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The Key Connection Between the Elements of Self-Regulated Learning (SRL) and Mathematics Performance: Literature Review

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Abstract

This conceptual paper is based on the review of literature on Self-Regulated Learning (SRL), its elements and link to performance in Mathematics. Over the past decades, SRL has been studied extensively. According to empirical investigations, Self-efficacy, Motivation, and Metacognition have been linked to a student's achievement. In this paper, a conceptual review on the elements of SRL is offered. It also discusses whether there is a link between the elements of SRL such as Self-efficacy, Motivation, and Metacognition with the performance of Mathematics among secondary students. According to researchers and many educators, the capacity for SRL is essential for academic achievement. It is described as a multifaceted, dynamic process that combines cognitive, motivational, and emotional components. A growing amount of evidence supports the idea that cognitive self-regulation can be taught and that students who employ these abilities tend to do better in the subject area in which they are used. As a result, researchers have started to focus on understanding the elements of SRL. In this paper, the theories will first be highlighted. This will be followed by explanations on emotions and self-efficacy in SRL and then the motivation in SRL will be explicated. The study will address metacognition in SRL and then it will demonstrate on SRL and performance. Additionally, SRL will provide the information on the significance of the study after the discussion.

Keywords: Self-Regulated Learning, Self-Efficacy, Metacognition, Motivation, Performance

1. Introduction

According to many researchers and educators, Self-Regulated Learning (SRL) is essential for academic performance. Secondary-level students are adolescents, who need to master their SRL to develop intrinsic motivation which is significant in performing well in mathematics. Rendering to reports, the qualities needed to function in the 21st century include higher order thinking and problem-solving capabilities (Ansari et al, 2021). The primary goal of education is to promote learning. Students are educated and provided with a variety of abilities

via learning. One crucial subject to learn is mathematics, which teaches and accustoms pupils to be logical, critical, methodical, effective, and efficient in problem-solving (Rohman et al., 2020).

This conceptual paper aims to give a review on the elements of SRL. It also examines on whether or not there is a link between the elements of SRL such as self-efficacy, motivation, and metacognition with the performance of mathematics, especially among secondary students. Learning is considered a complex interactive process which includes both cognitive, motivation and emotions, which are also the key elements of SRL. Secondary students go through distinct stages of cognitive and mental development than elementary children since they have transitioned into adolescence and can already think critically and abstractly (Kesuma et al., 2021).

A growing amount of evidence supports the idea that cognitive self-regulation can be taught and that students who employ these abilities do better in the subject area in which they are used. As a result, researchers have started to focus on understanding the elements of SRL. In this paper, a conceptual review on the elements of SRL is offered. First, this paper will discuss the theories of SRL. Secondly, emotions and self-efficacy in SRL will be described. Third, the motivational element in SRL will be explicated. Following on, it will address the metacognition in SRL which is vital for secondary level mathematics. All these will demonstrate SRL and its relation to performance. This paper will then discuss the findings and present the significance of this study.

Student Centred Learning is an active form of learning with an atmosphere of high learning activities. One of the characteristics of student-centered learning is shown by the self-regulation of learning (Khairuddin et al., 2020). ~~Self-Regulated Learning~~ (SRL) is one of the major factors determining students' achievements in mathematics (Rohman et al.). The practice of controlling one's thoughts, behaviours, and environment while learning or pursuing goals is known as SRL (Zimmerman as cited Cleary, 2020). The self-directed learning process, or SRL, is how a student transforms their mental faculties into academic information. Self-regulated learners control their behaviour toward goals of getting information, enhancing their expertise and self-improvement of their knowledge, set their learning goals and monitor their learning progress (Channer & Raza, 2021). Skills for problem solving, reasoning and comprehension of complicated concepts all depend on SRL (Gabriel et al., 2020).

The students' capacity to monitor and control their learning, particularly while studying and engaging with Science, Technology, Engineering, and Mathematics (STEM) subjects is significantly influenced by their emotions, motives, and metacognition (Gabriel et al., 2020). Some SRL models emphasise the function of metacognition more than others, even though the majority of SRL models claim that motivation, metacognition, and cognition are connected and promote SRL in an interactive way. As a result, SRL is viewed as a very steady competency with discrete components (Ulrich et al., 2021).

From empirical studies, experiments, training studies and meta-analysis, it has been demonstrated that SRL is favourably related to motivation, accomplishment, and learning behaviour. Despite evidence that SRL can improve performance, it is still unclear how instructors may improve SRL more effectively and what aspects of SRL are related to great performance and to what extent (Dignath and Veenman, 2021). To illustrate this, students who are motivated to study more and employ more adaptable learning strategies tend to attain higher levels of accomplishment. Motivation may be aided and enhanced more easily than intellect, which is frequently thought of as constant or unaffected by education (Callan et al., 2021).

2. Theories of SRL

According to theory, SRL is a process that involves learners actively setting their own objectives and using learning methods to control, assess and plan in terms of many factors, such as cognitive or metacognitive, motivational and behavioural, in order to achieve the desired outcomes. Bandura claimed that because SRL is self-directed, it partially depends on the accuracy, consistency, and temporal proximity of self-monitoring, which necessitates acting as a consistent driver (Lim & Yeo, 2021).

Developing responsibility and accountability for most students at this level, learning to take responsibility and participating in self-study is new and challenging. It may be claimed that pupils need to acquire self-regulated

behaviours. The theory of self-regulation, which is founded on social cognitive theory, contends that self-influence, which involves keeping an eye on one's own behaviour, its causes and its effects, regulates human behaviour. This necessitates the assessment of one's behaviour in connection to their goals and the environment and subsequent behaviour modification (Lyakhova et al., 2022).

3. Emotion and Self-efficacy in SRL

To help kids learn effectively, SRL techniques are employed. Rehearsal, organisation, time management, peer learning and effort restriction are some of these techniques. In order to achieve a goal, a person must be able to monitor, regulate, and manage their own behaviour, emotions and thoughts (Anthonysamy et al., 2021). When students are able to use self-regulation techniques, such as self-evaluation, organising and modifying instructional materials to enhance learning, goal-setting and planning, keeping track of progress, practicing and memorization, as well as asking for social help from peers, teachers, and adults, learning becomes more effective. While relying on adults may be inevitable, older students' rising self-efficacy is related with turning to peers for assistance rather than to instructors or parents (Lyakhova et al., 2021).

Self-efficacy is the belief in one's ability to execute specific activities at a particular degree of performance. This trait is acknowledged as a reliable mediator of relationships between environmental, motivational and achievement factors as well as is a powerful predictor of academic performance. Children who perceive their teachers as emotionally supportive and attentive to their needs are likely to exhibit more adaptive motivational beliefs in school, which include self-efficacy and curiosity, as well as higher levels of overall effort (Cleary et al., 2020). Additionally, when students feel strongly connected to their school, they are more likely to exhibit better levels of performance, engagement, positive feelings, and self-efficacy (Cleary et al., 2020). In a 9-week intervention with mathematics students in grade 4-6, it was found that there are positive effects from the use of rubrics in self-assessment and peer assessment on the students' self-efficacy and SRL behaviour (Granberg et al., 2021). Students who have strong levels of self-efficacy, self-attribution, and intrinsic task interest are motivated in SRL (Rohman et al., 2020).

Students' ability to effectively control their own learning and motivation both depend on their emotional state. While anxiety is linked to avoidance motivation and produces superficial learning tactics, unpleasant emotions like anxiety can give students the tools they need to manage their focus and dedication towards accomplishing their learning goals (Gabriel et al., 2020). Students must therefore be able to control their emotions if they are to remain focused on finding a solution, be persistent, and create the methods they need to succeed. Self-efficacy moderated the relationship between SRL and Math Anxiety, and it was found that less effective SRL decreased students' self-efficacy, and lead to increased levels of Math Anxiety (Gabriel et al., 2020).

4. Motivation in SRL

A student's motivation is what propels them to finish a task. Students require motivation to monitor their actions and accomplish learning objectives. Additionally, motivation serves as a psychological aid that contributes towards pupils' learning processes. Students who experience motivational issues may leave a learning environment more quickly (Anthonysamy et al., 2021). Self-regulated learners are able to control their behaviour while learning because they have the motivation and capacity to reflect on what, how, and why they are learning (Alten et al., 2020). Motivation is the mechanism through which people start and maintain behaviours including effort, persistence, and choice. Typical motivational beliefs include self-efficacy, goal-orientation, task values and attitude. These beliefs have an impact on one's behaviour (Cleary et al., 2020).

The use of technology-based approaches for self-efficacy, goal-orientation and task value belief are just a few examples of the motivational and emotional strategies that help students understand and meet their academic goals. With the use of these many strategies, students should be better able at shaping their learning from the perspectives of their personal functioning, academic performance, and the learning environment (Anthonysamy et al., 2021). The level of students' initial motivation may not be adequate to ensure that they follow through and successfully complete the learning assignment if they encounter a difficulty or a challenging environment that causes negative

feelings. Therefore, to remain focused on finding a solution, and continuing to create the strategies they need to succeed, students must be able to control their emotions (Gabriel et al., 2020). Moreover, perceived teacher support and degree of school connection are two crucial contextual factors associated with students' motivation and SRL skills (Cleary et al., 2020).

Learning performance and motivational belief techniques have been linked favourably in previous research. However, additional empirical data is still required to study motivating belief as a significant predictor of students' learning achievement (Anthonysamy et al., 2021). Higher levels of accomplishment are made possible by adaptive motivation because students put in more effort to learn and use adaptable learning techniques (Callan et al., 2021). All three factors of academic motivation; self-efficacy, theories of intelligence, and learning goals have emerged as positive predictors of academic achievement (Feraco et al., 2022).

5. Metacognition in SRL

Zimmerman asserts that the three essential components of SRL are metacognition, motivation, and active behaviour in their learning. Planning, goal-setting, organising, keeping track of oneself and self-evaluation at various stages throughout the acquisition process are all examples of SRL in the context of metacognitive processes. These procedures enable them to approach learning in a self-aware, informed, and aggressive manner (Rohman et al., 2020). Research demonstrates that students lack awareness of cognitive learning strategies, which limits the use of metacognition during self-study since students sometimes do not use the most effective study techniques (Alten et al., 2020).

In the 21st century, the industrial world requires Higher Order Thinking Skills (HOTS) which are required to succeed in mathematics as well. According to Zimmerman, in general, metacognition, motivation, and active behaviour in their learning are the three key components of SRL (Rohman et al., 2020). The SRL for metacognitive processes consists of planning, goal-setting, organising, monitoring, and self-reflection at various stages of the acquisition process. These processes provide individuals with the tools they need to approach learning in a self-aware, knowledgeable, and aggressive manner (Rohman et al., 2020). According to research, students frequently do not employ the best learning practices, which hinders metacognition during self-study (Alten et al., 2020).

A study done in 2019 on Metacognitive Strategy in facilitating students' critical thinking revealed that, teacher-centered learning, plans and arranges learning, and evaluates learning as three processes in the metacognitive method. Additionally, by having pupils interact with the outside world, examining sources and synthesising ideas, the teacher supports their critical thinking development. From this study, the use of metacognitive strategies to promote critical thinking has received a positive response from students. The metacognitive technique can therefore be regarded as one of the more effective methods for promoting pupils' critical thinking (Rosyada, 2019).

Because younger children have less SRL skills, age may also be a factor in this. Additionally, this can be a problem for students using flipped learning since they might not have the necessary cognitive learning techniques and metacognitive abilities to make full use of the greater autonomy (Alten et al., 2020). A quasi-experimental study including 115 eighth-grade students found that SRL support has a favourable effect on learning outcomes, but it was unable to account for the variations in each student's SRL. The study came to the conclusion that SRL support helped pupils learn. However, it must be carefully planned to prevent student dissatisfaction, which might potentially negate any positive learning outcomes (Alten et al., 2020).

Some SRL models place more emphasis on the function of metacognition in the entire SRL process, despite the majority of models claiming that motivation, metacognition, and cognition are all engaged and promote SRL in an interactive way. Beyond theoretical reasoning, it is less obvious whether metacognition is directly related to achievement, and the results are not conclusive (Rivers et al., 2021). One theory discovered a substantial correlation between cognitive strategies and metacognitive processes and academic success. Another research study indicated that the direct correlation between metacognition and achievement is not significant and that the effect of general metacognition on achievement is totally mediated by problem-solving techniques (Rivers et al., 2021).

For maintaining self-awareness of one's own strengths or weaknesses and overall learning development, it is crucial to apply good metacognition skills and tactics including planning, monitoring, and evaluation (Cleary et al., 2020). Knowing what, how, and when to use a certain approach for a given task is known as metacognitive knowledge. Students that are knowledgeable about their own metacognition will be able to apply their knowledge and skills more efficiently during the learning process (Anthonysamy et al., 2021). It has been demonstrated that metacognition is a powerful predictor of academic success, particularly in mathematics (Gabriel et al., 2020). The SRL has practical objectives for themselves, plans their coursework, is knowledgeable about and employs study techniques, and metacognitively aware of the learning process (Feraco et al., 2022).

6. SRL and performance

The ability of a student to retain and transmit information over the long term is referred to as learning performance, which is assessed by means of non-academic outcomes (Anthonysamy et al., 2021). Self-regulated learning is one of the primary factors affecting students' achievement in mathematics (SRL). The effect of SRL on academic performance is favourable. Students with high SRL will also perform well in school (Rohman et al., 2020).

Students use self-regulated learning tools to track their own development, recognise the advantages of the techniques they are employing and become aware of any shortcomings that may exist. Because SRL techniques give students the ability to become aware of their cognitive processes and actively engage in their learning process across all study settings, the success of students' learning in online and mixed environments is vital to SRL approaches (Anthonysamy et al., 2021). It is thought that high achievers typically possess a greater arsenal of SRL techniques when compared with low achievers. Numerous studies present evidence that links the usage of SRL methods by students to academic success. Furthermore, correlational research has demonstrated that particular SRL techniques are followed by metacognition, help-seeking, and study/time management as being favourably associated to accomplishment and GPA. (Kesuma et al, 2021).

In the 21st century, the industrial world needs Higher Order thinking which is fundamental in secondary mathematics as well (Rivers et al., 2021). Higher-order thinking includes problem-solving, critical thinking, reasoning, and decision-making, all of which are essential skills for today's students to have. To prepare students for higher-order thinking, it is vital to develop their capacity for self-regulation as learners and to evaluate their problem-solving techniques (Ansari et al., 2021).

The ability to practice excellent self-regulation is a major difficulty for senior high school students who want to pursue the goal of studying independently for the rest of their lives. It has been demonstrated that self-regulated learning significantly affects high school students. Self-regulated learning and academic success are substantially connected among senior high school pupils. Thus, the ability to control one's learning process and the preparation for exams are related (Kesuma et al., 2021).

7. Discussion

In an era where both parents are occupied with work to earn and provide for the family, children are mainly left to the hands of tuition teachers or shadow education for their learning or to finish their homework. This is since, many parents believe that tuition is the only way to improve and strengthen the learning process of their children. Nevertheless, research shows that kids who depend on tuition do not see benefits in the long run. There are negative consequences of private tutoring such as to pass in an exam, lack of student's attention during classroom lessons, and extra financial burdens for parents (Subedi, 2018). Some other parents leave their children on their own for independent learning, which is basically self-regulated learning. Many researchers have found that SRL helps the kids to strive and succeed more. This is especially for adolescents or secondary level students who are going through significant mental, emotional and psychosocial changes during adolescent phase.

Additionally, secondary-level students need intrinsic motivation when dealing with questions in mathematics which includes logical and critical thinking. Usually, the extrinsic motivation does not help to continue the process

of learning when the external factor which motivated the child to learn comes to an end. Intrinsic motivation keeps the process of learning steady and focused which facilitates in positive performance. Motivation serves as a psychologically helpful tool in the learning process and is one of the SRL components. The motivational element of SRL helps students to think about how, what, why, and when they solve critical thinking-related questions in mathematics, which is mostly difficult for students who depend on others to solve it.

Another significant element of SRL, self-efficacy, is very important to implement among secondary-level students which will make them responsible enough to be aware when, where, how and with whom they must approach to solve issues related to learning. This is especially in mathematics, where students not only need guidance from teachers and parents, but also from their peers. Additionally, research demonstrates that when teachers provide students with emotional support and are attentive to their needs, kids are more likely to achieve at a higher level and have great self-efficacy (Cleary et al., 2020).

In addition, another significant element identified in SRL is metacognition which is vital for a self-regulated learner. As mathematics in secondary level is not only focusing on knowledge and comprehension level, but includes analysis and evaluation as well, metacognition is a very critical element which needs to be developed among adolescents since critical thinking skills are the basis of metacognitive skills too. According to research, metacognition and critical thinking are both related to higher-order thinking. Additionally, kids with SRL are more eager to attempt mathematical problems requiring higher-level thinking skills. However, research indicates that students lack cognitive learning strategy expertise, which hinders metacognition during self-study because students don't always employ the best learning strategies (Alten et al., 2020). Lastly, after studying through numerous researches and papers which is related to SRL and mathematics performance, it is found that there is positive relationship with those who follow SRL and mathematics performance. As SRL includes elements such as self-efficacy, motivation, and metacognition which are vital for secondary mathematics when students need to analyse and evaluate using logic and deep thinking. Students who are able to maintain their motivation continue to achieve high scores in mathematics.

8. Significance

A comprehensive understanding of SRL and its elements is not only important to academic performance of mathematics but to many aspects of learning and pedagogy. Self-regulated learning was stronger among students who took a course online than those attending face-face (Lyakhova et al., 2022). Additionally, it has been demonstrated in both primary and higher education that providing students with video-embedded SRL support during the learning activities prior to class is an effective way to improve students' SRL and learning results (Lyakhova et al., 2022). Although it was discovered that the support for SRL had a good result on learning outcomes, this effect could not be attributed to the SRL disparities amongst students. Although most students had positive opinions of the flipped classroom, some were obviously against SRL training (Alten et al., 2020).

There were differences between male and female students in their SRL in terms of math learning. Every SRL parameter, including metacognition, motivation, and active engagement in class activities, showed that female students did better than male students. One can draw the conclusion that female students perform better than male students on the SRL for learning mathematics (Rohman et al., 2020). According to studies, self-regulated learning and the motivational construct are favourably and strongly connected (Lim & Yeo, 2021). However, because of how important SRL and motivation are to students' academic success, less focus has been placed on how they may affect students' welfare. This influence may be confined to scholastic fulfilment rather than general satisfaction, which merits additional investigation (Feraco et al., 2022).

9. Conclusion

To improve performance, particularly in mathematics, SRL elements can be analysed thoroughly and the link with students' performance can be assessed. Students require self-regulatory knowledge and abilities in order to benefit from the potent affordances of active learning pedagogies (Rakovic et al., 2022). Because schools and teachers lack the time and cognitive resources to implement a comprehensive intervention programme, SRL components

can be incorporated into the current curricula and pedagogical practices instead (Callan et al., 2021). Even though this is a conceptual paper, it is hoped that the findings of the target study provide a gateway to how the elements of SRL impacts the performance in mathematics, especially among secondary students. This in turn provides a significant impact on the authorities and policy makers in education system.

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