/degrees of freedom is less than 2 with a corresponding probability greater than 0.05. The Root Mean Square of Error Approximation is less than 0.05 with a corresponding p-close value greater than 0.05. The other indices, including the Normed Fit Index, Tucker-Lewis Index, Comparative Fit Index, and Goodness of Fit Index, are all greater than 0.95. As a result, the null hypothesis is rejected, signifying that there is a model among the hypothesized models that best fits the data related to academic achievement in Mathematics in the Modern World.

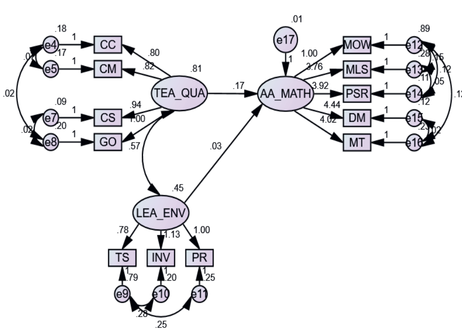

Figure 2. Best Fit Model for Academic Achievement in Mathematics in the Modern World

The developed structural model, which is Model 6 and considered the best fit model, is presented in Figure 2. In this model, it can be observed that two latent exogenous variables remain to explain academic achievement in Mathematics in the Modern World. Furthermore, from the data in Table 10, it can be inferred that the latent exogenous variable "teaching quality" has a more substantial influence on academic achievement. This influence is represented by a coefficient (beta) of .812. On the other hand, "learning environment" follows with a coefficient (beta) of .088, indicating a relatively smaller but still significant influence on academic achievement in this subject.

Table 10
Direct and Indirect Effects of Exogenous Variables on Endogenous Variable

Variables	Direct Effect	Indirect Effect	Total Effect
Teaching Quality	.812	-	.812
Learning Environment	.088	-	.088

The regression weights estimated to assess the effects between measured and latent variables are presented in Table 11, reflecting the estimates in generated Model 6. This table shows that teaching quality and the learning environment are the latent exogenous variables that remain in the best fit model for explaining academic achievement in Mathematics in the Modern World. Teaching quality has a significant impact, with a beta estimate of .173 and a p-value of .001. This suggests that teaching quality is statistically significant in influencing academic achievement in Mathematics in the Modern World. The learning environment is also considered significant, with a beta estimate of .025 and a p-value of .003. This indicates that the quality of the learning environment also has a statistically significant impact on academic achievement in this subject.

Table 11
Estimates of Variable Regression Weights in Generated Model 6

			Estimate	S.E.	Beta	C.R.	P-Value
AA_MATH	<---	TEA_QUA	.173	.053	.812	3.249	.001
AA_MATH	<---	LEA_ENV	.025	.039	.088	.641	.003
MOW	<---	AA_MATH	1.000		.201		
MLS	<---	AA_MATH	3.758	.931	.810	4.035	***
PSR	<---	AA_MATH	3.920	.974	.913	4.025	***
DM	<---	AA_MATH	4.437	1.143	.928	3.883	***
MT	<---	AA_MATH	4.021	1.010	.851	3.983	***
GO	<---	TEA_QUA	1.000		.897		
CS	<---	TEA_QUA	.938	.027	.943	34.301	***
CM	<---	TEA_QUA	.822	.032	.876	25.671	***
CC	<---	TEA_QUA	.802	.031	.866	26.102	***
PR	<---	LEA_ENV	1.000		.805		
INV	<---	LEA_ENV	1.132	.058	.860	19.383	***
TS	<---	LEA_ENV	.780	.060	.508	13.043	***

Table 12 provides measures of the goodness of fit for structural Model 6, indicating that the generated model fit is highly acceptable. Here is a summary of the goodness of fit measures:

CMIN/DF (Chi-square/degrees of freedom): The value is 1.564 with a probability value of .132. The value is greater than 0 and less than 2, which indicates a good fit. RMSEA (Root Mean Square of Error Approximation): The RMSEA is .002, which is less than 0.05, and the corresponding p-close is .236, which is greater than 0.05. These values support a good fit. NFI (Normed Fit Index): The NFI is .961, greater than the recommended threshold of 0.95. TLI (Tucker-Lewis Index): The TLI is .978, exceeding the threshold of 0.95. CFI (Comparative Fit Index): The CFI is .977, also greater than 0.95. GFI (Goodness of Fit Index): The GFI is .956, surpassing the threshold of 0.95. Based on these goodness of fit measures, it can be concluded that Model 6 is the best fit model for explaining academic achievement in Mathematics in the Modern World among education students.

In the analysis of the attributes of the best fit model for academic achievement in Mathematics in the Modern World, it is evident that only two latent variables remain exogenous. These two latent exogenous variables are teaching quality and the learning environment. The latent teaching quality comprises four indicators: *classroom climate, classroom management, challenging students,* and *goal orientation.* On the other hand, the latent learning environment still has three indicators: *teacher support, involvement,* and *personal relevance.*

Hence, the best fit model demonstrates a significant association between teaching quality and learning environment and its direct effect on academic achievement in Mathematics in the Modern World. This implies that teaching quality should be accompanied by a conducive learning environment in advancing the degree of academic achievement in Mathematics in the Modern World of education students.

Table 12
Goodness of Fit Measures of the Best Fit Model

Index	Criterion	Model Fit Value
CMIN/DF	0 < value < 2	1.564
P-value	>0.05	.132
NFI	>0.95	.961
TLI	>0.95	.978
CFI	>0.95	.977
GFI	>0.95	.956
RMSEA	<0.05	.002
P-close	>0.05	.236

Legend:
CMIN/DF – Chi Square/Degrees of Freedom
NFI – Normed Fit Index
GFI – Goodness of Fit Index
TLI – Tucker-Lewis Index
RMSEA – Root Mean Square of Error Approximation
CFI – Comparative Fit Index

The analysis of the interrelationships among self-concept, teaching quality, and learning environment towards education students' academic achievement in Mathematics in the Modern World was composed of five alternative models. These models were assessed to achieve the best fit model for academic achievement in Mathematics in the Modern World. Each of the models analyzed in this study has a structured framework divided into two sub-models: the measurement model and the structural model. Measurement Model: This component of the framework focuses on how the observed or measured variables are related to their respective latent constructs or factors. Structural Model: The structural model concerns the relationships and interactions among the latent variables. It explores how these latent constructs are interconnected and influence each other.

Accordingly, the model highlights the indispensable need for teaching quality and learning environment as predictors of academic achievement in Mathematics in the Modern World. Based on the existing literature, teaching quality and learning environment are vital elements that must be greatly implemented in mathematics classes. Therefore, the results strongly suggest that education students' academic achievement in Mathematics in the Modern World needs to be anchored on teaching quality and learning environment. Furthermore, the best fit model implies that the learning environment must be highly linked to teaching quality to significantly predict academic achievement in Mathematics in the Modern World.

Nevertheless, it is worth mentioning that one aspect of teaching quality, namely "clear instruction," was excluded from the model based on the recommendations of the modification indices generated by AMOS. Consequently, this implies that "clear instruction" does not significantly contribute to modeling academic achievement in Mathematics in the Modern World for education students. As evidenced by Roksa et al. (2017), the existing studies on clear and organized instruction had approximated its impact on student outcomes without considering substantial explanations that could link really clear instruction towards academic achievement. Then, such literature ignores the alternative pathways linking this educational practice to student results.

5.0. Conclusion

The best fit model for predicting academic achievement in Mathematics in the Modern World demonstrates a direct influence of teaching quality and the learning environment on academic performance in this subject. This finding aligns with the principles of the Educational Productivity Theory put forth by Walberg. According to this theory, teaching quality and the learning environment are crucial in facilitating successful learning outcomes. Therefore, the study's results align with the theoretical framework proposed by Walberg, highlighting the importance of these factors in determining academic achievement in Mathematics in the Modern World. The model highlights that the teachers' effective use of instruction, the views of learning, and peer and teacher relationships significantly affect education students' academic achievement in Mathematics in the Modern World. Moreover, the best fit model for predicting academic achievement in Mathematics in the Modern World illustrates a noteworthy correlation between teaching quality and the learning environment. This correlation is consistent with a body of research findings that have shown how effective instructional design can foster collaborative problem-solving skills among primary students within a well-structured learning environment. Then, the link concludes that both teaching quality and learning environment must be established in predicting education students' academic achievement in Mathematics in the Modern World.

Moreover, this will be of great value to the Commission on Higher Education with its efforts in advancing higher education, particularly in Mathematics in the Modern World. Specifically, following the best fit model, the agency may consider formulating interventions that aim to enhance both teaching quality and learning environment among higher education institutions since it was found out in the model that the interrelationship between teaching quality and learning environment significantly predicts academic achievement in Mathematics in the Modern World. For teachers in line with the course in study, they might consider participating in capability enhancement programs aiming to facilitate the advancement of the degree of their teaching quality as well as in institutionalizing a conducive learning environment, as it was revealed in the model that both teaching quality and learning environment were highly attributed to academic achievement in Mathematics in the Modern World. For students, their active involvement and cooperation in the learning process will greatly establish academic achievement in Mathematics in the Modern World.

6.0. Limitations of the Findings

Despite the scientific approach conducted in accomplishing this paper, limitations still need to be considered. Firstly, the data gathered from the higher education students may not represent the whole population of students in the Philippines. Secondly, the responses of the respondents may be unique from the other students of other higher education institutions. Thirdly, other factors that were not covered in this paper might predict academic achievement in Mathematics in the World.

7.0. Directions for Future Research

Given the findings of this paper, future researchers may investigate academic achievement in Mathematics in the Modern World utilizing other factors or variables that the study was not able to cover or might replicate the study in other contexts. Also, researchers may initiate analysis using mixed methods to further explain the factors predicting the achievement of students in Mathematics in the Modern World.

8.0. Declaration of Conflict of Interest

The authors have no conflict of interest to declare.

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Additional Author's Information:

ERIKA MAE P. ASOY
skane3660@gmail.com
https://orcid.org/0009-0008-1987-3780

RONEL G. DAGOHOY
ronelgdagohoy@gmail.com
https://orcid.org/0000-0003-4876-4694