

Path Analysis of Grit, Self-Regulation, and Attitude Towards Research

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ABSTRACT

This study explores the relationship between grit, self-regulation, and attitude toward research among Grade 11 and 12 STEM students in Bacolod City National High School. The study utilized three instruments to assess the levels of grit, self-regulation, and attitude toward research among the respondents. Two adopted instruments, namely the Short Grit Scale and Revised Attitude Towards Research Scale (R-ATR), and one adapted instrument which is the Self-Regulated Online Learning Questionnaire (SOL-Q), which was modified into the context of research to best fit the aim of the study. Path analysis was conducted to examine the independent effects of consistency of interest and perseverance of effort on various endogenous variables related to research. The results showed significant relationships between these variables, suggesting that fostering grit and self-regulation can contribute to a positive research culture among students. However, further research is needed to explore additional factors that may influence students' attitudes towards research. The findings of this study have implications for Department of Education officials and curriculum planners in generating ideas to battle students' negative attitude towards research and preparing learning guides to promote a research culture among students.

Keywords:

Grit, Self-Regulation, Attitude Towards Research, Path Analysis, STEM

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Introduction

The imperative role of research in propelling modernization and knowledge acquisition is indisputable. To promote a research culture among students, a "research-infused" curriculum was established for the senior high school level of the Philippine education system. (DepEd

2017). Both quantitative and qualitative methods are currently being incorporated into the curriculum. With most students lacking experience in conducting research, they may be affected by various factors, including their attitudes, which could potentially affect their level of appreciation and involvement in the field. (Roxas, 2018).

As indicated by a recent study, students encountered difficulties in various aspects of the research process, including population identification, sample selection, sampling bias detection, statistical analysis, and chart interpretation. These challenges led to negative perceptions of research among students. (Estacio et al., 2018). However, the significance of research cannot be disregarded, hence participating in and endorsing this type of scholarly pursuit. (Formalejo & Ramirez, 2017).

According to recent research, students exhibit a favorable disposition towards research and perceive it as a valuable asset for their professional development, (Maqsood et al., 2019; Formalejo & Ramirez, 2017; Roxas, 2018). However, there was a negative attitude toward research activities, notably one of research anxiousness. (Formalejo & Ramirez, 2017; Roxas, 2018). Additionally, self-regulation can assist students in defining objectives in advance and developing a plan of action to achieve those goals, approaching academic work with confidence and mindfulness, and more. (Cleary & Zimmerman, 2004). In addition, grit also has a strong connection to academic performance. There is a wealth of research conducted worldwide that provides evidence for the notion that higher levels of grit are linked to better outcomes in both academic and non-academic pursuits (Duckworth et al., 2007; Duckworth & Quinn, 2009).

Grit is simply described as “perseverance and passion” in the search of long-term objectives (Duckworth et al., 2007). The idea that those with greater grit are expected to do well in both academic and non-academic pursuits is one that has been the subject of many studies conducted internationally. In educational settings, grit is often depicted as a factor that may have a major impact on various outcomes, such as student engagement, academic performance, and retention. (Duckworth & Quinn, 2009; Maddie et al., 2012).

Conversely, it can be argued that Grit possesses a disadvantage. Based on results of a recent study, students who exhibit elevated levels of grit tend to invest more effort and persist through challenging tasks. (Flaming & Granato, 2017). Lucas et al (2015) stated that, while individuals with a gritty mindset may demonstrate high academic achievement, as evidenced by their GPA, their performance on standardized exams such as the SAT may not be as strong. This is because success on such exams often relies on the ability to efficiently navigate through challenging questions and prioritize simpler ones. Individuals with a greater level of resilience tend to persist in their efforts, potentially leading to misdirected efforts. (Lucas et al., 2015). This is where self-regulation comes into play.

The process of self-regulation entails the management of stress and subsequent recuperation in order to mitigate the frequency and intensity of potent impulses. (Shanker, 2016). Self-regulation is one of the educational theories that is most commonly used to explain student achievement since it considers a number of factors, including goal orientation, task-specific skills, and metacognitive methods (Panadero et al., 2017).

Attitude is a "psychological disposition that is communicated by viewing a particular entity with a certain extent of liking or dislike." as defined by Eagly and Chaiken (1993). Moreover, numerous studies have demonstrated the importance of attitude in influencing students' academic performance. (Reynolds et al., 1992; Boser, 1998).

Numerous studies have found a positive relationship between grit and self-regulation (Wolters, et al., 2015; Tiatri, et al., 2020). Weisskirch (2016) conducted a study which revealed that an individual's attitude towards lifelong learning and their learning

strategies can be used to predict a sub-construct of grit, specifically the perseverance of effort. Although there are correlational studies regarding grit, self-regulation and attitude towards research none has been done in path models. Thus, this study aims to determine the relationship between attitude towards research, self - regulation and grit using path models.

It specifically aims to:

- Determine the level of grit, measured in terms of consistency of interest and perseverance of effort; self-regulation, measured in terms of metacognitive skills; time management; environmental structuring; persistence; and help-seeking; and attitude towards research measured in terms of research anxiety, research usefulness, and research predisposition.
- Determine the significant relationships among the level of grit, measured in terms of consistency of interest and perseverance of effort; self-regulation, measured in terms of metacognitive skills; time management; environmental structuring; persistence; and help-seeking; and attitude towards research measured in terms of research anxiety, research usefulness, and research predisposition.

- Evaluate if each of the variables and constructs, specifically the level of grit, which is measured in terms of consistency of interest and perseverance of effort; self-regulation, which is measured in terms of metacognitive skills; time management; environmental structuring; persistence; and help-seeking, make independent contribution on the attitude towards research of students measured in terms of research anxiety, research usefulness, and research predisposition.
- Determine if self-regulation, measured in terms of metacognitive skills; time management; environmental structuring; persistence; and help-seeking have a mediational role on the attitude towards research of students measured in terms of research anxiety, research usefulness, and research predisposition.

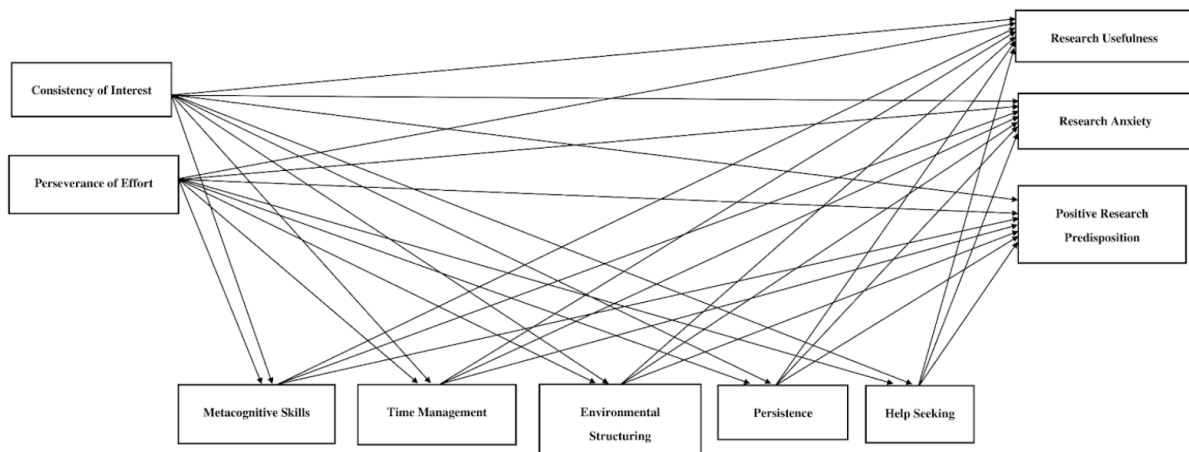


Figure 1. Hypothetical Path Model

Research Methodology

The design and methods necessary to conduct the research in accordance with the objectives of the study are covered in this chapter. Respondents of the study, sampling technique, data collection process, research design, research tools, statistical treatment and data analysis, and ethical considerations are all included in this section.

Research Design

The objective of the study is to identify and characterize the correlation between the variables that is Grit, Self-Regulation, and Attitude Towards Research, a descriptive-correlational design was employed in conducting this study. The variables and the underlying natural relationships that link and explain them are both described in descriptive correlational research. (Sousa et al., 2007).

Correlational designs are characterized by their systematic examination of relationships or correlations between variables, rather than a focus on direct cause-and-effect correlations. (Sousa et al., 2007). More specifically, in circumstances when the researcher lacks control over the exogenous variables, descriptive correlational studies are used to clarify the relationship between two variables. These variables are thought to influence or generate an effect on the endogenous variables. (Lappe, 2000).

Respondents

The study's respondents are a group of 204 students in Grade 11 and 12 STEM of Bacolod City National High School, School Year 2022 - 2023. It employed a stratified random sampling. In comparison to Simple Random Sampling (SRS), stratified random sampling is a type of probability sampling which enables researchers to improve precision while reducing error. Regarding

the target population's size of 411 students, we used a randomized sampling approach based on Yamane's formula to guarantee equitable representation for each strata (Singh & Masuku, 2014; Yamane, 1967). Additionally, a sample size of at least 200 must be used when using SEM, in order to give sufficient statistical power for data processing. (Hoe, 2008).

Instruments

The study has adopted 2 questionnaires and adapted 1 questionnaire to fit with the study's aim.

The first instrument in gathering the data for Grit, the study used the Short Grit scale developed by Duckworth & Quinn (2009) which is composed of 8 questions to measure the consistency of perseverance of effort and interest. The instrument is a Likert-type scale where for the items 2, 4, 7, and 8, the scoring ranges from 1 = "Not Like Me At All" to 5 = "Very Much Like Me", whereas for the items 1, 3, 5 and 6, the scoring ranges from 1 = "Very Much Like Me" to 5 = "Not Like Me At All"

The second is the adapted Self-Regulated Online Questionnaire (SOL-Q), which was developed in the context of Janssen et al., (2017) in eliciting data for Self-regulation and is composed of 43 questions to measure metacognitive skills, environmental structuring, time management, and help seeking. It is a Likert-type scale ranging from 1 = "Not All True For Me" to 7 = "Very True For Me".

The Revised - Attitude Towards Research (R-ATR) scale, established by Elena Papanastasiou in 2014, is the third method for gathering information about attitudes toward research. It consists of 13 questions that evaluate research usefulness, research anxiety, and positive research predisposition. The instrument is also a Likert-type scale that ranges from

1 = “Strongly Disagree” to 7 = “Strongly Agree”.

Validity

It is defined as the degree to which a measurement tool achieves its stated objectives. According to Zohrabi (2013), establishing validity involves attempting to justify the accuracy of study findings. The study adopted 2 questionnaires namely Short Grit Scale (Grit-S) and Revised Attitude Towards Research Scale (R-ATR) and adapted 1 questionnaire, the Self-Regulated Online Learning Scale (SOL-Q). The validity for the two adopted and one adapted questionnaire is shown below.

Short Grit Scale (Grit-S)

The validity of Short Grit Scale in eliciting information is proven by Duckworth and Quinn (2009). The Short Grit Scale (Grit-S) has four fewer items and superior psychometric qualities while maintaining the 2-factor structure of the original Grit Scale (Duckworth et al., 2007). The Short Grit Scale (Grit-S) demonstrated good internal consistency. $\alpha = .82$ and $.84$, respectively, in the 2006 and 2007 assessments. Moreover, Short Grit Scale is also supported by another study conducted in Indonesian millennials in which Analysis of Structural Moment (AMOS) was used to perform Confirmatory Factor Analysis (CFA), and it was evaluated for its validity. In addition, the Short Grit Scale (Grit-S) was shown to be valid with $\chi^2 = 20.97$, probability value = 0.138, RMSEA = 0.045, CFI = 0.972, GFI = 0.976, and AGFI = 0.941. (Priyohadi et al., 2019).

Revised Self-Regulated Online Learning Questionnaire (SOL-Q)

The study adapted the Self-Regulated Online Learning questionnaire (SOL-Q) which was originally developed by Jansen, et al. (2017). The modified SOL-Q instrument for Self-Regulation has

undergone face validity as its content was altered into the context of research.

Revised Attitude Towards Research Scale (R-ATR)

The validity is proven by Papanastasiou (2014) through Confirmatory Factor Analysis (CFA). The CFA conducted on the questionnaire's original version revealed that the model's fit was insufficient. The fit of the model was established after removing a total of 19 variables because of their amounts of error variance and by reducing the components to three separate factors. The correlations between the three factors of the revised model were presented in the study where “Positive research propensity” and “Research anxiety” had the strongest connection ($r=0.62$). Between the variables “Research usefulness” and “Research difficulty,” there was the least connection ($r=0.18$). And lastly, “Research usefulness” and “Positive research predispositions” have a 0.54 connection. The three components exhibit discriminant validity as a result of the low to moderate correlations between them.

Reliability

Reliability is defined as measurement stability in a range of circumstances when the results should be acquired (Nunnally, 1978). In essence, it is the ability to reproduce or replicate study findings (Edwin, K., 2019).

The reliability of Short Grit Scale, SOL-Q, and R-ATR was established in the study after the following instruments were delivered to Sum-Ag National High School for pilot testing among 30 Grade 11 and 12 STEM students with similar characteristics with our respondents in the study. They were not included in the study's final sampling frame, instead the results from their responses were calculated and solved using the formula for Cronbach's alpha for internal reliability.

Statistical Treatment and Data Analysis

To establish the association between the three variables, statistical tools such as Mean, Standard Deviation, Pearson's r, and Structural Equation Modeling, specifically path analysis were applied by utilizing the statistical program AMOS. The "AMOS" (Analysis of Moment Structures) module of IBM SPSS Statistics is utilized for analyzing covariance structure models such as structural equation modeling (SEM), path analysis, and confirmatory factor analysis (CFA) (Barnidge & Zuñiga, 2017).

According to Hamilton (2017), a statistical tool called path analysis enables users to examine influence patterns within a system of variables. It is a form of general linear model that investigates the interactions between a group of endogenous variables and a set of predictor variables. Pearson r was used to analyze the significant relationship between Grit in terms of Consistency of Interest and Perseverance of Effort, Self-Regulation in terms of Time Management, Metacognitive Skills, Environmental Structuring, Persistence and Help Seeking, and Attitude Towards Research in terms of Research Usefulness, Research Anxiety, Positive Research Predisposition, Relevance to Life,

and Research Difficulty. The p-value and coefficient "r," which range from -1 to +1, used in Pearson correlation analysis indicate if there is a linear relationship between two variables and how strong it is. It should only be used if the underlying assumptions are true. If the result is significant, we can say that there is a correlation. (Samuels & Gilchrist, 2014).

Results and Discussion

The level of Grit, Self-Regulation, and Attitude Towards Research as well as their relationship and significance was analyzed using statistical treatments to make conclusions.

Path Analysis

The AMOS program provides a variety of indicators for determining model fit. The Chi Square value χ^2 , is one of the most often used indices for determining the goodness of fit of a model. However, because χ^2 is based on limiting assumptions and is sensitive to sample size, it may not be a useful indicator of overall model fit (Tabachnick & Fidell, 1996). If the sample size for the study is more than 200, the absolute fit index of minimum discrepancy chi-square can be ignored (Hair et al., 1996; Joreskog & Sorbom, 1996). Other indices,

Table 1
Index category and the level of acceptance for every index

| Name of Category | Name of Index | Level of Acceptance | Comments |
|------------------|---------------|---------------------|---------------------------------|
| Absolute Fit | Chisq | $p > .05$ | Sensitive to sample size > 200 |
| | RMSEA | RMSEA < 0.08 | Range .05 to 0.1 is acceptable |
| | GFI | GFI > 0.90 | GFI = .95 is a good fit |
| Incremental Fit | AGFI | AGFI > 0.90 | AGFI = .95 is a good fit |
| | CFI | CFI > 0.90 | CFI = 0.95 is a good fit |
| | TLI | TLI > 0.90 | TLI = 0.95 is a good fit |
| | NFI | NFI > 0.90 | NFI = .95 is a good fit |
| Parsimonious fit | χ^2/df | Chi square/df < 5.0 | The value should be less than 5 |

Based from Hair et al., 1996; Joreskog and Sorbom, 1996

such as the Comparative Fit Index (CFI), the Bentler-Bonett Normed Fit Index (NFI), the Lisrel GFI/AGFI Index, and the Root Mean Square Error Approximation (RMSEA), were highlighted as indications of the goodness of fit. Values of .90 or higher for CFI, NFI, GFI/AGFI suggest a satisfactory model fit to the sample data. An RMSEA value of 0.08 to 0.10 provides a mediocre fit and below 0.08 shows a good fit (MacCallum et al, 1996). However, in recent years, authorities in this field have agreed on a cut-off value of around .06 (Hu & Bentler, 1999) or a strict upper limit of 0.07 (Steiger, 2007). Table 1 presents the index category and the level of acceptance for every index used in this study.

The hypothesized model includes the exogenous variables consistency of interest and perseverance of effort with paths to the different endogenous variables namely metacognitive skills, time management, environmental structuring, persistence, help-seeking, research usefulness, research anxiety, and positive research predisposition. Direct, indirect, and total effects were examined as seen in Figure 2.

The path diagram in Figure 2 includes standardized beta coefficients. Overall, the relationships specified in the hypothesized model were found, suggesting that there is a relationship between consistency of interest and perseverance of effort with paths to the different endogenous variables namely metacognitive skills, time management, environmental structuring, persistence, help-seeking, research usefulness, research anxiety, and positive research predisposition. However, in the hypothesized path model, the significant Chi-square value ($\chi^2(13)=403.078, p=.000$) suggested that this model did not account for all the data. Other goodness of fit indices ($\chi^2/df = 31.006$; RMSEA=.384; GFI=.656; AGFI = -.455; CFI=.372; TLI = -1.173; NFI=.395) also indicated that the model fitted the data only relatively. A modification was necessary in order to attain a better fitting and more parsimonious model.

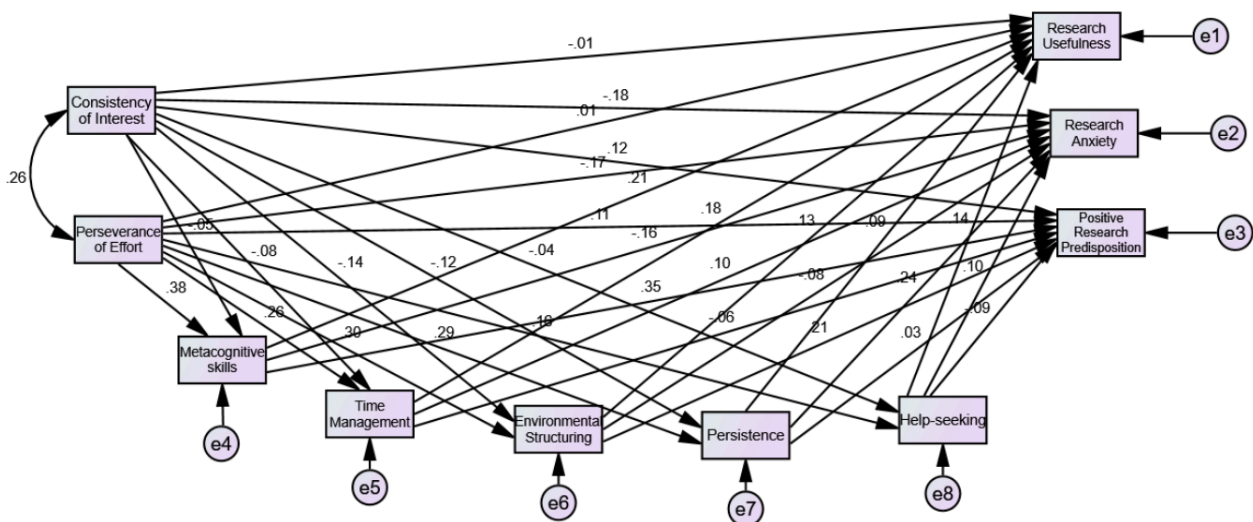


Figure 2. Hypothesized Path Model with Standardized Coefficients

The Revised Model

Researchers make assumptions about the direction of causality between variables when they include paths in a covariance structure model. These assumptions may not always be correct, especially if they are not based on a strong theoretical understanding or rigorous empirical findings (Ng, 2000). In this study, the researchers made the decision of which paths to include based on a theoretical understanding and empirical support. Figure 3 presents the revised model.

The revised model included five (4) additional paths between metacognitive skills and time management, environmental structuring, persistence and help-seeking. Some studies have shown that teaching and learning metacognitive skills to students improves their ability to manage their time efficiently (Imani, et al. 2011) with the use of additional tools (Kirsh, D., 2015).

Another study concluded that preservice teachers' management of their study environments and time can be predicted by their metacognitive self-regulation scores (Şen, Ş. & Yilmaz, A., 2016). Furthermore, the findings of Adis, et al. (2021) indicated that metacognition strategies significantly improve environment structuring.

“Help-seeking” and “metacognitive” are said to be causally related concepts. Help-seeking actions have the ability to enhance metacognitive skills, which subsequently encourage students' to strengthen their help-seeking behaviors during collaborative learning (Sumadyo, et al., 2021). Findings from another study showed that students who commonly utilize metacognitive strategies are more inclined to seek help when it is needed (Karabenick, S. A., & Knapp, J. R., 1991). Moreover, metacognitive can have a positive effect on persistence. According to the study of Martinez, M. E. (2006), persistence and

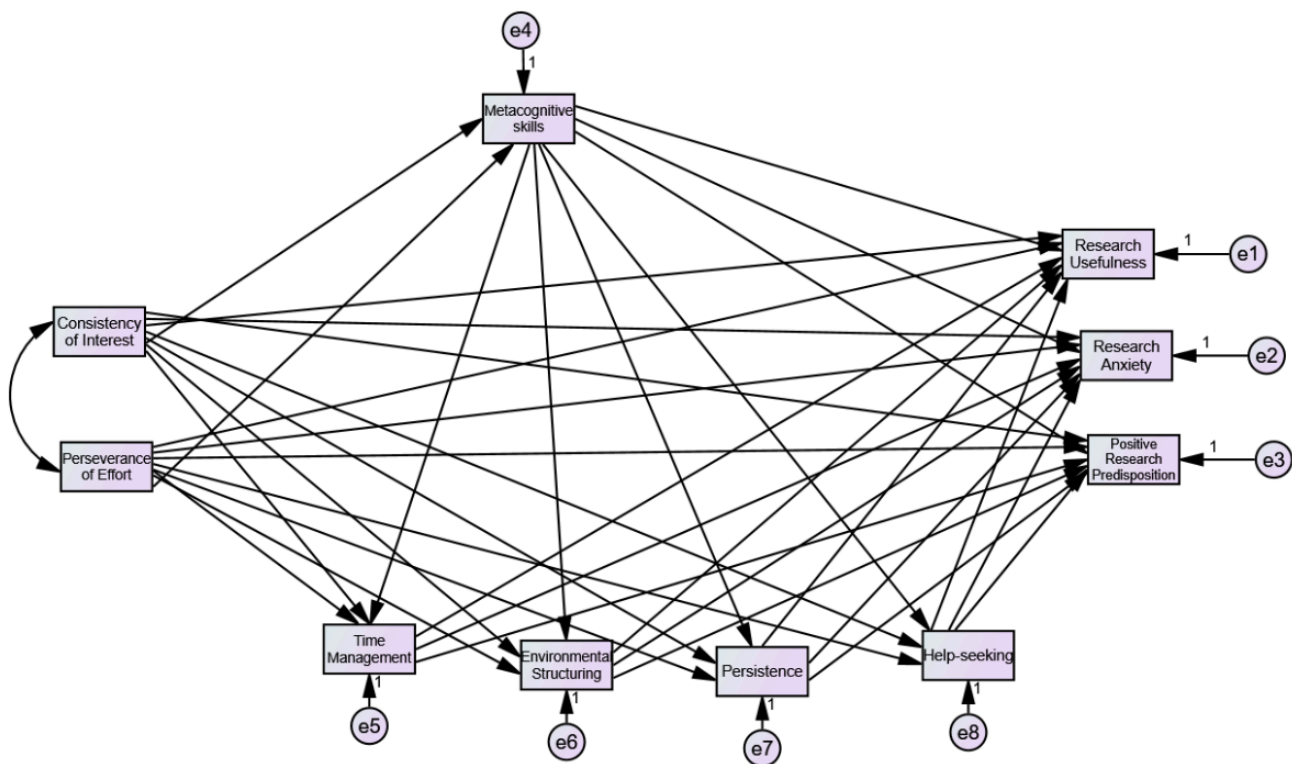


Figure 3. The Revised Path Model

focus can be strengthened by metacognitive thought, helping students to keep themselves persistent and concentrated.

The revised model was then subjected to analysis. Figure 4 shows the final path model and non-significant paths were deleted. The path diagram includes standardized beta coefficients.

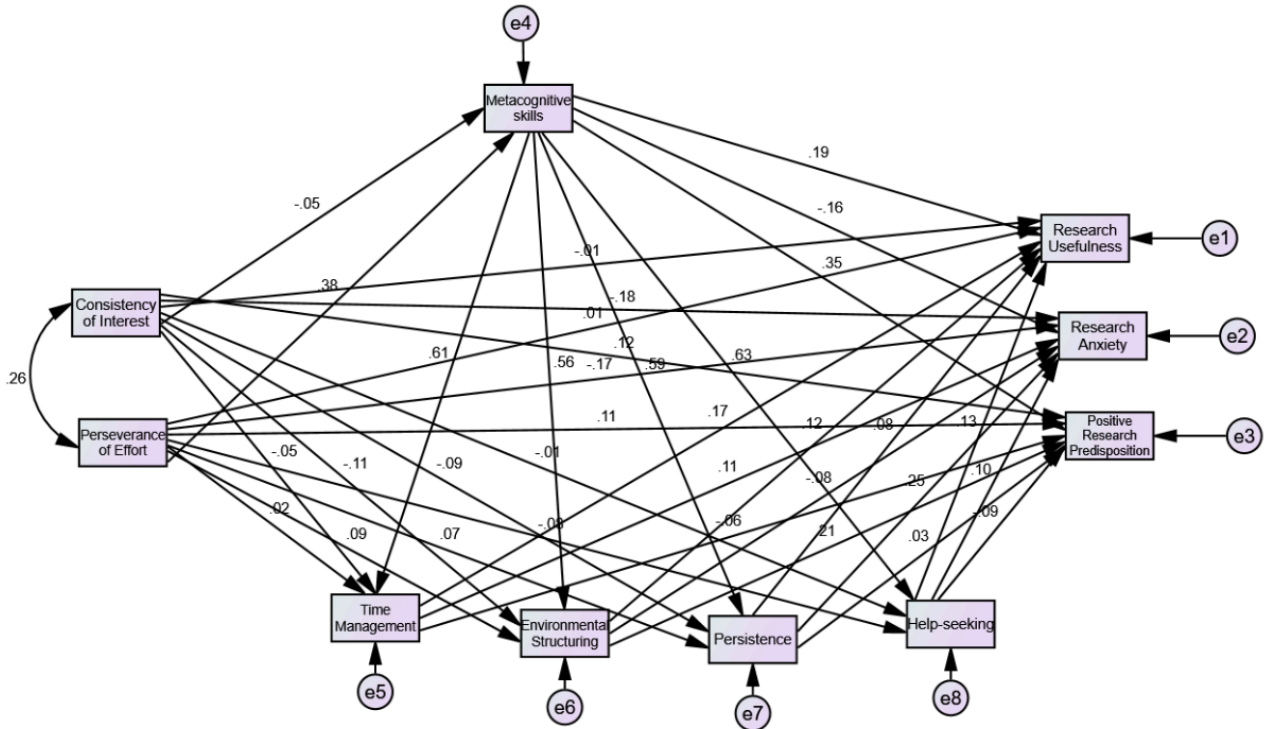


Figure 4. Revised Model with standardized estimates

Overall, the relationships specified in the revised model were discovered, indicating that there is a relationship between consistency of interest and perseverance of effort with paths to the different

endogenous variables namely metacognitive skills, time management, environmental structuring, persistence, help-seeking, research usefulness, research anxiety, and positive research predisposition.

Table 2

Statistical Values Related to the Fitting of the Revised Model

| Category | Measure | Level of Acceptance | Acceptable Fit | Fit Index Values of the Model |
|------------------|---------------|---------------------|---------------------------------|-------------------------------|
| Absolute fit | χ^2 | P > .05 | P > .05 | 78.415 |
| | RMSEA | < 0.08 | Range 0.05 to 0.1 is acceptable | .192 |
| Incremental fit | GFI | > 0.90 | 0.85 — 0.89 | 0.935 |
| | AGFI | > 0.90 | 0.85 — 0.89 | 0.603 |
| | CFI | > 0.90 | 0.80 — 0.85 | 0.888 |
| | TLI | > 0.90 | 0.85 — 0.89 | 0.441 |
| | NFI | > 0.90 | 0.85 — 0.89 | 0.882 |
| Parsimonious fit | (χ^2/df) | < 5.0 | The value should be less than 5 | 8.713 |

Based from Hair et al., 1996; Joreskog and Sorbom, 1996

The Chi-square value ($\chi^2 (9) = 78.415$, $p=.000$) of the model is however, significant which may be ignored because the sample size obtained for the study is greater than 200 (Hair et al., 1996; Joreskog and Sorbom, 1996). The other absolute fit indices RMSEA = .195 and GFI = 0.935 are within the acceptable fit. The

incremental fit indices CFI = 0.888; and NFI = .882 are all within the acceptable range, except for AGFI = 0.603 and TLI = 0.441. The parsimonious fit index (χ^2/df) = 8.713 is outside the acceptable value of less than 5. This indicated that the model indicated an acceptable fit of the data, hence the model was accepted.

Table 3
Decomposition of Effects of the Revised Model

| Effect | Direct | Indirect | Total Effect |
|--------------------------------------|---------|----------|--------------|
| Of Perseverance of Effort on | | | |
| Metacognitive Skills | .384** | -- | .384** |
| Time Management | .023 | .236** | .259** |
| Environmental Structuring | .085 | .217** | .302** |
| Persistence | .065 | .225** | .290** |
| Help-Seeking | -.084 | .242** | .157* |
| Positive Research Predisposition | .109 | .177** | .286** |
| Research Anxiety | -.170* | .028 | -.142* |
| Research Usefulness | .008 | .197** | .205* |
| Of Consistency of Interest on | | | |
| Metacognitive Skills | -.051 | --- | -.051 |
| Time Management | -.049 | -.031 | -.080 |
| Environmental Structuring | -.112* | -.029 | -.140 |
| Persistence | -.092 | -.030 | -.122 |
| Help-Seeking | -.007 | -.032 | -.039 |
| Positive Research Predisposition | .123* | -.043 | .080 |
| Research Anxiety | -.181** | -.023 | -.204** |
| Research Usefulness | -.012 | -.055 | -.067 |
| Of Metacognitive Skills on | | | |
| Time Management | .615** | -- | .615** |
| Environmental Structuring | .565** | -- | .565** |
| Persistence | .585** | -- | .585** |
| Help-Seeking | .629** | -- | .629** |
| Positive Research Predisposition | .345** | .046 | .391** |
| Research Anxiety | -.160 | .224* | .064 |
| Research Usefulness | .189 | .300** | .490** |
| Of Time Management on | | | |
| Positive Research Predisposition | -.059 | -- | -.059 |
| Research Anxiety | .106 | -- | .106 |
| Research Usefulness | .169** | -- | .169** |
| Of Environmental Structure on | | | |
| Positive Research Predisposition | .213** | -- | .213** |
| Research Anxiety | -.082 | -- | -.082 |
| Research Usefulness | .118 | -- | .118 |
| Of Persistence on | | | |
| Positive Research Predisposition | .035 | -- | .035 |
| Research Anxiety | .246* | -- | .246* |
| Research Usefulness | .084 | -- | .084 |
| Of Help-Seeking on | | | |
| Positive Research Predisposition | -.092 | -- | -.092 |
| Research Anxiety | .097 | -- | .097 |
| Research Usefulness | .128* | -- | .128* |

* $p < .05$, ** $p < .01$

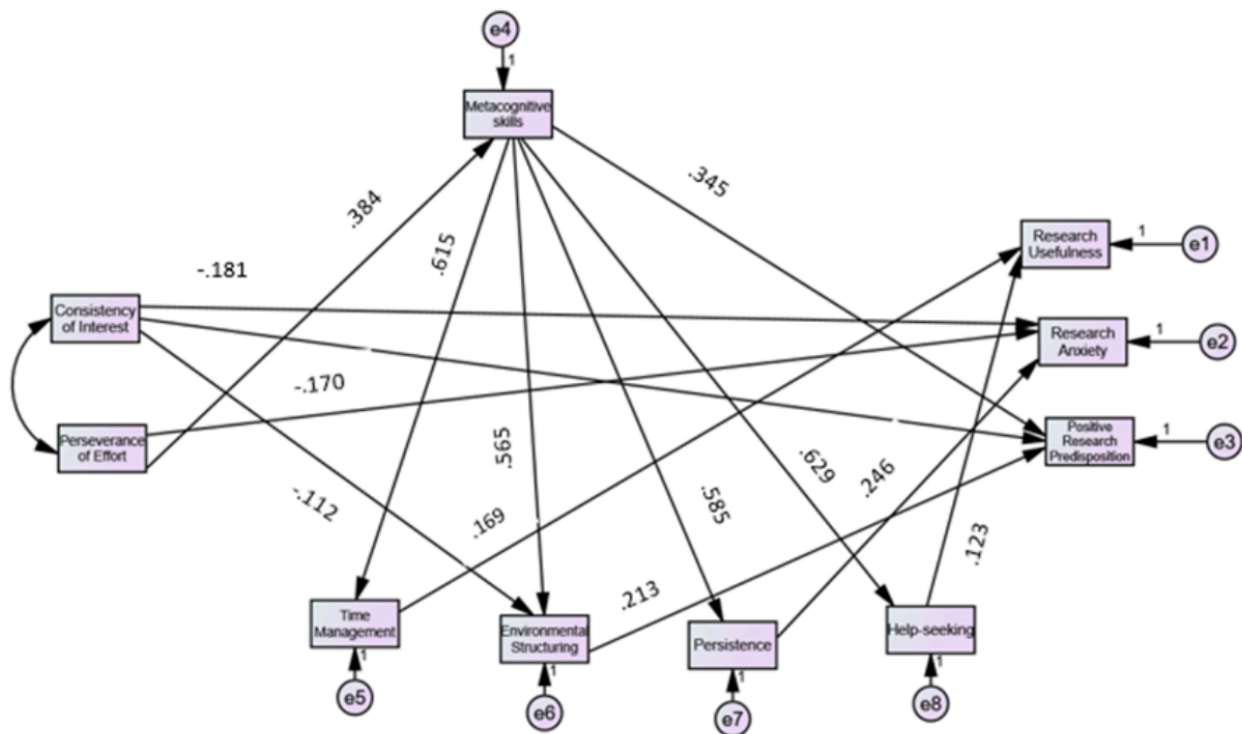


Figure 5. Revised Model with Significant Path

Perseverance of effort (PE) did not exhibit a significant direct effect to help-seeking ($\beta = -.084$, $p = .105$), however it exhibited a significant direct effect to metacognitive skills ($\beta = .384$, $p = .002$) and metacognitive skills also showed a significant direct effect to help-seeking ($\beta = .629$, $p = .004$). This resulted in a significant indirect effect ($\beta = .242$, $p = .001$) and a significant total effect ($\beta = .157$, $p = .020$) implying that perseverance of effort can affect help-seeking through metacognitive skills. This is in line with the study of Wolters, C. & Husain, M. (2015) and Arslan et al., (2013) where their findings show that perseverance of effort has a positive relationship with Metacognitive Strategies. It can be said that students who have high perseverance of effort are likely to use metacognitive skills. Metacognitive Skills predicting help-seeking are supported by the study of Sumadyo, et al., (2021), wherein help-seeking behaviors can strengthen metacognitive skills, which in turn motivates students to increase their help-seeking behaviors during collaborative

learning. Furthermore, students who commonly utilize metacognitive strategies are more inclined to seek help when it is needed (Karabenick, S. A., & Knapp, J. R., 1991).

PE was also found to have an indirect effect on time management ($\beta=.236$, $p=.001$), environmental structuring ($\beta=.217$, $p=.001$), and persistence ($\beta=.225$, $p=.001$) via metacognitive skills. This was supported by the study of Imani, et al., (2011) and Shen, C-Y., & Lui, H-C., (2011), who found that learning and training metacognition strategies will help increase time management skills. Şen Ş., & Yilmaz A., (2016) also found that metacognitive self-regulation predicts preservice teachers' time and study environment management. With that being said, students who utilize metacognitive skills are likely to seek help when needed. Meanwhile, perseverance of effort and consistency of interest have a negative direct effect on research Anxiety ($\beta= -.170$, $p= .020$ & $\beta= -.181$, $p= .008$ respectively), this is consistent with the

study of Eteng-Uket, S. & Njaka, R. C. (2023) and Khajavy et., al (2022) where their findings indicate that both perseverance of effort and consistency of interest predicted research anxiety and subject anxiety. It can be said that students whose interests are consistent and persevere despite setbacks have lower anxiety toward research.

Additionally, consistency of interest was found to have a negative direct effect on environmental structuring ($\beta = -.112$, $p = .031$), but have a positive direct effect on positive research predisposition ($\beta = .123$, $p = .030$). This counters the study of Khajavy et al. (2022) where only perseverance of effort predicted course enjoyment. This means that students with high levels of perseverance of effort are likely to enjoy research. The study of Wolters et al. (2017) where they found that students who reported greater consistency in pursuing their established goals also tended to report increased use of time and study environment management strategies. While in the case of metacognitive skills predicting environment structuring, the findings are consistent with the study of Şen Ş., & Yilmaz A., (2016) and Adis, et al. (2021) where they found that metacognition strategies have a positive significant effect on time and study environment. This indicates that students who apply metacognitive skills are likely to engage in environmental structuring.

It was found that PE has an indirect effect on research usefulness ($\beta = .197$, $p = .001$) via time and management and help-seeking, and on positive research predisposition ($\beta = .177$, $p = .002$) via metacognitive skills. In addition, environmental structuring has a direct effect on positive research predisposition ($\beta = .213$, $p = .006$). These findings are supported by Lee et al., (2020), Yusri et al., (2011), and Pintrich et al., (1993) to which they pointed out that students who view their academic subject as interesting, important, or useful also use

metacognition, time management strategies frequently, environment structuring, persist through challenging or boring tasks, and seek out help. Contrary to our study, only time-management and help-seeking have a positive prediction on research usefulness. Kesici et al., (2011) and Garcia et al., (2016) found in their study that students who employ metacognitive strategies, time and study environment management, persistence and help seeking have low anxiety towards statistics and a more positive attitude towards statistics and mathematics. Unfortunately, our study only found environmental structuring to have a direct positive relationship, and an indirect effect via metacognitive skills on positive research predisposition. This implies that students who have high metacognitive skills and employ environmental structuring have better attitudes on research.

Metacognitive skills was found to have a positive direct effect on time management ($\beta = .615$, $p = .002$), environmental structuring ($\beta = .565$, $p = .002$), persistence ($\beta = .585$, $p = .002$), help-seeking ($\beta = .629$, $p = .004$) and positive research predisposition ($\beta = .345$, $p = .003$). These are supported by the findings of Şen Ş., & Yilmaz A., (2016) and Adis, et al. (2021), where it was discovered that the time and study environment management are positively impacted by metacognition strategies. This suggests that students who use metacognitive skills are more likely to structure their environments. Martinez, M. E. (2006), found that students' persistence and focus can be improved by metacognitive thought. Furthermore, metacognitive skills affecting positive research predisposition positively, are supported by the aforementioned study of Kesici et al., (2011), where it was found that students who use metacognitive strategies, time and study environment management and help seeking have lower anxiety around statistics and a more positive attitude toward statistics and mathematics.

But only metacognitive skills and environmental structuring were found to have a positive and direct effect on positive research predisposition.

However, metacognitive skills have an indirect effect on research usefulness ($\beta=.300$, $p=.001$) and research anxiety ($\beta=.224$, $p=.019$) via time management and help-seeking, and persistence, respectively. These are supported by the study of Shen, C-Y., & Lui, H-C. (2011) and Imani, et al., (2011). Şen Ş., & Yilmaz A., (2016) additionally discovered that preservice teachers' time and study environment management is predicted by metacognitive self-regulation. It can be stated that time and the study environment are positively impacted significantly by metacognition strategies. The findings were also in line with the study of Lee et al., (2020), wherein they found that learners are more likely to employ metacognition, Time management, help-seeking, and environment structuring skills if they perceive tasks as important, interesting, and useful. This was further supported by Yusri et al., (2021), they found that students who view their academic subject as interesting, important or useful also employ time management, environment structuring, persist in challenging or boring tasks, and seek help frequently. However, our study found that environmental structuring and persistence did not predict Research Usefulness. As for persistence having a direct effect on research anxiety, Xiao and Sun (2021) found persistence to have a negative effect on math anxiety. Even so, our findings found that persistence has a positive effect on research anxiety.

Time Management and help-seeking was found to predict research usefulness ($\beta=.169$, $p=.009$; $\beta=.128$, $p=.040$). These findings were supported by the results of the study of Lee et al., (2020) and Yusri et al., (2011), where they found that students who view their academic subjects as useful,

important and interesting are more likely to exhibit metacognition, time management, environment structuring, persistence and help-seeking in difficult or boring tasks. However the findings imply that only time management and help-seeking predicted research usefulness. Environmental structuring directly predicted positive research predisposition ($\beta=.213$, $p=.006$) and persistence was found to directly predict research anxiety ($\beta=.246$, $p=.018$). This was supported by the study of Kesici et al., (2011), wherein students that use metacognitive strategies, time and study environment management, and help-seeking have been reported to have less anxiety regarding statistics and a more positive attitude toward statistics. On the contrary, our study only found environmental structuring as a significant positive predictor on positive research predisposition, but not on research anxiety. This suggests that students who use environmental structuring and have good metacognitive skills have lower levels of research anxiety. As of Persistence predicting Research Anxiety, Xiao and Sun (2021) found Persistence to have a negative effect on Math Anxiety. Unfortunately, our findings found that Persistence has a positive effect on Research Anxiety.

Summary of Findings

With a 100% response, or 204/204 responses gathered, respondents include both Grade 11 and 12 STEM students from each 12 sections. Based on the objectives, the notable findings of the study are as follows.

Overall, the level of grit of students in terms of perseverance of effort (PE) was average with a mean of 3.32, while in terms of consistency of interest (CI) the result was also found to be average with a mean of 2.56. The level of self-regulation in terms of metacognitive skills, environmental

structuring, time management and persistence was moderately high among students with averages of 5.19, 5.33, 4.80, and 5.09 respectively, while help-seeking was found to be high among them with a mean of 5.66. Students somewhat agree that research is useful in their lives having a mean average of 5.45, also they have somewhat agreed to have experienced research anxiety with an average of 4.97, as they have slightly agreed to exhibit positive research disposition with a 4.24 average.

Grit in terms of perseverance of effort has a significant indirect effect on time management with, environmental structuring, persistence, and help-seeking with a p value of .001, along with positive research predisposition and research usefulness via metacognitive skills with p values of .002 and .001. Perseverance of effort and consistency of interest have a significant negative direct effect on research anxiety having p values of .020 and .008, which implies an inverse relationship. While consistency of interest had a negative direct effect on environmental structuring with a p value of .031, but a positive direct effect on positive research predisposition having a p value of .030. Time management only had a significant effect on research usefulness with a p value of .009. Environmental structuring was found to have a direct effect on positive research predisposition, having a p value of .006, which shows to be significant. Persistence was found to have a direct effect on research anxiety, having a p value of .018, which is a significant relationship. Lastly, help-seeking has a significant direct effect on research usefulness, with a p value of .128.

The study found that perseverance of effort made an independent contribution to metacognitive skills ($\beta = .384$, $p = .002$) and research anxiety ($\beta = -.170$, $p = .020$). Consistency of interest was also found to have an independent contribution on environmental structuring ($\beta = -.112$, $p = .031$) and positive research predisposition ($\beta = .123$, $p = .030$). In terms of self-regulation, metacognitive skills made an

independent contribution on time management ($\beta = .615$, $p = .002$), environmental structuring ($\beta = .565$, $p = .002$), persistence ($\beta = .585$, $p = .002$), and positive research predisposition ($\beta = .345$, $p = .003$). Time management and help-seeking was found to have an independent contribution to research usefulness ($\beta = .169$, $p = .009$; $\beta = .128$, $p = .040$). Environmental structuring has an independent contribution to positive research predisposition ($\beta = .213$, $p = .006$). Persistence was found to have an independent contribution to research anxiety ($\beta = .246$, $p = .018$).

The study found that self-regulation in terms of time management, metacognitive skills, environmental structuring, persistence, and help-seeking did not have mediational roles between grit in terms of consistency of interest and perseverance of effort and attitude towards research in terms of research usefulness, research anxiety, and positive research predisposition. However, metacognitive skills have a partial mediation between perseverance of effort and help-seeking.

Conclusion

This study provides insights on the levels and significant relationships of grit, self regulation and attitudes towards research of students. Overall, the level of grit of students was found to be average. The level of self-regulation in terms of metacognitive skills, environmental structuring, time management and persistence was moderately high among students, while help-seeking was found to be high among them. Students somewhat agree that research is useful in their lives, also they have somewhat agreed to have experienced research anxiety even though they have slightly agreed to exhibit positive research predisposition.

Grit, in terms of perseverance of effort (PE), had significant indirect effects on the sub-constructs of self-regulation and attitude towards research, but only had a significant positive direct effect on metacognitive skills and a negative direct effect on research anxiety. However, consistency of interest only predicted positive research predisposition, and inversely on environmental structuring and research anxiety. Effects of metacognitive skills on self-regulation and attitude towards research was directly significant, except for research anxiety and research usefulness which was found to be indirectly significant. Furthermore, self-regulation overall significantly predicts attitude towards research.

Additionally, the findings showed that each of the sub-constructs of grit and self-regulation made independent contributions to the various facets of attitudes towards research. These independent contributions can be directly, as well as inversely.

Lastly, the study reports that self-regulation as a whole did not have a mediational role between the sub-constructs of grit and attitude towards research, however only one sub-variable of self-regulation, namely metacognitive skills, played a partial role as a mediator between grit and attitude towards research.

Overall, the study highlights the importance of incorporating metacognitive skills, time management, and help-seeking strategies with grit in students' academic experiences to improve their research attitudes and outcomes.

Recommendations

Based on the above findings, we proposed the following suggestions. First, a more comprehensive study should be done on the domains of Grit, Self-regulation and attitude towards research to fill the

aforementioned gaps between them. Regarding the sub variables, future researchers are encouraged to fill the gaps of this study especially in the context of causal modeling.

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