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RESEARCH ARTICLE OPEN ACCESS

A STRUCTURAL EQUATION MODEL on THE INFLUENCE of COGNITIVE, NON-COGNITIVE, AND ENVIRONMENTAL FACTORS on STUDENTS' ACADEMIC PERFORMANCE

Angelo S. Villanueva*, Emil C. Alcantara**

*Department of Education, Region IV-A, Schools Division of Lucena City, Mayao Parada Agricultural Integrated High School

Email: angelo.villanueva@deped.gov.ph

** Batangas State University, College of Teacher Education, Main Campus, Batangas City, Philippines

Email: emil.alcantara@r.batstate-u.edu.ph

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Abstract:

This study aimed to develop Structural Equation Models for STEM student academic performance in Quezon, Province. Cognitive, non-cognitive and environmental factors were used as independent variables. Descriptive research was utilized and combination of adopted and researchers' made questionnaire was distributed to 487 STEM students in Quezon province using stratified random sampling. Frequency, percentage, Chi-square and Structural Model Equation with path analysis were used as statistical tools. It was found that most of the STEM students in Quezon province find mathematics as useful in everyday life, people smart, have visual learning style, have also high level of academic self-efficacy, achievement motivation, academic engagement and social engagement while classroom lighting, classroom ventilation and classroom size are favorable for them. Majority of the students have outstanding academic performance. Attitude towards mathematics has significant relationship with achievement motivation, social engagement and classroom lighting; learning style has significant relationship with academic motivation and classroom ventilation; multiple intelligence has significant relationship with academic self-efficacy and classroom lighting; classroom lighting has significant relationship with self-efficacy, academic motivation, academic engagement, and social engagement; classroom ventilation has significant relationship with academic engagement and classroom size has significant relationship with academic self-efficacy, achievement motivation and social engagement. Usefulness of Math in everyday life, linguistic, musical, interpersonal, bodily-kinesthetic, intrapersonal, naturalist, and existential, academic self-efficacy and achievement motivation have significant positive relationship with academic performance with small effect while classroom ventilation has significant negative relationship with academic performance with small effect. Lastly, three (3) Structural Equation Models were developed.

Keywords —Structural Equation Model, Cognitive and Non-Cognitive Factors, Environmental Factors, Academic Performance.

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I. INTRODUCTION

The role of education plays a huge impact in the society because it is through education that individuals learn fundamental skills, abilities, and knowledge that are necessary to attain growth and prosperity in the micro and macro levels. When people are educated, they are better able in attaining their goals and they more likely become productive members of the community. Gaining skills, abilities, and knowledge is established through learning [1].

One of the basic measures of the success of education is their academic performance of the students. Commonly, academic performance is measured through the general weighted average of the students. Several researches dealt with how academic performances of students develop. One of the studies conducted related to academic performance gauged it in terms of cumulative grades of students based on course or based on strand, such as those majors is in science and technology. Reference [2] identified that learning facilities, communication skills, and guidance from parents are the factors impacting students' academic performance. Meanwhile, reference [3] found out that communication, learning facilities, proper guidance, and family stress are the factors affecting students' academic performance.

Despite of the different study conducted, there is still a gap on a more holistic approach of determining the factors affecting academic performance. In addition, the study focuses on the elementary, junior high school and college students. There are very limited studies academic performance conducted focusing on the senior high school with specific strand like Science, Technology, Engineering and Mathematics (STEM). Further, there is no specific model that can explain the academic performance which will be the basis of academic policies, guidelines and curriculum of the teachers.

The first challenge is to identify factors that might affect academic performance on a holistic approach. To address this, it is important to base the factors on the literature available in public domain. Generally, the factors that affect academic performance of students are cognitive, non-cognitive and environmental factors.

Reference [4] shows, cognitive factors are found to be correlates of students' academic performance. Cognitive factors are cognitive functions of an individual such as attention, memory, and reasoning that impact performance and learning. Cognitive factors measured the students' attitudes towards mathematics using mathematics attitude scale. It also covers the multiple intelligences of students and various learning styles.

Aside from cognitive, several researches also mentioned that non-cognitive aspect of student might affect academic performance. Non-cognitive factors are generally behaviors, skills, attitudes, and strategies that impact the academic performance and success of students[5]. Prior studies have established that non-cognitive factors act as correlates of students' academic performance. Non-cognitive factors that may impact academic performance are academic self-efficacy, achievement motivation, academic engagement, and social engagement.

Prior studies have also found out that environmental factors may impact the academic performance of students. In the reference [6] reveals, the author argued that the level of noise, lighting of classrooms, and school's open space affect the academic performance of students. Furthermore, school facilities, instructional materials, and size of classes are factors also affect students' academic performance. Same is true for adequacy of school facilities, number of good teachers, and conducive learning environment are the correlates of academic performance of students.

Since most of studies focused in elementary, secondary (junior high school) and college students, there is a need to test whether the abovementioned factors also affect academic performance of senior high school. One of the strands needed to deal is the Science, Technology, Engineering and Mathematics' strand. Based on the data from DepEd as of 2SY 017-2018, STEM composed the 12.0 percent of the total enrolment in the Philippines and predicted to increase rapidly due to the demand in the labor market [7].

With this it is justifiable to conduct study of academic performance and factors affecting it in STEM Senior High School students.

Quezon province is one of the largest provinces in the Philippines. Due to its characteristics, it is expected also that it is the one with highest number of enrollees within the region and country.

As of the moment, most of the graduates of STEM have well to outstanding academic performance during senior high school but as the move to college it is too different. Based on some informal interview of the graduates of STEM strand in the province as they go on college, it become a challenge for them to cope up with new environment, new classmates from different schools, and the approach of studying courses under Engineering, Science and Technology.

With this, the challenge as of now for educators is to develop a model that will enhance the academic performance of the currently enrolled students for them to adopt better once they go for college. So it is important to identify the factors (cognitive, non-cognitive and environmental) and test the relationship in order to formulate a model. This model can be used for academic policy, curriculum and instruction enhancement.

II. OBJECTIVES

This study aimed to develop Structural Equation Models for STEM student academic performance in Quezon, Province. Cognitive, non-cognitive and environmental factors were used as independent variables. Specifically, the study attained the following objectives: (1) described the students' cognitive factors in terms attitude, learning style and multiple intelligence; the non-cognitive factors were also determined in terms of academic self-efficacy, achievement motivation, academic engagement and social engagement while environmental factors were assessed in terms of classroom size, classroom ventilation and classroom lighting; (2) described the academic performance of students using the General Point Average of the previous years; (3) tested if the independent variables are related; (4) tested if there is significant effect of cognitive, non-cognitive and environmental factors to academic performance; (5) developed a Structural Equation Model for the academic performance of the STEM students in Quezon.

III. MATERIALS AND METHODS

Research Design

The present study utilized exploratory research design and at the same time causal-predictive since the latent variables was measured using partial least squares – structural equation modelling (PLS-SEM). Exploratory research is a type of research design where the goal of the researcher to find or "explore" the nature of the problem to enlighten or provide better understanding of the problem at hand. In this type of research, the researcher conducts a study to provide a clearer picture of the problem which as less or no prior studies [8].

Furthermore, a causal-predictive research design was used to examine the influence of the exogenous latent variables – cognitive, non-cognitive, and environment factors on endogenous latent construct – academic performance.

Subjects of the Study

The respondents of the study were Grade 12 STEM students. The total population of the STEM students in Quezon Province was utilized in this study. With the total sample size of 487, the sample size is sufficiency enough to explain the results of the structural model.

The respondents came from the sixteen (16) Senior High School STEM offering schools in Quezon Province comprising of DepEd Lucena City with two (2) schools [LCNHS-Main & GNHS); and DepEd Quezon Province with fourteen (14) schools [Alabat Island NHS, Atimonan NCHS, Quezon Science High School, Paaralang Sekondarya ng Heneral Nakar, Guinyangan NHS, Gumaca NHS, Infanta NHS, Lopez NHS, Paaralang Sekondarya ng Lukban, Dr. Maria D. Pastrana NHS, Tagkawayan NHS, Lusacan NHS, Lutucan NHS, and Recto Memorial NHS].

Data Gathering Instrument

The instruments utilized in the present study were composed of five (5) survey-questionnaires which were explored in three parts focused on cognitive factors, non-cognitive factor, and environmental factor. Three of these were adopted from previous studies.

The first part focuses on the cognitive factor and it is divided into three (3) sub-parts. These are mathematics attitude scale, learning styles and multiple intelligences test. The second part which are researcher made questions focused on non-cognitive factors with four (4) sub-parts; the academic self-efficacy, achievement motivation, academic engagement and social engagement. The last part of the instrument emphasizes the respondents' assessment on environmental factors which is also divided into three (3) sub-parts. These are classroom lighting, classroom ventilation and classroom size.

The Chron-bach alpha was tested and it has a value of 0.956 in general. Since it is greater than 0.70, actual surveys were conducted.

Data Gathering Procedure

The researcher sought the permission from the Schools Division Superintendents of DepEd Quezon Province, and DepEd Lucena, then to sixteen (16) Principals of STEM offering schools. The researcher administered the survey-questionnaires to the respondents. The participants were oriented on the objectives of the survey and the importance of their contribution to the study. Their permission to participate in the study was also sought. They were given survey forms which include a letter of permission before the actual conduct of the survey. Instructions were given and provided. The participants were assured of the confidentiality of answers.

After the administration of the questionnaires, the researcher gathered the data and tabulated. All data gathered were inspected, cleaned, transformed, and modeled for the purpose of data analysis using PLS-SEM.

Statistical Treatment of Data

The researcher used the free software statistical package to calculate the results of the study. Frequency, percentage, Chi-square and Structural Model Equation with path analysis were used as statistical tools for the study.

IV. RESULTS AND DISCUSSION

Characteristics of the STEM students

I.) Cognitive Factor

The study describes the characteristics of the respondents in terms of cognitive factors such as attitude towards mathematics, multiple intelligences and learning styles. Most of the respondents find mathematics as useful in everyday life with 374 or 76.80 percent of the total respondents, people smart with a frequency of 97 or equivalent to 19.92 percent and have visual learning style with 344 respondents of 70.64 percent,

II.) Non-Cognitive Factor

The study measures the level of manifestation for each non-cognitive factors such as academic self-efficacy, achievement motivation, academic engagement and social engagement. Among the four (4) non-cognitive factors, the participants have high manifestation of achievement motivation with a mean of 3.38. As for academic self-efficacy academic engagement, and social engagement, the respondents poses or manifest high level of these non-cognitive factors proven by their mean values of 3.08, 2.91 and 3.21 respectively,

III.) Environmental Factor

This determines the classroom lighting, classroom ventilation and classroom size.

The study manifests the assessment of the respondents in terms of the environmental factors that might affect academic performance. Analysis of the data revealed that the respondents perceived that classroom lighting which include proper illumination, well-painted classroom, and adequacy of light supply are favorable in their learning as manifested by its mean of 3.26. Class size, such as, enough number of chairs and desks, right space, and number of classrooms are conduciveness for learning of the classroom has a mean of 3.27 and verbal interpretation of favorable. Furthermore, in terms of classroom ventilation, respondents perceived that it is favorable for their learning with frequency of 2.90.

Academic Performance of STEM students in Quezon Province

Data showed that 410 or 84.2 percent of the respondents were considered outstanding with a grade ranges from 90-100.

On the other hand, 75 or 15.4 percent of them were very satisfactory with a grade of 85-89. Moreover, only 2 out of the 487 or 0.4 percent have satisfactory performance.

TABLE 1
RESPONDENTS' ACADEMIC PERFORMANCE

Academic Performance	Interpretation	Frequency	Percentage
90-100	Outstanding	410	84.2
85-89	Very Satisfactory	75	15.4
80-84	Satisfactory	2	0.4
75-79	Fairly Satisfactory	0	0
Below 75	Did Not Meet Expectation	0	0
Total		487	100

Relationship of the latent variables

This section presents the results of the test for significant relationship among latent variables. In this study, latent variables refer to cognitive, non-cognitive and environmental factors that might affect academic performance.

Attitude towards mathematics has significant relationship with achievement motivation (Chi^2 = 1.864E2, p= <0.001) , social engagement (Chi^2 = 1.249E2, p= 0.009) and classroom lighting (Chi^2 = 1.172E2, p= 0.001); learning style has significant relationship with academic motivation (Chi^2 = 1.100E2, p= <0.001) and classroom ventilation (Chi^2 = 1.096E2, p= <0.001); multiple intelligence has significant relationship with academic self-efficacy (Chi^2 = 7.996E2, p= <0.001) and classroom lighting (Chi^2 = 5.013E2, p= 0.003); classroom lighting has significant relationship with self-efficacy (Chi^2 = 1.514E2, p= <0.001), academic motivation (Chi^2 = 1.535E2, p= 0.001), academic engagement (Chi^2 = 1.329E2, p= 0.008), and social engagement (Chi^2 = 1.054E2, p= <0.030); classroom ventilation has significant relationship with academic engagement (Chi^2 = 2.119E2, p= <0.001) and classroom size has significant relationship with academic self-efficacy (Chi^2 = 2.776E2, p= <0.001), achievement motivation (Chi^2 = 2.134E2, p= 0.002) and social engagement (Chi^2 = 1.906E2, p= <0.001).

Effect of Latent Variables to Academic Performance

In terms of Mathematics attitude, usefulness of Math in everyday life showed a positive and significant relationship to academic performance (β = .088, p = 0.025) with an effect size of small (f^2 = 0.011). In terms of multiple intelligences, linguistic (β= .090, p = 0.022), musical (β = .083, p = 0.032), interpersonal (β= .168, p < 0.001), bodily-kinesthetic (β = -.080, p = 0.039), intrapersonal (β= .128, p = 0.002), naturalist (β = -.094, p = 0.018), and existential (β = .137, p = 0.001) showed significant relationships to academic performance. In terms of learning styles, only auditory was found be significantly and positively related to academic performance (β = 0.086, p = 0.028) with a small effect size (f^2 = 0.011).

The results showed that academic self-efficacy significantly and positively influencesacademic performance (β = 0.098, p = 0.014) with a small effect size (f^2 = 0.016). It was also found out that achievement motivation is significantly and positively influences academic performance (β = 0.085, p = 0.029) with a small effect size (f^2 = 0.014).

The classroom ventilation is significantly but negatively related to academic performance (β = -0.135, p = 0.001) with a small effect size (f^2 = 0.020).

Developed Structural Equation Model for STEM Students of Quezon Province

This study developed three (3) Structural Equation Models that shows the effect of cognitive, non-cognitive and environmental factors to academic performance.

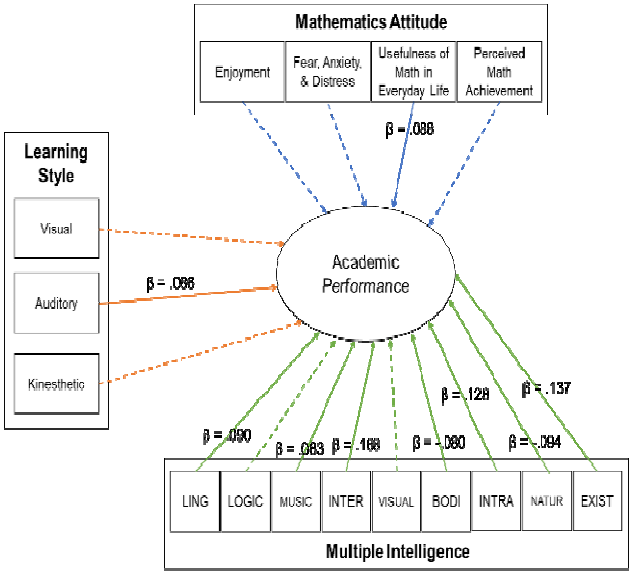

Fig 1. Structural Model for Cognitive Factors and Academic Performance

The Fig. 1 presents the structural model of cognitive factors – attitude toward Mathematics, multiple intelligences, and learning styles - with parameter estimates. The straight lines represent the significant path coefficients while broken lines represent non-significant path coefficients.

Among the four (4) dimensions of Mathematic attitude, only usefulness of Math in everyday life showed a positive and significant relationship with academic performance (β = .088). The rest – enjoyment, fear anxiety & distress, and perceived Math achievement – reflected insignificant relationships with academic performance.

In terms of multiple intelligences, linguistic (β= .090), musical (β = .083), interpersonal (β= .168), bodily-kinesthetic (β = -.080), intrapersonal (β= .128), naturalist (β = -.094), and existential (β = .137) showed significant relationships to academic performance.

On the other hand, among the different learning styles, only auditory (β = .086) showed positive and significant relationship with academic performance.

In the succeeding page, Fig,2 manifests the structural model for the influence of non-cognitive factors on academic performance. Analysis of the data revealed that only academic self-efficacy (β = .098) and achievement motivation (β = .085) have significant and positive influence on academic performance.

The results showed that academic self-efficacy significantly and positively influencesacademic performance (β = 0.098, p = 0.014) with a small effect size (f^2 = 0.016). This finding suggests that as the level of confidence of students in accomplishing specific academic requirements rises, students' academic performance improves.

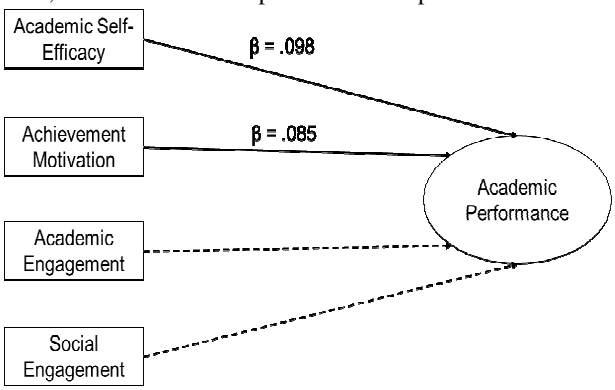

Fig 2. Structural Model for Non-Cognitive Factors and AcademicPerformance

Furthermore, it was also found out that achievement motivation is significantly and positively influences academic performance (β = 0.085, p = 0.029) with a small effect size (f^2 = 0.014). This result indicates that, when the level of motivation of students in surpassing struggles in accomplishing academic requirements and achieving positive results increases, the academic performance of students also moves in the same direction. As for academic engagement (β = -0.056, p = 0.106) and social engagement (β = 0.065, p = 0.074), these two (2) dimensions were found to be insignificantly related to academic performance

Fig. 3 illustrates the structural model of environmental factors and their influence on academic performance. Based on the structural model, only classroom ventilation has significant influence on academic performance (β = -.135).

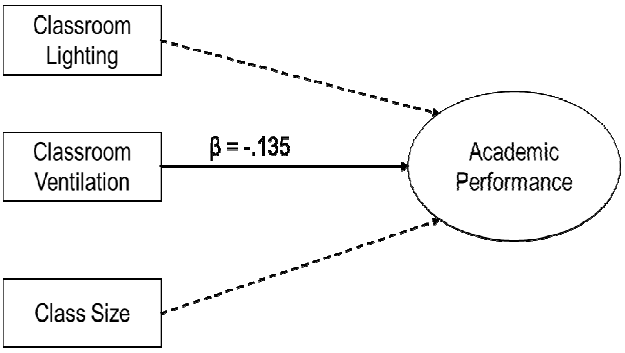

Fig.3. Structural Model for Environmental Factors and Academic Performance

V. CONCLUSIONS

Most of the STEM students in Quezon province find mathematics as useful in everyday life, people smart, have visual learning style, have also high level of academic self-efficacy, achievement motivation, academic engagement and social engagement while classroom lighting, classroom ventilation and classroom size are favorable for the STEM students.

Majority of the STEM students in Quezon province have outstanding academic performance or their Grade Point average ranges.

Attitude towards mathematics has significant relationship with achievement motivation, social engagement and classroom lighting; learning style has significant relationship with academic motivation and classroom ventilation; multiple intelligence has significant relationship with academic self-efficacy and classroom lighting; classroom lighting has significant relationship with self-efficacy, academic motivation, academic engagement, and social engagement; classroom ventilation has significant relationship with academic engagement and classroom size has significant relationship with academic self-efficacy, achievement motivation and social engagement.

Usefulness of Math in everyday life, linguistic, musical, interpersonal, bodily-kinesthetic, intrapersonal, naturalist, and existential, academic self-efficacy and achievement motivation have significant positive relationship with academic performance with small effect while classroom ventilation has significant negative relationship with academic performance with small effect.

This study developed three (3) Structural Equation Models that shows the effect of cognitive, non-cognitive and environmental factors to academic performance.

VI. RECOMMENDATIONS

Based on the findings and results, and the conclusions are drawn, the following are recommended:

1. That STEM teachers must emphasize the importance of Mathematics in one's everyday life. Students must appreciate that Mathematics is a subject that is useful in everyday lives of the people. When STEM students find

the subject useful in their daily lives, their academic performance improves.

2. In terms of multiple intelligences, since the findings revealed varied results, STEM teachers must learn to value that very intelligences of STEM students. Exhibiting one of more intelligences and having poor academic performance does not mean STEM students are not excelling. Not all intelligences mean better grades academically.
3. Since auditory learning style showed significant relationship to academic performance of STEM students, STEM teachers must focus on this type of learning styles. Classroom activities must be geared toward auditory learning.
4. STEM teachers and school administrators should provide a learning environment where STEM students may show confidence in accomplishing specific academic requirements. Furthermore, they need to motivate STEM students in surpassing struggles in accomplishing academic requirements and achieving positive results because academic self-efficacy and achievement motivation lead to better academic performance.
5. Lastly, STEM teachers and school administrators may help in improve school infrastructure. The result of the study showed that classroom ventilation leads to academic performance, whether the ventilation is good or bad. Hence, when STEM students will be housed in classrooms with excellent ventilation, their academic performance may tremendously improve.

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