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Cognitive Strategies, Visual-Spatial Abilities, and Memorization Efficacy among Stem Senior High School Students

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Abstract This study explores cognitive strategies, visual-spatial abilities, and memorization efficacy among 95 senior high school STEM students at the University of Mindanao, Matina Campus. The study employs meticulous quantitative analysis, utilizing Spearman correlation analysis and multiple linear regression models. The investigation revealed a moderate utilization of cognitive strategies among participants, favoring rehearsal over organization strategies. Meanwhile, visual-spatial abilities are found to be at an average proficiency level, with a strong inclination towards interpretation. Participants exhibit high level of memorization efficacy, with retrieval accuracy and retention rate outperforming recall speed. Contrary to previous studies, there was no significant relationship found between cognitive strategies and memorization efficacy, while a strong correlation was found between visual-spatial abilities and memorization efficacy, which underscores the importance of incorporating more visual-spatial learning experiences into educational curricula to enhance memory retention and foster academic success among senior high school STEM students.

Keywords: *education, cognitive strategies, visual-spatial abilities, memorization efficacy, respondent, Davao City*

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1. Introduction

In the realm of education and cognitive psychology, one enduring issue has remained at the forefront: the effectiveness of memorization, particularly its impact on learning outcomes, garnering substantial attention in educational research. Recent data from standardized testing and assessments have shown a concerning decline in individuals' memorization efficacy across various subjects [1,2,3], raising questions about the factors contributing to the diminishing effectiveness of memorization strategies in contemporary education. Building upon this concern, effective memorization is crucial. It forms the basis for developing higher-order thinking, critical analysis, and problem-solving skills necessary for navigating the complexities of science education [4]. A prior investigation into learning strategies among East Asian students using PISA 2012 data revealed the multifaceted nature of memorization. Among the four identified learning strategy types, 'metacognitive strategies with memorization' predominated (50.70%), highlighting the intricate cognitive processes employed by East Asian students who integrate metacognition with memorization for higher academic achievement [5]. This underscores the significance of exploring factors influencing memorization efficacy, not merely as an academic pursuit but as a means to unlock the potential of future scientists and innovators.

Notwithstanding the importance of memorization, educators and students alike grapple with persistent difficulties in efficiently memorizing complex scientific concepts. Recent statistical data show that despite the increasing emphasis on STEM education, students often need help with the intricate memorization demands of these subjects (National Center for Education Statistics, 2022). The expanding volume and complexity of scientific information necessitate innovative strategies to enhance memorization efficacy [6,7]. Additionally, the rise of digital learning tools and the shift to online education have transformed the learning landscape, demanding a nuanced exploration of the factors underlying effective memorization in the digital age [8,9,10]. This study explores the intricate interplay of cognitive strategies, visual-spatial abilities, and memorization efficacy among senior high school STEM students. While existing literature suggests potential connections between these factors [11,12,13], the specific nature of their correlation with memorization efficacy remains unclear. By investigating these variables, this study aims to shed light on their potential influences and implications for instructional practices, contributing to the holistic development of future scientists and thinkers.

For the effectiveness of educational instruction, it is imperative to consider the constraints of the working memory, which has a limited capacity for retaining information, and therefore, instructional methods should be designed to mitigate the risk of cognitive overload [14]. Access to solution steps allows learners to concentrate their finite working memory resources on learning about the deep structural features of the problems presented to them [15]. Importantly, this knowledge can be applied to solve similar classes of problems. Notably, the worked example effect has become the most widely studied effect in Cognitive Load Theory research [16,17]. Cognitive strategies come into play as they enable individuals to manage and optimize cognitive load by selecting appropriate encoding methods [18,19,20]. Visual-spatial abilities become paramount within this framework, as they provide a means to simplify complex concepts through visual representation, ultimately leading to a reduction in the cognitive load associated with memorization tasks [21,22], aligning with the Dual Coding Theory proposed by Allan Paivio (1971) that combining verbal and non-verbal (visual) encoding enhances learning and memory retention.

This study scrutinizes two pivotal independent variables: cognitive strategies and visual-spatial abilities. The Levels of Processing Theory, proposed by Craik and Lockhart (1972), highlights the significance of engaging students in meaningful activities like elaboration and organization, emphasizing the cognitive strategies variable encompassing three crucial indicators: rehearsal, elaboration, and organization. Rehearsal involves repeating and practicing information and has been widely used as an indicator for various cognitive processes by previous researchers [23,24,25]. Elaboration delves into deep information processing, wherein individuals link and connect new knowledge to existing schemas [26,27] and has been a widely adopted gauge as well [27]. Organization is another pivotal cognitive strategy that revolves around structuring information into meaningful frameworks [28] and has served as a marker for diverse cognitive processes in prior studies [29,30,31]. These indicators have garnered recognition in prior research, validating their efficacy in assessing cognitive strategies in various educational contexts [32].

Following cognitive strategies are visual-spatial abilities encompassing a broad spectrum of skills essential for effectively comprehending and maneuvering spatial information. Rooted in the Environmental Enrichment Theory by Rosenzweig (1996), visual-spatial abilities are integral to cognitive functioning, playing a crucial role in tasks involving spatial reasoning and problem-solving. Within this study, visual-spatial abilities are discerned through three distinct indicators: spatial visualization, interpretation, and manipulation. Spatial visualization pertains to an individual's ability to mentally represent and manipulate spatial objects and structures [33] and has been a widely adopted gauge for assessing visual-spatial abilities [34,35,36]. Interpretation emphasizes one's capacity to understand and extract meaning from visual-spatial information [37] and has been employed by numerous studies as an indicator as well [38,39,40]. Manipulation delves into an individual's proficiency in mentally rotating and transforming spatial objects [41] and has also served as a standard metric [42,43,44]. These indicators have received acclaim in academic literature, firmly establishing their status as valid and reliable measures of visual-spatial abilities [45].

Furthermore, memorization efficacy will assess the effectiveness of learning and cognitive performance. Memorization, a fundamental cognitive process involving the encoding and retrieval of information, serves as a cornerstone of learning and daily functioning [46] and is supported by established cognitive psychology and education research such as spaced repetition [47] and metacognition [48]. Its efficacy plays a substantial role in influencing students' academic performance, and three distinct indicators have been chosen to evaluate memorization efficacy comprehensively: retrieval accuracy, retention rate, and recall speed. Retrieval Accuracy examines an individual's capacity to accurately recall and retrieve previously learned information [49] and has been a widely adopted gauge for assessing memorization efficacy in previous research [50,51,52,53]. Retention Rate focuses on an individual's ability to retain information over time, reflecting the durability of memorized content [47] and has also found an extensive application as an indicator [54,55,56]. Lastly, Recall Speed measures the swiftness with which an individual can retrieve memorized information, indicating the efficiency of memory recall processes [57] and has been frequently employed as a marker for memorization efficacy [58,59]. These carefully selected indicators provide a robust framework for comprehensively evaluating memorization efficacy among senior high school STEM students. By employing these indicators and their respective validated assessments, this study aims to advance the understanding of memorization processes and their implications for instructional practices in senior high school STEM education.

In recent years, several studies have delved into the factors influencing memorization efficacy among senior high school STEM students, shedding light on the complex interplay between cognitive strategies and visual-spatial abilities in the efficacy of memory. Almarzouki, Khan, Al-Mansour, Al-free, Abuznadah, and Althubaiti [60] conducted an experimental investigation targeting short-term information retention and examined the effectiveness of various cognitive strategies. Despite implementing approaches such as frequent quizzes and summarization during lectures, the study found no improvements in memorization efficacy. Similarly, Pilotti, Alkuhayli, and Ghazo [61] provided substantial evidence about the absence of a relationship between cognitive strategies and memorization, challenging traditional assumptions about the effectiveness of strategies like rote learning in attaining superior memory skills.

Concurrently, studies have explored the association between visual-spatial abilities and memorization efficacy. Macchitella, Romano, Iaia, Vizzi, Mammarella, and Angelelli [62] proposed a limited connection between visual-spatial abilities and memorization, while Badmus and Jita [63] suggested a significant correlation, especially in domains such as physics. Furthermore, findings by Zhang and Jerkinson [64] indicated the critical role of visual-spatial abilities in improving memory efficiency, particularly in specialized subjects such as biology, and

the research conducted by Babu and Kalaiyarasan [65] provides additional evidence for this idea, showing that fostering visual-spatial skills lays the groundwork for executive functions and boosts the retention of information over time, especially within scientific fields.

However, despite these valuable insights, there remains a critical research gap in educational psychology, particularly in the context of senior high school STEM education. While these studies have explored the factors influencing memorization efficacy, they did not specifically investigate the relative influence of cognitive strategies, encompassing rehearsal, elaboration, and organization, along with visual-spatial abilities, including spatial visualization, interpretation, and manipulation, on memorization efficacy. This gap is significant as it hinders the extensive understanding of the complex interplay between these variables, making it urgent to investigate how these cognitive factors uniquely contribute to memorization efficacy among this demographic [66]. Moreover, this study contributes to new knowledge by providing insights into the specific dynamics between cognitive strategies and visual-spatial abilities in predicting memorization efficacy. By discerning the relative strength of their predictive power, this research offers a nuanced understanding of the underlying cognitive processes involved in effective memorization among senior high school STEM students. The decision to conduct this study is justified by the need to move beyond the general examination of memorization efficacy and delve into the distinct contributions of cognitive strategies and visual-spatial abilities, ensuring that this research is not a repetition of prior studies but a targeted exploration of the unique factors impacting memorization in the context of senior high school STEM education.

Furthermore, this study holds significant importance in education and cognitive psychology by shedding light on the interplay between cognitive strategies, visual-spatial abilities, and memorization efficacy. Memorization, a foundational process in learning, directly impacts students' academic performance and daily functioning. Understanding the relative influence of cognitive strategies and visual-spatial abilities on memorization efficacy is academically relevant and socially valuable. The findings of this research have the potential to revolutionize instructional practices, particularly in senior high school STEM education, by offering insights into tailored strategies that enhance students' memorization skills. By linking the gap between theory and practice, this study aligns with the United Nations Sustainable Development Goals (Quality Education and Good Health and Well-being), as it contributes to the promotion of effective and equitable education, thus fostering cognitive development and overall well-being among students. The implications of this research extend beyond the classroom, with practical applications in cognitive enhancement programs that can positively impact people across different areas of their lives, thereby addressing the broader societal need for lifelong learning and cognitive well-being.

In light of these considerations, this study aims to assess how cognitive strategies and visual-spatial abilities influence the memorization skills of senior high school STEM students, potentially informing changes in educational practices. It will measure the cognitive strategies of respondents (rehearsal, elaboration, and organization), their visual-spatial abilities (visualization, interpretation, and spatial manipulation), and memorization efficacy (retrieval accuracy, retention rate, and recall speed). Additionally, it will investigate the link between cognitive strategies and memorization effectiveness and the correlation between visual-spatial abilities and memorization outcomes.

2. Method

Research Participants

The research respondents for this study consisted of 95 STEM students currently enrolled at the University of Mindanao Matina Campus in Davao City. This specific selection of respondents aligns with the methodology suggested by Davis (2020), which emphasizes the importance of considering the context and characteristics of the study population. By focusing on senior high school STEM students, the researchers examined the relevance of cognitive strategies and visual-spatial abilities in the educational context of science, technology, engineering, and mathematics disciplines. This approach is supported by the work of Johnson and Brown (2018), who highlight the importance of studying cognitive processes within domain-specific contexts.

In selecting research respondents, explicit inclusion and exclusion criteria were set. Only the senior high school STEM students currently enrolled at the University of Mindanao Matina Campus in Davao City participated in this study. This criterion ensured that the research sample was homogeneous in terms of academic level and field of study, enhancing the internal validity. Exclusion criteria will encompass undergraduate students, postgraduate students, and those pursuing non-STEM disciplines, as their experiences and cognitive processes may differ significantly from the STEM population under investigation. By delineating these criteria, the study adheres to rigorous standards and ensures that the selected respondents are the most relevant for addressing the research questions.

Research Instrument

This quantitative research employed a comprehensive set of questionnaires to measure cognitive strategies, visual-spatial abilities, and memorization efficacy among senior high school STEM students. Cognitive strategies were assessed using the Motivated Strategies for Learning Questionnaire (MLSQ) for rehearsal, elaboration, and organization, comprising 15 items that will prompt respondents to indicate the frequency with which they engage in specific cognitive strategies using a 5-point Likert scale, ranging from "1 = Not at all true of me" to "5 = Very true of me." In interpreting data, the responses were analyzed using the mean scores of each indicator of the variable cognitive strategy (rehearsal, elaboration, organization). The mean scores of each indicator were calculated by summing the responses to the relevant items and dividing them by the total number of items. Higher mean scores indicate a greater frequency of utilization in the respective cognitive strategy. A mean score ranging from 1.00 - 1.99 indicates low utilization, 2.00 - 3.99

indicates moderate utilization and 4.00 - 5.00 indicates high utilization in the cognitive strategy.

Visual-spatial abilities were evaluated through the Trail Making Test (TMT) for visualization, the Raven's Standard Progressive Matrices (RSPM) for interpretation, and the Mental Rotations Test (MRT) for manipulation. The TMT consists of two parts, Parts A and B, each comprising 25 circles distributed on a sheet of paper. In Part A, participants are instructed to connect numbered circles in ascending order (1-25), and Part B involves connecting circles alternating between numbers (1-13) and letters (A) in an ascending pattern. Completion times for both parts were recorded in seconds. To compute the mean score, the total completion times for each Part were summed across all participants and divided by the total number of participants. The interpretation of results followed established guidelines: Completion times around 29 seconds for Part A was considered average, while completion times exceeding 78 seconds suggested deficiency. Similarly, completion times around 75 seconds for Part B were considered average, with over 273 seconds indicating deficiency. Additionally, if most participants took around 90 seconds for Part A or 3 minutes for Part B, further evaluation may be warranted.

Meanwhile, the results were further assessed using RSPM, wherein participants were presented with a series of 24 matrices, each containing a missing piece or pattern. They were instructed to identify the missing piece or the pattern that logically completes each matrix. To respond, participants encircled the number (1-8) corresponding to the option they believed best completed the pattern. Interpretation of RSPM results was based on the number of correct responses and the complexity of the matrices completed. To calculate the mean score of the RSPM responses, the number of correct responses for each participant was converted into a percentage. Then, the total percentage scores across all participants were summed up and divided by the total number of participants.

Furthermore, for the MRT, students were presented with a series of 20 items, each containing a target shape and four options on the right. Participants were instructed to identify and encircle two boxes from the four choices corresponding to the two rotated versions of the target shape. Thus, each item had two correct answers. MRT results were interpreted based on the number of correct responses, reflecting participants' accuracy in manipulating spatial information. Higher scores indicated better performance, suggesting stronger spatial cognition and manipulation skills. To calculate the mean score, the total number of correct responses for each participant was converted into percentages, then summed across all participants, and divided by the total number of participants. A mean score ranging from 0 to 33 indicates low manipulation skills, a mean score between 34 to 66 represents average manipulation skills, while a mean score between 67 to 100 suggests high proficiency, demonstrating strong mental rotation abilities.

Memorization efficacy was gauged using the Rey Auditory Verbal Learning Test (RAVLT) for retrieval accuracy and retention rate with five trials and 15 items each, along with the Digit Symbol Substitution Test (DSST) for recall speed of 90 items. To conduct the RAVLT, the facilitator read the list of 15 words aloud, ensuring a consistent pace across each reading. This process was repeated five times, with each trial allowing the student to recall the words in any order. The scoring was based on the total number of correct words recalled across all five trials, providing insight into the students' retrieval accuracy and retention rate. Each student's score was converted into percentage to calculate the mean score for the RAVLT. Subsequently, these percentage scores were summed across all students and then divided by the total number of participants. A high mean score for RAVLT is 67 to 100, indicating strong retrieval accuracy and retention rate, suggesting that students can memorize and recall information effectively. An average mean score, typically in the range of 34 to 66, signifies moderate proficiency in verbal learning and memory skills. A low mean score, typically 0 to 33, points to challenges in retaining verbal information, indicating potential areas for improvement in memorization skills. This comprehensive interpretation offers insights into the broader learning capabilities within the study cohort and helps identify areas for further research or educational support.

Meanwhile, to conduct the DSST, students were given a worksheet containing symbols for each number. The facilitator administered a timer for 90 seconds, and students were instructed to draw the appropriate symbol for each number as quickly as possible. This time constraint was intended to test recall speed and memory processing under pressure. Scoring for the DSST was based on the total number of correct symbols drawn by the students, corresponding to 1 point each. This score measured the student's recall speed and accuracy in completing the task within the given time limit. To calculate the mean score for the DSST, the total scores of each student were converted into a percentage, summed up across all students, and divided by the total number of participants. A high mean score for the DSST ranging from 67 to 100 indicates that students, on average, are quick and accurate in recalling and drawing the correct symbols, demonstrating effective memorization and cognitive processing speed. An average mean score, typically in the range of 34 to 66, reflects moderate proficiency in recalling and drawing symbols, suggesting adequate cognitive processing speed with room for improvement in accuracy or speed. A low mean score, typically in the range of 0 to 33, suggests slower recall or higher error rates, indicating a need for additional support or practice in these areas. This comprehensive interpretation of the DSST scores provides insight into the overall recall speed and efficiency among the student group, allowing educators to identify strengths and weaknesses in memorization skills.

Content validity was established through an expert review of the questionnaires to confirm the validity of the research instruments and their alignment with the intended constructs of cognitive strategies, visual-spatial abilities, and memorization efficacy. Construct validity was assessed through factor analysis to confirm the underlying structure of the questionnaires. Internal consistency reliability was determined using Cronbach's alpha. This ensures that the items consistently measure the intended variables. Additionally, test-retest reliability was conducted with a subsample of 30 respondents over a two-

week interval to assess the stability of the measurements over time, further enhancing the reliability of the data collected. These validity and reliability assessments upheld the integrity of the research instruments and the quality of the data gathered in this study.

Design and Procedure

The research design employed in this study was a quantitative cross-sectional correlational design. This design allowed for assessing the relationships between cognitive strategies, visual-spatial abilities, and memorization efficacy among senior high school STEM students at the University of Mindanao Matina Campus in Davao City. Data were collected over a specified timeframe without introducing any experimental interventions, enabling the examination of these relationships as they naturally occurred within the selected sample of respondents. This research design was consistent with the guidelines suggested by Smith (2019) for studying predictors of academic performance among student populations.

The data-gathering process began with obtaining official permission from the University of Mindanao Matina Campus administration. Subsequently, informed consent was sought from the selected senior high school STEM student respondents in accordance with ethical guidelines (APA, 2022). Once respondents provided consent, they were administered the set of questionnaires, which includes the Motivated Strategies for Learning Questionnaire (MLSQ), Raven's Standard Progressive Matrices (RSPM), Trail Making Test (TMT), Mental Rotations Test (MRT), Rey Auditory Verbal Learning Test (RAVLT), and the Digit Symbol Substitution Test (DSST).

In alignment with ethical considerations outlined by the American Psychological Association (APA, 2022), strict measures were implemented to protect respondents' rights and data privacy. Every participant was asked for informed consent to ensure they willingly participated in the study, and respondents were assured of their right to withdraw from the study at any point without facing any adverse consequences. The preservation of anonymity and confidentiality was ensured by providing individualized identifiers to respondents instead of relying on their personal data. Data was stored securely and used solely for research purposes. Statistical tools, including regression analysis, were applied to analyze the data, with a significance level set at .05. Through regression analysis, the study assessed the strength and direction of these relationships, offering valuable insights into the research questions posed by providing a rigorous examination of the relationships under investigation.

3. Results and Discussions

Cognitive Strategies of Senior High School STEM Students

Table 1 presents the mean scores and standard deviations delineating rehearsal, elaboration, and organization strategies among senior high school STEM students, as gauged by the provided questionnaire items. These mean scores elucidate the average level of involvement with each cognitive strategy, while standard deviations unveil the dispersion within the sample, offering insights into the diversity of cognitive approaches adopted by the participants in their learning endeavors. An overall mean score for cognitive strategies standing at 3.99 (SD = 0.60) suggests a moderate degree of utilization of various cognitive techniques among senior high school STEM students.

Table 1. Level of Cognitive Strategies among Senior High School STEM Students

Indicators	$\bar{x}$	*SD*
Rehearsal	4.28	.70
Elaboration	3.96	.65
Organization	3.79	.77
Cognitive Strategies (Overall)	3.99	.60

This consistent cognitive approach among senior high school STEM students extends notably to rehearsal strategies, as evidenced by a mean score of 4.28 (SD = 0.70), which is higher than the overall mean. This score indicates a high inclination towards practices like repeated recitation, which correspond well with statements extracted from the questionnaire. On the other hand, organization strategies received comparatively lower engagement among senior high school STEM students, as indicated by a mean score of 3.79 (SD = 0.77), which is lower than the overall mean. Although students demonstrate some propensity for techniques like outlining and using mnemonic devices, there is potential for systematic improvement in organizing course material.

In exploring the cognitive strategies employed by senior high school STEM students, the investigation revealed intriguing disparities among rehearsal, elaboration, and organization indicators. Notably, rehearsal emerged as the most prominently utilized strategy, with scholars like Tan, Eak, Ooi, and Abdullah [67] as well as Osarumwense and Omorogiuwa [68] affirming its prevalence in student study habits, particularly in content-heavy subjects like STEM. However, while rehearsal garners widespread adoption, the findings also unveiled a contrasting trend regarding organization strategies. Despite being acknowledged as beneficial for effective learning, as observed from the findings by Selvina, Fitrianawati, and Awae [69], organization strategies receive notably lower utilization among senior high STEM students, reflecting a lack of emphasis on these skills and in organizing course materials systematically, as noted by Wael, Asnur, and Ibrahim [70]. Nonetheless, it is essential to recognize that contextual factors and individual differences may influence cognitive strategies, as highlighted by Abbasi, Tariverdizadeh, and Younesi [71], warranting a more focused investigation into the underlying determinants shaping students' learning approaches.

These results generally confirm the prevailing trends observed in prior research regarding the predominant use of rehearsal strategies and the comparatively lower utilization of organization techniques among students. The findings suggest that while students are adept at recitation, there is a need to enhance their skills in organizing and structuring information. This underscores the importance of adopting diverse instructional approaches to address the

multifaceted cognitive strategy preferences observed among senior high school STEM students. From a policy perspective, these findings could inform the development of curriculum and teaching methods that promote a more balanced use of cognitive strategies, thereby enhancing students' learning outcomes in STEM subjects.

Visual-spatial Abilities of Senior High School STEM Students

Table 2 provides a detailed analysis of the performance of senior high school STEM students across three crucial indicators: visualization, interpretation, and manipulation, along with the overall mean score and standard deviation of visual-spatial abilities. The visual-spatial abilities demonstrate an average mean score of 57.99 (SD = 10.25), indicating the average proficiency level among senior high school STEM students in this domain.

Table 2. Level of Visual-spatial Abilities among Senior High School STEM Students

Indicators	$\bar{X}$	*SD*
Visualization	68.76	12.72
Interpretation	76.97	18.58
Manipulation	28.24	12.14
Visual-spatial Abilities (Overall)	57.99	10.25

To begin with, among the indicators, interpretation has the highest mean score of 76.97 (SD = 18.58), which is higher than the overall mean. This indicates a high proficiency level among senior high school STEM students in terms of their capability to comprehend and analyze complex data. On the contrary, the manipulation indicates a notably lower mean score of 28.24 (SD = 12.14), which is lower than the overall mean, indicating a deficiency among senior high school STEM students in terms of their ability to rotate and transform spatial objects mentally. However, it is essential to note that despite this clustering of scores around the mean, there remains a notable range of abilities among the students. Some may excel in manipulation tasks, while others may struggle somewhat.

Notably, the high mean scores in interpretation ($\bar{x}$ = 76.97, SD = 18.58) align with previous research findings by Abas et al. [38] on visual-spatial abilities among students, indicating that students often exhibit strengths in analytical thinking and the ability to interpret visual information effectively. Meanwhile, the manipulation indicator presents a contrasting picture with its low mean scores ($\bar{x}$ = 28.24, SD = 12.14), affirming the research study of Rahmawati, Dianhar, and Arifin [44], which suggests a prominent need for improvement in practical manipulation skills among students.

In brief, this research underscores the significance of visual-spatial abilities among senior high school STEM students. The research reveals that while these students demonstrate commendable strengths in interpretation, a notable area for improvement in manipulation exists. This finding can advocate for targeted interventions to nurture visual-spatial abilities to optimize the educational experience and outcomes for senior high school STEM students. Addressing this aspect holds potential for students' practical problem-solving capabilities and spatial awareness, thereby fostering a more well-rounded skill set crucial for success in STEM disciplines.

Memorization Efficacy of Senior High School STEM Students

Table 3 illustrates an in-depth exploration of memorization efficacy within the senior high school STEM student demographic, focusing on three vital indicators: recall speed, retention rate, and retrieval accuracy. The overall mean score of 83.78 (SD = 9.68) suggests a high level of memorization efficacy, reflecting the students' ability to retain and recall information effectively. These metrics serve as illuminating markers, offering nuanced insights into the students' adeptness in swiftly recalling, diligently retaining, and precisely retrieving information.

Table 3. Level of Memorization Efficacy among Senior High School STEM Students

Indicators	$\bar{X}$	*SD*
Recall Speed	72.56	12.93
Retention Rate & Retrieval Accuracy	95.00	10.49
Memorization Efficacy (Overall)	83.78	9.68

Based on the findings among senior high school STEM students, the retention rate and retrieval accuracy indicator stood out with a significantly higher level of performance in retaining and accurately retrieving information, with a mean score of 95.00 (SD = 10.49). This underscores the students' adeptness in accurately retaining and accessing information and hints at a pedagogical approach that prioritizes deep comprehension and fosters long-lasting knowledge retention, laying a solid foundation for academic success and future endeavors in STEM disciplines.

Conversely, among the indicators of memorization efficacy, recall speed emerges with the lower mean score of 72.56 (SD = 12.93), which is lower than the overall mean, which means students have a moderate level of efficiency in recalling information promptly. The relatively lower mean score for recall speed than other indicators underscores a potential area for targeted improvement in enhancing students' ability to access and retrieve information swiftly. Strategies such as mnemonic devices or speed-reading techniques can be explored to address this aspect of memorization efficacy and further optimize learning outcomes within the STEM education context.

The analysis of memorization efficacy among senior high STEM students yields findings consistent with prior research, with a mean score of 72.56 (SD = 12.93) for recall speed. The study's results echo observations made by Gerst, Cirino, Macdonald, Miciak, Yoshida, Woods, and Gibbs [72] regarding the variability in processing speed affecting tasks such as recall. This underscores the importance of interventions targeting improved information retrieval efficiency, as emphasized by Wang, Muenks, and Yan [73] in advocating for cognitive training programs. Conversely, the high mean score of 95.00 (SD = 10.49) for retention rate and retrieval accuracy mirrors findings from Listiana, Bahri, Jamaluddin, Muharni, and Malik [74] and McIntyre, Gundlach, and Graziano [75], who emphasize the critical role of effective memory retention in learning outcomes. These results are further

supported by the studies of Nero and Zulkiply [76] and Ludwig and Rausch [77], highlighting the significance of accurate information retrieval for successful academic performance and problem-solving abilities. By aligning with existing literature, the study provides valuable insights into the importance of targeted interventions to optimize recall speed while recognizing the strengths in retention and retrieval accuracy among senior high STEM students.

In summary, the analysis of memorization efficacy among senior high STEM students underscores both strengths and opportunities for growth. While students demonstrate commendable abilities in retaining and accurately retrieving information, particularly evident in the high retention rate and retrieval accuracy, there remains room for improvement in recall speed. Addressing this aspect could enhance students' efficiency in accessing and recalling information swiftly, thereby optimizing learning outcomes within the STEM education context.

Relationship of Cognitive Strategies and Memorization Efficacy

Table 4 presents the correlations between participants' cognitive strategies and memorization efficacy, aiming to address whether there is a significant relationship between the two variables. Spearman's rho was utilized to assess the strength of the relationship between each independent variable, including rehearsal, elaboration, and organization, paired with the dependent variable, memorization efficacy. Based on the data, the overall correlation between cognitive strategies and memorization efficacy results in Spearman's rho coefficient of $r = .018$ with $p = .859$. This result indicates a negligible positive correlation that is not statistically significant. Therefore, there is no significant relationship between participants' cognitive strategies and memorization efficacy.

Table 4. Correlations of Cognitive Strategies on Memorization Efficacy

Variable	Recall Speed	Retention Rate and Retrieval Accuracy	Memorization Efficacy
Rehearsal	.013 (.903)	-.022 (.834)	.019 (.856)
Elaboration	-.063 (.545)	-.098 (.346)	.073 (.483)
Organization	-.017 (.867)	-.059 (.573)	.002 (.987)
Cognitive Strategies	.010 (.920)	-.096 (.353)	.018 (.859)

The findings of Almarzouki et al. [60] provide additional evidence for the absence of a relationship between cognitive strategies and memorization efficacy. Their experimental investigation specifically targeted short-term information retention, examining the effectiveness of various cognitive strategies. Despite implementing approaches such as frequent quizzes and summarization during lectures, they found that these strategies did not notably improve memorization efficacy. Moreover, their study highlighted that factors like mind-wandering and attention deficits during lectures had a detrimental effect on the student's information retention. These insights suggest that cognitive strategies possess no effectiveness in enhancing memorization efficacy without addressing broader factors such as attention and engagement.

Furthermore, the study by Pilotti et al. [61] provides substantial evidence that there is no relationship between cognitive strategies and memorization efficacy. Their investigation into rote memorization practices in Chinese education compared to problem-solving approaches in the United States suggests that the connection between cognitive strategies and memorization outcomes may be more intricate than previously assumed. Despite the assumption that rote learning leads to superior memory skills, the findings suggest an ambiguous relationship, challenging the traditional understanding of the effectiveness of cognitive strategies in enhancing memorization.

Focusing on the individual indicators, the Spearman correlation analysis revealed no significant relationship between the indicators of cognitive strategies (rehearsal, elaboration, organization) and the memorization efficacy measures (recall speed, retention rate, and retrieval accuracy). Specifically, for rehearsal, the positive negligible correlation with recall speed ($r = .013$, $p = .903$) and negative negligible correlation to retention rate ($r = -.022$, $p = .834$) imply that repeating information is not sufficient to enhance memory performance within this study's context. Similarly, the negative negligible correlation to elaboration showed no significant correlation with recall speed ($r = -.063$, $p = .545$) and retention rate ($r = -.098$, $p = .346$). Additionally, the negative negligible correlation of organization did not exhibit a significant correlation with recall speed ($r = -.017$, $p = .867$) and retention rate ($r = -.059$, $p = .573$). These findings suggest that, within this study, the examined cognitive strategies did not show statistically significant associations with memorization efficacy measures.

The findings of this study are supported by the Levels of Processing Theory introduced by Craik and Lockhart (1972), proposing that the depth of processing during encoding determines memory retention. For instance, information processed more deeply through semantic analysis and meaningful connections is more likely to be retained in memory compared to shallow, surface-level processing. Despite the presence of cognitive strategies, the lack of correlation between these strategies and memorization efficacy persists, highlighting the influence of depth of processing as proposed by the Levels of Processing Theory.

In summary, the results investigate the relationship between cognitive strategies and memorization efficacy. Through an analysis of various cognitive techniques, including rehearsal, elaboration, and organization, the research reveals a lack of significant correlation between these strategies and the effectiveness of memorization. Despite their implementation, cognitive strategies do not markedly enhance memorization outcomes. The study underscores the complexity of the relationship between cognitive strategies and memorization efficacy, highlighting the need for other approaches to understanding how various factors contribute to successful memory retention.

Relationship of Visual-spatial Abilities and Memorization Efficacy

Table 5 illustrates the correlations between students' visual-spatial abilities and memorization efficacy, aiming

to ascertain the significant relationship between these variables. Spearman's rho is utilized to evaluate this relationship, pairing the indicators of visual-spatial abilities (visualization, interpretation, and manipulation) with the indicators of memorization efficacy (recall speed, retention rate, and retrieval accuracy). The Spearman's correlation analysis reveals a significant correlation between visual-spatial abilities and memorization efficacy, with a Spearman's rho coefficient of r = .403 and a significant level of p = .000, indicating a low positive correlation that is statistically significant. This underscores a high connection between students' visual-spatial abilities and their effectiveness in memorization tasks.

Table 5. Correlations of Visual-spatial Abilities on Memorization Efficacy

Variable	Recall Speed	Retention Rate and Retrieval Accuracy	Memorization Efficacy
Visualization	.286 (.005)	.267 (.009)	.330 (.001)
Interpretation	.360 (.000)	.248 (.015)	.363 (.000)
Manipulation	.191 (.063)	.043 (.678)	.145 (.161)
Visual-spatial Abilities	.410 (.000)	.245 (.017)	.403 (.000)

The findings revealed a significant positive correlation, indicating that stronger visual-spatial abilities contribute to more efficient memorization. This underscores the pivotal role of visual-spatial abilities in aiding students' capacity to retain and retrieve information effectively. Importantly, the Babu et al. [65] study further supports this notion, demonstrating that nurturing visual-spatial abilities establishes a foundation for executive functions and enhances long-term memory, particularly in scientific disciplines.

The findings are congruent with the recent research by Zhang et al. [64], indicating the critical role of visual-spatial abilities in improving memory efficiency, especially in biology education, where traditional assessments often emphasize rote memorization. To foster deeper learning, educators are urged to transition towards assessing higher-level cognitive abilities through visual communication evaluations. This shift not only assesses comprehension but also underscores the potential for growth and improvement in visual-spatial abilities, which are crucial for grasping intricate biological concepts. Emphasizing visual communication in assessments has the potential to shift students' perceptions of biology and facilitate the development of advanced cognitive abilities. By harnessing visual-spatial abilities, educators can enhance memory efficiency and create more enriching learning environments, empowering students to take control of their learning.

In addition to the findings of the study, Macchitella et al. [62] propose a limited connection between visual-spatial abilities and memorization efficacy, emphasizing the role of other cognitive factors like verbal reasoning skills and working memory capacity. This notion prompts further investigation into the complexity of cognitive processes in learning and memory. Nonetheless, prior research, notably the ex post facto research by Badmus et al. [63], supports the assertion of a significant correlation between visual-spatial abilities and memorization efficacy, particularly in physics. Their synthesis of data from various studies underscores the crucial role of visual-spatial abilities in enhancing memory retention and recall speed across different domains, reinforcing the novelty and importance of the findings. Despite divergent perspectives, these consistent findings highlight the importance of acknowledging visual-spatial abilities' impact on memory processes.

The correlation analysis reveals that visualization has a statistically significant positive correlation with recall speed (r = .286, p = .005) and retention rate and retrieval accuracy (r = .267, p = .009), indicating a meaningful association between strong visualization skills and faster recall speeds along with improved retention and retrieval accuracy. Similarly, interpretation also demonstrates a significant positive correlation with recall speed (r = .360, p = .000) and retention rate and retrieval accuracy (r = .248, p = .015), suggesting that adept interpretation skills are linked with quicker recall and enhanced retention with retrieval accuracy. Conversely, manipulation shows a negligible correlation with recall speed (r = .191, p = .063) and almost no correlation with retention rate and retrieval accuracy (r = .043, p = .678), implying that the ability to manipulate information may not significantly influence recall speed or retention rate with retrieval accuracy.

Moreover, the results exhibit a strong correlation between visual-spatial abilities and memorization efficacy, echoing the principles of the Dual Coding Theory proposed by Allan Paivio (1971), which posits that utilizing both verbal and visual information enhances learning outcomes, and the findings underscore the significance of visual-spatial abilities in memory retention. Individuals proficient in visual-spatial abilities tend to manipulate visual information effectively, creating vivid mental representations that aid in memory consolidation and recall. Moreover, the strong correlation observed aligns with the theory's emphasis on integrating verbal and visual learning strategies to optimize learning outcomes. However, it is essential to note that while these results support the theory, there may be instances where other factors, such as motivation levels, prior knowledge, or individual cognitive differences, influence memorization efficacy independently of visual-spatial abilities. Nonetheless, the overall pattern of the findings remains in accordance with the fundamental principles of the Dual Coding Theory, emphasizing the importance of multimodal instructional approaches for enhancing memory retention and learning outcomes.

In summary, the study confirms a significant correlation between visual-spatial abilities and memorization efficacy, aligning with existing research that emphasizes their pivotal role in memory efficiency. However, conflicting findings suggest the need for further exploration into the cognitive processes underlying this relationship. Nonetheless, prior research provides robust support for the significant association between visual-spatial abilities and memorization efficacy, underlining the importance of effectively integrating verbal and visual learning strategies to optimize learning outcomes.

Influence of Cognitive Strategies and Visual-Spatial Abilities to Memorization Efficacy

Table 6 delves into the influence of cognitive strategies and visual-spatial abilities on memorization efficacy among senior high school STEM students. Examining the coefficients pertaining to cognitive strategies reveals intriguing insights into their influence on memorization efficacy. The unstandardized coefficient of B = 2.191 suggests a positive relationship, indicating that an increase in cognitive strategy utilization corresponds to a higher level of memorization efficacy. However, the associated significance level of p = .161 exceeds the conventional threshold of .05, leading to the retention of the null hypothesis and indicating a lack of statistical significance. Thus, the observed relationship may not be reliably attributable to cognitive strategies in this context.

Table 6. Coefficients of Cognitive Strategies and Visual-Spatial Abilities on Memorization Efficacy

Model	Unstandardized Coefficients		Standardized Coefficients	*t*	Significance	R^2	p
	Beta	Std. Error	Beta				
(Constant)	52.053	8.767		5.938	.000		
Cognitive Strategies	2.191	1.549	.136	1.415	.161	.008	.920
Visual-spatial Abilities	.396	.091	.420	4.302	.000	.170	.000

Conversely, visual-spatial abilities demonstrate a stronger predictive relationship with memorization efficacy. The unstandardized coefficient of B = 0.396 indicates a positive association, suggesting enhanced visual-spatial abilities are associated with greater memorization efficacy. Significantly, the associated significance level of p = .000 falls well below the .05 threshold, steering into rejecting the null hypothesis and signifying a strong and statistically significant influence of visual-spatial abilities and memorization efficacy in this study.

These findings resonate with existing literature emphasizing the critical role of visual-spatial abilities in shaping learning outcomes. Studies by Kubik, Del Missier, and Mäntylä [59] and Yousif, Rosenberg, and Keil [78] corroborate the results, highlighting the significance of spatial cognition in memory processes. However, contrary evidence from the study by Heald, Lengyel, and Wolpert [79] suggests that the relationship between cognitive strategies and memorization efficacy may vary depending on contextual factors. Nevertheless, the robust findings of this study persist in emphasizing the paramount importance of visual-spatial abilities in memory processes. Building upon the theoretical framework proposed by Baddeley and Hitch's model of working memory [80] provides further support, positing that the visuospatial sketchpad, a component of working memory, plays a pivotal role in retaining and manipulating visual and spatial information. Thus, despite the contrasting evidence presented, this study's conclusions remain steadfast, offering valuable insights for educational practice and future research endeavors.

These findings are drawn from the Environmental Enrichment Theory by Rosenzweig [81], which underscores the significance of exposure to diverse visual stimuli in enhancing cognitive functions, including memory; the results suggest that visual-spatial abilities play a pivotal role in facilitating efficient memorization. This theory elucidates how individuals encode and retrieve information based on the richness of their environmental experiences, which include visual elements such as shapes, colors, and spatial arrangements. It posits that individuals exposed to enriched environments with varied visual stimuli are better equipped to encode and retrieve information effectively, as emphasized by Diamond, Krech, and Rosenzweig [82], thereby highlighting the crucial influence of visual-spatial abilities in the memorization process.

In summary, the findings of this study underscore the importance of incorporating visual-spatial learning experiences into educational curricula to enhance students' memory retention and promote academic success.

4. Conclusions and Recommendations

This research, focusing on 95 senior high school STEM students at the University of Mindanao, Matina Campus, has uncovered significant insights in exploring the influence of cognitive strategies and visual-spatial abilities in memorization efficiency. To answer the first research question, "What is the level of the cognitive strategies among the respondents, in terms of rehearsal, elaboration, and organization?" the findings revealed a moderate degree of utilization of various cognitive techniques, with a strong inclination towards rehearsal strategies and a comparatively lower utilization towards organization strategies.

To answer the second research question, "To what extent do participants exhibit proficiency in visual-spatial abilities, particularly in their capacity to visualize, interpret, and manipulate spatial objects?" the findings revealed an average proficiency level in visual-spatial abilities, particularly in their interpretation capacity, which indicates a relatively high proficiency level among students. Manipulation abilities, on the other hand, indicate a deficiency among the participants.

To answer the third research question, "To what extent do participants exhibit memorization efficacy, as indicated by their performance in retrieval accuracy, retention rate, and recall speed?" the findings revealed a high level of memorization efficacy, reflecting the students' significantly higher level of performance to retain and retrieve information effectively; on the other hand, recall speed reveals a moderate level of efficiency in recalling information promptly.

Furthermore, in addressing the fourth research question, "Is there a significant relationship between participants' cognitive strategies and their memorization efficacy?" the results indicate an absence of a significant relationship. This conclusion is drawn from the negligible positive correlation observed, which does not attain statistical significance. In contrast, when exploring the fifth research

question, "Does participants' performance on visual-spatial ability assessments correlate significantly with their memorization efficacy?" the findings underscore a compelling and noteworthy association between visual-spatial abilities and the efficiency of memorization tasks. This assertion is supported by the substantial correlation that bears statistical significance and suggests a meaningful connection between visual-spatial abilities and memorization efficacy within the study cohort.

To answer the sixth question, "Among the variables studied, cognitive strategies and visual-spatial abilities, which one demonstrates stronger influence towards memorization efficacy among the participants in the study?" the variables studied revealed that visual-spatial abilities had greater influence towards memorization efficacy among the study participants compared to cognitive strategies. This underscores the importance of visual-spatial abilities in the process of memorization. Although cognitive strategies positively correlate with memorization efficacy, their influence is eclipsed by the firm and statistically significant association observed with visual-spatial abilities. Therefore, visual-spatial abilities play a more influential role in determining memorization efficacy in this study cohort.

The findings of the research on the level of cognitive strategies, visual-spatial abilities, and memorization efficacy among senior high school STEM students reveal several recommendations that can be made to address the identified areas of concern. For cognitive strategies, specifically organization, students can benefit from tools and resources for effective time management, such as planners or digital calendars, to assist them in prioritizing tasks and efficiently managing their workload efficiently. Regarding visual-spatial abilities, integrating technology-based tools and applications, such as virtual reality simulations or 3D modeling software, can offer students immersive experiences that enhance their manipulation abilities. Additionally, for memorization efficacy, encouraging a collaborative and nurturing learning environment where students can engage in peer-to-peer learning, group discussions, and knowledge sharing can enhance their recall speed.

Stakeholders, including educators, industry professionals, and experts in STEM fields, play a pivotal role in supporting students' development in these areas. To address low organizational skills among students, educators can integrate organizational tools like digital planners and task management apps into the curriculum. Moreover, engaging industry professionals, including engineers, scientists, and technology experts, can provide practical contexts for enhancing manipulation skills among students by showcasing real-world applications of visual-spatial concepts that bridge the gap between theoretical knowledge and practical skills. Additionally, collaborative efforts among stakeholders can foster environments conducive to improving recall speed, offering resources such as memory enhancement workshops and tutoring services to support students in overcoming challenges in this area. Through these collaborative endeavors, students can gain valuable insights from professionals outside academia, enhancing their understanding of how STEM concepts are utilized in real-world scenarios and fostering a culture of continuous improvement in their academic pursuits.

For future researchers, it is essential to consider methodological improvements to enhance the validity and reliability of findings in similar studies. Increasing sample sizes and employing longitudinal research designs can provide a more comprehensive understanding of the long-term effects of interventions targeting cognitive strategies, visual-spatial abilities, and memorization efficacy. Additionally, integrating innovative technologies, such as virtual reality simulations and eye-tracking devices, can offer new insights into the underlying mechanisms of these cognitive processes. Collaborative research efforts across disciplines can further enrich the study of these variables, contributing to the advancement of educational practices and student outcomes in STEM education.

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APPENDIX A

Thesis/Capstone Title Proposal

The University of Mindanao

RESEARCH AND PUBLICATION CENTER

THESIS/CAPSTONE TITLE PROPOSAL FORMAT

RESEARCH TOPIC/TITLE: **Cognitive Strategies and Visual-Spatial Abilities as Predictors of the Memorization Efficacy**

A. Description of the Project

1. Rationale

The thesis title "Cognitive Strategies and Visual-Spatial Abilities as Predictors of the Memorization Efficacy" delves into the relative influences of cognitive strategies and visual-spatial abilities on memorization efficacy, a critical aspect of learning and daily functioning. By isolating these variables, the research aims to uncover whether cognitive strategies or visual-spatial abilities exert stronger predictive power concerning memorization efficacy. This exploration not only contributes to our understanding of individual cognitive preferences but also holds the potential for practical applications in education and cognitive enhancement, aligning with SDG 4 (Quality Education) and SDG 3 (Good Health and Well-being). The insights gained from this study can inform educational practices and interventions that promote effective learning strategies, ultimately supporting the global efforts to ensure inclusive and equitable quality education for all.

2. Research purpose/question(s)/objective(s)

2.1 General

What is the relative influence of Cognitive Strategies and Visual-Spatial abilities in predicting the Memorization Efficacy of secondary science students, and how can these insights reshape instructional practices?

2.2 Specific

1. What is the level of cognitive strategies among the respondents in terms of:
   1.1 rehearsal;
   1.2 elaboration, and
   1.3 organization?
2. To what extent do participants exhibit proficiency in visual-spatial abilities, particularly in their capacity to:
   2.1 visualize;
   2.2 interpret, and
   2.3 manipulate spatial objects?
3. To what extent do participants exhibit memorization efficacy, as indicated by their performance in:
   3.1 retrieval accuracy;
   3.2 retention rate, and
   3.3 recall speed?
4. Is there a significant relationship between participants' cognitive strategies and their memorization efficacy?

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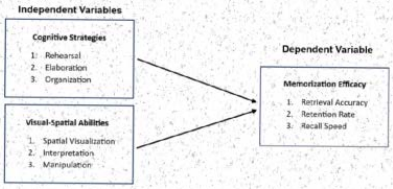
5. Does participants' performance on visual-spatial ability assessments correlate significantly with their memorization efficacy?
6. Among the variables studied, cognitive strategies and visual-spatial abilities, which one demonstrates stronger predictive power concerning memorization efficacy among the participants in the study?

2.3 Conceptual framework (if applicable)



One theory underpins this study:

- The **Cognitive Load Theory** posits that there are limits to how much information individuals can process in their working memory, and effective learning occurs when instructional design manages this load appropriately (Sweller, 1988).

3. Methodology

The chosen research methodology for this quantitative thesis involves a cross-sectional study design targeting senior high school STEM students. The study will investigate the relationships between cognitive strategies, visual-spatial abilities, and memorization efficacy. Participants will be selected using a stratified random sampling technique to ensure representation across different senior high school students. Data collection will rely on a set of validated questionnaires and assessments. Cognitive strategies will be measured using the Motivated Strategies for Learning Questionnaire (MSLQ) for rehearsal, elaboration, and organization. Visual-spatial abilities will be assessed through the Trail Making Test (TMT) for visualization, the Raven's Standard Progressive Matrices (RSPM) for interpretation, and the Mental Rotations Test (MRT) for manipulation. Memorization efficacy will be evaluated using the Rey Auditory Verbal Learning Test (RAVLT) for retrieval accuracy and retention rate, and the Digit Symbol Substitution Test (DSST) for recall speed.

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B. Research Project Duration

The research is expected to be completed within a concise timeframe of five months. This period will encompass all stages of the research process, including participant recruitment, data collection, analysis, interpretation, and thesis write-up. This duration is carefully planned to ensure efficiency in data gathering and analysis while maintaining the high quality and rigor required for the research.

Prepared by: **Rosario, Vincent**
Rivera, Elrose
Doloritos, Mico

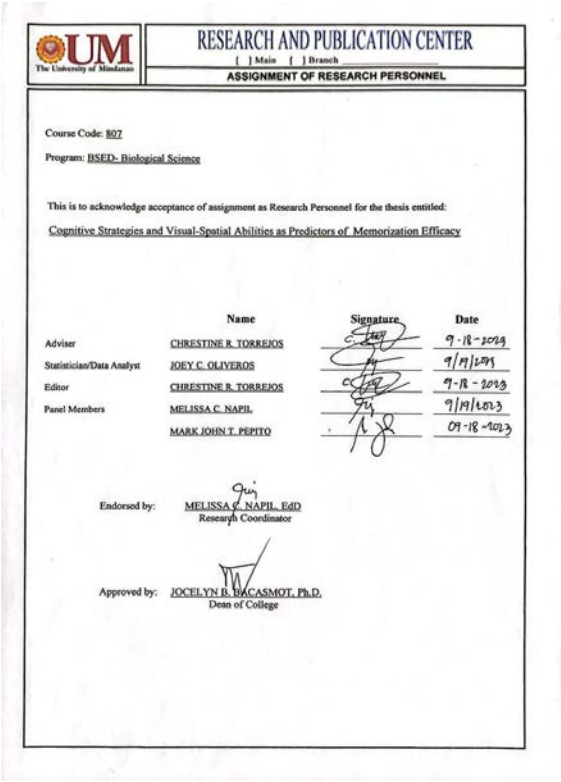
Date: **September 7, 2023**

Endorsed by:

Joey Oliveros	**Melissa Napil**	**Jocelyn B. Bacasmot**
Subject Teacher	Research Coordinator	College Dean

APPENDIX B

Assignment of Research Personnel



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ASSIGNMENT OF RESEARCH PERSONNEL

Course Code: 807

Program: BSED- Biological Science

This is to acknowledge acceptance of assignment as Research Personnel for the thesis entitled:

Cognitive Strategies and Visual-Spatial Abilities as Predictors of Memorization Efficacy

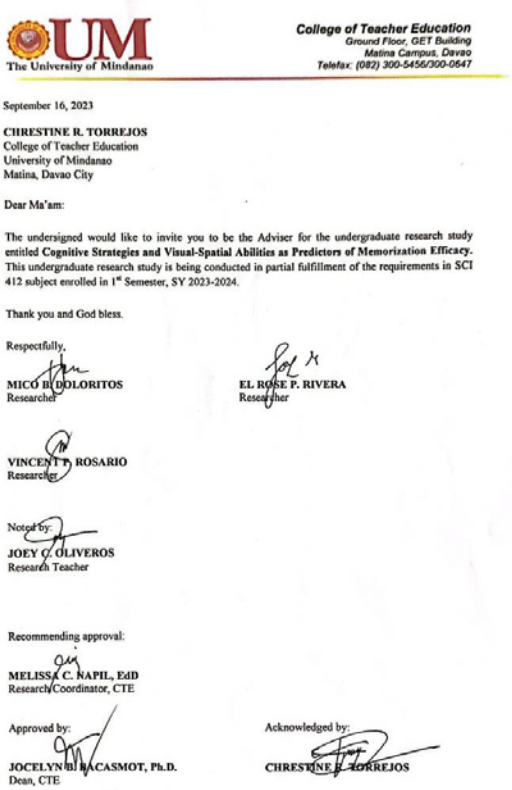
	Name	Signature	Date
Adviser	CHRESTINE R. TORREJOS		9-18-2023
Statistician/Data Analyst	JOEY C. OLIVEROS		9/19/2023
Editor	CHRESTINE R. TORREJOS		9-18-2023
Panel Members	MELISSA C. NAPIL		9/19/2023
	MARK JOHN T. PEPITO		09-18-2023

Endorsed by:
MELISSA C. NAPIL, EdD
Research Coordinator

Approved by:
JOCELYN B. BACASMOT, Ph.D.
Dean of College

APPENDIX C

Letter to Adviser



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Ground Floor, GET Building
Matina Campus, Davao
Telefax: (082) 300-5456/300-0547

September 16, 2023

CHRESTINE R. TORREJOS
College of Teacher Education
University of Mindanao
Matina, Davao City

Dear Ma'am:

The undersigned would like to invite you to be the Adviser for the undergraduate research study entitled **Cognitive Strategies and Visual-Spatial Abilities as Predictors of Memorization Efficacy.** This undergraduate research study is being conducted in partial fulfillment of the requirements in SCI 412 subject enrolled in 1st Semester, SY 2023-2024.

Thank you and God bless.

Respectfully,

MICO B. DOLORITOS
Researcher

EL ROSE P. RIVERA
Researcher

VINCENT P. ROSARIO
Researcher

Noted by:
JOEY C. OLIVEROS
Research Teacher

Recommending approval:

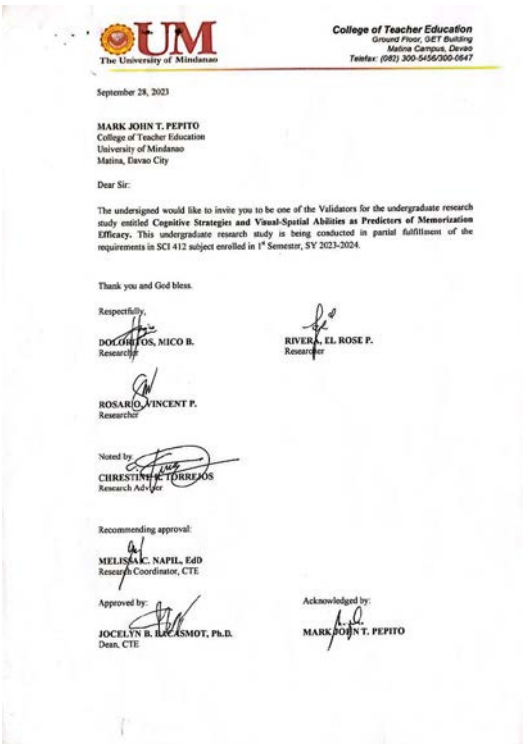
MELISSA C. NAPIL, EdD
Research Coordinator, CTE

Approved by:
JOCELYN B. BACASMOT, Ph.D.
Dean, CTE

Acknowledged by:
CHRESTINE R. TORREJOS

APPENDIX D

Letter to Validators



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Telefax: (082) 300-5456/300-0647

September 28, 2023

MARK JOHN T. PEPITO
College of Teacher Education
University of Mindanao
Matina, Davao City

Dear Sir:

The undersigned would like to invite you to be one of the Validators for the undergraduate research study entitled **Cognitive Strategies and Visual-Spatial Abilities as Predictors of Memorization Efficacy.** This undergraduate research study is being conducted in partial fulfillment of the requirements in SCI 412 subject enrolled in 1st Semester, SY 2023-2024.

Thank you and God bless.

Respectfully,

DOLORITOS, MICO B.
Researcher

RIVERA, EL ROSE P.
Researcher

ROSARIO, VINCENT P.
Researcher

Noted by:
CHRESTINE B. TORREJOS
Research Adviser

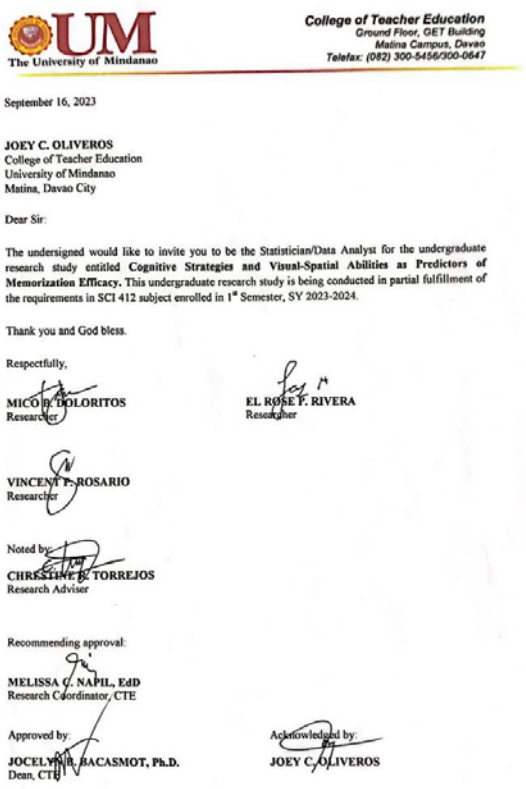
Recommending approval:
MELISSA C. NAPIL, EdD
Research Coordinator, CTE

Approved by:
JOCELYN B. BACASMOT, Ph.D.
Dean, CTE

Acknowledged by:
MARK JOHN T. PEPITO

APPENDIX E

Letter to Data Analyst/Statistician



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Telefax: (082) 300-5456/300-0647

September 16, 2023

JOEY C. OLIVEROS
College of Teacher Education
University of Mindanao
Matina, Davao City

Dear Sir:

The undersigned would like to invite you to be the Statistician/Data Analyst for the undergraduate research study entitled **Cognitive Strategies and Visual-Spatial Abilities as Predictors of Memorization Efficacy.** This undergraduate research study is being conducted in partial fulfillment of the requirements in SCI 412 subject enrolled in 1st Semester, SY 2023-2024.

Thank you and God bless.

Respectfully,

MICO B. DOLORITOS
Researcher

EL ROSE P. RIVERA
Researcher

VINCENT P. ROSARIO
Researcher

Noted by:
CHRESTINE B. TORREJOS
Research Adviser

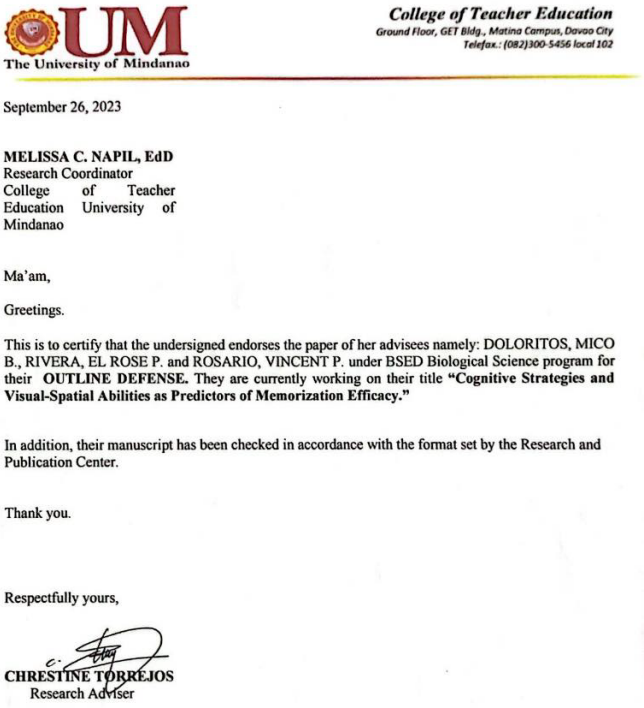
Recommending approval:
MELISSA C. NAPIL, EdD
Research Coordinator, CTE

Approved by:
JOCELYN B. BACASMOT, Ph.D.
Dean, CTE

Acknowledged by:
JOEY C. OLIVEROS

APPENDIX F

Endorsement for Thesis Outline Defense



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September 26, 2023

MELISSA C. NAPIL, EdD
Research Coordinator
College of Teacher Education University of Mindanao

Ma'am,

Greetings.

This is to certify that the undersigned endorses the paper of her advisees namely: DOLORITOS, MICO B., RIVERA, EL ROSE P. and ROSARIO, VINCENT P. under BSED Biological Science program for their **OUTLINE DEFENSE.** They are currently working on their title **"Cognitive Strategies and Visual-Spatial Abilities as Predictors of Memorization Efficacy."**

In addition, their manuscript has been checked in accordance with the format set by the Research and Publication Center.

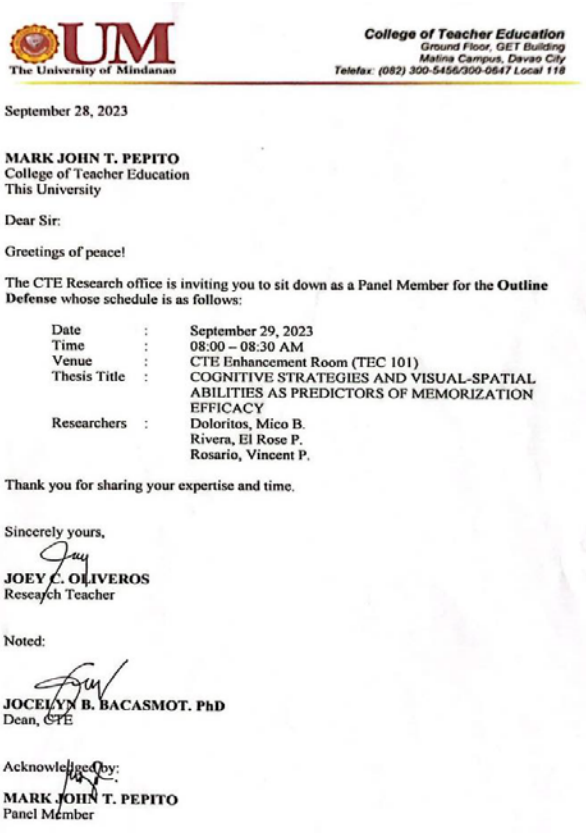
Thank you.

Respectfully yours,

CHRESTINE TORREJOS
Research Adviser

APPENDIX G

Sample Letter of Invitation to the Panel Member for Outline Defense and Final Defense



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September 28, 2023

MARK JOHN T. PEPITO
College of Teacher Education
This University

Dear Sir:

Greetings of peace!

The CTE Research office is inviting you to sit down as a Panel Member for the **Outline Defense** whose schedule is as follows:

Date	:	September 29, 2023
Time	:	08:00 – 08:30 AM
Venue	:	CTE Enhancement Room (TEC 101)
Thesis Title	:	COGNITIVE STRATEGIES AND VISUAL-SPATIAL ABILITIES AS PREDICTORS OF MEMORIZATION EFFICACY
Researchers	:	Doloritos, Mico B. Rivera, El Rose P. Rosario, Vincent P.

Thank you for sharing your expertise and time.

Sincerely yours,

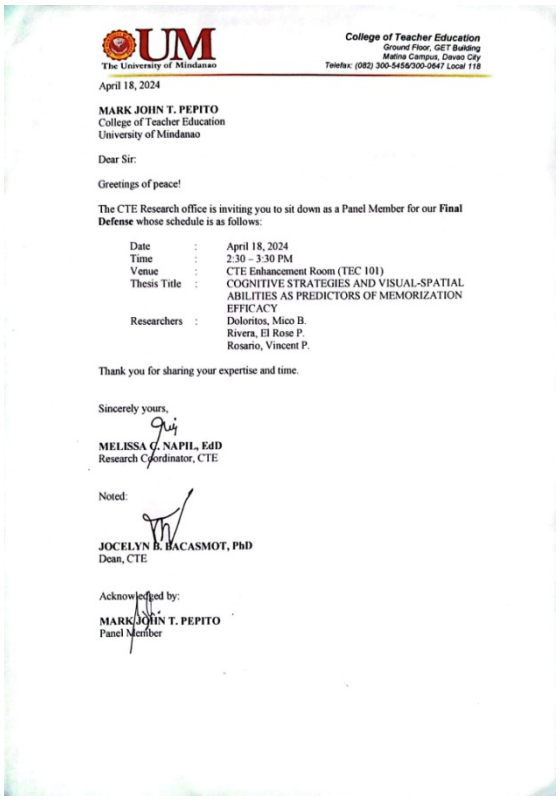
JOEY C. OLIVEROS
Research Teacher

Noted:

JOCELYN B. BACASMOT. PhD
Dean, CTE

Acknowledged by:

MARK JOHN T. PEPITO
Panel Member



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College of Teacher Education
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Matina Campus, Davao City
Telefax: (082) 300-5456/300-0647 Local 118

April 18, 2024

MARK JOHN T. PEPITO
College of Teacher Education
University of Mindanao

Dear Sir:

Greetings of peace!

The CTE Research office is inviting you to sit down as a Panel Member for our **Final Defense** whose schedule is as follows:

Date	:	April 18, 2024
Time	:	2:30 – 3:30 PM
Venue	:	CTE Enhancement Room (TEC 101)
Thesis Title	:	COGNITIVE STRATEGIES AND VISUAL-SPATIAL ABILITIES AS PREDICTORS OF MEMORIZATION EFFICACY
Researchers	:	Doloritos, Mico B. Rivera, El Rose P. Rosario, Vincent P.

Thank you for sharing your expertise and time.

Sincerely yours,

MELISSA C. NAPIL, EdD
Research Coordinator, CTE

Noted:

JOCELYN B. BACASMOT, PhD
Dean, CTE

Acknowledged by:

MARK JOHN T. PEPITO
Panel Member

APPENDIX H

Questionnaire

Name: _____ **Year Level:** _____ **Date:** _____

We invite you to participate in our research study titled "**Cognitive Strategies and Visual-Spatial Abilities as Predictors of the Memorization Efficacy**," conducted by researchers **Mico B. Doloritos**, **El Rose P. Rivera**, and **Vincent P. Rosario**, all pursuing their **Bachelor of Secondary Education Major in General Science** at the **University of Mindanao**.

This study explores the interplay between cognitive strategies and visual-spatial abilities in influencing memorization efficacy—an essential aspect of learning and daily functioning. By delving into these variables, we aim to determine whether cognitive strategies or visual-spatial abilities have a more significant impact on memorization efficacy.

We appreciate your consideration and kindly ask for your consent to be a part of this phase, contributing to the success of our study. Thank you for your time and willingness to be involved!

I. COGNITIVE STRATEGIES

Directions: For each item on the survey, please mark or put a check (√) in the box that best represents your response. Use the following scale for your responses:

Scale: 5 - Very true of me
4 - Moderately true of me
3 - Somewhat true of me
2 - Slightly true of me
1 - Not at all true of me

A. REHEARSAL	**5**	**4**	**3**	**2**	**1**
1. When I study for this class, I practice saying the material to myself over and over.					
2. When studying for this class, I read my class notes and the course readings over and over again.					
3. I memorize key words to remind me of important concepts in this class.					
4. I make lists of important terms for this course and memorize the lists.					
B. ELABORATION					
5. When I study for this class, I pull together information from different sources, such as lectures, readings, and discussions.					
6. I try to relate ideas in this subject to those in other courses whenever possible.					
7. When reading for this class, I try to relate the material to what I already know.					
8. When I study for this course, I write brief summaries of the main ideas from the					

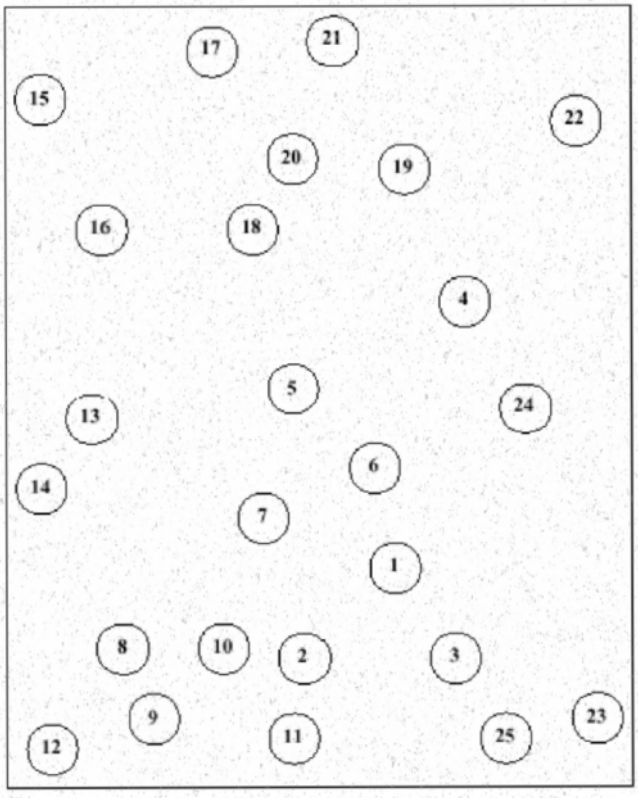
readings and the concepts from the lectures.					
9. I try to understand the material in this class by making connections between the readings and the concepts from the lectures.					
10. I try to apply ideas from course readings in other class activities such as lecture and discussion.					
C. ORGANIZATION					
11. When I study the readings for this course, I outline the material to help me organize my thoughts.					
12. When I study for this course, I go through the readings and my class notes and try to find the most important ideas.					
13. I make simple charts, diagrams, or tables to help me organize course material.					
14. When I study for this course, I go over my class notes and make an outline of important concepts.					
15. When preparing for this course, I use mnemonic devices or memory aids to help me organize and retain key concepts and information.					

II. VISUAL-SPATIAL ABILITIES

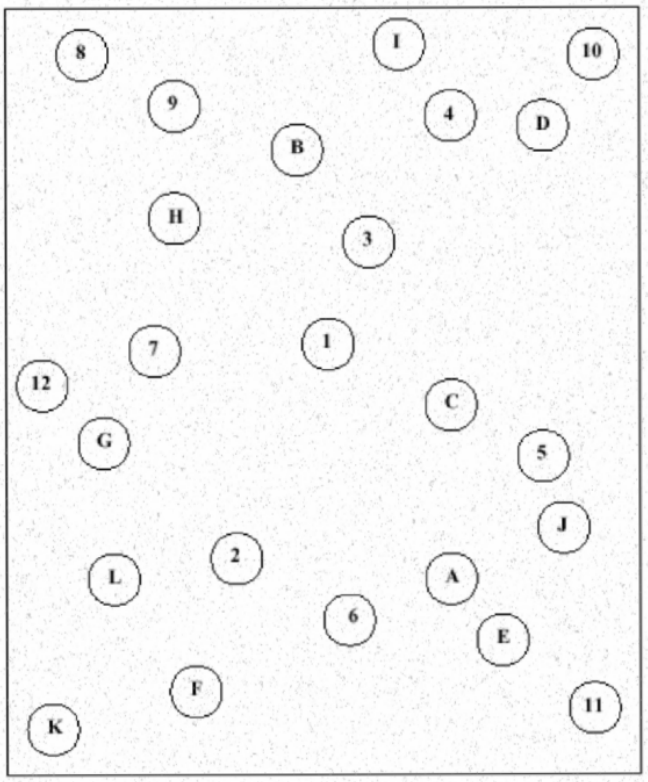
Directions: In Part A, draw the lines to connect the numbers in ascending order. The same thing goes for Part B but with the added task of alternating between the numbers and letters (i.e., 1-A-2-B-3-C, etc.). It should be done as quickly as possible, without lifting the pen or pencil from the paper.

A. Visualization

Part A



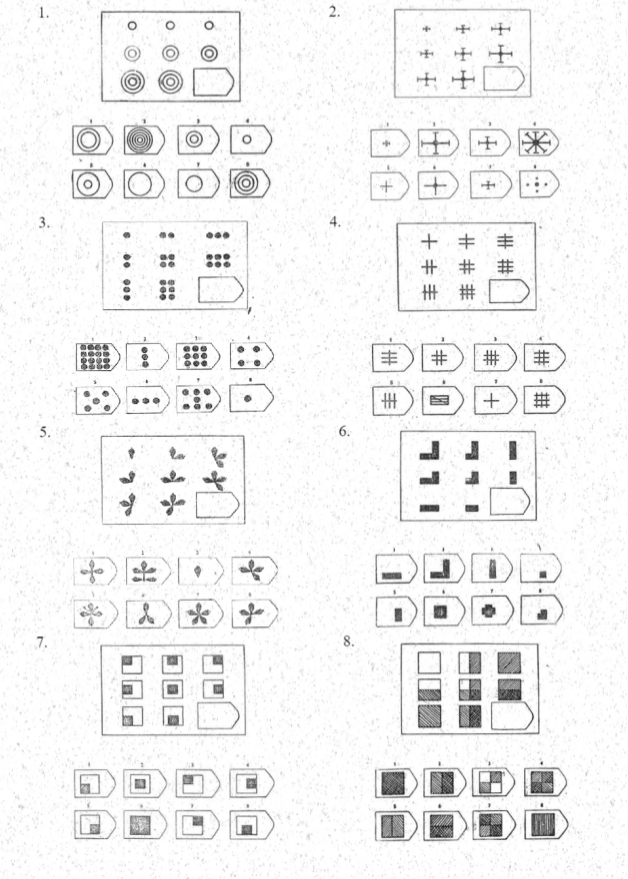
Part B



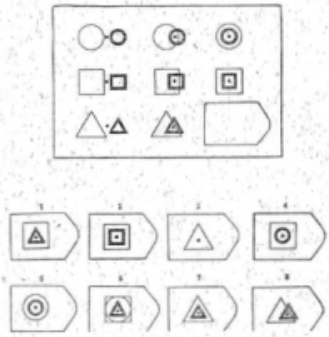
Directions: Circle the number (1-8), corresponding to the option that you believe best completes the pattern.

B. INTERPRETATION

Set A



9.



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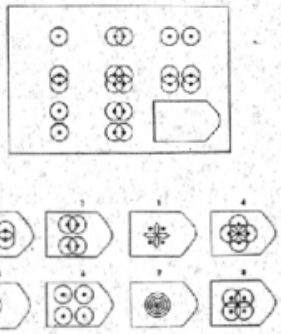

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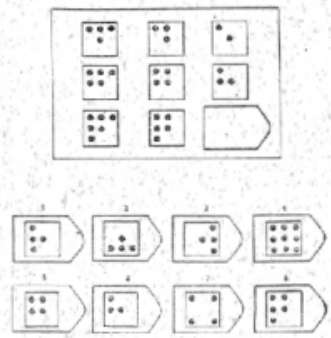

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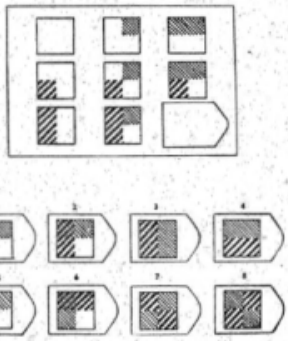
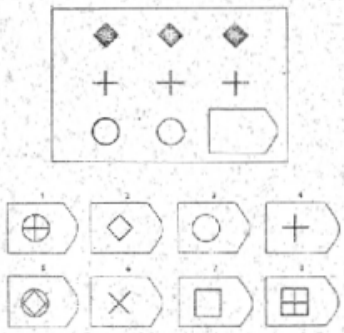
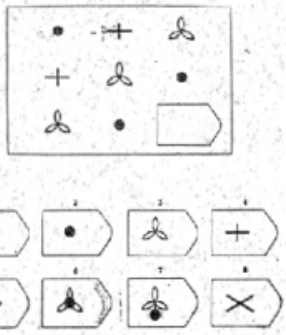


Set B

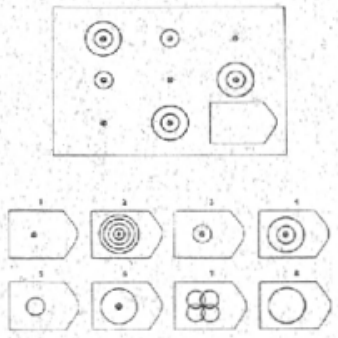
1.



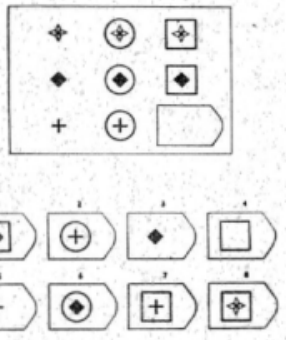
2.

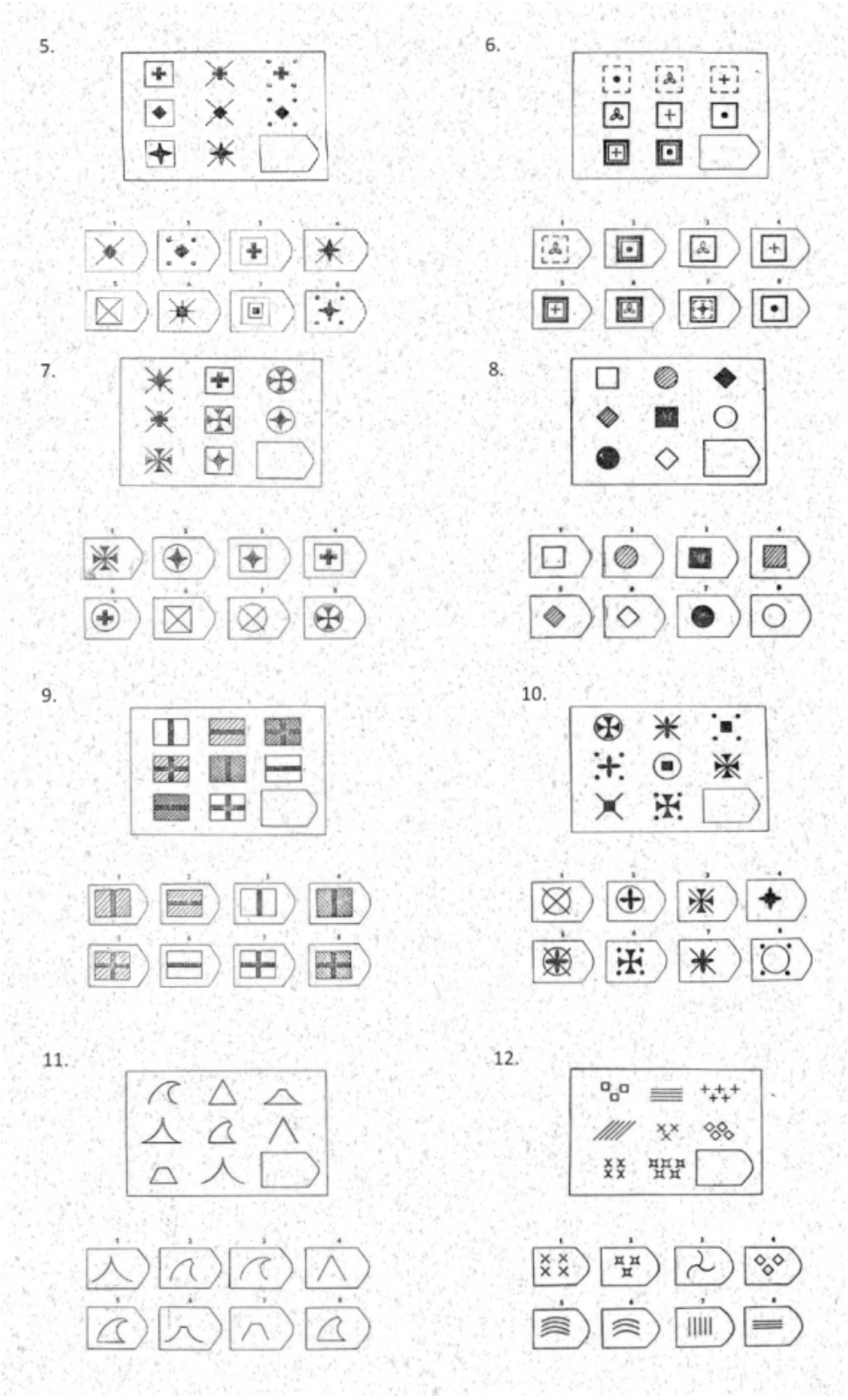


3.



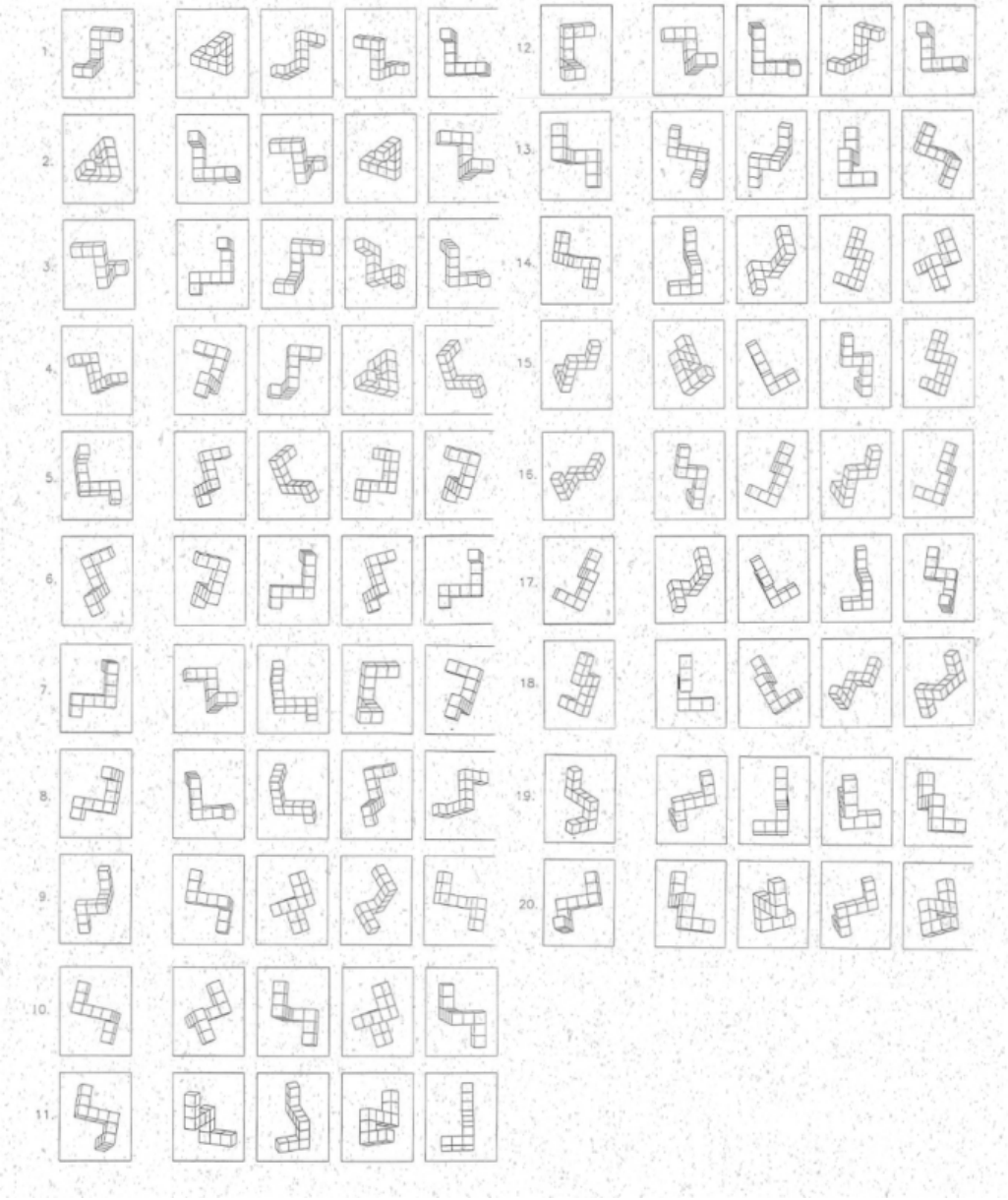
4.




5.
6.
7.
8.
9.
10.
11.
12.

Directions: Circle the box from the four choices on the right, corresponding to the two rotated version of the first box.

C. MANIPULATION



III. MEMORIZATION EFFICACY

Directions: Complete 10 boxes by matching numbers 1-9 to symbols within 90 seconds, progressing from left to right without skipping any, beginning with a sample and completing as many boxes as possible.

A. RECALL SPEED

DIGIT	1	2	3	4	5	6	7	8	9	SCORE
SYMBOL	–	⊥	⊐	L	U	0	Λ	X	=	

SAMPLES

2	1	3	7	2	4	8	1	5	4	2	1	3	2	1	4	2	3	5	2	3	1	4	6	3

1	5	4	2	7	6	3	5	7	2	8	5	4	6	3	7	2	8	1	9	5	8	4	7	3

6	2	5	1	9	2	8	3	7	4	6	5	9	4	8	3	7	2	6	1	5	4	6	3	7

9	2	8	1	7	9	4	6	8	5	9	7	1	8	5	2	9	4	8	6	3	7	9	8	6

Directions: There are 15 words listed, read it aloud one per second. Repeat all the words you can remember, in any order. This procedure is carried out a total of five times.

B. RETENTION RATE & RETRIEVAL ACCURACY

	TRIAL I	TRIAL II	TRIAL III	TRIAL IV	TRIAL V
1	Drum	Drum	Drum	Drum	Drum
2	Curtain	Curtain	Curtain	Curtain	Curtain
3	Bell	Bell	Bell	Bell	Bell
4	Coffee	Coffee	Coffee	Coffee	Coffee
5	School	School	School	School	School
6	Parent	Parent	Parent	Parent	Parent
7	Moon	Moon	Moon	Moon	Moon
8	Garden	Garden	Garden	Garden	Garden
9	Hat	Hat	Hat	Hat	Hat
10	Farmer	Farmer	Farmer	Farmer	Farmer
11	Nose	Nose	Nose	Nose	Nose
12	Turkey	Turkey	Turkey	Turkey	Turkey
13	Color	Color	Color	Color	Color
14	House	House	House	House	House
15	River	River	River	River	River

REFERENCES

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, *82*(1), 33–40. https://doi.org/10.1037/0022-0663.82.1.33

Reitan, R. M. (1958). Validity of the trail making test as an indicator of organic brain damage. *Perceptual and Motor Skills*, *8*(3), 271–276. https://doi.org/10.2466/pms.1958.8.3.271

Raven J. C. (1953). Human nature: its development, variations and assessment. The Eugenics review, 44(4), 245–246.

Vandenberg, S. G., & Kuse, A. R. (1978). Mental Rotations, a group test of Three-Dimensional Spatial Visualization. *Perceptual and Motor Skills*, *47*(2), 599–604. https://doi.org/10.2466/pms.1978.47.2.599

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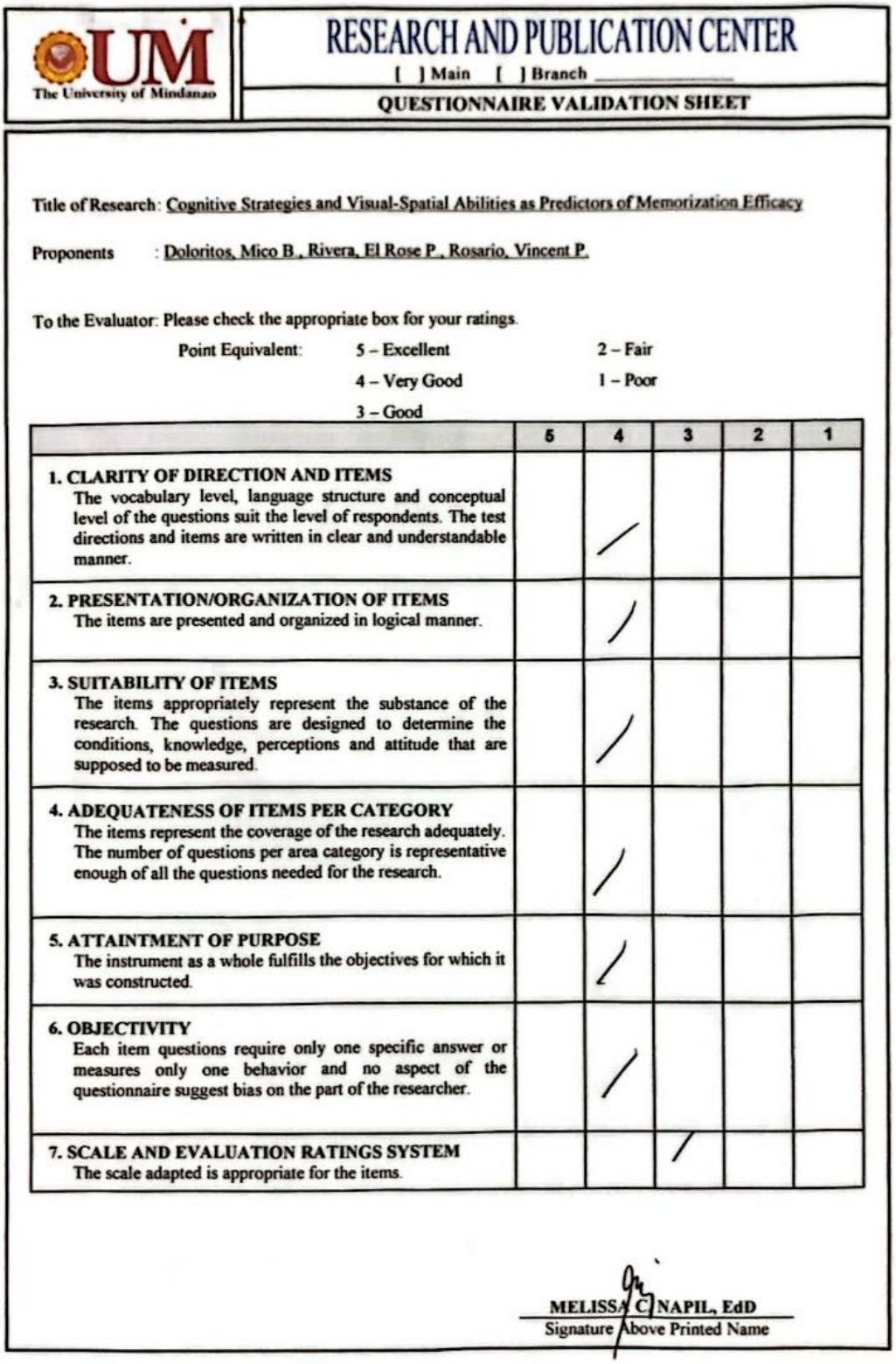
Wechsler, D. (1939). The measurement of adult intelligence. In *Williams & Wilkins Co eBooks*. https://doi.org/10.1037/10020-000

APPENDIX I

Questionnaire Validation Sheets



The University of Mindanao

RESEARCH AND PUBLICATION CENTER

[ ] Main [ ] Branch _____

QUESTIONNAIRE VALIDATION SHEET

Title of Research: Cognitive Strategies and Visual-Spatial Abilities as Predictors of Memorization Efficacy

Proponents : Doloritos, Mico B., Rivera, El Rose P., Rosario, Vincent P.

To the Evaluator: Please check the appropriate box for your ratings.

Point Equivalent: 5 – Excellent 2 – Fair
4 – Very Good 1 – Poor
3 – Good

	5	4	3	2	1
1. CLARITY OF DIRECTION AND ITEMS The vocabulary level, language structure and conceptual level of the questions suit the level of respondents. The test directions and items are written in clear and understandable manner.		✓			
2. PRESENTATION/ORGANIZATION OF ITEMS The items are presented and organized in logical manner.		✓			
3. SUITABILITY OF ITEMS The items appropriately represent the substance of the research. The questions are designed to determine the conditions, knowledge, perceptions and attitude that are supposed to be measured.		✓			
4. ADEQUATENESS OF ITEMS PER CATEGORY The items represent the coverage of the research adequately. The number of questions per area category is representative enough of all the questions needed for the research.		✓			
5. ATTAINTMENT OF PURPOSE The instrument as a whole fulfills the objectives for which it was constructed.		✓			
6. OBJECTIVITY Each item questions require only one specific answer or measures only one behavior and no aspect of the questionnaire suggest bias on the part of the researcher.		✓			
7. SCALE AND EVALUATION RATINGS SYSTEM The scale adapted is appropriate for the items.			✓		

MELISSA C. NAPIL, EdD
Signature Above Printed Name

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QUESTIONNAIRE VALIDATION SHEET

Title of Research: Cognitive Strategies and Visual-Spatial Abilities as Predictors of Memorization Efficacy

Proponents : Doloritos, Mico B., Rivera, El Rose P., Rosario, Vincent P.

To the Evaluator: Please check the appropriate box for your ratings.

Point Equivalent: 5 – Excellent 2 – Fair
4 – Very Good 1 – Poor
3 – Good

	5	4	3	2	1
1. CLARITY OF DIRECTION AND ITEMS The vocabulary level, language structure and conceptual level of the questions suit the level of respondents. The test directions and items are written in clear and understandable manner.		/			
2. PRESENTATION/ORGANIZATION OF ITEMS The items are presented and organized in logical manner.		/			
3. SUITABILITY OF ITEMS The items appropriately represent the substance of the research. The questions are designed to determine the conditions, knowledge, perceptions and attitude that are supposed to be measured.		/			
4. ADEQUATENESS OF ITEMS PER CATEGORY The items represent the coverage of the research adequately. The number of questions per area category is representative enough of all the questions needed for the research.		/			
5. ATTAINTMENT OF PURPOSE The instrument as a whole fulfills the objectives for which it was constructed.		/			
6. OBJECTIVITY Each item questions require only one specific answer or measures only one behavior and no aspect of the questionnaire suggest bias on the part of the researcher.		/			
7. SCALE AND EVALUATION RATINGS SYSTEM The scale adapted is appropriate for the items.			/		

MARK JOHN T. PEPITO
Signature Above Printed Name

APPENDIX J

Sample Tabulation and Computation of Data

Descriptive Statistics

	N	Mean	Std. Deviation
Rehearsal	95	4.2816	.69787
Elaboration	95	3.9627	.65097
Organization	95	3.7853	.77088
Cog_Strat	95	3.9886	.59885
Valid N (listwise)	95		

Descriptive Statistics

	N	Mean	Std. Deviation
Con_Vis	95	68.7606	12.72007
Con_Int	95	76.9736	18.58299
Con_Man	95	28.2368	12.14317
VSA	95	57.9904	10.24654
Valid N (listwise)	95		

Descriptive Statistics

	N	Mean	Std. Deviation
Con_Rec	95	72.5612	12.92605
Con_Ret	95	95.0036	10.48939
Memo_Eff	95	83.7824	9.67916
Valid N (listwise)	95		

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	52.053	8.767		5.938	.000
	Cog_Strat	2.191	1.549	.136	1.415	.161
	VSA	.396	.091	.420	4.380	.000

Correlations

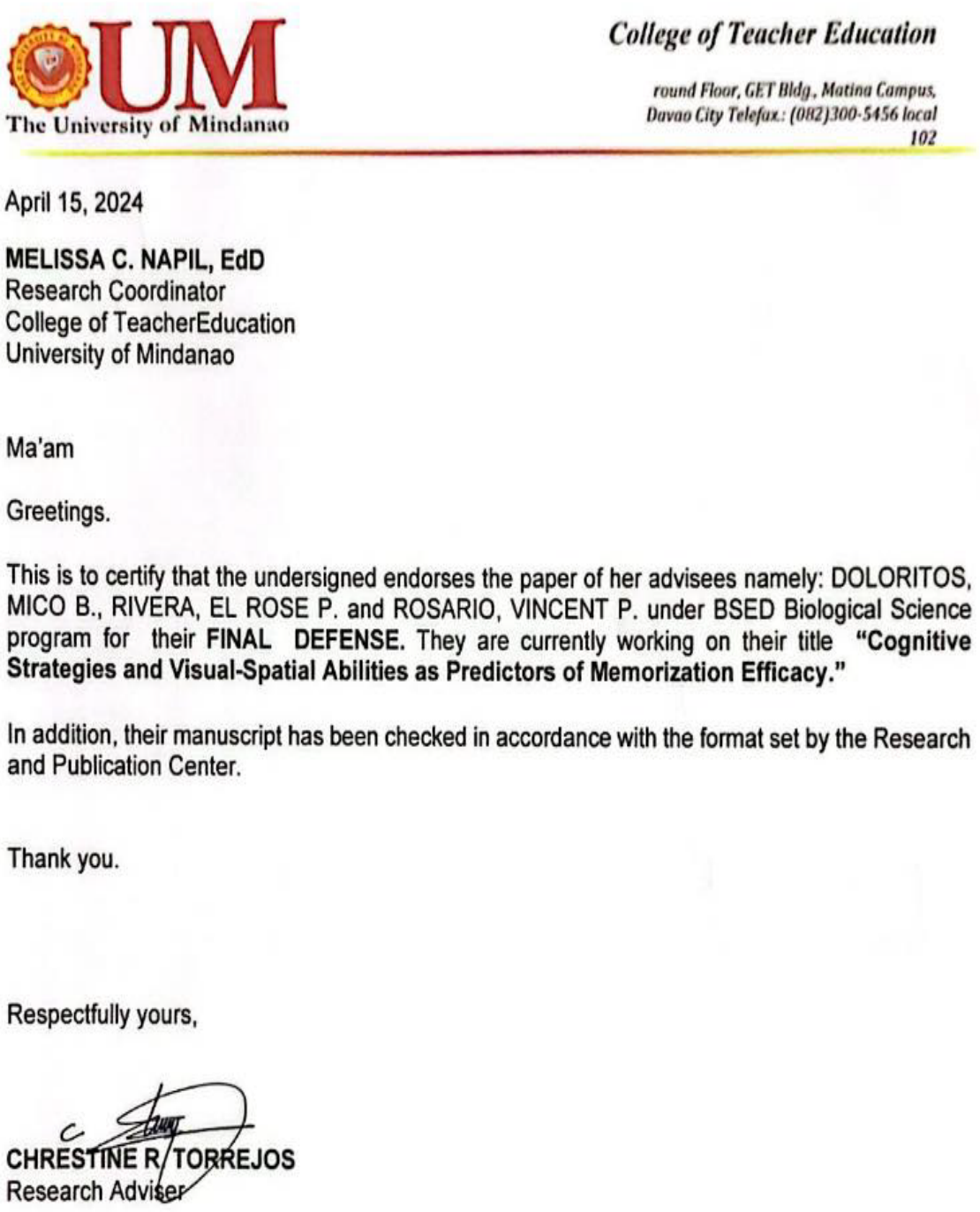
			Rehearsal	Elaboration	Organization
Spearman's rho	Rehearsal	Correlation Coefficient	1.000	.459**	.562**
		Sig. (2-tailed)	.	.000	.000
		N	95	95	95
	Elaboration	Correlation Coefficient	.459**	1.000	.563**
		Sig. (2-tailed)	.000	.	.000
		N	95	95	95
	Organization	Correlation Coefficient	.562**	.563**	1.000
		Sig. (2-tailed)	.000	.000	.
		N	95	95	95
	Cog_Strat	Correlation Coefficient	.745**	.811**	.886**
		Sig. (2-tailed)	.000	.000	.000
		N	95	95	95
	Con_Rec	Correlation Coefficient	.013	.063	-.017
		Sig. (2-tailed)	.903	.545	.867
		N	95	95	95
	Con_Ret	Correlation Coefficient	-.022	-.098	-.059
		Sig. (2-tailed)	.834	.346	.573
		N	95	95	95
	Memo_Eff	Correlation Coefficient	.019	.073	.002
		Sig. (2-tailed)	.856	.483	.987
		N	95	95	95

Correlations

			Con_Rec	Con_Ret	Memo_Eff	Con_Vis
Spearman's rho	Con_Rec	Correlation Coefficient	1.000	.376**	.947**	.286**
		Sig. (2-tailed)	.	.000	.000	.005
		N	95	95	95	95
	Con_Ret	Correlation Coefficient	.376**	1.000	.592**	.267**
		Sig. (2-tailed)	.000	.	.000	.009
		N	95	95	95	95
	Memo_Eff	Correlation Coefficient	.947**	.592**	1.000	.330**
		Sig. (2-tailed)	.000	.000	.	.001
		N	95	95	95	95
	Con_Vis	Correlation Coefficient	.286**	.267**	.330**	1.000
		Sig. (2-tailed)	.005	.009	.001	.
		N	95	95	95	95
	Con_Int	Correlation Coefficient	.360**	.248*	.363**	.341**
		Sig. (2-tailed)	.000	.015	.000	.001
		N	95	95	95	95
	Con_Man	Correlation Coefficient	.191	.043	.145	.130
		Sig. (2-tailed)	.063	.678	.161	.211
		N	95	95	95	95
	VSA	Correlation Coefficient	.410**	.245*	.403**	.622**
		Sig. (2-tailed)	.000	.017	.000	.000
		N	95	95	95	95

APPENDIX K

Endorsement for Thesis Final Defense



The University of Mindanao

College of Teacher Education

round Floor, GET Bldg., Matina Campus,
Davao City Telefax.: (082)300-5456 local
102

April 15, 2024

MELISSA C. NAPIL, EdD
Research Coordinator
College of TeacherEducation
University of Mindanao

Ma'am

Greetings.

This is to certify that the undersigned endorses the paper of her advisees namely: DOLORITOS, MICO B., RIVERA, EL ROSE P. and ROSARIO, VINCENT P. under BSED Biological Science program for their **FINAL DEFENSE.** They are currently working on their title **"Cognitive Strategies and Visual-Spatial Abilities as Predictors of Memorization Efficacy."**

In addition, their manuscript has been checked in accordance with the format set by the Research and Publication Center.

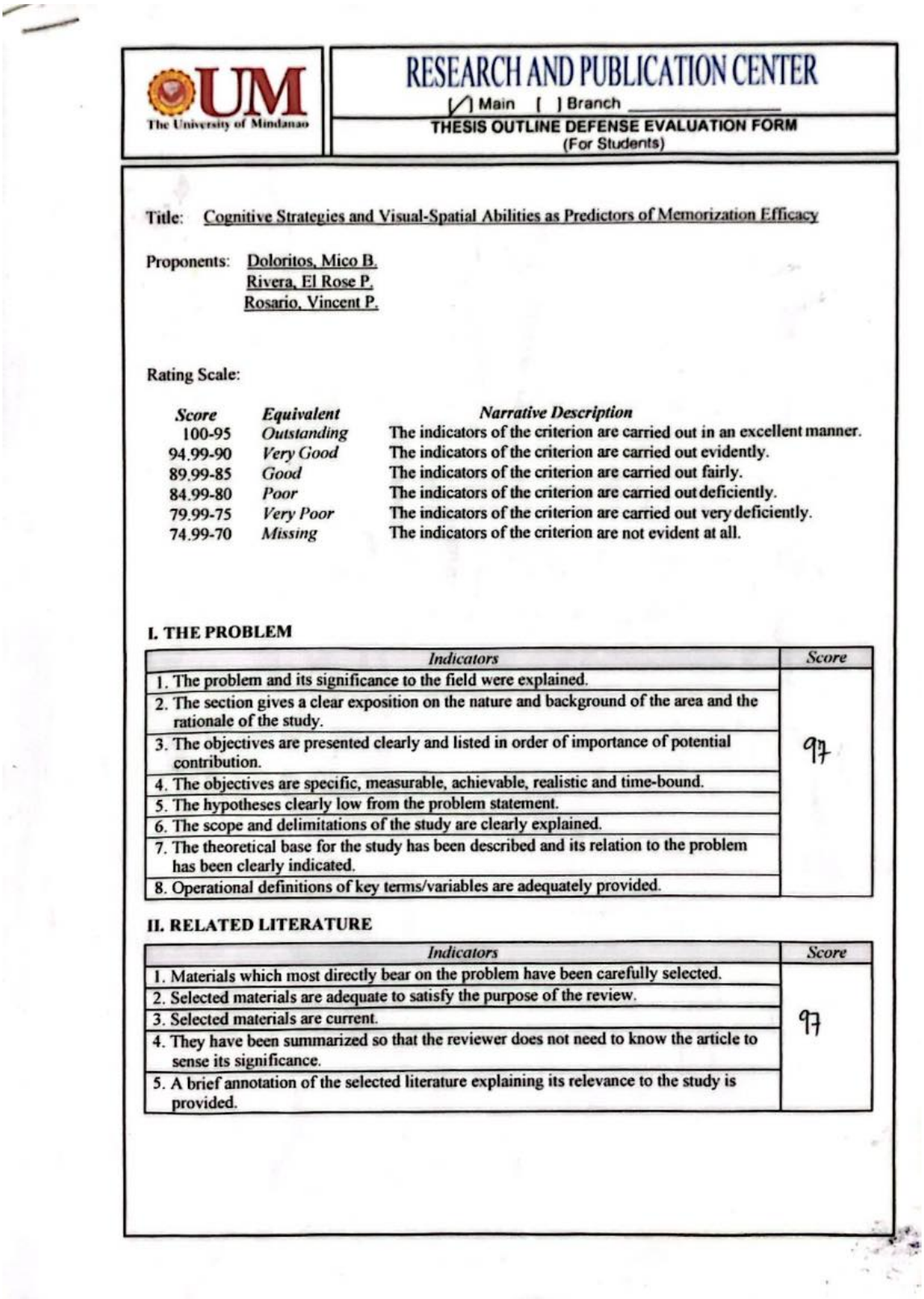
Thank you.

Respectfully yours,

CHRESTINE R. TORREJOS
Research Adviser

APPENDIX L

Thesis Evaluation Form (Title, Outline, Final)



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THESIS OUTLINE DEFENSE EVALUATION FORM
(For Students)

Title: Cognitive Strategies and Visual-Spatial Abilities as Predictors of Memorization Efficacy

Proponents: Doloritos, Mico B.
Rivera, El Rose P.
Rosario, Vincent P.

Rating Scale:

Score	*Equivalent*	*Narrative Description*
100-95	*Outstanding*	The indicators of the criterion are carried out in an excellent manner.
94.99-90	*Very Good*	The indicators of the criterion are carried out evidently.
89.99-85	*Good*	The indicators of the criterion are carried out fairly.
84.99-80	*Poor*	The indicators of the criterion are carried out deficiently.
79.99-75	*Very Poor*	The indicators of the criterion are carried out very deficiently.
74.99-70	*Missing*	The indicators of the criterion are not evident at all.

I. THE PROBLEM

Indicators	*Score*
1. The problem and its significance to the field were explained.	97
2. The section gives a clear exposition on the nature and background of the area and the rationale of the study.	
3. The objectives are presented clearly and listed in order of importance of potential contribution.	
4. The objectives are specific, measurable, achievable, realistic and time-bound.	
5. The hypotheses clearly low from the problem statement.	
6. The scope and delimitations of the study are clearly explained.	
7. The theoretical base for the study has been described and its relation to the problem has been clearly indicated.	
8. Operational definitions of key terms/variables are adequately provided.	

II. RELATED LITERATURE

Indicators	*Score*
1. Materials which most directly bear on the problem have been carefully selected.	97
2. Selected materials are adequate to satisfy the purpose of the review.	
3. Selected materials are current.	
4. They have been summarized so that the reviewer does not need to know the article to sense its significance.	
5. A brief annotation of the selected literature explaining its relevance to the study is provided.	

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THESIS OUTLINE DEFENSE EVALUATION FORM
(For Students)

III. METHODOLOGY

Indicators	*Score*
1. The research design chosen is appropriate and capable of obtaining reliable and valid data to answer the research problem.	96
2. Sampling technique is appropriate and discussed clearly.	
3. Sample size is justified.	
4. Important details regarding the subjects/participants are included.	
5. Research instruments are described and their functions are explained.	
6. Validity and reliability of research instruments are discussed.	
7. Research procedure is logical and suitable.	
8. The choice of statistical tests is appropriate to the chosen research design and to the nature, level and distribution of data.	

IV. GENERAL FORMAT

Indicators	*Score*
1. The paper is well organized and contains all the main requisites of a typical thesis outline.	97
2. The paper is well organized and its physical appearance is attractive.	
3. The prescribe rules format, spacing, pagination, tables and figures are followed.	
4. Mechanics of writing is satisfactory, The style is impersonal, straight forward, objective and affective	

V. ORAL PRESENTATION

Indicators	*Score*
1. Oral presentation is methodological, rational and coherent.	96
2. It is brief but complete.	
3. Visual aids are appropriate.	
4. Presenters are articulate.	
5. Questions are answered satisfactorily.	

Average Score: 96.6
(Passing Score = 85)

Remarks: Passed [✓]
Failed [ ]

Comments:

Congratulations! However, kindly edit your manuscript based on the comments given.

MARK JOHN T. PEPITO
Signature Above Printed Name of Panel of Member

Date: _____

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THESIS OUTLINE DEFENSE EVALUATION FORM
(For Students)

Title: Cognitive Strategies and Visual-Spatial Abilities as Predictors of Memorization Efficacy

Proponents: Doloritos, Mico B.
Rivera, El Rose P.
Rosario, Vincent P.

Rating Scale:

Score	*Equivalent*	*Narrative Description*
100-95	*Outstanding*	The indicators of the criterion are carried out in an excellent manner.
94.99-90	*Very Good*	The indicators of the criterion are carried out evidently.
89.99-85	*Good*	The indicators of the criterion are carried out fairly.
84.99-80	*Poor*	The indicators of the criterion are carried out deficiently.
79.99-75	*Very Poor*	The indicators of the criterion are carried out very deficiently.
74.99-70	*Missing*	The indicators of the criterion are not evident at all.

I. THE PROBLEM

Indicators	*Score*
1. The problem and its significance to the field were explained.	
2. The section gives a clear exposition on the nature and background of the area and the rationale of the study.	
3. The objectives are presented clearly and listed in order of importance of potential contribution.	
4. The objectives are specific, measurable, achievable, realistic and time-bound.	
5. The hypotheses clearly low from the problem statement.	
6. The scope and delimitations of the study are clearly explained.	
7. The theoretical base for the study has been described and its relation to the problem has been clearly indicated.	19
8. Operational definitions of key terms/variables are adequately provided.	

II. RELATED LITERATURE

Indicators	*Score*
1. Materials which most directly bear on the problem have been carefully selected.	
2. Selected materials are adequate to satisfy the purpose of the review.	
3. Selected materials are current.	
4. They have been summarized so that the reviewer does not need to know the article to sense its significance.	19
5. A brief annotation of the selected literature explaining its relevance to the study is provided.	

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(For Students)

III. METHODOLOGY

Indicators	*Score*
1. The research design chosen is appropriate and capable of obtaining reliable and valid data to answer the research problem.	19
2. Sampling technique is appropriate and discussed clearly.	
3. Sample size is justified.	
4. Important details regarding the subjects/participants are included.	
5. Research instruments are described and their functions are explained.	
6. Validity and reliability of research instruments are discussed.	
7. Research procedure is logical and suitable.	
8. The choice of statistical tests is appropriate to the chosen research design and to the nature, level and distribution of data.	

IV. GENERAL FORMAT

Indicators	*Score*
1. The paper is well organized and contains all the main requisites of a typical thesis outline.	20
2. The paper is well organized and its physical appearance is attractive.	
3. The prescribe rules format, spacing, pagination, tables and figures are followed.	
4. Mechanics of writing is satisfactory, The style is impersonal, straight forward, objective and affective	

V. ORAL PRESENTATION

Indicators	*Score*
1. Oral presentation is methodological, rational and coherent.	20
2. It is brief but complete.	
3. Visual aids are appropriate.	
4. Presenters are articulate.	
5. Questions are answered satisfactorily.	

Average Score: 97
(Passing Score = 85)

Remarks: Passed [✓]
Failed [ ]

Comments:
Look for a main theory on your DV & provide 2 supporting theories.

MELISSA G. NAPIL, EdD
Signature Above Printed Name of Panel of Member

Date: Sept 29, 2023

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THESIS FINAL DEFENSE EVALUATION FORM
(For Students)

Title: Cognitive Strategies and Visual-Spatial Abilities as Predictors of Memorization Efficacy.

Proponents: Doloritos, Mico B.
Rivera, El Rose P.
Rosario, Vincent P.

Instructions:

Enclosed are the criteria-indicators and rating scale to help you evaluate the various components of this thesis work. Please read the criteria carefully and place the corresponding score of each item on the blank provided for. Multiply the score with its corresponding weight and enter it on the last column. Add the points in the last column to compute the final grade. Space is provided for your comments at the bottom of the page. Thank you.

100.00 - 95	Outstanding	The indicators of the criterion are carried out in an excellent manner.
94.99 - 90	Very Good	The indicators of the criterion are carried out evidently.
89.99 - 85	Good	The indicators of the criterion are carried out fairly.
84.99 - 80	Poor	The indicators of the criterion are carried out deficiently.
79.99 - 75	Very Poor	The indicators of the criterion are carried out very deficiently.
74.99 - 70	Missing	The indicators of the criterion are not evident at all.
N/A		Not Applicable

Criterion	*Score*	*Weight*	*Points*
The Problem An explosion on the background, rationale and significance of the study are given, The objectives are specific, measurable, achievable, realistic and time-bond. The scope and delimitations of the study are clearly explained. The theoretical base for the study is described and its relation to the problem clearly indicated. Operational definitions of key terms/variables are adequately provided.		10%	10
Related Literature There is evidence that the writer made a scholarly attempt to find his precursors in the field. The review provides relevant discussion on theories, concepts, facts, and/or ideas related to the subject. The materials are current, adequate and carefully selected. A synthesis is provided at the end of the section describing the review's significance.		10%	N

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Criterion	Score	Weight	Points
Methodology Description of the research approach used is concisely written. Procedures are presented in very clear and logical sequence. The rationale behind the choice of method/procedure is explained. Sample size, sampling technique, research instruments and statistical treatment are suitable.		10%	9
Results The purpose of the study is attained. Data are sufficient, logically presented, thoroughly analyzed, and soundly interpreted as to their meanings, substance, trends, relationships, implications, and/or statistical significance. Weaknesses, inconsistencies and other limitations of the findings are admitted and discussed.		20%	18
Conclusion and Recommendations The summary of findings is logically presented. Conclusions are valid outgrowths of the findings and formulated concisely. Recommendations offered are logical, valid, feasible, practical, and attainable.		20%	19
General Format The manuscript is very well-organized and contains all the main requisites of a typical thesis manuscript. The prescribed rules on the format, spacing pagination, tables and figures are strictly followed. Mechanics of writing is satisfactory. The style is impersonal, straight forward, objective and effective.		15%	14
Oral Presentation Oral presentation is methodical, rational and coherent. It is brief but complete. Appropriate and attractive visual aids are used. Presenters are articulate and questions are answered satisfactorily.		15%	14
		100%	94

A

Comments:

Since cognitive strat is not significantly influence Memorization efficacy - there will be a new New Title: Cognitive Strategies, visual-spatial abilities and Memorization Efficacy among STEM Senior High School Strand, Review your RRL

Remove the $\bar{x}$ in the textual presentation. Incorporate

MELISSA C. NAPIL, EdD
Name and Signature of Panel Member

April 18, 2024
Date

F-13100-013 /Rev. # 2 /Effectivity: August 29, 2018

Page 2 of 2

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THESIS FINAL DEFENSE EVALUATION FORM
(For Students)

Title: Cognitive Strategies and Visual-Spatial Abilities as Predictors of Memorization Efficacy.

Proponents: Doloritos, Mico B.
Rivera, El Rose P.
Rosario, Vincent P.

Instructions:

Enclosed are the criteria-indicators and rating scale to help you evaluate the various components of this thesis work. Please read the criteria carefully and place the corresponding score of each item on the blank provided for. Multiply the score with its corresponding weight and enter it on the last column. Add the points in the last column to compute the final grade. Space is provided for your comments at the bottom of the page. Thank you.

100.00 - 95	Outstanding	The indicators of the criterion are carried out in an excellent manner.
94.99 - 90	Very Good	The indicators of the criterion are carried out evidently.
89.99 - 85	Good	The indicators of the criterion are carried out fairly.
84.99 - 80	Poor	The indicators of the criterion are carried out deficiently.
79.99 - 75	Very Poor	The indicators of the criterion are carried out very deficiently.
74.99 - 70	Missing	The indicators of the criterion are not evident at all.
N/A		Not Applicable

Criterion	*Score*	*Weight*	*Points*
The Problem An explosion on the background, rationale and significance of the study are given, The objectives are specific, measurable, achievable, realistic and time-bond. The scope and delimitations of the study are clearly explained. The theoretical base for the study is described and its relation to the problem clearly indicated. Operational definitions of key terms/variables are adequately provided.	96	10%	9.6
Related Literature There is evidence that the writer made a scholarly attempt to find his precursors in the field. The review provides relevant discussion on theories, concepts, facts, and/or ideas related to the subject. The materials are current, adequate and carefully selected. A synthesis is provided at the end of the section describing the review's significance.	97	10%	9.7

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THESIS FINAL DEFENSE EVALUATION FORM

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Criterion	*Score*	*Weight*	*Points*
Methodology Description of the research approach used is concisely written. Procedures are presented in very clear and logical sequence. The rationale behind the choice of method/procedure is explained. Sample size, sampling technique, research instruments and statistical treatment are suitable.	95	10%	9.5
Results The purpose of the study is attained. Data are sufficient, logically presented, thoroughly analyzed, and soundly interpreted as to their meanings, substance, trends, relationships, implications, and/or statistical significance. Weaknesses, inconsistencies and other limitations of the findings are admitted and discussed.	97	20%	19.4
Conclusion and Recommendations The summary of findings is logically presented. Conclusions are valid outgrowths of the findings and formulated concisely. Recommendations offered are logical, valid, feasible, practical, and attainable.	97	20%	19.4
General Format The manuscript is very well-organized and contains all the main requisites of a typical thesis manuscript. The prescribed rules on the format, spacing pagination, tables and figures are strictly followed. Mechanics of writing is satisfactory. The style is impersonal, straight forward, objective and effective.	98	15%	14.7
Oral Presentation Oral presentation is methodical, rational and coherent. It is brief but complete. Appropriate and attractive visual aids are used. Presenters are articulate and questions are answered satisfactorily.	96	15%	14.4
		100%	96.7

Comments:

Please see minutes.

MARK JOHN T. PEPITO
Name and Signature of Panel Member

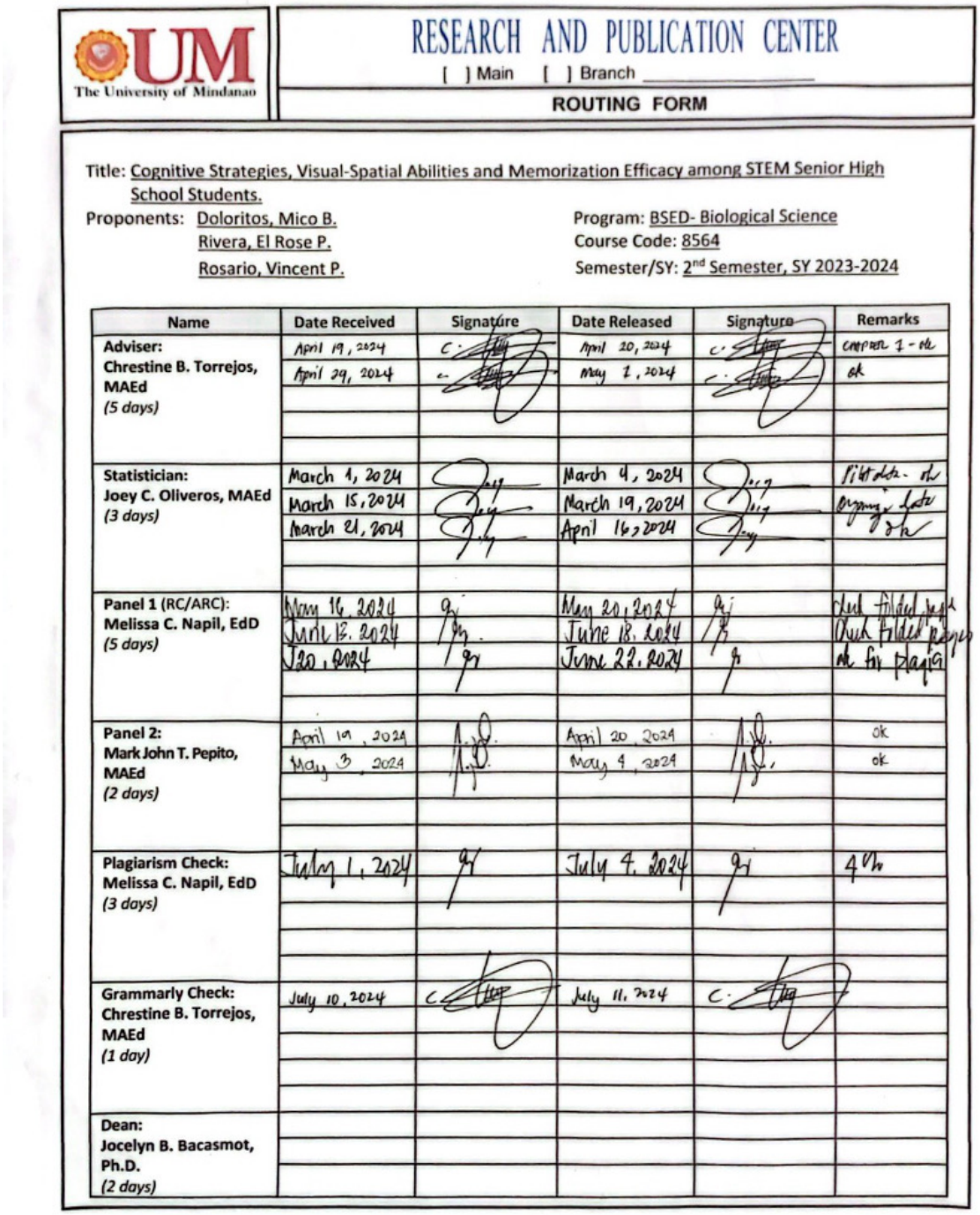
April 18, 2024
Date

F-13100-013 /Rev. # 2 /Effectivity: August 29, 2018

Page 2 of 2

APPENDIX M

CTE Research Routing Form



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ROUTING FORM

Title: Cognitive Strategies, Visual-Spatial Abilities and Memorization Efficacy among STEM Senior High School Students.

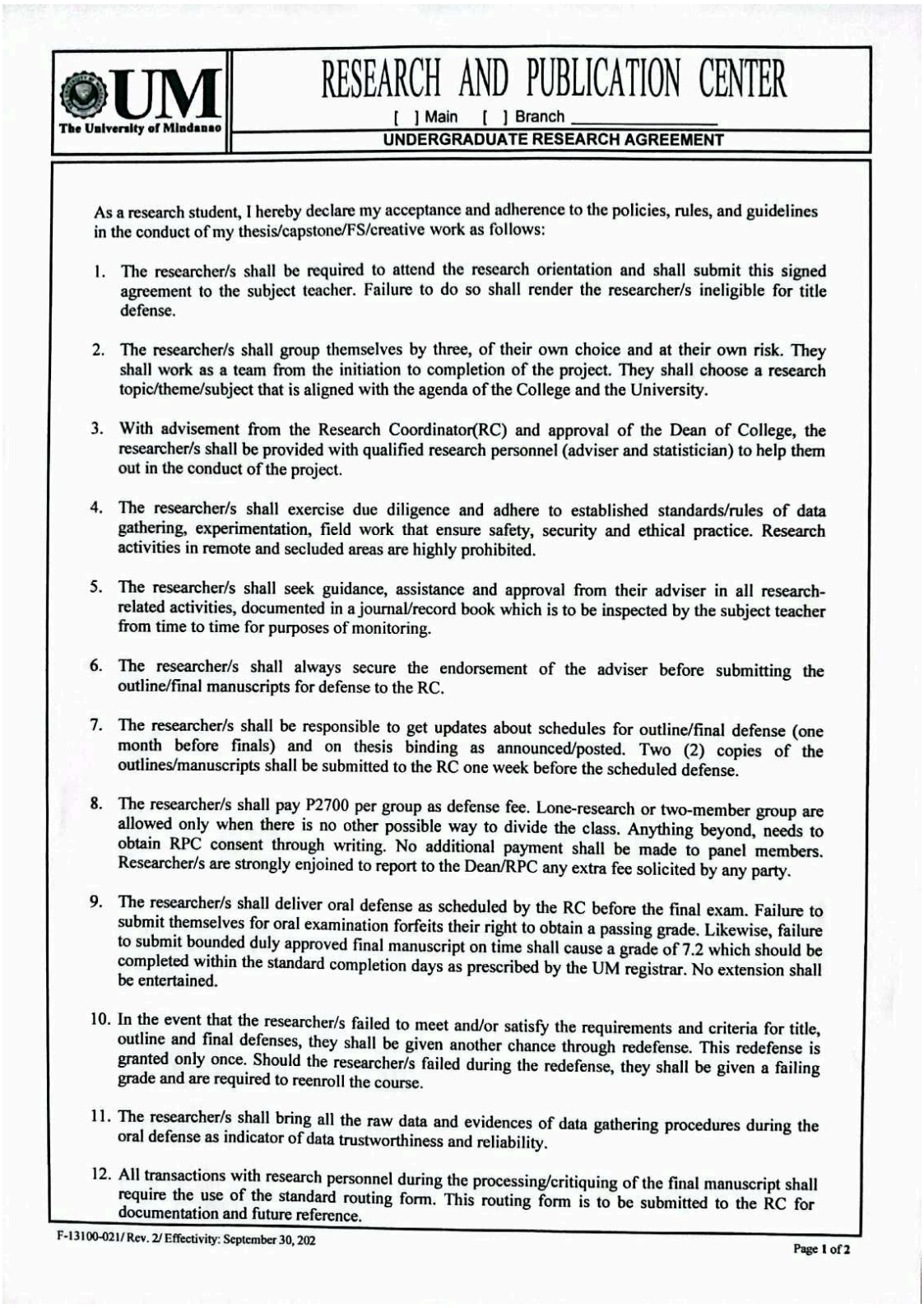
Proponents: Doloritos, Mico B.
Rivera, El Rose P.
Rosario, Vincent P.

Program: BSED- Biological Science
Course Code: 8564
Semester/SY: 2nd Semester, SY 2023-2024

Name	Date Received	Signature	Date Released	Signature	Remarks
Adviser: **Chrestine B. Torrejos, MAEd** *(5 days)*	April 19, 2024	C.	April 20, 2024	C.	Chapter 1 - 4
	April 29, 2024	C.	May 1, 2024	C.	ok
Statistician: **Joey C. Oliveros, MAEd** *(3 days)*	March 1, 2024		March 4, 2024		Table data - ok
	March 15, 2024		March 19, 2024		Typing, data ok
	March 21, 2024		April 16, 2024		
Panel 1 (RC/ARC): **Melissa C. Napil, EdD** *(5 days)*	May 16, 2024		May 20, 2024		check filled page
	June 18, 2024		June 18, 2024		check filled page
	June 20, 2024		June 22, 2024		ok for plagia
Panel 2: **Mark John T. Pepito, MAEd** *(2 days)*	April 19, 2024		April 20, 2024		ok
	May 3, 2024		May 4, 2024		ok
Plagiarism Check: **Melissa C. Napil, EdD** *(3 days)*	July 1, 2024		July 4, 2024		4%
Grammarly Check: **Chrestine B. Torrejos, MAEd** *(1 day)*	July 10, 2024	C.	July 11, 2024	C.	
Dean: **Jocelyn B. Bacasmot, Ph.D.** *(2 days)*					

APPENDIX N

Consent Form for Undergraduate Thesis Utilization



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UNDERGRADUATE RESEARCH AGREEMENT

As a research student, I hereby declare my acceptance and adherence to the policies, rules, and guidelines in the conduct of my thesis/capstone/FS/creative work as follows:

1. The researcher/s shall be required to attend the research orientation and shall submit this signed agreement to the subject teacher. Failure to do so shall render the researcher/s ineligible for title defense.
2. The researcher/s shall group themselves by three, of their own choice and at their own risk. They shall work as a team from the initiation to completion of the project. They shall choose a research topic/theme/subject that is aligned with the agenda of the College and the University.
3. With advisement from the Research Coordinator(RC) and approval of the Dean of College, the researcher/s shall be provided with qualified research personnel (adviser and statistician) to help them out in the conduct of the project.
4. The researcher/s shall exercise due diligence and adhere to established standards/rules of data gathering, experimentation, field work that ensure safety, security and ethical practice. Research activities in remote and secluded areas are highly prohibited.
5. The researcher/s shall seek guidance, assistance and approval from their adviser in all research-related activities, documented in a journal/record book which is to be inspected by the subject teacher from time to time for purposes of monitoring.
6. The researcher/s shall always secure the endorsement of the adviser before submitting the outline/final manuscripts for defense to the RC.
7. The researcher/s shall be responsible to get updates about schedules for outline/final defense (one month before finals) and on thesis binding as announced/posted. Two (2) copies of the outlines/manuscripts shall be submitted to the RC one week before the scheduled defense.
8. The researcher/s shall pay P2700 per group as defense fee. Lone-research or two-member group are allowed only when there is no other possible way to divide the class. Anything beyond, needs to obtain RPC consent through writing. No additional payment shall be made to panel members. Researcher/s are strongly enjoined to report to the Dean/RPC any extra fee solicited by any party.
9. The researcher/s shall deliver oral defense as scheduled by the RC before the final exam. Failure to submit themselves for oral examination forfeits their right to obtain a passing grade. Likewise, failure to submit bounded duly approved final manuscript on time shall cause a grade of 7.2 which should be completed within the standard completion days as prescribed by the UM registrar. No extension shall be entertained.
10. In the event that the researcher/s failed to meet and/or satisfy the requirements and criteria for title, outline and final defenses, they shall be given another chance through redefense. This redefense is granted only once. Should the researcher/s failed during the redefense, they shall be given a failing grade and are required to reenroll the course.
11. The researcher/s shall bring all the raw data and evidences of data gathering procedures during the oral defense as indicator of data trustworthiness and reliability.
12. All transactions with research personnel during the processing/critiquing of the final manuscript shall require the use of the standard routing form. This routing form is to be submitted to the RC for documentation and future reference.

F-13100-021/ Rev. 2/ Effectivity: September 30, 202

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UNDERGRADUATE RESEARCH AGREEMENT

13. The researcher/s shall maintain the right for three (3) free plagiarism checks: one during Methods of Research or its equivalent, and two during Research Proper after final oral presentation. Five hundred pesos shall be charged for the fourth and succeeding checks. Threshold of similarity is 25% and lower.

14. Manuscripts shall follow the institutional format and referencing style; the study must be a product of exercise of intellect, free of dishonesty and fraud. Also, the papers shall be subjected for Grammarly check to ensure adherence to rules of language and writing conventions. Threshold of grammar accuracy is 95% and above.

15. The researcher/s shall acknowledge the right of the College to disallow or reject researches found to be deficient, unsatisfactory or plagiarized in form or substance.

16. The researcher/s shall take precautionary measures to ensure that their paper will not be copied, replicated or duplicated by others.

17. The researcher/s shall transfer the ownership of the study to the College once the paper has been successfully defended and bound. After which no paper shall be published or presented without consent/approval from the College. Sharing and/or furnishing copies of the research paper to pertinent offices or parties is subject to the approval of the College and shall require a signed Non-Disclosure Agreement from the receiving parties.

18. The researcher/s shall present their research projects strictly during their scheduled oral defense. Failure to present as scheduled, the researcher/s will have to wait for another cycle of defense.

I affix my signature to signify that I read, understand, and conform to the items enumerated above.

Conformed:

MICO B. DOLORITOS
Signature over printed name of student

EVANGELINE B. DOLORITOS
Signature over printed name of parent/guardian

CHRESTINE R. TORREJOS
Signature over printed name of adviser

UM
The University of Mindanao

RESEARCH AND PUBLICATION CENTER

[ ] Main [ ] Branch _____

UNDERGRADUATE RESEARCH AGREEMENT

As a research student, I hereby declare my acceptance and adherence to the policies, rules, and guidelines in the conduct of my thesis/capstone/FS/creative work as follows:

1. The researcher/s shall be required to attend the research orientation and shall submit this signed agreement to the subject teacher. Failure to do so shall render the researcher/s ineligible for title defense.

2. The researcher/s shall group themselves by three, of their own choice and at their own risk. They shall work as a team from the initiation to completion of the project. They shall choose a research topic/theme/subject that is aligned with the agenda of the College and the University.

3. With advisement from the Research Coordinator(RC) and approval of the Dean of College, the researcher/s shall be provided with qualified research personnel (adviser and statistician) to help them out in the conduct of the project.

4. The researcher/s shall exercise due diligence and adhere to established standards/rules of data gathering, experimentation, field work that ensure safety, security and ethical practice. Research activities in remote and secluded areas are highly prohibited.

5. The researcher/s shall seek guidance, assistance and approval from their adviser in all research-related activities, documented in a journal/record book which is to be inspected by the subject teacher from time to time for purposes of monitoring.

6. The researcher/s shall always secure the endorsement of the adviser before submitting the outline/final manuscripts for defense to the RC.

7. The researcher/s shall be responsible to get updates about schedules for outline/final defense (one month before finals) and on thesis binding as announced/posted. Two (2) copies of the outlines/manuscripts shall be submitted to the RC one week before the scheduled defense.

8. The researcher/s shall pay P2700 per group as defense fee. Lone-research or two-member group are allowed only when there is no other possible way to divide the class. Anything beyond, needs to obtain RPC consent through writing. No additional payment shall be made to panel members. Researcher/s are strongly enjoined to report to the Dean/RPC any extra fee solicited by any party.

9. The researcher/s shall deliver oral defense as scheduled by the RC before the final exam. Failure to submit themselves for oral examination forfeits their right to obtain a passing grade. Likewise, failure to submit bounded duly approved final manuscript on time shall cause a grade of 7.2 which should be completed within the standard completion days as prescribed by the UM registrar. No extension shall be entertained.

10. In the event that the researcher/s failed to meet and/or satisfy the requirements and criteria for title, outline and final defenses, they shall be given another chance through redefense. This redefense is granted only once. Should the researcher/s failed during the redefense, they shall be given a failing grade and are required to reenroll the course.

11. The researcher/s shall bring all the raw data and evidences of data gathering procedures during the oral defense as indicator of data trustworthiness and reliability.

12. All transactions with research personnel during the processing/critiquing of the final manuscript shall require the use of the standard routing form. This routing form is to be submitted to the RC for documentation and future reference.

UM
The University of Mindanao

RESEARCH AND PUBLICATION CENTER

[ ] Main [ ] Branch _____

UNDERGRADUATE RESEARCH AGREEMENT

13. The researcher/s shall maintain the right for three (3) free plagiarism checks: one during Methods of Research or its equivalent, and two during Research Proper after final oral presentation. Five hundred pesos shall be charged for the fourth and succeeding checks. Threshold of similarity is 25% and lower.

14. Manuscripts shall follow the institutional format and referencing style; the study must be a product of exercise of intellect, free of dishonesty and fraud. Also, the papers shall be subjected for Grammarly check to ensure adherence to rules of language and writing conventions. Threshold of grammar accuracy is 95% and above.

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I affix my signature to signify that I read, understand, and conform to the items enumerated above.

Conformed:

EL ROSE P. RIVERA
Signature over printed name of student

EVA P. RIVERA
Signature over printed name of parent/guardian

CHRESTINE R. TORREJOS
Signature over printed name of adviser

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I affix my signature to signify that I read, understand, and conform to the items enumerated above.

Conformed:

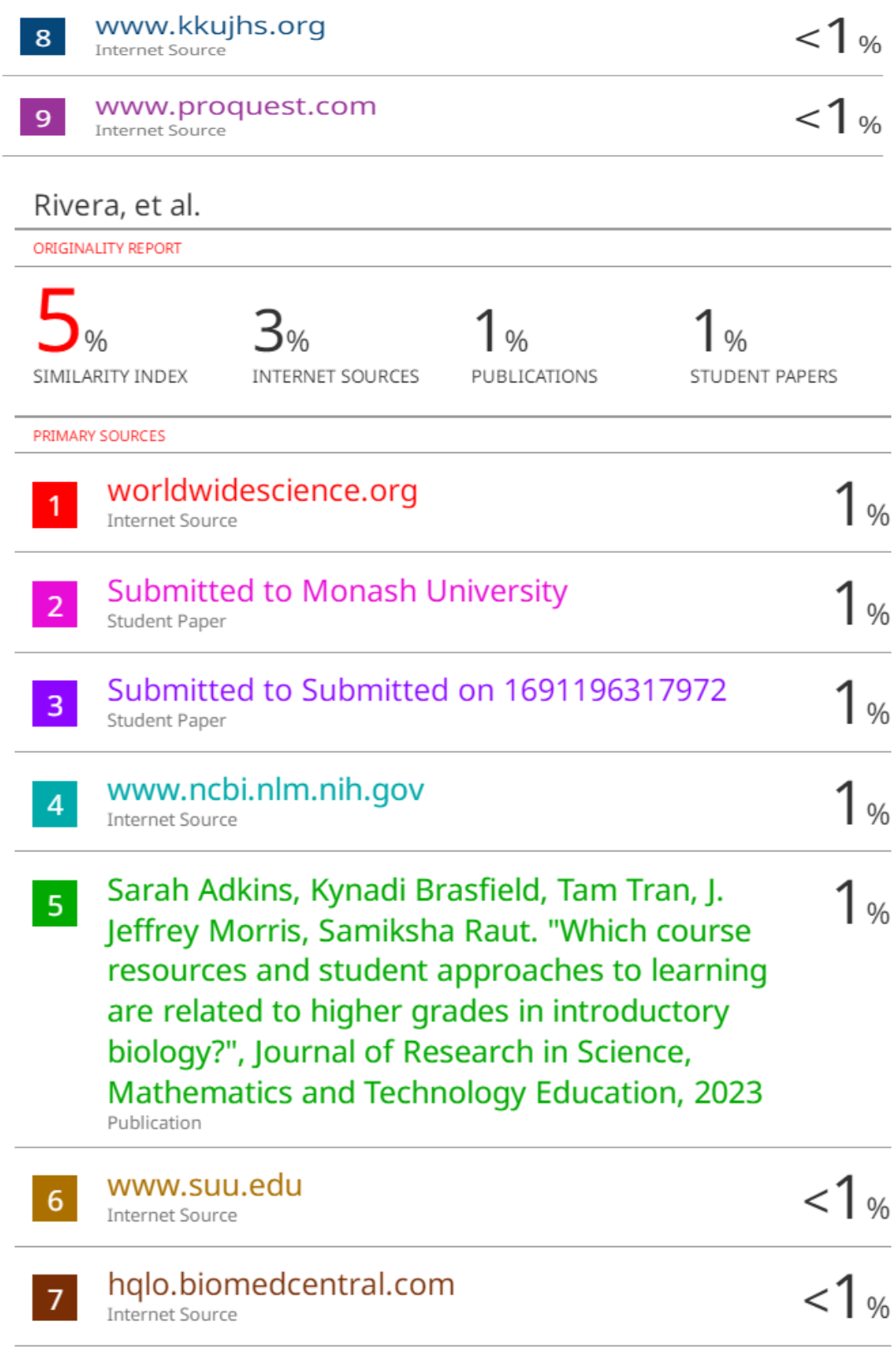
VINCENT P. ROSARIO
Signature over printed name of student

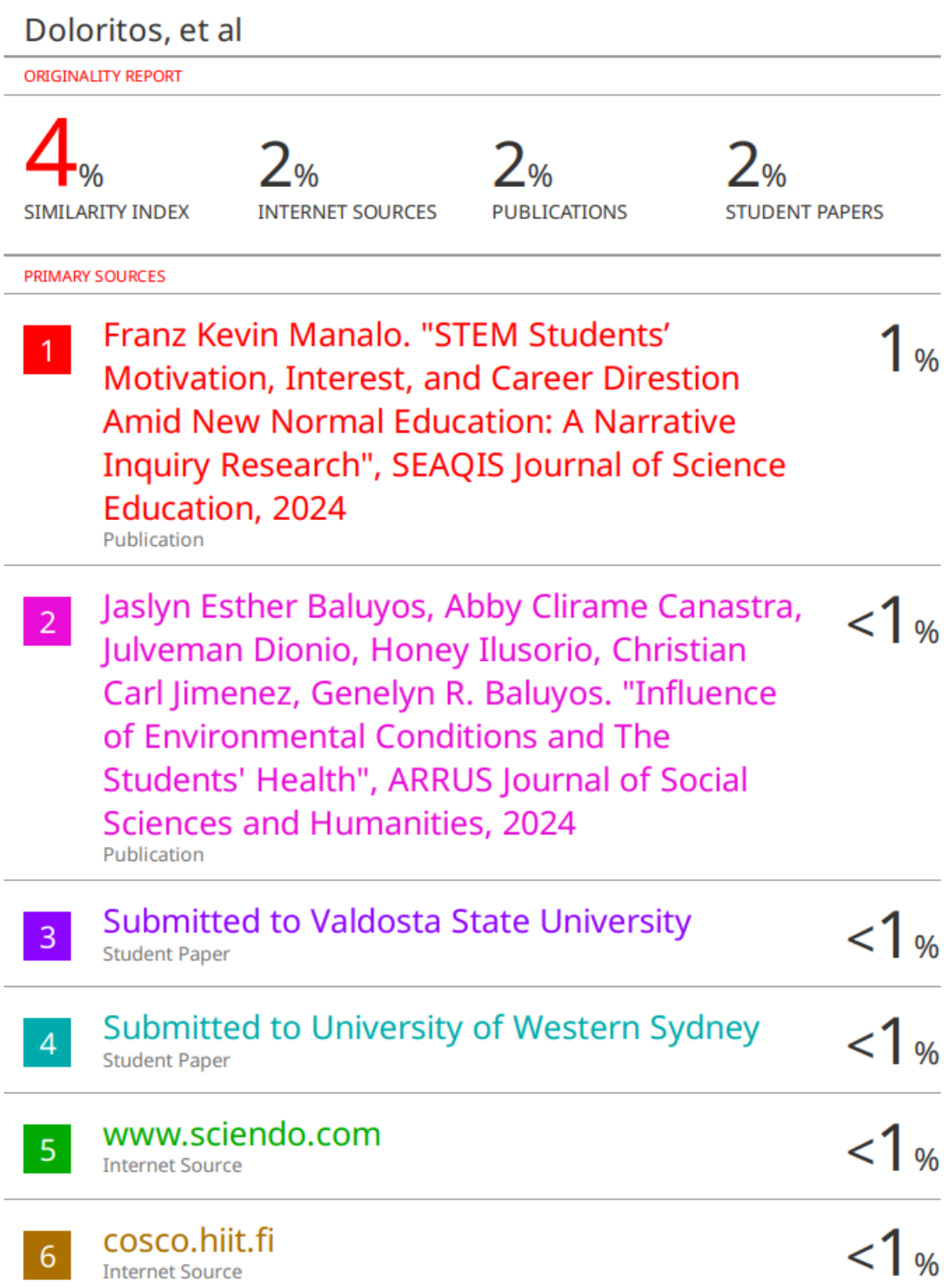
RENZO P. LOPEZ
Signature over printed name of parent/guardian

CHRESTINE R. TORREJOS
Signature over printed name of adviser

APPENDIX O

Turnitin Originality Report





Doloritos, et al

ORIGINALITY REPORT

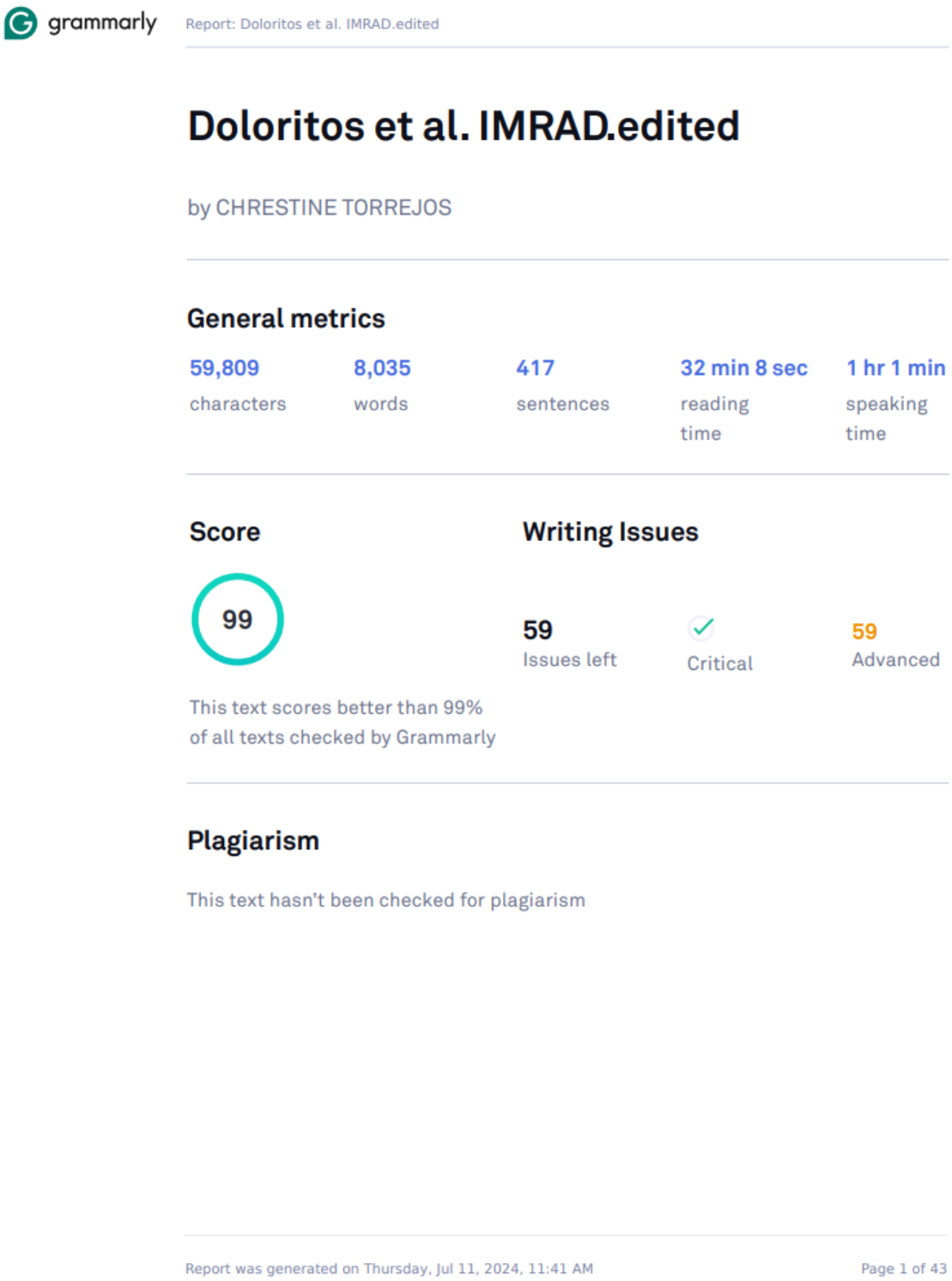
4%	2%	2%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Franz Kevin Manalo. "STEM Students' Motivation, Interest, and Career Direstion Amid New Normal Education: A Narrative Inquiry Research", SEAQIS Journal of Science Education, 2024 Publication	1%
2	Jaslyn Esther Baluyos, Abby Clirame Canastra, Julveman Dionio, Honey Ilusorio, Christian Carl Jimenez, Genelyn R. Baluyos. "Influence of Environmental Conditions and The Students' Health", ARRUS Journal of Social Sciences and Humanities, 2024 Publication	<1%
3	Submitted to Valdosta State University Student Paper	<1%
4	Submitted to University of Western Sydney Student Paper	<1%
5	www.sciendo.com Internet Source	<1%
6	cosco.hiit.fi Internet Source	<1%

APPENDIX P

Grammarly Report



APPENDIX Q

The University of Mindanao

ege of Teacher Education
Ground Floor, GET Building
Matina Campus, Davao City
32)300-5456/305-0641 Local 102

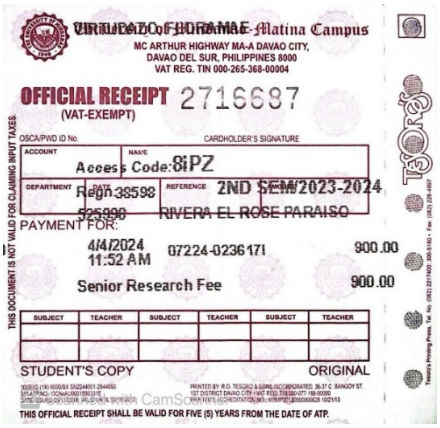
Senior Research Fee

Title: Cognitive Strategies, Visual-Spatial Abilities, and Memorization Efficacy Among STEM Senior High School Strand

Proponents: Mico B. Doloritos, El Rose P. Rivera, & Vincent P. Rosario
Subject Code: SCI 413 – Research in Teaching Science 2 (8564)
Sem/AY: 2nd Semester / 2023 – 2024
Editor/Grammarian: Chrestine R. Torrejos, MAED
Validators: Melissa C. Napil, EdD & Mark John T. Pepito, MAED
Panelists: Melissa C. Napil, EdD & Mark John T. Pepito, MAED

Name: Mico B. Doloritos
SRF OR #: 07224-0236181

Name: El Rose P. Rivera
SRF OR #: 07224-0236171



Name: Vincent P. Rosario
SRF OR #: 07224-0236161