International Journal of Academic Multidisciplinary Research (IJAMR)
ISSN: 2643-9670
Vol. 8 Issue 5 May - 2024, Pages: 133-144

Unlocking Student's Mathematical Retention: A Narrative Inquiry

Maria Niza E. Cabildo[1], Jujaylyn Hope E. Labay[2], Amor B. Robles[3], Jay Fie P. Luzano[4]

Bukidnon State University, Malaybalay City, Bukidnon, Philippines

Abstract: *Mathematical retention is crucial to learning as it determines how students can effectively recall and apply mathematical concepts and skills over time. This study explored the various narratives of students toward mathematical retention conducted at Casisang National High School (CNHS) in the school year 2023-2024. Moreover, the study used a narrative inquiry design, and five Grade 11 Senior High School STEM students participated in the study, drawn by the purposive sampling method. In gathering the data through in-depth narrative interviews, the researchers utilized a semi-structured guide questionnaire validated by two experts in the field of mathematics. The gathered narratives were then analyzed using Reissman's thematic analysis. The narratives revealed five themes, which included the Definition of mathematical retention based on students' perspectives, Mathematical Retention Opportunities, Mathematical Retention Challenges, Retention Strategies, and Remembering Practices. From the findings drawn, students may merge themselves in the proper utilization of strategies that will boost their mathematical retention. It may include listening to math-related songs, jotting and reviewing notes, associating math lessons with real-life experiences, peer-teaching, and purposeful doodling.*

Keywords — mathematical retention, narrative inquiry

1. INTRODUCTION

Essentially, mathematics succors humans with multiple cognitive skills that serve as the substructure for reaching success in both academic and professional domains. However, challenges are inevitable in learning the subject, such as the long-intrigued problem of mathematical knowledge and skill retention. By all means, it remained a dilemma for every mathematics educator (Bonyah, Larbi, & Owusu, 2023).

One of the indicators of long-term academic success is the student's capacity to retain and apply what they have learned in mathematics. However, considering that learners have varying aptitudes, learning schemes, and prior knowledge degrees, not all reach the same success. Some learners can remember mathematical knowledge and skills like a piece of cake, while some have difficulty doing so, for they tend to forget it gradually. Learning mathematics is a cumulative process. So, those learners who fall behind in retaining the prerequisites in math will need help to get a firm grip on more advanced topics. When this concern persists, it will perpetuate a cycle of poor mathematics performance among learners and ultimately widen educational gaps. Thus, the dual goal of the Philippine Mathematics Curriculum of developing the student's critical thinking and problem-solving skills (Balagtas, Garcia, & Ngo, 2019) might be impeded.

The foundering of students' mathematical retention is reflected in the Philippines' ranking in the 2018 and 2022 Programme for International Student Assessment (PISA) organized by the Organization for Economic Co-operation and Development (OECD) to weigh up internationally the literacy of 15-year-olds enrolled in the formal education. 2022 the country scored 355 in mathematics, two points higher than the 2018 PISA score. Generally, the Philippines ranked 77th globally in 2022 PISA out of all 81 participating countries. Such ranking is four spots higher compared to 2018, when the country ranked last internationally out of all 78 participating countries (Congressional Policy and Budget Research Department, 2024).

Despite this little progress, it is undeniable that the results still suggest that Filipino students need to improve in subjects: science, reading, and mathematics. Since mathematical retention is the understructure for successful and continuous learning, the PISA result is a stimulant for Filipino mathematics educators to reinforce and enhance students' knowledge retention in mathematics so that Filipino students can elevate their ranks in PISA (Barroso, 2020). However, since teachers are merely responsible for facilitating the learning process, students must take ownership of elevating their mathematical retention. In short, their commitment is in demand.

Under no circumstance has an investigation of students' narratives apropos of their mathematical retention been accomplished. By addressing this research gap, researchers can comprehensively understand the hows and whys of students' mathematical retention. Hence, this study aims to explore the various narratives of senior high school STEM students in Casisang National High School regarding their experiences with retaining mathematical knowledge using a narrative inquiry design. This study garnered qualitative data primarily through in-depth interviews. As the aspects that hinder and facilitate mathematical retention were determined, adopting efficient retention approaches will be the succeeding step for both the student and the teacher to facilitate successful mathematical retention.

2. FRAMEWORK

This study is anchored on John Sweller's Cognitive Load Theory (2010). Cognitive load theory (CTL) suggests that managing cognitive load is crucial for optimizing learning outcomes when applied to retention (Paas, Van & Sweller 2010). It underscores the significance of working and long-term memory in knowledge acquisition— essential for retaining mathematical concepts.

CTL focuses on how learners learn complex cognitive tasks, where learners can feel overwhelmed by the amount of information they need to process before learning meaningfully. This theory has three types. It includes the intrinsic, extraneous, and germane (Paas et al., 2003; Sweller et al., 1998). The Intrinsic Load is the complexity of the new knowledge and would require simplification. Germane load pertains to the semantic processing of new knowledge and requires linking it to prior knowledge. In particular, the Germane Load is about optimization. On the other hand, Extraneous Load results from poorly designed instructional methods. It often deflects the acquisition of schema.

John Sweller's CLT is relevant to this study because it provides insights into how the human brain processes and retains information. Humans only have a limited capacity for processing knowledge. If this capacity exceeds, it will impede learning and memory retention. When tasks place too much cognitive demand on students, they might find it challenging to remember essential information or feel overwhelmed, resulting in diminished learning achievements (Sweller, 1988). Consequently, it is when they become more driven to foster academic success. A student's mathematical retention can be contingent if the cognitive demand is satisfied.

3. OBJECTIVE OF THE STUDY

This study aimed to explore and code the various accounts of students linked to their capacity to retain mathematical concepts. Fundamentally, it revealed the aspects obstructing or amplifying their mathematical retention.

Specifically, it sought to answer the question:

1. What are the narratives of students towards mathematics retention?

4. METHODS AND PROCEDURES

Research Design

This study is qualitative, considering that it sought to understand a particular phenomenon in a real-world context. The researcher utilized narrative inquiry design, a method of investigating human lives that respects lived experiences as a valuable source of significant knowledge and comprehension (Clandinin & Connelly, 2004). This design strongly emphasized laying bare the causal aspects behind a student's mathematical retention by embracing a variety of stories and experiences.

Participants & Sampling

The participants in this study were the Grade 11 Senior High School STEM students of Casisang National High School who are enrolled in the S.Y. 2023-2024. The STEM student strand was chosen because they have engaged with mathematics throughout their educational journeys. Furthermore, this study employed purposive sampling that helped ensure that the participants would represent a range of stories regarding mathematical retention. There were five of them in total since the sample size for the narrative research design can be one to twenty participants (Adhikari, 2021). Those participants were identified after reaching out to a mathematics teacher. They were assigned a pseudonym to keep their identity hidden, of which three are females (Marty et al.), and two are males (Tyler and Timmy).

Research Locale

This study was conducted at Casisang National High School, located at Purok 2 Barangay Casisang, Malaybalay City, Bukidnon. The institution described above was formerly known as Bukidnon National High School Annex Campus until the DepEd's order of termination was issued in 2013. CNHS offers secondary education, specifically Junior High School (Grades 7-10) and Senior High School (Grades 11 and 12). In addition, the school specializes in five different Senior High School strands, which are Science, Technology, Engineering, and Mathematics (STEM), Humanities and Social Sciences (HUMSS), General Academic Strand (GAS), Technical- Vocational and Livelihood (TVL), and Accountancy and Business Management (ABM).

Research Instrument

The research instrument used in this study consists of two parts. Specifically, it includes the letter of intent with informed consent and the semi-structured questionnaire crafted by the researchers used to explore the participants' narratives toward mathematical retention. Lastly, the crafted guide questionnaire was cross-checked and validated by two experts in the field of mathematics, ensuring its alignment with the study's goal.

Data Gathering Procedure

In conducting the study, a communication letter was sent to the Dean of the College of Education and the Department of Education, Division of Malaybalay City. A communication letter and an endorsement letter from the Department of Education, Division of Malaybalay City, were successfully sent to the School Principal of Casisang National High School. After the approval, the researchers reached out to a mathematics teacher in the school to ask for help identifying the target respondents. After the identification, researchers communicated the study's intent, aim, and probable ramifications to the parents and participants. Thus, assent forms were given to the participant's parents, and informed consent forms were handed over to the five identified participants to set foot a fixed definitive agreement. The interviews were personally administered to the respondents at their school campus on March 21, 2024. Before the interview, the researchers introduced themselves decently, read the instructions, and put the participants at ease, which helped establish rapport. The researchers asked probing questions to the participants based on their responses to elicit extensive and comprehensive data. The interviews were recorded, and the researchers complied with the basic ethical principles in conducting the study.

Ethical Considerations

Throughout the research process, researchers conformed to the ethical principles by abiding with the Data Privacy Act of 2012 (DPA), which intends to safeguard personal data in information and communication systems. In particular, this is in line with the 11th section (General et al.) and 12th section (Criteria for Lawful Processing of Personal Information) of Chapter 3, which was given utmost consideration. In line with the respondent's voluntary participation, they were sanctioned to withdraw their involvement in the study at any time. Moreover, the personal information collected was used exclusively for research and remained confidential.

5. RESULTS AND DISCUSSION

Reflecting on this section are the results of this narrative inquiry. From the commonalities in the narratives, themes were derived. These themes include (*1) Definition of mathematical retention based on students' perspectives, (2) Mathematical Retention Opportunities, (3) Mathematical Retention Challenges, (4) Retention Strategies, and (5) Remembering Practices*.

Theme 1: Definition of mathematical retention based on students' perspectives

All five participants have shaped their perceptions about mathematical retention for years of learning mathematics. Two of them construed that remembering and understanding are the main essences of retaining their learnings in mathematics.

"Para sa ako, ang mathematical retention kay kanang pakasabot ko sa math dayon diko pakalimot sa akong natun-an." (Timmy)
"Mathematical retention is about understanding but at the same time not forgetting the lessons nga akong gakaagian." (Dianne)

On the other hand, Tyler and Alex emphasized in their articulations that mathematical retention means having a solid grasp of mathematical knowledge and knowing the appropriateness of its application, even for an extended period. Tyler shared:

"Mathematical retention is when I don't easily forget math bisan pag unsa na kadugay and kaya nako i- apply nako akong nalearn nga walay help sa uban."

While Alex asserted:

"Based on my perspective, mathematical is remembering everything I learned in math and knowing how to solve math problems even after a long time."

In contrast with those definitions, one participant considered it truthful that mathematical retention is remembering a previously studied material when the teacher administers a mathematics assessment. Marty conveyed that:

"I think mathematical retention is kanang madumduman nako ang lesson nga akong gistudyhan sa math pag mag exam mi or quiz."

Thus, one of the reasons the long-term mathematical retention of students gets obstructed is the short-term goals they have set in the subject (Luzano, 2024). Soderstrom and Bjork (2015) ratified this, saying that students only put effort into retaining knowledge in mathematics to perform a task that does not foster firmly established learning.

Theme 2: Mathematical Retention Opportunities

The accounts gathered revealed that the participants have procured constructive opportunities to retain their learning in mathematics. The participants asserted that certain circumstances in the classroom when they received assistance from their mentors have contributed to their capability to remember specific mathematical knowledge and skills.

Frequent Administration of Quizzes

For Marty, the more frequently the teacher will administer quizzes, the better her mathematical retention becomes. She shared in her account that:

"We have this math teacher sauna nga everytime mahuman iyahang discussions, gapaquiz gyud sya amo. So, wala koy other choice but maminaw sa iya kay syempre dili pud ko gusto na gagmay akong scores. Then if mashort sya sa time, mag expect na dayon mi nga magpaquiz na sya the next day. Then pag duol na dayon ang exam, dili na kaayo ko gakahago magreview."

As for Marty, her mathematics teacher's regular administration of quizzes was a beneficial factor for her retention in the subject. She recognizes that it lessens the burden she has to face in going over the lessons taught to them. This result is corroborated by the study of Valderama and Oltiga (2021), suggesting that teachers must plan and administer quizzes as frequently as possible, in consideration that the extent to which students retain their learning in mathematics becomes less over seven consecutive weeks at a rate of 3% weekly. Moreover, this is further supported by the findings of Naseem (2021) and Luzano (2023) that when math quizzes are given regularly, students become more driven to learn and revisit the materials in a definite pattern rather than cramming at the last minute.

Prior Learning Assessment

Meanwhile, Timmy finds it advantageous when the teacher directs assessments about their prior knowledge before the teacher introduces them to a new topic in math. He shared:

"I appreciate those instances when our math teacher conducts test review before mi magproceed sa lahi nga topic because maretain dayon nako ang lesson better. And gakagamit na nako nga chance para maclarify nako akong wala nasabtan."

Timmy's experience unveils the essence of retrieving formerly acquired knowledge in math, and accordingly, doing so usually raises the odds that the knowledge will be preserved in the future (Rowland, 2014; Pang-an et al, 2022). The study by Lyle, Bego, Hopkins, Hieb, and Ralston (2019) validated this notion, saying that teachers could allocate classwork that demands retrieval to elevate knowledge retention in mathematics. Furthermore, the finding is substantiated by Britton (2023) and Luzano and Ubalde (2023), who attested that the lead to elevating students' long-term mathematical retention is reviewing the previously taught content to students, especially if they are learning something new.

Integration of Relevant Humor in Discussions

Conversely, according to Dianne's experience, her retention in math is elevated when teachers explain the lesson in the most fathomable and humorous manner. She stated that:

"I remember lessons better in math in those situations nga ginatudlo ang lesson in a way nga klaro, sayon, then lingaw. My math teacher in grade 7 teach like that. Like kung magtudlo sya kay ginamake niya ang topic nga sayon para sa amoa, and para dili mi maglisud kay gatudloan mi niya ug shortcut methods. Dili pud boring among klase sa iya kay lingaw kaayo magtudlo si sir. Always jud sya naay balon na mga jokes na related sa among topics. Sauna gani is dili gyud ko ganahan ug math, pero it changed because of him."

The study conducted by Bakar and Mallan (2022) supports this finding as it reveals that students tend to remember and understand learning content better when relevant humor is associated with the teaching and learning processes.

Use of Concrete Materials

Two participants shared their experiences regarding how advantageous it is to retain mathematical skills and knowledge when the teacher uses physical objects in teaching (Luzano, 2020). Alex said that what helps her remember what has been taught is when the teacher presents the step-by-step process of solving math problems and integrates concrete instructional materials in teaching. She shared:

"It helps me even remember the math lesson more kung ishow sa teacher in actual na step-by-step na pagsolve sa math, samot na if gagamit sya ug mga math materials. Pareha atong number line in solving integers, then katong probability kit na gigamit namo to learn about probability."

On the other hand, Dianne expressed that manipulating concrete materials like algebra tiles strengthens the way she retains mathematical solving skills. She said:

"Pag naa koy gakamanipulate na material, mas makasabot ko and mas ma retain nako ang process sa solving. Just like using algebra tiles sa pagfactor ug mga algebraic expressions."

This result gives credence to the study of Mutodi and Ngirande (2017) and Romorosa et al (2023), divulging that using concrete materials in teaching math intensifies the students' knowledge grasp and retention regarding how teachers perceive it.

Theme 3: Mathematical Retention Challenges

The student's challenges in retaining mathematical knowledge and skills were determined through the lens of five distinct narratives. Their narratives shed light on hurdles like the absence of self-regulated learning, high intrinsic cognitive load tasks, a distracting environment, and difficulty in grasping fundamental mathematical knowledge.

Absence of self-regulated learning

Mathematical retention demands effort, like how worth doing things does. In this case, the lack of self-regulated learning could negatively impact successful mathematical retention, and this conviction is derived from what Marty and Dianne expressed. According to Marty:

"*It becomes difficult for me to retain something in math kay usahay dijud ko mueffort. Kay gasuol-suol akong gana sa math. Naay times nga makadecide ko na dili ko mag review sa among gilesson, dili ba kaha maminaw sa discussion, usahay pud dili ko mangitag lahi nga paagi para magets nako ang topic. Pag inana na gani na magtinapulan ko, wala gyud magpabilin sa akong utok. Daghan man gud opportunities na pwede nako igrab aron maretain ra sa akong huna-huna akong nalearn. Just like consistent practice, maminaw sa discussions ug uban pa. Pero ang reason gyud ngano maglisud ko kay kung dili nako na itake na mga opportunity*."

Dianne also added:

"*My laziness when it comes to studying is what made it difficult for me to retain math knowledge. Okayhan rako usahay with what I already know, and I do not study in advance."*

These narratives reveal that self-regulated learning and mathematical retention are closely related, and the study of Fauzi and Widjajanti (2018) substantiates this result. Accordingly, self-regulated learning in mathematics helps learners foster the mental power, self-discipline, and drive needed for profound discernment, especially knowledge retention.

High intrinsic cognitive load tasks

It's undeniable that math has complexity, and Alex acknowledges this. She shared:

"Kung lisdan kaayo ko sa topic, maglisud sad kog retain. It's like kung beyond ra sa akong makaya ang lesson namo sa math, di nako sya ditso maabsorb. I'll need to do more practice until magets na nako sya totally pareha sa basic calculus."

This result implies that complexity could explain why students cannot retain mathematical knowledge and skills (Aranzo et al, 2023; Tortola, 2021). The degree of a topic often makes it difficult for learners to retain the content because of their learning capacity (Nallada et al., 2024). This result corroborates the idea that arduous tasks tend to inflict learners with a high intrinsic cognitive load, which diminishes their cognitive resources, particularly their working memory (Gupta & Zheng, 2020).

Distracting environment

Concentration capacitates a long-lasting memory (Sridhar, 2020). This notion denotes that numerous distractions in the scheme of absorbing content might deplete one's knowledge retention (Casanova et al., 2023; Luzano et al., 2024). Alex's acquaintance in learning math made her think that way. The following statement is how she expressed the difficulty she experienced with her mathematical retention:

"*Mga situation nga gubot akong palibot tas daghan akong labhunon. Actually, I tried ignoring those kind of situations pag magstudy ko, pero dili jud sya ga work sa akoa. Busa sa balay, before ko magstudy, manglimpyo sako daan dayon manglaba kung naay labhunon*."

This finding is backed up by the idea that if the learners' attention is apportioned in knowledge acquisition, their long-term content retention will be marred (Schmidt, 2020).

Difficulty of grasping the fundamental math lessons

Contents in mathematics are linked to each other. In other terms, one content is a prerequisite for another content. However, the opposite happened on Timmy's account, as he encountered a circumstance that hindered his retention of trigonometry. He shared:

"Pag wala gani koy enough na knowledge about sa mga basics in math, gastruggle dayon kog retain sa mga bag-o na topics. Just like my encounter atong pandemic nga modular rami. Wala gyud kaayo koy natun-an sa basics about trigonometry ato na time which gave a negative impact sakoa pag STEM nako. Akong ginabuhat lang ato kay galantaw og mga youtube tutorials tas search-search sa google, inana. Pero lisud kaayo to sa akong end kay kung gakaconfuse ko, dili ko makakuha ditso ug tubag sa akong mga pangutana."

Timmy's narrative proves how highly beneficial it is to have a solid grasp of the fundamental topics in math. This is in consideration of the fact that connecting the knowledge accumulated in the long-term memory with present knowledge to be decoded is crucial in mathematics (Ningsih & Retnowati, 2019). However, in his account, the obstruction of his retention on trigonometry did not capacitate him to have a good start in his transition to senior high school.

Theme 4. Student's retention strategies

Conforming to the narratives of Marty, Tyler, Timmy, Alex, and Dianne, they averred that they used specific strategies that ultimately aided their retention of particular mathematical contents.

Listening to songs

As mentioned by Marty, listening to and familiarizing herself with songs is serviceable to how she comprehends and calls to mind her learnings in math.

"One of the best strategy na nakahelp sa akong retention is listening to math songs. Pareha atong kanta ni Michael Bautista bitaw, about sa unit circle. Ganahan kayko ato. Tas since nakatatak natos akong utok na kanta, I can really remember kung unsa tong mga radians tas mga degree sa unit circle."

This result is borne out by Walsh and Coleman (2023), who affirmed that music is a functional instrument that can amplify learning and the ability to recall subject matters in math. Songs conveniently satisfy the learner's capacity to encode and decode data in mind when required (Trinick et al., 2016).

Taking and revisioning notes

Conversely, Tyler reckons that jotting and revising notes works best for his retention in math. He stressed that:

"Taking notes and rewriting it using my own understanding. Bahalag bati kog agi, ga takenote jud ko kung magdiscuss na among math teacher. Pag-abot dayon sa balay kay ginareview dayon try-try. Kung unsa dayon akong masabtan, ibalhin nako nag sulat sa lahi nga papel. Mao na dayon na akong silbi study."

This finding is confirmed by Ibañez (2021). Ibañez elaborated that taking notes by hand actuates a portion of the human brain, the hippocampus, which is in charge of processing and retaining articulated memories. Consequentially, forgetting will crop up when the recently fathomed knowledge is not jotted down (Özçakmak & Sarigöz, 2019). Moreover, rewriting notes is another recourse that students may opt to do to fortify their understanding of a subject matter. Frequent contact with notes means better recall (American InterContinental University, 2019).

Peer Teaching

On the other hand, what helps Timmy understand and remember a particular subject matter in depth in math is taking on the role of the teacher to assist his peers in learning.

"I do a lot of practice, and once makasabot nako sa tibuok na process sa pagsolve, I teach it to my classmates. I feel happy dayon kung maexplainan nako sila. Same pud if sila ang ga explain sa ako, paka tuon japon ko and mas ma remember nako kay gakalingaw ko. Pero depende pud sa akong makauban."

Not only did peer teaching heighten Timmy's social skills, but he was also able to uplift his mathematical retention. Based on Edgar Dale's learning pyramid, teaching others is the most potent strategy to get the hang of knowledge and retain it for the foreseeable future (Masters, 2013). This is because before teaching, one puts effort into understanding the content first. The time the knowledge is shared later contributes to such reinforcement (Hansen, 2022 & Stigmar, 2016).

Association of real-life scenarios

Preferentially, Alex is fond of taking heed of the significance of the content he is learning in mathematics through association. He does this by associating real-life scenarios with the stuff he is learning in math to grasp and retain mathematical knowledge longer swiftly.

"For me, I can recall better if the things I'm learning in math can be related to real-life and that I can relate to it. An example of this kay kanang sa probability na magpredict or magplan kog certain thing. Like when there is an upcoming exam, if I will not study the lessons, the closer the day of the exam, the lesser the chance that I will pass the test and the higher the chance that I will fail. When I forgot the process and formula of the problem, I will most likely will remember what are the contents kung na associate nako sya sa isa ka situation."

The National Council of Teachers of Mathematics (2000) even said that applying lessons in mathematics to real-life scenarios would pave the way for learners to hark back their attained knowledge conveniently. So, it is plain to see that real-life scenarios are the spearhead of a meaningful learning process. It further supplements knowledge retention (Cengiz & Eğmir, 2022).

Doodling

As for a visual learner like Dianne, she uses his creativity to leave marks on her mind about the things she is learning in math. Her technique involves casual little drawings that she intentionally makes to bolster her retention. She said:

"At home, I doodle what I learn in math sa akong notebook bisan dili jud ko ingon na artistic. It just helps me to remember the lesson better that way because I am a visual learner. In times dayon na mag quiz mi or mag exam unya naa koy nalimtan, ginarecall dayon to nako akong gidoodle."

Significantly, this result is perceived to be true since doodling deliberately is an effective technique that learners can use to reach an eminent degree of information visualization and retention (Zeyab, 2017). This is also supported by Brown (2014), who affirmed that doodling creates traces in a person's mind that upholds thinking.

Theme 5: Remembering Practices

Forgetting is one of the most common problems that learners face in applying what they have learned in mathematics. That phase could be in exams, quizzes, or math-related activities requiring executing their learned knowledge. Moreover, this is evident in the narratives garnered among the five participants. They emphasized the individual practices they firmly believe have helped them to manage to retrieve what they have forgotten. These practices are classified according to the following subthemes.

Getting ample rest

Two of the five participants presumed that having enough rest enables them to retrieve what they inadvertently neglected to remember. Marty said:

"*I try my best to study in advance tas tulog jud, since dili man pud ko makahuna-huna ug tarong kung bilar. Labaw na kung naa mi upcoming nga quiz or exam, gina try jud nako karon ug prioritize nga 7-8 hours akong sleep para dili blangko akong utok. Nalugda naman gud ko last time atong nagbilara rakog lantaw ug kdrama bisan naa mi long quiz sa pre-cal pagka ugma. Funny sya na experience pero nagbasol jud kog maayo ato kay dili Gagana akong utok during sa quiz. Ang resulta gamay kaayo akong score*."

Moreover, Dianne stated:

"Gapalabihon nako akong tulog if mag study ko, then kung naa koy free time, I take naps."

Various studies supported the findings about how sleep impacts student's mathematical retention. Accordingly, good quality of sleep is pivotal for improved acquisition of knowledge, including skill and memory recall/retention (Walker, 2017; Bell et al., 2014; Cappello, 2020; & Mazza, Gerbier, Gustin, Kasikci, Koenig, Toppino, & Magnin, 2016).

Consuming brain-boosting foods

While seeking additional knowledge, Tyler and Alex assumed that what prevented them from forgetting what they studied in mathematics was the consumption of brain-boosting foods like eggs, chocolates, peanuts, and coffee. Tyler said:

"Usually, kung mag study kos math especially kung naa mi upcoming nga exam or quizzes kay gakaon kog itlog, chocolates or mani. I started doing that ever since elementary tungod sa influence sa akong mama. And I guess isa pud sya sa reason ngano makaanswer kos math dayon para maremeber nako akong gistudyhan. Pwera nalang anang times na wala ko kastudy or wala ko nakasabot sa lesson."

While Alex stated that:

"Gainom ko ug kape kung magstudy ko."

Notably, consuming these kinds of brain foods can improve brain health and stimulate good mental function when studying and taking exams (Tinsley, 2020). However, according to Forge and Kubala (2021), one should remember that the nutrients acquired from eating brain foods tend to go to the part of your body where it is greatly needed and only sometimes where we expect them to be. Hence, it is preferable to include brain foods in a healthy lifestyle. Concerning coffee, it does not necessarily affect one's memory or memory capacity. Instead, it only serves as a vitality booster when reviewing, which helps activate one's mind (Rosales et al., 2023). Contrarily, research published by Nature Neuroscience said that caffeine amplifies memories in no less than 1440 minutes after consumption (Borota et al., 2014).

Uncommon remembering practices

Timmy and Alex also shared some remembering practices in mathematics that might sound different from most people. For Timmy, it is chewing gum while studying and taking tests.

"Gakaon kog bubblegum kung magstudy ko and I do the same kung naa mi exams in math. Because it helps me para dili makulbaan and to keep in mind kung unsa akong gistudyhan."

According to the study conducted by Mefoh, Mbanefo, Ezeh, and Ugwueze (2016), it is feasible that chewing gum enhances the learner's capability to recall knowledge. Thus, they earnestly suggest that teachers should not discourage the consumption of gums inside the class. On the other hand, Alex tends to clench her fist to retrieve what she has learned when she fails to remember it.

"Then in times nga mamental block kos exam sa math, kay gakumuton nako akong kamot for like pila ka seconds nya ginhawag lalom. After that maremember ra dayon nako akong nalimtan."

In particular circumstances, it is said that clenching the right-hand shapes a stronger memory of an experience. At the same time, clenching the left-hand helps a person remember the memory soon after (Propper, 2013).

6. CONCLUSION AND RECOMMENDATION

From the findings, students' mathematical retention is an upshot of their initiatives toward learning mathematics, including the pedagogical support they receive. Consequently, this calls for considering appropriate retention strategies in the teaching and learning processes to facilitate successful mathematical retention. In essence, the study contrasts the idea that skills in mathematics are sufficient. Being able to retain mathematical knowledge demands students to create a master plan.

With the findings and drawn conclusions, researchers propose the following recommendations:

1. Students may learn how to implement self-regulated learning and reckon studying in a non-distracting environment to augment their retention in math.
2. Students may merge themselves in the proper utilization of strategies that will boost their mathematical retention. This may include listening to math-related songs, jotting and reviewing notes, associating math lessons with real-life experiences, peer-teaching, and purposeful doodling.

3. Students will not neglect their health as it threatens their working memory. Thus, they might consider taking enough time to rest and eat healthy nourishments, including brain foods.
4. Teachers may provide support to students to amplify their mathematical retention. It may involve frequently administering quizzes, conducting reviews before introducing new topics, using relevant humor in discussions, and using concrete instructional materials.
5. Future researchers may explore whether there is a relationship between students' mathematical goals and retention (short-term and long-term).

7. REFERENCES

[1] Adhikari, S. P. (2021). Revealing the story of an individual through narrative inquiry: A methodological review. Interdisciplinary Research in Education, 6(1), 71-80.

[2] AIU. (2019). 7 Information Retention Tips for Long-Term Learning. https://www.aiuniv.edu/blog/2019/april/7-information-retention-tips-for-long-term-learning

[3] Andjamba, M. N. L. (2021). Teaching senior secondary school mathematics for retention (Doctoral dissertation, Stellenbosch: Stellenbosch University).

[4] Aranzo, R., Damicog, M., Macahito, C., Reyes, A. Tancio, K., & Luzano, J. (2023). A Case Analysis of the Strategies of Students in Learning Mathematics amidst Academic Disruption. International Journal of Multidisciplinary Approach and Studies, 10(2), 1-15.

[5] Anwer, M., Masood, S., & Sarwar, M. N. (2020). How Do Self-Regulation and Retention in Math Relate with Classroom Learning Environment: Students' Perspective. Pakistan Journal Of Distance And Online Learning, 6(1), 115-127.

[6] Bakar, F., & Mallan, V. (2022). How students perceive the teacher's use of humour and how it enhances learning in the classroom. The European Journal of Humour Research, 10(4), 187-199.

[7] Balagtas, M. U., Garcia, D. C. B., & Ngo, D. C. (2019). Looking through Philippine's K to 12 Curriculum in Mathematics and Science vis-a-vis TIMSS 2015 Assessment Framework. EURASIA Journal of Mathematics, Science and Technology Education, 15(12), em1788.

[8] Barroso, N. C. (2020). Mathematical models in predicting retention of STEM students in pre-calculus. International Journal of Professional Development, Learners and Learning, 1(1), ep2004.

[9] Bell, M. C., Kawadri, N., Simone, P. M., & Wiseheart, M. (2014). Long-term memory, sleep, and the spacing effect. Memory, 22, 276–283. doi:10.1080/09658211.2013.778294

[10] Bonyah, E., Larbi, E., & Owusu, R. (2023). Mathematical Modeling of Forgetfulness and Memorization of Mathematical Concepts. International Journal of Mathematics and Mathematics Education, 31-50.

[11] Borota, D., Murray, E., Keceli, G., Chang, A., Watabe, J. M., Ly, M., ... & Yassa, M. A. (2014). Post-study caffeine administration enhances memory consolidation in humans. Nature neuroscience, 17(2), 201-203.

[12] Britton, J. (2023). Rethinking How We Teach Math: Three Tips for Better Long- term Retention. Retrieved from https://thejournal.com/articles/2023/02/01/rethinking-how-we-teach-math-three-tips-for-better-retention.aspx

[13] Brown, S. (2014). The Doodle Revolution. New York: The Penguin Group.

[14] Cappello, K. (2020). The Impact of Sleep on Learning and Memory. https://www.med.upenn.edu/csi/the-impact-of-sleep-on-learning-and-memory.html

[15] Casanova, E., Octaviano, D., Okit, R., Tactacon, J., Arcaya, J. & Luzano, J. (2023). Enhancing Academic Performance via Web-Based Learning Material Development in Mathematics. International Journal of Arts, Humanities and Management Studies, 9 (5), 1-11.

[16] Cengiz, S., & Eğmir, E. (2022). The Effect of Realistic Mathematics Education on Academic Achievement, Motivation and Retention of Fifth Grade Students i. Universal Journal of Educational Research, 10(3), 225-239.

[17] Chetty, R., Friedman, J. N., & Rockoff, J. E. (2014). Measuring the impacts of teachers I: Evaluating bias in teacher value-added estimates. American economic review, 104(9), 2593-2632.

[18] Clandinin, D. J., & Connelly, F. M. (2004). Narrative inquiry: Experience and story in qualitative research. John Wiley & Sons.

[19] Clift, L. D. (2015). The effects of student self-assessment with goal setting on fourth grade mathematics students: Creating self-regulating agents of learning. Liberty University.

[20] Creswell, J. W., & Poth, C. N. (2016). Qualitative inquiry and research design: Choosing among five approaches. Sage publications.

[21] Congressional Policy and Budget Research Department. (2024). FF2024-11: Philippines' Performance In The 2018 And 2022 Pisa. Retrieved from https://cpbrd.congress.gov.ph/2012-06-30-13-06-51/2012-06-30-1336-50/1715-ff2024-11-philippines-performance-in-the-2018-and-2022-Pisa.

[22] Edwards, C. M., Rule, A. C., & Boody, R. M. (2017). Middle school students' mathematics knowledge retention: Online or face-to-face environments. Journal of Educational Technology & Society, 20(4), 1-10.

[23] Fauzi, A., & Widjajanti, D. B. (2018). Self-regulated learning: the effect on student's mathematics achievement. In Journal of Physics: Conference Series 1097(1), 012139.

[24] Gupta, U., & Zheng, R. Z. (2020). Cognitive Load in Solving Mathematics Problems: Validating the Role of Motivation and the Interaction among Prior Knowledge, Worked Examples, and Task Difficulty. European Journal of STEM Education, 5(1), 5.

[25] Hansen, J. (2022). Peer Learning: Overview, Benefits, and Models. https://www.wgu.edu/blog/peer-learning2208.html

[26] Ibañez, F. (2021). Study Reveals the Advantages of Taking Notes by Hand. https://observatory.tec.mx/edu-news/study-reveals-the-advantages-of-taking-notes-by-hand/

[27] Koenig, G. (2007). Orchard Software and the NCTM principles and standards for school mathematics. Reston: Siboney Learning Group.

[28] Kubala, J. (2021). 15 Brain Foods for Studying and Memory. https://greatist.com/eat/brain-food-for-studying#food-for-concentration

[29] Lee, K., & Bull, R. (2016). Developmental changes in working memory, updating, and math achievement. Journal of Educational Psychology, 108(6), 869.

[30] Luzano, J. F. (2020). Development and Validation of Strategic Intervention Materials (SIMs) of the Selected Topics in Trigonometry of Precalculus Discipline in Senior High School. Journal of Mathematics and Statistics Studies, 1(2), 26–37.

[31] Luzano, J. & Ubalde, M. (2023). Notable Accounts of the Professional Practice of Tertiary Mathematics Teachers in the Philippines. Science International (Lahore), 35(2), 129-133.

[32] Luzano, J. (2023). The Interplay of Conceptual Understanding and Problem-Solving Competence in Mathematics. International Journal of Multidisciplinary Approach and Studies, 10(2), 89-97.

[33] Luzano, J. (2023). An ADDIE Model Analysis on the Engineering of Contextualized Intervention Materials (CIMs) and Students' Achievement in Mathematics. International Journal of Multidisciplinary Approach and Studies, 10 (6), 25-47.

[34] Luzano, J. (2023). Revolutionizing Calculus Education on Flexible Learning: A Tale of Students in a State University. International Journal of Arts, Humanities and Management Studies, 9(11), 30-37.

[35] Luzano, J. (2024). Assessment in Mathematics Education in the Sphere of Artificial Intelligence: A Systematic Review on Its Threats and Opportunities. International Journal of Academic Multidisciplinary Research, 8(2), 100-104.

[36] Luzano, J. (2024). Robustness of Quantitative Research Methods in Mathematics Education. International Journal of Academic and Applied Research, 8(3), 55-58.

[37] Luzano, J. (2024). Exploring Gender-Inclusive Pedagogical Strategies in Mathematics. International Journal of Academic Pedagogical Research, 8(3), 39-42.

[38] Luzano, J. (2024). Dichotomies of Mathematics Classroom Discourses in Higher Education: A Systematic Review. International Journal of Academic Multidisciplinary Research, 8(3), 84-87.

[39] Luzano, J. (2024). A Scoping Review of the Professional Practices and Standards in Mathematics in Higher Education. Journal of Harbin Engineering University, 45(3), 1 – 6.

[40] Luzano, J., Binayao, B., & Peligrino, M. (2024). Empowering Child Development Workers in Classroom Management and Pedagogy Extension Project: An Impact Study. International Journal of Academic Multidisciplinary Research, 8(4), 256-263.

[41] Luzano, J. (2024). Strategic Foresight in Mathematics Education: A Post-COVID Integrative Assessment. International Journal of Academic and Applied Research, 8(4), 138-144.

[42] Luzano, J. (2024). An Integrative Review of AI-Powered STEM Education. International Journal of Academic Pedagogical Research, 8(4), 113-118.

[43] Luzano, J. (2024). Pedagogical Influence of an AI Chatbot Gemini in Mathematics Education. International Journal of Academic Pedagogical Research, 8(4), 107-112.

[44] Luzano, J. (2024). Transformational Learning Experiences on Productive-Failure Approach in Mathematics. International Journal of Academic Pedagogical Research, 8(4), 54-58.

[45] Luzano, J. (2024). Success Initiatives of Mathematics Educators as Inspired by Taylor Swift's Commencement Address at New York University. International Journal of Academic Multidisciplinary Research, 8(4), 14-20.

[46] Luzano, J. (2024). Physical and Psychological Well-being of Higher Education Students in Mathematics Context. International Journal of Academic Multidisciplinary Research, 8(4), 10-13.

[47] Lyle, K. B., Bego, C. R., Hopkins, R. F., Hieb, J. L., & Ralston, P. A. (2020). How the amount and spacing of retrieval practice affect the short-and long-term retention of mathematics knowledge. Educational Psychology Review, 32, 277-295.

[48] Masters, K. (2013). Edgar Dale's Pyramid of Learning in medical education: A literature review. Medical teacher, 35(11), e1584-e1593.

[49] Mazza, S., Gerbier, E., Gustin, M. P., Kasikci, Z., Koenig, O., Toppino, T. C., & Magnin, M. (2016). Relearn faster and retain longer: Along with practice, sleep makes perfect. Psychological science, 27(10), 1321-1330.

[50] Mefoh, Philip & Mbanefo, Ifunanya & Ezeh, Micheal & Ugwueze, Stella. (2016). Chewing gum and gender differences on recall memory. European Journal of Scientific Research. 139. 96 - 103.

[51] Nallada, J., Hulagpos, D., Damasco, J., & Luzano, J. (2024). Unveiling the Power of Educational Mathematics Applications as Formative Assessment Tools: A Multiple Case Study. International Journal of Research in STEM Education, 6(1), 15–35. https://doi.org/10.33830/ijrse.v6i1.1657

[52] Noreen, S., & de Fockert, J. W. (2017). The role of cognitive load in intentional forgetting using the think/no-think task. Experimental Psychology, 64(1), 14.

[53] Özçakmak, H., & Sarigöz, O. (2019). Evaluation of Turkish Teacher Candidates' Perception of Note Taking Concept. Educational Research and Reviews, 14(3), 78-86.

[54] Pang-an, A., Arceno, J., Tantog, A. Alayon, M., & Luzano, J. (2022). Learning Experiences of College Students in Mathematics in the Modern World during Synchronous Classes. International Journal of Academic Multidisciplinary Research, 6(10), 89-97.

[55] Pillado, I. A. (2020). Factors on Memory Retention: Effect to Students' Academic Performance in Mathematics (Doctoral dissertation, Foundation University).

[56] Popov, V., Marevic, I., Rummel, J., & Reder, L. M. (2019). Forgetting is a feature, not a bug: Intentionally forgetting some things helps us remember others by freeing up working memory resources. Psychological Science, 30(9), 1303-1317.

[57] Propper, R. E., McGraw, S. E., Brunye, T. T., & Weiss, M. (2013). Getting a grip on memory: Unilateral hand clenching alters episodic recall. PloS one, 8(4), e62474.

[58] Riessman, C. K. (2008). Narrative methods for the human sciences. Sage.

[59] Romorosa, Q., Dahe, K., Colanggo, M., Resabal, D., Anlicao, R., Boquia, R., Acot, C., Luzano, J. (2023). Improving Students' Achievement of Learning Competencies in Mathematics through Micro-Lecture via ED Puzzle. International Journal of Multidisciplinary Approach and Studies, 10(4), 120-133.

[60] Rosales, D. M., Alonzo, J. A., Bagasbas, J. G., Bonga, J. J., Buenaventura, E., Dirain, F. I., Glinoga, E.M. , & Sigue, J. M. (2023). The Effects of Coffee Intake on the Memory Retention of Centro Escolar University College Students Taking General Zoology. https://www.researchgate.net/publication/371606468

[61] Rowland, C. A. (2014). The effect of testing versus restudy on retention: a meta-analytic review of the testing effect. Psychological bulletin, 140(6), 1432.

[62] Schmidt, S. J. (2020). Distracted learning: Big problem and golden opportunity. Journal of Food Science Education, 19(4), 278-291.

[63] Stigmar, M. (2016). Peer-to-peer teaching in higher education: A critical literature review. Mentoring & Tutoring: partnership in learning, 24(2), 124-136.

[64] Sridhar, G. (2020). Here's How Students Can Improve Their Concentration and Retention Power. https://highereducationdigest.com/heres-how-students-can-improve-their-concentration-and-retention-power/

[65] Soderstrom, N. C., & Bjork, R. A. (2015). Learning versus performance: An integrative review. Perspectives on Psychological Science, 10(2), 176-199.

[66] Tinsley, G. (2020). The Top 9 Brain Foods for Studying and Exams. https://www.healthline.com/nutrition/brain-food-for-studying

[67] Tortola, R. (2021). Is Mother Tongue Based Worth Continuing? A Policy Brief. International Journal of Multidisciplinary Approach and Studies, Volume: 8, Sep-Oct 2021(No: 5), 1–10.

[68] Tortola, R. (2021). Voices of Teachers in Teaching Mathematics using Mother Tongue-Based Multilingual Education. International Journal of Multidisciplinary Approach and Studies, 4. https://doi.org/10.13140/RG.2.2.10949.01769

[69] Trinick, R., Ledger, G., Major, K., & Perger, P. (2016). More than counting beats: Connecting music and mathematics in the primary classroom. International Journal for Mathematics Teaching and Learning, 17(3).

[70] Valderama, J., & Oligo, J. (2021). Learning Retention in Mathematics over Consecutive Weeks: Impact of Motivated Forgetting. International Journal of Evaluation and Research in Education, 10(4), 1245-1254.

[71] Walker, M. (2017). Why We Sleep: Unlocking the Power of Sleep and Dreams. Scribner.

[72] Walsh, J. D., & Coleman, B. K. (2023). Using Music to Teach Math in Middle School. South Carolina Association for Middle Level Education Journal, 2(1), 144-151.

[73] Zeyab, A. J. (2017). Educational technology and visual literacy: the effect of using doodling on student learning performance. University of Northern Colorado.