

## Research Article

### PATH ANALYSIS MODEL EXAMINING GRIT, ATTITUDE AND STUDENT'S ACADEMIC ACHIEVEMENT IN ABSTRACT ALGEBRA

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#### ABSTRACT

This undertaking analyzed the degree of relationship of Profile, Grit Mindset and Attitude to Academic Achievement in Abstract Algebra of BSE-Mathematics students at Central Bicol State University of Agriculture, AY 2020-2021 and create a Path Model. Specifically, it answers to the following questions: 1). What is the degree of relationship of profile along Age and Sex, Grit Mindset, Attitude towards success with the Level of Academic Achievement in Abstract Algebra of the respondents? 2). What is the extent of effect of profile, Grit Mindset, Attitude towards success to the Level of Academic Achievement in Abstract Algebra of the respondents? 3). What mathematical model could be crafted to represent the relationship between the profile of the respondents, Grit Mindset, Attitude towards success in Abstract Algebra and Academic Achievement in Abstract Algebra? This study utilized quantitative method. Descriptive correlational design was used in the conduct of this study. Validated questionnaire was used to gather data. There exists significant relationship between the profile of the respondents to their Grit Mindset, Attitude towards success in Abstract Algebra and Level of Academic Achievement in Abstract Algebra. Path Model could be used to represent the relationship between the profile of the respondents, Grit Mindset, Attitude towards success in Abstract Algebra and Academic Achievement in Abstract Algebra.

**Keywords:** Direct Effect, Indirect Effect, Path Model.

#### INTRODUCTION

Mathematics was considered as basis in making decisions in daily life of humanity. Mathematics learning was intended to connect school to everyday living, deliver skill acquisition, prepare students for work industry and nurture mathematical thinking. With the advent of technological innovation, learning mathematics was simplified. Thus, mathematics instructions provided an opportunity for creative merging of both traditional and progressive methods of teaching. Many innovations had been made to make learning easy and convenient. There are tremendous efforts to further polish the pedagogy in mathematics teaching. With the unexpected onset of pandemic brought by Corona Virus Disease (COVID-19), the modes of instructions were placed into state of uncertainty coupled with exploration. Many highly technical disciplines, such as mathematics and sciences, call for more stable modes of delivery so that conceptual understanding and holistic grasp of concepts and principles would still be possible. Due to the state of transition to "the new normal", students' interest relative to learning concepts and skills was compromised. Learning difficulties on part of both students and teachers will become the new avenue for investigation.

Mathematics teaching and learning had been subjected for investigation even before the advent of pandemic. Up to this moment, teaching and learning mathematics was still examined. Teaching and learning mathematics were subjected for analysis in general context. Many researchers and educators went through series of investigation relative to teaching and learning mathematics on the side of applied mathematics. Very few educators ventured on analyzing mathematics on the side of pure mathematics. So, Abstract Algebra, as a course in

pure mathematics and a newly discovered field was still an unexplored area. Aside from the fact that Abstract Algebra (Modern Algebra) was a newly discovered field, it is also an active agent for numerous advancement and innovations in technology. Artificial Intelligence (AI), advanced computer programming and the likes, were made possible with the aid of Abstract Algebra. As an element in the revised teacher education curriculum, Abstract Algebra would be an essential subject for analysis in relation to students' learning. And, as an inherent function of every institution in the higher learning echelon, it was an utmost duty to maintain and deliver high quality education. Going back to the very nature of mathematics as basis in making decisions in daily life of humanity, it was therefore a must for every educational institution to maintain and establish a mechanism to ensure smooth delivery of mathematics instructions.

#### OBJECTIVES OF THE STUDY

This undertaking analyzed the degree of relationship of Profile, Grit Mindset and Attitude to Academic Achievement in Abstract Algebra of BSE-Mathematics students at Central Bicol State University of Agriculture, AY 2020-2021 and create a Path Model. Specifically, it was anchored on the following objectives:

- 1). Determine the degree of relationship between Profile, Grit Mindset, Attitude towards success with the Level of Academic Achievement in Abstract Algebra of the respondents.
- 2). Determine the extent of effect of Profile, Grit Mindset, Attitude towards success with the Level of Academic Achievement in Abstract Algebra of the respondents.
- 3). Create a mathematical model that could represent the relationship between the profile of the respondents, Grit Mindset, Attitude towards success in Abstract Algebra and Academic Achievement in Abstract Algebra.

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## REVIEW OF RELATED LITERATURE

This section presented some of the related literature and studies relative to academic achievement in Abstract Algebra of the respondents arranged thematically.

### GRIT MINDSET

This part presents literature about Grit Mindset structured in sub-themes as patterned in the research problem to be examined. Sub-themes include Age and Grit Mindset, Sex and Grit Mindset, Grit Mindset and Attitude towards Abstract success in Algebra, and Grit Mindset and Academic Achievement in Abstract Algebra.

#### Age and Grit Mindset

Mayr H. L. *et al.*, (2020) conducted an intervention program for children and adolescents. At the end of their undertakings, they had found out that both children and adolescents had significantly improved their self – concept.

On the same vein, Fernández-Martín F. D. *et al.*, (2020) had conducted a study about “Grit as a Predictor and Outcome of Educational, Professional, and Personal Success”. The results of their study revealed that age and sex predict grit level among students and general population. Older students and women showed higher level of Grit. They further added that educational variables predict Grit. On the other side of the coin, Bowman (2019) conducted a meta-analysis on how to create an enduring academic legacy. In his paper he pointed out that GRIT was the engine for human accomplishments. He further stipulated that if students are inspired to pursue the right goals in the right way, they will surely succeed. In addition, Cosgrove J. M. *et al.*, (2018) had conducted study about “Physical Fitness, Grit, School Attendance, and Academic Performance among Adolescents”. They found out that adolescents have high grit score. They further added that GRIT and total number of attendance to class are significant contributors to academic success.

#### Sex and Grit Mindset

Fernández-Martín F. D. *et al.*, (2020) had conducted a study about “Grit as a Predictor and Outcome of Educational, Professional, and Personal Success”. The results of their study revealed that age and sex predict grit level among students and general population. Older students and women showed higher level of Grit. They further added that educational variables predict Grit.

In the three sets of study conducted by Kannangara CS *et al.*, (2018) about Grit of the University students they had found out that gender was related to Grit level. Furthermore, in the first study, they had found out that Grit is significantly related to age and attitudes towards something. In addition, their second study concluded that Grit is related to resilience, mental well-being, mind-sets, and self-control. And, on their third study they had found out that Grit is a predictor of academic success. In addition, Usher E. L *et al.*, (2018) had investigated Grit and self-efficacy in relation to academic success of children. They found out that girls have higher Grit level as compared to boys. Furthermore, they added that age and Grit are related to self-efficacy.

Furthermore, Stoffel J.M. and Cain J. (2018) had examined Grit and resilience with health professions. At the end of their undertakings, they had concluded that Grit is related to resilience. However, they did not find any significant relationship between Grit and sex.

### Grit Mindset and Attitude towards success in Abstract Algebra

Lechner C. M. *et al.*, (2019) investigated about Grit in relation to socio-demographic profile, career success and career engagement. At the end, they found out that Grit level is related to attitude towards studies. In addition, they found out that Grit is related to gender. Female is grittier than male. Age was also found related to Grit. In addition, with the three sets of study conducted by Kannangara CS *et al.*, (2018) about Grit of the University students they had found out that gender was related to Grit level. Furthermore, in the first study, they had found out that Grit is significantly related to age and attitudes towards something. In addition, their second study concluded that Grit is related to resilience, mental well-being, mind-sets and self-control. And, on their third study they had found out that Grit is a predictor of academic success.

As studied by American Mathematical Association of Two-Year Colleges (2018), attitudes towards mathematics could be analysed in relation to several factors. One of them was students’ motivation of the students towards mathematics. The higher the level of motivation of the students, the better the way they appreciate the subjects.

### Grit Mindset and Academic Achievement in Abstract Algebra

Lechner C. M. *et al.*, (2019) investigated about Grit in relation to socio-demographic profile, career success and career engagement. At the end, they found out that Grit level is related to attitude towards studies. In addition, they found out that Grit is related to gender. Female is grittier than male. Age was also found related to Grit as well as academic performance. In addition, Wills G. and Hofmeyr H. (2018) had conducted a study about academic resilience in primary schools of South Africa. They had found out that girls tend to be more academic resilient than boys. They further identified a significant relationship between academic resiliency, Grit level and attitude towards school. Al - Mutawah M. and Fateel M. J (2018) conducted a study about students’ achievement in math and science in relation to Grit. They found out that there is a significant relationship between Grit level and attitude towards mathematics and science as well as Grit and academic performance in mathematics and science. On the other hand, Palisoc A.J. *et al.*, (2017) had examined the Grit level, Academic Performance and Attainment of Postgraduate students. They found out that there was no significant correlation between Grit-S scores and variables related to academic success. However, students were more likely to pursue postgraduate training with higher academic success and higher Grit-S. Lastly, students with higher Grit-S were also more likely to obtain a postgraduate training position.

### ATTITUDE TOWARDS SUCCESS IN ABSTRACT ALGEBRA

This part presents literature about Attitudes towards success in Abstract Algebra structured in sub-themes as patterned in the research problem to be examined. Sub-themes include Age and Attitude towards success in Abstract Algebra, Sex and Attitude towards success in Abstract Algebra, and Attitude towards success in Abstract Algebra and Academic Achievement in Abstract Algebra.

#### Age and Attitude towards success in Abstract Algebra

Silao (2018) had examined the Factors Affecting the Mathematics Problem Solving Skills of Filipino Pupils. Based on his findings, there is a significant relationship between pupil factor and attitude towards mathematics. He further added that pupil factor and performance in mathematics had significant relationship. On the same contentions, Luttenberger, *et al.*, (2018), conducted study on math anxiety in US. They found out that age difference affects the attitude towards

mathematics. They further emphasized that math anxiety affects individuals of all ages in academic situations as well as in their academic success and well-being. In addition, Fabian K., *et al.*, (2018) examined the effect of using mobile technologies for teaching mathematics. Based on their findings, they found out that all the participants, regardless of age have positive attitude towards mathematics. They generally label the respondents as having relatively high level of enjoyment towards mathematics. It was established by several literature reviews that attitudes towards mathematics vary across age. Furthermore, gender difference and other socio-demographic characteristics had a significant relationship with achievement in mathematics.

### **Sex and Attitudes towards success in Abstract Algebra**

It was established by several literature reviews that attitudes towards mathematics vary across age. Furthermore, gender difference and other socio-demographic characteristics had a significant relationship with achievement in mathematics. In addition, G. Kaiser and N. Presmeg (2019) had examined sex and mathematics education in general. They pointed out that there are transitions from traditional point of view that male were generally fit for mathematics education than female. They made mention about several literature and studies pointing out equality in mathematics performance of both male and female. Parallel to these, Otoo D. *et al.*, (2018) had examined the interest and motivation of students in learning mathematics. They had constructed a structural model explaining the relationship between student's interest, motivation, and mathematics performance. They had explained that sex and age have direct effect to students' attitude towards mathematics. In addition, Uwineza I. *et al.*, (2018) had conducted a study about gender attitudes and perceptions towards mathematics of secondary students. They found out that boys and girls shared the same perceptions towards the importance of mathematics subjects. However, they also discovered that boys manifested more negative perceptions towards girls' ability to perform well in mathematics.

Furthermore, Mensah F. and Yankson O. (2017) had examined the attitude of the students towards mathematics in relation to sex. They found out that girls seemed to have higher positive attitude towards mathematics than boys.

### **Attitude towards success in Abstract Algebra and Academic Achievement in Abstract Algebra**

Mazana M. Y *et al.*, (2020) assessed student's performance in mathematics based on teachers' perspectives. They found out that there is a higher failure rates in primary and secondary school's particularly lower secondary school. Gender differences exist at all levels of education with girls underperforming in primary, lower secondary, and college examinations due to cultural factors impacting female students' learning. On the other hand, Ganesan P. *et al.*, (2020) examined factors and interventions influencing children's attitudes towards mathematics. They found out that there is only a weak correlation between attitude towards mathematics and their performance in mathematics.

Meanwhile, Fabian K. *et al.*, (2018) had examined the effect of mobile technologies in students' attitudes and achievement in mathematics. They found out that the use of mobile technologies elicits positive responses from students both in terms of how they perceive the mobile activities and how it improved their performance but its' effect on students' attitudes towards mathematics will need to be further investigated.

## **ACADEMIC ACHIEVEMENT IN ABSTRACT ALGEBRA**

This part presented literature about Academic Achievement in Abstract Algebra structured in sub-themes as patterned in the research problem to be examined. Sub-themes include Age and Academic Achievement in Abstract Algebra and Sex and Academic Achievement in Abstract Algebra.

### **Age and Academic Achievement in Abstract Algebra**

Abramovich S. *et al.*, (2019) conducted a study about "Teaching Mathematics through Concept Motivation and Action Learning". They had found out that action learning could be used in teaching mathematics across k-12 curriculum. Age factor relative to performance in mathematics could be minimized using action learning. In addition, Koponen T. *et al.*, (2018) examined the prevalence of comorbidity of dysfluent reading and math skills. They found out that children who showed very low performance in one skill also evidenced low or very low performance in the other. They further emphasize that difficulties had somewhat higher prevalence in third and fourth graders than in first and second graders.

Furthermore, H. M. Costa *et al.*, (2018) had examined the performance of pre-schoolers in mathematics. They had found out that preschool low achievers constitute a heterogeneous group, and they stress the importance of domain-general factors for the development of mathematical abilities during the preschool years. Anders J. *et al.*, (2018) examined the variation of subject choices relative to their previous school attended. They found out that young students studying core subjects performed the same as those who are not studying the core subjects' combination. They further noted a statistically significant association between an individual's gender and the academic selectivity of the subjects they study.

### **Sex and Academic Achievement in Abstract Algebra**

Rodríguez S. *et al.*, (2020) had investigated about the effects of motivation in mathematics performance of students in primary education. They found out that girls tend to exhibit fewer positive attitudes towards mathematics than boys. And they further explained that motivation towards mathematics was significantly related to academic performance. Hinojo-Lucena FJ. *et al.*, (2020) had examined the status of STEM in the web of science. They had found out that there are differences at the level of gender in its use in teaching and learning process. Leder G. C. (2019) had examined gender and mathematics education. She had reviewed studies about gender relative to mathematics education. She had pointed out the gender difference in terms of opportunity to participate in mathematics education. Guhn M. *et al.*, (2019) examined the level of participation and academic achievement of students in music, mathematics, and English. They had found out that the positive engagement in music and academic achievement in independent with sex. Dorta-Guerra R. *et al.*, (2019) conducted a study about academic performance of first year science degrees students. They found out that that there are no significant differences in the academic achievement of female and male students.

## **METHODOLOGY**

This study utilized quantitative method. Descriptive-Evaluative-Correlational design was utilized in this study. Descriptive components deal with the profile of the respondents. Evaluative will focus on determining the Grit Mindset, Attitudes towards success in Abstract Algebra and Academic Achievement in Abstract Algebra. Correlation aspect entails determining the extent of correlation of the

profile to Grit Mindset, Attitude towards success in Abstract Algebra and Academic Achievement in Abstract Algebra, degree of correlation of Grit Mindset to Attitude towards success in Abstract Algebra and Academic Achievement in Abstract Algebra.

**Respondents of the Study**

G-Power 3.1.9.7 was used to determine the sample size for the study. Using F-Test with two predictors at 95% test power and 5% level of significance, a sample size of 107 was identified. These 107 respondents were taken randomly from the four (4) campuses of CBSUA.

**Research Instrument**

This study utilized several instruments to facilitate the gathering of data. Profile of the respondents was gathered using questionnaire. Grit Mindset was determined using validated Grit Scale instrument. Attitude towards success in Abstract Algebra was gathered using validated survey questionnaire. And lastly the Academic Achievement of the students in Abstract Algebra was determined through the final grade submitted by the instructor/teacher in Abstract Algebra course.

**Method Of Data Analysis**

The correlation between the profile, Grit Mindset, Attitude and Academic Achievement was calculated using MS Excel. The extent of effect of the profile, Grit Mindset, Attitude to Academic Achievement was indicated using Path Analysis where the direct, indirect and total effect was calculated using MS Excel.

**RESULTS AND DISCUSSIONS**

**CORRELATION BETWEEN PROFILE, GRIT MINDSET, ATTITUDE TOWARDS SUCCESS AND LEVEL OF ACADEMIC ACHIEVEMENT IN ABSTRACT ALGEBRA OF THE RESPONDENTS**

The relationship between profile along age and sex, with Grit Mindset, Attitude Towards Success in Abstract Algebra and Academic Achievement in Abstract Algebra were analyzed by this study.

**Table 1. Correlation Between Profile, Grit Mindset, Attitude and Academic Achievement in Abstract Algebra**

		Correlation		t-test for testing the significance of r		
		Comp.	Interpretation	Comp.	Crit.	Interpretation
S	Grit	0.2845	Slight Correlation	1.7050	1.6931	Significant
E	Att.	0.2854	Slight Correlation	1.7106	1.6931	Significant
X	Acad	0.2845	Slight Correlation	1.7048	1.6931	Significant
A	Grit	0.4340	Moderate Correlation	2.7675	1.6931	Significant
G	Att.	0.4665	Moderate Correlation	2.9477	1.6931	Significant
E	Acad	0.2878	Slight Correlation	1.7263	1.6931	Significant
G	Att.	0.2858	Slight Correlation	1.7131	1.6931	Significant
R	Acad	0.2835	Slight Correlation	1.7131	1.6931	Significant
I						
T						
A	Acad	0.2856	Slight Correlation	1.7120	1.6931	Significant
T						

Table 1 shown that the profile along sex was slightly related with Grit Mindset, Attitude towards Success in Abstract Algebra and Academic Achievement in Abstract Algebra. Age moderately related to Grit Mindset and Attitude, but slightly related to Academic Achievement. Similarly, Grit Mindset was slightly related with Attitude towards success in Abstract Algebra and Academic Achievement in Abstract Algebra. Additionally, Attitude towards Success in Abstract Algebra was slightly related with Academic Achievement in Abstract Algebra. The result revealed that there exists a significant relationship between the profile of the respondents along age and sex, Grit Mindset, Attitude towards Success, and Academic Achievement in Abstract Algebra of the respondents.

**EXTENT OF EFFECT OF PROFILE, GRIT MINDSET, ATTITUDE TOWARDS SUCCESS TO THE LEVEL OF ACADEMIC ACHIEVEMENT IN ABSTRACT ALGEBRA OF THE RESPONDENTS**

The extent of effect of the profile of the respondents along sex and age, Grit Mindset, Attitude towards success with the Academic Achievement in Abstract Algebra was examined in this study. The direct, indirect, and total effect of the independent variables was presented in Table 2. Based on Table 2, the data revealed that the Sex of the respondents has a direct effect of 0.2845. It implies that the sex of the respondents has a contribution of 0.2845 standard units

**Table 2. Direct, Indirect and Total Effect of Profile, Grit Mindset and Attitude on Academic Achievement in Abstract Algebra**

	Direct Effect	Indirect Effect	Total Effect
Sex	0.2845	0.0232	0.3077
Age	0.2878	0.0383	0.3261
Grit	0.2835	0.0231	0.3066
Attitude	0.2856	None	0.2856

with the Academic Achievement in Abstract Algebra. The indirect effect of 0.0232 of sex with Academic Achievement was meaningful but not significant. The total effect of the sex of respondents was 0.3077 standard units with the Academic Achievement. Meanwhile, the age of the respondents has a direct effect 0.2878 with the Academic Achievement. A year of increase in age would yield an increase of 0.2878 standard units with the Academic Achievement. The indirect effect of age was 0.0383 standard units. The total effect of age with the Academic Achievement was 0.3261 standard units. Grit Mindset has a direct effect of 0.2835. A standard unit change in Grit would result to 0.2835 standard unit change in Academic Achievement. The meaningful yet not significant effect of Grit with the Academic Achievement was 0.0231. The total effect of Grit with the Academic Achievement in Abstract Algebra was 0.3066 standard unit. Attitude towards success has a direct effect of 0.2856. A standard unit change in Attitude would result to 0.2856 standard unit change in Academic Achievement. Attitude has no indirect effect with achievement. The total effect of Attitude to Academic achievement was 0.2856 standard units.

**PATH MODEL THAT REPRESENTS THE RELATIONSHIP BETWEEN THE PROFILE OF THE RESPONDENTS, GRIT MINDSET, ATTITUDE TOWARDS SUCCESS IN ABSTRACT ALGEBRA AND ACADEMIC ACHIEVEMENT IN ABSTRACT ALGEBRA**

The main goal of this study was to create a path model that represents the relationship between variables. The model developed as the result of this study represented the relationship between the

profile along sex and age, Grit Mindset, Attitude and Academic Achievement in Abstract Algebra. The direct effect of each independent variable was illustrated using arrow. The figure shown the existing relationship among the variables involved in the study.

**CONCLUSIONS AND RECOMMENDATIONS**

Based on the results and discussions, the following conclusions and recommendations were drawn.

**Conclusions**

The profile of the respondents along sex was slightly related to their GritMindset, Attitude towards success in Abstract Algebra and Level of Academic Achievement in Abstract Algebra. The age of the respondents was moderately related to related to their GritMindset, Attitude towards success in Abstract Algebra but slightly related to their Level of Academic Achievement in Abstract Algebra. The GritMindset of the respondents is slightly related to

instructors/teachers might be considered. Proper information dissemination regarding the relationship between profile, GritMindset, Attitude towards success in Abstract Algebra and Level of Academic Achievement in Abstract Algebra might be considered by instructors, OSAS and/or Program Chair. Seminars on improving Grit Mindset of the students might be considered by the OSAS to further enhance their attitude towards studies. Improving the attitude towards studies of the students through seminars might be conducted by the Program Chair or OSAS. This would also be helpful in enhancing the academic achievement of the students. Studying the limitations of the model might be considered to enhance its generalizability. Possible applications of the Path Model in other disciplines might be explored.

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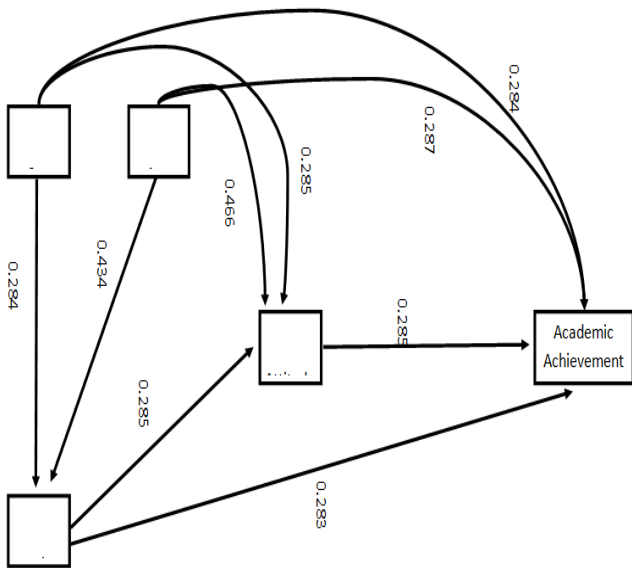
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their Attitude Towards Success in Abstract Algebra and Academic Achievement in Abstract Algebra. The Attitude Towards Success in Abstract Algebra of the respondents is slightly related with their Academic Achievement in Abstract Algebra. Path Model could be used to represent the relationship between the profile of the respondents, GritMindset, Attitude towards success in Abstract Algebra and Academic Achievement in Abstract Algebra.

**Recommendations**

To maintain the high level of Grit Mindset of the respondents, integrating the importance of persistence towards studies might be considered by professional education subject instructors/teachers. Seminar on importance of Grit Mindset towards studies could also be considered by the Program Chair/OSAS. To maintain the positive attitude towards Abstract Algebra of the respondents, integrating the importance of Abstract Algebra on their lesson could be undertaken by Mathematics instructors/teachers. Seminars on importance of Mathematics might be conducted by the OSAS. In order to sustain the high level of Academic Achievement in Abstract Algebra, continuous improvement of instructional practices of