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Self-Regulated Learning and Students' Authentic Engagement: A Panacea for Enhancing Students' Retention in Mathematics

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Abstract

Self-regulated learning strategies enables students to determine factors that affect their learning, and effectively choose or adopt strategies that increases their retention level in mathematics. Self-regulated learning brings about students' authentic engagement which facilitates deeper understanding of abstract mathematical concepts and optimal performance. The study focused on self-regulated learning and authentic engagement as sure way to enhance students' retention in mathematics. It provided solid background on how self-regulated learning cycle enhances students' retention, how to reduce the teacher talk time, the characteristics of mathematics learners and levels of authentic engagement. Based on the relevance of self-regulated learning and authentic engagement of students, it was concluded that mathematics teachers as a necessity need to motivate students' to self-regulate their learning by providing them with an engaged classroom that increases retention. Hence school management and authorities should provide and create an engaged learning environment. Also, there should be teacher, student and content interaction to facilitate retention and optimal performance of students in mathematics.

Keywords: Mathematics, Self-regulated Learning, Authentic Engagement, and Retention

Introduction

The most perplexing difficulties facing mathematics education researcher is the complex interaction of variables impacting student learning, engagement, achievement and retention. It is therefore necessary to develop systems of teaching and learning that accelerate the growth of mathematical understanding, retention and students' subsequent ability to use mathematics in science, engineering, business, and other applied contexts. But this cannot be achieved without a properly engaging the students and improving students' self-regulation abilities. Thus, this study aimed to discuss the place of self-regulated learning and students' authentic engagement on the improvement students' retention in mathematics'**.** Mathematics is fundamental to people's way of life and knowing how the world operates and functions. This is because mathematics is all around us, and having a solid knowledge of mathematics is vitally indispensable and extremely priceless for all students, as it enables learners to navigate the world, and answer complicated real-life problems. Ugwuanyi, Nnolum, Nwachukwu and Inweregbuh (2019) opined that mathematics is a broad subject that touches every facet of modern society. If not for mathematical knowledge most modern civilization and breakthroughs in science, technology, engineering, accounting and computing would have been absolutely impossible and unrealistic (Ugwuanyi, Nwachukwu & Odo, 2020). This is to say that mathematics is a crucial and essential tool for the scientific and technological development. Mathematics is the pillar of almost every field of the academic enterprise.

Despite the importance attached to mathematics, students continue to underperform in this subject. Reports on students' academic achievement in mathematics depicts a very unsatisfactory situation. Ugwuanyi (2015) reported a disheartening high failure rate in mathematics at pre-tertiary schools. The West African Examination Council Report also revealed a very poor achievement in mathematics among

secondary school students. The percentage of students who got A1-C6 in mathematics includes; 24.38% (2016), 20.09% (2017) and 30.63% (2018) with little improvements in recent years (Metu, Ugwuanyi, Nwoye, Odo & Nwachukwu, 2023). Mathematics educators, examination bodies and many prior researchers attributed students' poor performance in mathematics to different factors to include; maladaptive behaviours among students' such as phobia, depression, misconceptions and anxiety towards word problems and mathematics. Teachers and classroom variables such as classroom practices, classroom management, professional development, pedagogical content knowledge, teachers' qualification and teachers' experience. This poor performance could be caused by series of factors such as students' self-concept, self-awareness and self-motivation, psychological constructs of mathematics learners, as we as students level of retention (Ugwuanyi,2015; Valderama & Oligo, 2021; Metu, Ugwuanyi, Nwoye, Odo & Nwachukwu, 2023). This article focuses on how self-regulated learning and authentic engagement could enhance students' retention in mathematics which in turn improves their academic performance. It will be discussed under the following sub-heading: the concept of retention, self-regulated learning, elements of self-regulations, self-regulated learning cycle. The study will also explore the concept of authentic engagement, purpose of engagement and the various characteristic of mathematics learners that must be considered during mathematics lessons in other to increase students' retention rate.

Retention is the ability to retain information in mind. It is the preservation of the after effects of experience and learning that makes recall or recognition possible. In mathematics teaching and learning, retention plays a vital role for a learner to successfully learn the concepts taught inside or outside the classroom. Choosing a teaching strategy that result in knowledge retention on the part of learners can be challenging for educators (Huitt, 2018). Retention is the cognitive information processing of the learner which involves understanding, information processing, and storing within memory. Students remember what they have learned, whereas transfer requires students not only to remember but also to gain a conceptual understanding and be able to use what they have learned (Valderama & Oligo, 2021).

Retention of mathematical ideas is the capability and capacity of students to retain and retrieve already learnt information and patterns. For a student to retain or hold back something, the student must have good memory where what he has learnt can be stored and hence retrieved when the need arises (Ugwuanyi, 2015). This process relates to the main stages in information and retrieval of memory from information processing perspectives which are: Encoding (processing and combination of retrieved information), Storage (creation of a permanent record of encoded information), Retrieval (calling back the stored information in response to some).

From the fore going, retention can be seen as the ability to absorb, hold or keep in memory what has been learned and hence remember or utilize the already acquired knowledge or skills over an extended period of time. In mathematics teaching and learning, the ability to remember mathematical concepts takes place more effectively when the concepts are presented to the students through an appropriate instructional method. The techniques that can aid retention should be sought by teachers and educators so as to improve the retentive ability of the students. These may include the following among others. Use of meaningful and organized materials, over-learning and use of mnemonics such as SOHCAHTOA (Ugwuanyi, 2015). Also, students' participation, active involvement, classroom collaboration, authentic engagement and self-regulations may affects their retention and performance in mathematics.

Self-regulated Learning and Students' Retention

Self-regulated learning (SRL) is the process whereby learners monitor and regulate their internal abilities and responses against internal and external environments situations using self-awareness and self-reflection. Self-regulation is defined as "the degree to which students are meta-cognitively and motivationally active participate actively in their own learning process'' (Zimmerman, 2008). The definition focuses on students' proactive ability in using specific processes, such as goal setting, strategic planning, and self-monitoring to improve their academic achievement. Self-regulation stresses the importance of self-awareness during a task, monitoring one's progress, and finding new strategies if the original ones did not lead to success. Those students who can regulate their learning are proposed to gain the most out of education and achieve more academically because their actions are motivated by learning rather than external rewards (Dignath & Buttner, 2018).

As students learn to self-regulate, they begin not only to control the way they think but also how to

manipulate their behaviors and environment for the benefit of their learning. Research has found a positive relationship between intervention studies aimed at fostering SRL skills and academic performance in both primary and secondary schools (Dignath & Buttner, 2018). It is an internal process that influences what action or behavior will be taken (Medina, 2011). Student who are self-regulated learners have higher achievement as students significantly improved their mathematics achievement (Medina, 2011). Through the use of self-regulation, students learned to determine factors that affect their learning and effectively choose and adopt strategies that increases their retention level. According to Mutawaha, Thomasa and Khine (2017), self-regulation abilities include goal setting, self-monitoring, self-instruction, and self-reinforcement that can help students create better learning habits which in turns strengthen their achievement. To maximize the efficiency of self-regulation, students may choose among a variety of self-regulation strategies. Self-regulation strategies are techniques aimed at obtaining knowledge and skills. Commonly used academic self-regulation strategies have been identified as organizing information; goal-setting and planning; looking for information; providing self-monitoring, self-evaluation, asking for help from a peer, teacher, or adult; rearranging the physical environment; and reviewing tests, notes, and texts. This helps to improve students' retention of abstract mathematical concepts.

Following the social cognitive perspective, self-regulation strategies fall into three categories: personal, behavioral and environmental. Personal strategies consist of how the student manages information. This can include the student taking notes, summarizing, making chapter outlines, and monitoring themselves. The student may also set up goals and plan how they are going to accomplish them. Behavioral strategies consist of what behaviors or actions the student is going to take. For example, if a student determines that a factor that is affecting their learning is not paying attention in class, they may take on a behavioral strategy such as being more attentive. Finally, environmental strategies include the student seeking help or making adjustments to his or her physical study environment (Medina, 2011). Learners potentially control, arrange, organize, and judge their own cognition, motivation, and behaviours with regard to potential for control assumption (Mutawaha, Thomasa & Khineb, 2017). Researchers have found that student mathematics achievement has a positive correlation to self-regulated learning (Clearly, Platten, & Nelson, 2008; Dignath & Buettner, 2008). Also Medina (2011) found self-regulated learning to be a tool to improve students' mathematics achievement. Asanee (2013) model showed that self-regulated learning and achievement have a common antecedent which may include emotional intelligence and other psychological constructs. In addition, another opinion put forward by Gunzenhauser & Saalbach (2020) stated that self-regulation in the mathematics domain contributed greatly to retention mathematics performance. Self-regulated learning positively correlate influences students' academic achievement and retention of contents (Vrugt & Oort, 2008; Okun, Fairholme, Karoly, Ruehlman, & Newton, 2006). The need for self-regulation is apparent in mathematics as it significantly affects students' mathematics achievement (Becker, McClelland, Loprinzi, & Trost, 2014).

Elements of Self-Regulated Learning

These are the various medium through which students can regulate their own learning process thereby increasing their retention levels. Acoording to Basack (2014) the following strategies are elements of self-regulated learning: rehearsal, elaboration, organization, critical thinking, and metacognitive self-regulation.

- Rehearsal: Rehearsal strategy focuses on basic memorization of factual information by overt and covert practice. It involves copying, underlining, reciting, and listing the major parts of the material at hand for the selection and acquisition of the information. This strategy is mainly used to store information in working memory rather than in the long term memory as learners are expected to select important parts of the material and transfer them into their working memory.
- Elaboration: Elaboration strategy builds a relationship between new and old information to provide integration of new knowledge to the current one that is why it enhances to store information in the long term memory. It is a cognitive learning strategy that includes paraphrasing, summarizing, describing the information, creating analogies, and generative note taking in order to integrate the current knowledge with the previous one. This strategy is mainly used to store the information in the long term memory.
- Organization: Organization strategy requires structuring the knowledge to provide

assimilation of new information by overt and covert rearrangement of learning materials so that individuals might decide information that are relevant through outlining, sequencing, clustering, and reordering, and selecting the main ideas in a given material providing individuals to select and structure the relevant knowledge to be learned (Basack, 2014).

- Critical thinking: Critical thinking as a cognitive learning strategy is about the application of knowledge in a novel condition to solve problems and make criticisms
- Metacognition: Metacognitive strategy use refers the methods for students to manage their behaviour and affect. There are three important components of metacognitive strategies: monitoring, planning, and regulation. Monitoring is a kind of implementation of self-judgment providing to determine whether the material is understood or not via self-checking or questioning. Planning refers a comprehensive preparation for the accomplishment, activating the previous knowledge, which facilitates comprehension and organization of the material through goal setting, task analysis, and time management. Lastly, regulation attempts altering one's mistakes on a given task as a kind of assistance leading the improvement of the learner

Self-regulated Learning Cycle that Enhances Retention

Self-regulation is concerned as an interaction between personal, behavioural, and environmental triadic processes. The link between personal, behavioural and environmental factors implies the cyclical structure of self-regulation. Hence mathematics teachers may employ this continuous cycle to change their students' strategies, cognitions, and behaviours (Basack, 2014). Of the three factors, self-regulated learning is previewed as personal influences involving self-efficacy perceptions of individuals depending on their knowledge, metacognitive processes, goals, and affect. Performance-related influences are consisted of self-observation, self-judgment and self-reaction to provide strategic adjustments for performances. Environmental influences includes enactive outcomes, modelling and verbal persuasion to observe and adjust to environmental conditions and outcomes (Basack, 2014). The cyclical nature of self-regulation phases and sub-processes is explained in a three-phase self-regulation model.

Self-regulated learners are viewed as active participants according to constructive assumption. That is they are active on the learning process metacognitively, motivationally, and behaviourally with the help of directing their efforts to gain knowledge and skills instead of being passive receivers of information from their parents, teachers, or others (Zimmerman, 2008). In addition, learners potentially control, arrange, organize, and judge their own cognition, motivation, and behaviours with regard to potential for control assumption. It is also notified that there is a criterion or standard among all regulation models in relation to criterion or standard to be able to make comparisons providing to see the extent of the progress Mutawaha, Thomasa & Khineb, 2017)

As students learn to self-regulate, they begin to learn not only how to control the way they think but also how to manipulate their behaviors and environment for the benefit of their learning and retention of learnt materials. In view of this, mathematics teachers, school administrators and parents have a significant role in boosting and improving students' academic performance and learning ability. This can be accomplished by consistently and authentically engaging the learners during instructional delivery of mathematics lessons. Self-regulation has been shown to be important for academic achievement (Zimmerman 2008; Medina, 2011). In mathematics specifically, self-regulation has been linked with academic performance since it impacts actual study processes. The use of self-regulation results in an improved performance. Experimental studies have proven the strong link between the capacity to self-regulate one's learning and retention (Zimmerman and Kitsantas 2015).

Authentic Engagement and Mathematics Students' Retention

Generally speaking, the concept of student engagement is predicated on the belief that learning improves when students are inquisitive, interested, or inspired, and that learning tends to suffer when students are bored, dispassionate, disaffected, or otherwise 'disengaged. In education, student engagement refers to the degree of attention, curiosity, interest, optimism, and passion that students show when they are learning or being taught, which extends to the level of motivation they have to learn and progress in their education. Learning engagement is a multi-dimensional construct influenced by both individual and institutional

characteristics. In other words, engagement is a function of both a student's intrinsic desire and the extrinsic opportunities provided by the teacher and school management to engage learners with the course content (Akanimoh, 2023). Engagement is defined as active involvement in learning that is relevant, valuable, and interesting that brings about equality and liberation for all students. Engagement becomes authentic when every students' are immersed in work/activities with personal meaning and discussing a topic of personal interest. Student authentic engagement may be the most important component of the framework for teaching, and engaging students is the job of every effective classroom mathematics teacher. In general, authentic engagement reduces the teacher talk time and gives more room for students' interaction. Mathematics teachers must seek to direct, influence, instruct, guide, motivate and initiate learning. Authentic engagement is anchored on the Moore's model of engagement in 1989. The model explains the interaction between the classroom teacher, mathematics learners and subject matter content. It is very useful and effective in enhancing students' retention and thus became a universal design for learning (UDL). Moore's explained the essential nature of the interaction between student, teacher, and content which is paramount in building and developing students' optimal performance.

The Purpose of Authentic Learning Engagement

This relate to the why, what, how and who of engagement and was summarized according to Akanimoh (2023) to include the following

- To stimulate motivation and sustain enthusiasm for learning by promoting various ways of engaging students with content
- To monitor students' understanding
- To present information and mathematics content in a variety of ways to support understanding by students with different learning styles and abilities.
- To uncover commons misunderstandings or misconceptions
- To facilitate deeper processing of the content and improvement of performance of individuals and the school optimal performance.
- To offer options for students to demonstrate their learning in various ways

Levels of Authentic Engagement

Student engagement in the classroom falls within three categories: behavioral, cognitive, and affective. These three level are distinct, interrelated and effective in increasing students' retentive ability and their complete interaction is what make it authentic

- Cognitive engagement: This connotes investment aimed at comprehending complex concepts and issues and acquiring difficult skills. It conveys deep (rather than surface-level) processing of information whereby students gain a critical or higher-order understanding of the subject matter and solve challenging problems. Cognitively engaged students often go beyond the requirements because they enjoy being challenged self-regulates, plans, monitors, and evaluates one's thinking and learning (Akanimoh, 2023).
- Affective engagement: This is sometimes refer to as emotional engagement seek to determine the extent to which students are comfortable talking to peers and also engage in group learning. It include all the experiences, feelings, attitudes, and perceptions a student has towards school, including their sense of belonging, interest, willingness to learn, and general sense of liking school. The greater the student's interest level, enjoyment, positive attitude, the positive value held, curiosity, and a sense of belonging (and the less the anxiety, sadness, stress, and boredom), the greater the affective engagement.
- Behavioral engagement: a student's willingness to follow rules and adhere to cultural norms and involvement in the classroom and with extracurricular activities. It conveys the presence of general "on-task behavior." This entails effort and persistence along with paying attention, asking questions, seeking help that enables one to accomplish the task at hand, and not disrupting instruction. It is the observable act of students being involved in learning in class activities and discussions studies completion of assignments

Characteristics of Mathematics Learners

Mathematics teachers must as a necessity vary their means of engagement, representation,

introduction, organization and assessment for each lesson to cater for the various learning styles. Acording to Fisher, Frey, Quaglia, Smith and Lande (2018), we have different kinds of learners to include:

- Visual learners- a visual learner learns more with his eyes. The eyes are connected to the brain
- Auditory learners- they use their sense of hearing to learn to learn better. The ears are connected to the brain.
- . Tactile learners- they learn more by touching or manipulating objects. Their hands are connected to the brain.
- Verbal learners- they learn more by talking about the topic. Their mouth is connected to their brain
- Kinaesthetic learners- They learn more by moving around. They learn with their legs
- Melodic learners / rhythmic leaners- they learn best through music
- Solitary learners prefer to study alone. Use exercise that encourage individual learning to teach them.
- Sequential learners- they learn in a specific order logically and sequentially. All learners are sequential.
- Indirect experience learners- they learn from the experience of others.
- Natural learners- they learn best when they interact with nature. Make them to learn by conducting outdoor classes.
- Simultaneous learners- they learn the big picture, overall message and how the topics are inter related. They are called global learners.
- Reflective/logical learners-they use their reasoning skills to solve problem and ponder complex issues. The brain is highly developed to reason. Use brainstorming approach to teach this learners.
- Interactive learners- they can only learn in the company of other people. They are called social learners.
- Direct experience learners- they learn by doing it on their own.

Summary

In order to increase the retention level of students, mathematics teachers must as a necessity motivate students to self-regulate their learning by providing then with an engaged classroom. Engaged classrooms don't just happen. They are led by teachers who deeply understand their craft and the essential nature of the interaction between student, teacher, and content. In an engaged classroom there is students' collaboration and meaningful conversation between students and teachers. Everyone is a teacher and a learner as all voices are heard and valued as personalization influences the content. To increase students' retention of mathematical concepts, teacher must adopt series of skill, strategies and resources during the instructional delivery of mathematics lessons such as good introduction and set induction, good body language (movement, eye contact, facial expression), good communication skills (voice clarity, good articulation, modulation for emphasis), project based learning, repetitions and callbacks, listening skills, mnemonics, acronyms, songs, questioning, collaborations, storytelling, illustrations, dramatization, observation, discussion and use of varieties of resources (Fisher, Frey, Quaglia, Smith, Lande, 2018).

Conclusion

Self-regulated and engaged students have a high sense of belonging since the students are recognized and valued. Such students are curious, inquisitive and continually ask question like why, how, and why not until they gain satisfaction. The students are not afraid to fail but possess high confidence to take responsibilities and tackle any given mathematical task. Thus, based on the relevance of self-regulated learning and authentic engagement on students' retention level, it can be stated that: school management and authorities should provide and create an engaged learning environment, mathematics teachers should be encouraged to improvise and procure relevant and useful instructional material that will increase students engagement and retention. Also students' should be directed and instructed on how they can self-regulate learning intrinsically and with ease, there should be teacher, student and content interaction to facilitate optimal performance of students, and the mathematic laboratory or corner should be well equipped with information and communication technologies and resources to encourage collaborative, cooperative and project based learning.

Recommendations

Based on the effectiveness and efficacy of self-regulated learning and authentic engagement of students, the following recommendations were made.

- School management and authorities should as a necessity provide an engaged learning environment
- Mathematics teachers must regularly dramatize and concretize learning contents
- Mathematics teachers should be encouraged to improvise and procure relevant and useful instructional material that will increase students engagement and retention
- Students should be directed and instructed on how they can self-regulate learning intrinsically and with ease
- There should be teacher, student and content interaction to facilitate optimal performance of students.
- Teacher should encourage collaborative, cooperative and project based learning
- Government through the ministry of education should constantly provide in-service training, seminars and workshops on innovative teaching methods and strategies for every mathematics teachers.

Conflict of Interest

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