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Exploring Effective Methods of Self-Regulated Learning (SRL) for Medical Students

A Review of established SRL models and their impact on the academic life of medical students.

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Abstract

Objective: This paper examine established theoretical models of Self-Regulated Learning (SRL) and their practical applications in medical education. The aim is to understand how SRL affects outcome of medical student’s academic performance and clinical practice. This paper also compare applicable strategies to integrate SRL into medical curriculum to foster independent and lifelong learning.

Method: This paper conducted comparative analysis of well-known SRL models, including Zimmerman's cyclical model (1989) and Hadwin, Järvelä, and Miller's collaborative learning theory (2015). This paper focuses on how to apply theses models to unique medical education environment since medical schools require ability for understanding both theoretical knowledge and its practical application. Furthermore, integration of new technologies such as digital tools in collaborative learning environments is also discussed as a direction for the advancing medical education.

Conclusion: Many researches have investigated effect of self-regulated learning in medical education. Established research claim that using SRL in medical education significantly improves medical students' academic performance and clinical competency. SRL model is used to help students take control of their learning by setting goals, reflecting on progress, and adjusting strategies to meet the challenges of the medical environment. It is also useful in collaborative learning environment. SRL not only enhances individual learning, but also enhance overall teamwork result. Importance has been emphasized, but way of applying has many challenges due to different environmental factors. Further researches have to be done to integrate SRL effectively into medical curriculum to use its full potential.

The integration of SRL into the medical curriculum can be done by using Problem-Based Learning and e-portfolios which encouraged a more active and personalized learning experience. These methods develop critical thinking and problem-solving skills, which are crucial for changing environment of medical students; transition from classroom to clinical settings. However, the successful implementation of SRL is challenging. Many students find it difficult to maintain the self-discipline required to effectively use SRL, because of high-pressure academic settings.

The future of SRL in medical education depends on enhancing technology integration such as using mobile apps, virtual simulations, and adaptive learning platforms to provide personalized feedback and real-time learning adjustments. Furthermore, long-term research has to be followed to better understand how SRL affects both academic success and clinical performance throughout a medical career.

Table of Contents

List of abbreviations

1. SRL : self-regulated learning
2. MSLQ: Motivated Strategies for Learning Questionnaire
3. CME : continuing medical education
4. PBL : Problem-Based Learning
5. ICU : intensive care units
6. OSCE : Objective Structured Clinical Examination
7. VR : Virtual reality

1. Introduction

Understanding self-regulated learning (SRL) is important in educational psychology research. SRL contains cognition, metacognition, emotions, motivations, and behaviors.[1,2]

As the academic world becomes more competitive and complex, students need the ability to manage their own learning. SRL engages learners actively in the learning process. By using SRL, learners set goals and then monitor, regulate, control their cognition, motivation, and behavior.[2,3] With a high level of self-regulated learning ability, the students can facilitate better academic performance and other positive behavioral and attitudinal aspects such as eagerness toward learning, creativity, task engagement.[2]

In the medical field, students struggle to adapt to a new academic environment. Medical training requires a strong grasp of theory, effective communication skills, and practical clinical experience. SRL is crucial for students to effectively manage their learning processes and achieve academic success.[4] Its importance remains even after graduation for ongoing professional development and effective clinical adaptation. SRL requires a supportive environment. It's important to track the current level of SRL and metacognitive awareness of medical students.[3,4]

SRL is about how learners think and learn. Self-awareness is important for students to consider learning strategies, evaluate their results, and improve learning outcomes.[3] SRL models present different approaches to effectively manage learning, each focusing on different aspects of learning's thinking process, motivation, behavior, and emotions.[2,3,4] Although different models vary from one model to another, all SRL models have a common purpose in helping learners actively participate in learning by setting goals, monitoring progress, and adjusting strategies to achieve them. Metacognition plays important role in this process.[4] Students who understand how to learn can assess their learning progress, find areas to improve, and actively utilize strategies to overcome difficulties.[5,6] This self-awareness helps students be more active in their learning and ultimately more effective overall. Models for SRL are widely used in education, especially in fields like medical education where independent learning and problem-solving are important. In medical education, students need to take charge of their learning as they develop the skills needed for clinical practice. SRL helps them to recognize their weaknesses and power, set appropriate learning goals, and seek feedback to strengthen their performance. [3,6]

There is growing interest in reviewing previously developed models and how they should be applied to medical education. Medical students face unique challenges. They must manage a large volume of information, develop clinical skills, and adapt to rapidly changing medical knowledge throughout their career. As a result, understanding how SRL models can be applied is critical for improving medical education.

This paper examines several SRL models and how they can be applied to medical students. It also finds the various factors that can affect the effectiveness of self-regulated learning, such as motivation, emotional regulation, and the ability to manage feedback.[5,6,7] By understanding these factors, educators and students can identify personalized strategies that can help improve learning.

SRL is not only about improving study habits. It is more complicated educational strategy. A Comprehensive cognitive, emotional, and behavioral approach are divided into different key factors.[7,8] It is important for medical students not only to develop effective learning strategies, but also to learn how to manage stress, maintain motivation, and constantly adjust learning strategies based on feedback from colleagues, instructors, and self-assessments.[9]

Many studies show that students actively using SRL are more likely to succeed academically. They handle the complex and demanding nature of medical education better. [10] These students set challenging goals, seek feedback, and persist through difficult tasks, leading to long-term success in medical careers.[10,11]

In conclusion, reviewing self-regulated learning models provides valuable insights into how these models can be used in the medical environment. Educators can take into account both the cognitive and emotional aspects of learning, giving feedback and helping students adjust their strategies for self-directed learning.[12,13] This can help students improve their academic performance, deepen their understanding of clinical practice, and lead to positive changes in patient care in the future.

2. Understanding Self-Regulated Learning

2.1 Definition and Components of SRL

Self-regulated learning (SRL) means that learners self-manage and regulate their own learning process. [3] They are not passively receiving information. They actively take action in their study process. SRL has four phases: setting goals, planning how to achieve them, monitoring their progress, and adjusting strategies.[3,6] There are several factors in SRL.

Cognition refers to connecting new information to previous knowledge and organizing information to make it easier to understand. Metacognition is planning how to approach a task, keeping track of how studying is going on, and making constant changes.[14]

Self-efficacy refers to the mind that believes that a student can do a task well on his or her own and achieve his or her goals. According to studies, the more students who believe in themselves, the more active they are in learning.[2.3.4] They overcome difficulties, set challenging goals, and have the power to find ways to learn that suit them.

Volition is the ability to stay focused and keep working towards final goals, even when faced with challenges.[14.15] This persistence is crucial for success, as it helps learners stay motivated and keep going when things become tough.

The emotional aspect of SRL is about how students handle feelings like stress, anxiety, and motivation. Staying positive, managing stress, and staying calm under high pressure can really help with learning.[7]

In short, SRL involves many different things. Research on SRL aims to understand how these elements work together to improve learning. Learning ‘how to use SRL’ is particularly important for medical students. [16] Medical students need to accept different types of feedback to improve their clinical skills. Improving by accepting good-quality feedback is essential for their future careers as independent clinicians and ultimately ensures the safe and good quality of patient care.[17]

2.2 Theoretical Frameworks of SRL

The concept of self-regulated learning is based on many theories, such as Social Cognitive Theory and cyclical models of SRL. These models provide a background for understanding SRL's cognitive, metacognitive, and motivational processes and provide a pathway for medical students to control their learning effectively. The Zimmerman Model focuses on the dynamic and interactive nature of self-regulation.[3,14,15] It highlights the importance of setting goals, monitoring progress, implementing strategies, and reflecting on the learning process. Educators can use this understanding to enhance medical education.

3. Importance of SRL for Medical students

It is well-known why self-regulated learning (SRL) is important. In particular, medical schools have a high difficulty in studying, so many students suffer from academic stress. SRL models can help students relieve stress and focus on their academic goals and success.[18] They provide strategies that help students set goals, monitor their progress, and adjust their learning methods when needed, helping them stay on track.[17]

Many medical students experience anxiety about the possibility of failure as they face direct academic results every semester. As each student encounters different difficulties, applying individualized SRL strategies tailored to their unique needs is crucial.[19] This personalized approach allows students to address specific learning challenges and overcome obstacles effectively.

The significance of SRL goes beyond academic success in medical schools. It becomes even more critical when students enter clinical practice.[19] Several studies have shown that medical students who practice SRL strategies during their academic years are more likely to become competent physicians when they transition to real-life medical settings.[19,20] This is because the knowledge they acquire in medical schools is mostly theoretical, while the skills they need as practicing physicians are much more practical.

3.1 Academic Success

Medical education research has well-documented the relationship between SRL and academic success.[21] SRL helps students manage the overwhelming amount of information. Studies have shown that medical students actively engaging in SRL techniques tend to have higher grades, better material retention, and improved exam performance.[18,21]

In a study conducted among medical students in China, students who used cognitive and metacognitive strategies such as time management, cognitive monitoring, and emotional regulation reported significantly better academic outcomes than those who did not engage in SRL practices.[10] A cross-sectional survey was used on 878 medical students at TCM University from March 2020 to May 2021. An independent t-test and analysis of variance were applied to assess factors linked to SRL. Multi-linear regression analysis examined the relationship between SRL and learning strategies.[10] This research found that students who actively applied SRL strategies in their learning scored better in learning motivation, setting, self-regulation, and overall performance (115.16 ± 12.42). Learning strategies, such as metacognitive, emotional, cognitive, and resource management, were positively correlated with SRL ($r = 0.421$, $P < 0.01$). About 32% of the variation in SRL could be explained by factors such as preference for their field, academic rank, and family background. Personal factors such as physical, mental, and social self also affected SRL deeply. The research gives a discussion about educators' role in improving the implementation of SRL strategies for individual students. [10]

However, limitations of current SRL strategies were found in a study conducted at the University of Birmingham. They examined how medical students use personalized feedback based on their Objective Structured Clinical Examinations(OSCEs).[11] Three studies were conducted focusing on the role of reflection. An interview study (N=11) revealed differences in feedback engagement based on performance.[11] However, two larger questionnaire studies (N=180 & 233) showed that most students had a cognitive engagement with feedback, and fewer took actual actions to improve their clinical knowledge. Performance levels and reflective behavior did not show a big relationship.

Although the current SRL framework emphasizes the close relationship between participation and reflection, there is an unrevealed gap in using feedback to lead to actual action in real situations. Finding factors between this gap is a new challenge in this field of study. [11]

Another study from the 5th-year students in the UK focused on the role of self-reflection after receiving a feedback. [12] The study emphasized that feedback alone is not sufficient. The students must reflect on the feedback and incorporate it into their learning process to achieve meaningful improvements. Reflective practice makes students to assess their strengths and weaknesses, leading to greater academic engagement and improved performance in subsequent clinical tasks.[12]

These studies emphasized the importance of appropriate feedback and attempted to find ways for students to achieve behavioral change by reflecting on feedback. Further research is needed on how to utilize them practically.

3.2 Transition to Clinical Practice

After medical school, the work environment changes dramatically for medical students. In school, they learn about the causes and treatments of diseases, but in the real world, they need practical knowledge to make quick, precise, and flexible decisions in different situations. They have to adapt their learning strategies, clinical reasoning, and interpersonal skills to new environments.[22] SRL can help medical students manage their learning independently, reflect on their experiences, and continually improve their clinical skills.[23] For example, when faced with a patient whose symptoms don't match a textbook case, students need to reflect on what they know, seek feedback from a supervising physician, and adjust their diagnosis. SRL strategies can help with this process. It is important to encourage students to take control of their learning by setting goals, tracking progress, and asking feedbacks. They can modify and supplement existing strategies based on feedback on their experience. [22,24]

Reflective practice is a key aspect of SRL in clinical education.[26,27] Reflective practice in the medical field means carefully looking at one's performance in patient care, finding areas to improve, and making changes. Medical students who think about their experiences in clinical settings do better at handling challenges. Reflecting on decisions and getting feedback from mentors and peers helps them improve patient care and grow personally.[27] Seeking feedback from mentors, physicians, and colleagues also helps students bridge the gap between theoretical knowledge and practical application.[25]

One study used a five-stage framework of Arksey and O'Malley to identify the role of SRL in clinical settings. It was found that SRL is positively linked to academic performance, proficiency in clinical skills, and mental health. Also, the level of SRL changes within the clinical environment.[28] Multiple factors are related to the SRL level in medical students, especially with past experiences. The students who had a PBL curriculum during medical studies effectively used SRL. Technologies used during studies also enhanced the level of SRL. For example, tablet computers used as a study tool have increased access to more clinical information.[28] Still, many students struggle to self-reflect despite high SRL levels. Finding the right factor for different individuals is a key assignment. [28]

Another study invited medical students to complete a questionnaire at the start of the clinical year(Time 0) and 10 weeks later (Time 1). Motivated Strategies for Learning Questionnaire(MSLQ) was used. Additional data about students' previous clinical experience and background were also collected. [11] Out of 118 students approached, 72 provided complete responses at both time points (61% response rate). At Time 1, there was an increase in extrinsic goal orientation, particularly among male students assigned to critical care and those who had community attachments. Conversely, metacognitive self-regulation decreased at Time 1 and was negatively correlated with prior clinical experience.[11] This research demonstrated the importance of teaching students to consider their own thinking before they start working with patients.

Two studies discovered that factors such as where students learn and their personal background influence how well they can manage their own learning. In the future, researchers should use long-term methods to learn more about how students in medical school learn to manage their own learning during the years they work with patients.[11,28]

There is a long-term benefit to SRL for medical students. Doctors must engage in lifelong learning about new treatment protocols and the latest technologies in line with the rapidly changing pace of medical advancement.[29] This process will be much easier if the doctor has already practiced high-level SRL during his undergraduate years.

Since continuous medical education is directly related to improved patient care in the long term, it also helps improve the overall medical system. [29]

Studies have also highlighted the role of SRL in improving clinical competence. Medical students who develop strong SRL skills during their clinical training gave successful results in Objective Structured Clinical Examinations(OSCEs), diagnostic reasoning, and procedural tasks such as cannulation or suturing. These students also showed greater resilience and confidence in their clinical abilities. [7]

4. Analyzing different models of SRL

4.1. Zimmerman's cyclic phases model

Zimmerman's cyclic phase model (1989) is a widely used theory used to study how people learn. [3] This model can be used to understand how learners take control of their learning. This helps students actively manage their learning experience. Zimmerman's cyclical phases model includes three key phases: forethought, performance, and self-reflection.[3, 30]

During the forethought phase, learners plan and set achievable goals. They also think about how to overcome challenges and find motivation for the task.[3]

For example, medical students set a goal to improve their knowledge about specific diseases. At this stage, they choose the resources they will use, such as textbooks, online resources, etc., and decide how much time they will devote to this goal in total. They also decide how to receive feedback if goals are not achieved.

In the Performance phase, they take action according to their plans. During this phase, they carry out the planned tasks and monitor their progress. Zimmerman calls this self-monitoring, where learners must actively check to see if they are on track toward their goals and, if not, what is problematic. [3]

Medical students learn by attending clinical placements, reading medical literature, and participating in case studies. During this learning process, they must continually evaluate how well they are performing. They can ask themselves several questions. They may ask questions about whether they are properly understanding the material and performing clinical procedures correctly. In addition, they can ask themselves questions about their learning attitude. They must judge for themselves their will, concentration and attitude.

This step is more than just "doing the task." This is when students are aware of the task and coordinate the process. [31] As students become aware that they are struggling in certain areas, they can spend more time in that area or try to find additional resources.

After completing the assignment, learners enter the stage of self-reflection and evaluate their performance to consider what worked and what didn't. This step is very important because learners can find their own complementary points through positive and negative experiences. Learners who do self-reflection correctly can properly make up for their shortcomings when making new plans in the future.[30,31]

At this stage in medical school, it may be about reviewing test scores and thinking about how well learner applied their knowledge. Students may ask themselves various questions during the self-reflection phase. They may ask questions such as whether they achieved their goals, which strategies worked, what difficulties they faced, and how they should supplement them next time.

The self-reflection phase also includes evaluating outcomes.[3] Students who perform poorly can reflect on why that happened and what they can change. If the performance was good, they can consider how to maintain or improve their strategy.

The strength of the Zimmerman model lies in its characteristic of 'cyclic'. Self-reflection phase leads directly back into the forethought phase. After reflecting on their performance, learners use their lessons to achieve their next goals and plans. This cycle of continuous improvement is what makes this model powerful for learners, particularly in fields like medicine, where new knowledge and skills must be constantly developed and refined. [3,6]

This continuous cycle of setting goals, monitoring progress, and reflecting results in setting new goals is essential for lifelong learning. Medical knowledge develops rapidly, and clinical practice requires professionals who can constantly update and improve their skills. Zimmerman's model allows learners to have an active, reflective, and adaptive attitude toward learning.

Zimmermann's SRL model is effective for medical students who need to improve their academic success, patient safety responsibility, and clinical performance because it emphasizes self-monitoring and reflection, which are critical to healthcare practice.[1] In a healthcare setting, mistakes sometimes teach more about success than about success. Doctors can self-reflect through failed experiences and be aware of similar problems later on. If a student or clinician is able to recognize the problem, they can quickly take steps to reduce the risk of life-threatening the patient. If doctors are not actively self-reflecting, serious problems can arise later on.

The model helps medical students develop habits to pass exams in the short term. It also contributes to developing long-term habits needed to grow into skilled and adaptive clinicians. Educators should teach students how to set goals. It is also important to support them in developing self-regulation skills to cope with complex medical tasks, and to provide adequate feedback on their performance.

4.2. Boekaerts' different goal roadmaps and the role of emotion

Boekaerts' self-regulated learning (SRL) model focuses on how learners can control their emotions as they achieve their goals. Boekaerts emphasizes the learner's cognitive process, and the model focuses on their goals and emotional states.[7,8] Students often set several competitive goals in their learning process, and their emotions have an impact when prioritizing them. This model can be used to balance students' stress and academic performance, which is a chronic problem in medical schools, which is a high-pressure environment. [7]

Boekaerts' model sets different goal roadmaps for individual learners. These roadmaps are mental plans that students create based on their goals, which can be classified into mastery and well-being goals.[8]

Mastery goals focus on learning and achievement. [8] These goals reflect the desire to acquire knowledge, develop skills, and perform tasks well. For example, medical students set mastery goals to fully understand a subject called pathology. These goals allow students to make continuous efforts to improve their knowledge of the subject.[7,8]

Well-being goals focus on maintaining emotional and physical comfort, protecting oneself from stress, and avoiding negative emotions.[7] In high-stress environments, such as medical schools, goals related to reducing anxiety, managing stress, and balancing academic needs and personal life are also important. For example, medical students can take a break to prepare for their next goal to prevent burnout.

Boekaerts points out the problem that these two types of goals often conflict. Students think their priorities are mastery goals, but they can adjust it by overwhelming stress. However, if they improperly prioritize their goals at the moment they are needed, they may not be able to achieve their ultimate first goal of graduating from a medical school.[8], [14]

Boekaerts emphasizes the role of emotions in learning.[7] Depending on students' ability to manage their emotions, emotions can help or interfere with learning. Positive emotions, such as interest and passion, motivate students to pursue mastery goals and deeply engage in learning. When students feel pleasure in learning new materials or gain confidence in their abilities, they are more likely to continue their challenges.[7,8]

However, negative emotions such as anxiety and fear of failure can hinder learning. These emotions allow students to focus on well-being goals such as avoiding stress rather than learning goals. For example, medical students who are burdened with upcoming exams may choose to avoid studying. These protective responses may be helpful in the short term but hinder long-term academic progress.[29] Negative emotions can be felt by anyone in medical education, but the results may vary depending on how well they perceive and deal with them.

Learners constantly change the priorities of their mastery and well-being goals according to their emotional state. These change can have a positive or negative impact on achieving their learning goals.

Boekaerts' model suggests that students should practice dual processing, simultaneously managing cognitive tasks and emotional states.[7] Students should learn how to control their emotions while performing their learning tasks. For example, a medical student can deal with complex clinical cases and feel frustrated by the difficulty of diagnosing. Managing these frustrations can help them achieve their goal of finding the proper diagnosis. Balancing these cognitive and emotional needs is an essential ability for effective self-regulation.

Boekaerts says that learners who can effectively control their emotions can focus more on mastery goals. If learners are interested in emotional regulation and try to improve it, they are more likely to achieve academic and professional goals. Medical students who have managed their emotional responses to challenges such as complex tests are more likely to become calm and competent doctors in hospital life later on.

Boekaerts' model provides a framework for students to balance their mastery and well-being goals. Medical students often have conflicts between their desire to do well in their studies (mastery goals) and their desire to manage stress and pressure from workload (well-being goals). Balancing is essential for both educators and students. Boekaerts emphasizes that medical students need to develop strategies regulate their emotions with academic goals. This includes teaching students to deal effectively with stress, manage their time efficiently, and build resilience. Incorporating this emotional regulation into the learning process can help students move steadily toward mastery goals despite the pressures of medical education.[7,8]

Medical educators should create supportive learning environments. For example, educators can look at students' emotional states together, providing them with feedback to improve their performance. This can present students with encouragement and strategies to manage their stress. Understanding impact of emotions on learning and recognizing the balance between achievement and well-being goals can help students and educators develop more effective strategies to succeed in academic and clinical settings together.

4.3. Winne and Hadwin's model of SRL from a metacognitive perspective

Winne and Hadwin's model emphasizes metacognition which is thinking about one's learning in a self-regulated learning process.[4] This model focuses on how learners monitor and control their cognitive activities during learning. Adjusting strategies based on feedback allows for a dynamic and adaptive learning process. [4]

Winne and Hadwin's SRL model has four phases: First, task definition, Second, goal setting and planning, Third, enacting tactics, and Fourth, adapting metacognitive strategies.[4,9] At each stage, learners actively think and make decisions, which allows them to continuously check their progress and make adjustments to improve learning outcomes. This model has a large role to play in educational settings, especially those facing complex challenges such as medical education, where problem solving, critical thinking, and self-assessment are important.[35]

The first phase is task definition. In this phase, learners interpret and define the task.[4] It starts with identifying the task, what it requires, and what cognitive skills can use to complete it. This step is very important because only by accurately understanding the task can learner determine the appropriate approach. If they misinterpret the task, their strategy may not be effective and the results may be poor. For example, in medical school, students go through a process of analyzing a variety of clinical cases. In this phase, students can define the task by asking, “What is the goal of this case study? Am I supposed to diagnose the condition, determine a treatment plan, or simply gather patient data?” Accurate task definition helps the students select appropriate strategies.

This phase requires metacognitive awareness because students must be conscious of how they interpret the task.[4,9] When a task's requirements are unclear, it may be necessary to seek clarification or revisit one's understanding.

Once task is defined, learners move to second stage, goal setting and planning. This stage, it is important to set achievable goals and make specific plan.[4] Goal should be clear, achievable, and plan should be detailed what actions learners will take to achieve them. This process requires deep thinking as learners asked to check their level of knowledge, evaluate their strength and weaknesses, and choose the most appropriate strategy.

For example if a medical students’ task is to make a correct diagnosis, the goal set at this stage is to accurately diagnose the patient's condition based on given data. Through this, learners can develop the ability to analyze necessary information, think logically, and make accurate diagnose base on signs. Plan can be reviewing the patient’s symptoms, reading medical literature, comparing differential diagnosis. Goal setting and planning help students to stay organized, focused. At this stage, students should anticipate potential difficulties and consider how they will be managed. For example, a student might recognize that they lack confidence in interpreting lab results and plan to spend additional time on that part of the work.

The third step is for the learner to actually implement the plan using tactics and strategies. At this stage, the learner uses a variety of ways of thinking and problem-solving strategies.[4] For example, summarizing given information, linking different ideas, and applying what they already know.

For medical students, this step involves using clinical reasoning to analyze patient cases, utilize diagnostic tools, or make differential diagnoses. Students actively use their knowledge and skills to focus on solving problems and completing tasks.

Checking progress is also very important at this stage. Students should assess whether the strategies they are using are effective as they perform their assignments. If progress is not made or the approach is deemed ineffective, the strategy should be modified.[33] For example, if learners are experiencing difficulties during the diagnosis process, they may realize that they need to use additional data or review their initial ideas.

The final step is to use metacognitive strategies. [4] At this stage, the learners reflect on their performance and the effectiveness of the strategy, and sets out to adjust for the next task. In this process, the learners evaluate themself and ask questions such as "Did I achieve my goal?" "Did the strategy work?" and "What can I do differently next?"

It is particularly important for medical students to look back on the clinical cases they have studied.[32] If they have difficulties in the diagnosis process or missed important information, they should analyze what was problem. They can reflect on whether they did not understand the task properly or if they didn't use the right strategy. This process of reflection plays an important role in helping them learn from mistakes and improve their approach to improve future performance. This helps learners build on their previous experiences to make better decisions and set stage for continuous growth.

Core of Winne and Hadwin model lies in 'metacognitive monitoring', which involves constantly checking and adjusting the learner's own thinking process.[4,33] This model helps learners take a second look at their thinking processes and look for improvement. This allows learners to adjust their strategies. This includes understanding the learning content, evaluating the effectiveness of the chosen strategy, and making real-time adjustments based on feedback.

Metacognitive monitoring makes this model especially powerful.[4] Learning is not simply following a planned plan; it is a process of active participation, continually examining whether learners' method is working and changing direction whenever necessary. For example, if a medical student interprets patient data and feels that it is difficult to reach an accurate diagnosis with their current approach, they can change their strategy by looking for new data or approaching it again from a different perspective.

This focus on metacognition makes Winne and Hadwin's models particularly useful in medical education. Students who can control cognitive processes in medical school can make accurate diagnosis, plan treatment, and continuously improve their clinical performance.

4.4. Pintrich's SRL model by emphasizing the role of motivation

Paul Pintrich's self-regulated learning model is famous for emphasizing importance of motivation in learning process.[34] While other self-regulated learning models focus primarily on cognitive or metacognitive strategies, Pintrich includes motivation at the core to show how factors such as learners' beliefs, values, and emotions regulate and guide learning. This model provides framework for understanding how motivation, cognition, and metacognition work together to drive learning. [34]

Pintrich's self-regulated learning (SRL) model describes four main steps in the learning process: foresight, planning, and activation, where goals are set and preparations are made; monitoring, which involves assessing progress throughout; control, where strategies are adjusted as needed; and finally, response and reflection, a stage focused on reviewing what worked and identifying areas for improvement in future learning efforts.[34] At each step, motivation has important implications for the way students set goals, immerse themselves in tasks, check their progress, and look back on learning outcomes. This role of motivation is especially important in educational settings such as demanding curriculums and stressful medical schools.[35]

The first step in Pintrich's self-regulated learning model is the preparation phase, in which students plan and implement strategies for learning tasks. In this process, motivation plays an important role in setting goals and making efforts to achieve them. Pintrich explains that several motivational factors come into play at this stage, such as self-efficacy, task value, and goal orientation.[34]

Self-efficacy means the belief that a learner can complete a task.[3] In medical education, students with high self-efficacy tend to become more confident and actively participate in learning when dealing with complex medical procedures or concepts. The value of a task represents how important a student considers the task. For example, if a medical student considers difficult anatomical concepts to be essential knowledge for his or her future career, he or she is more likely to devote himself or herself to learning them.

A student's goal orientation is divided into two parts. Learning goal orientation focuses on improving knowledge and skills, and performance goal orientation focuses on demonstrating one's abilities compared to others.[34] Learning goal-oriented medical students can set challenging goals and actively participate in self-regulated learning, while performance goal-oriented students can focus on improving grades or outperforming their peers.

At this stage, highly motivated learners set clear and achievable goals and plan effective learning strategies. [34] For example, a highly motivated medical student may plan to spend a certain amount of time each day studying, accessing additional materials, and repeatedly practicing clinical skills until they are sufficiently mastered.

The monitoring stage involves tracking how well the learner is progressing toward the goal and evaluating how smooth the current progress is. [34] It is important to stay motivated at this stage. Only when motivation is maintained can the learner move toward the goal until the end without giving up even if there are difficulties. This is because it has a huge impact on how actively learners monitor and work on their own performance.[35]

For medical students, the monitoring phase involves checking how well information is remembered during a study session or assessing how well they can apply theoretical knowledge in clinical situations. Highly motivated students, especially those with strong confidence in their abilities, tend to monitor their learning more closely when they do not understand certain content well, and change their strategies if necessary. For example, when a medical student encounters a difficult concept, high motivation may lead them to seek out more explanations or practice more.[36] In addition, the more students who value their assignments, the more carefully they monitor their learning process. Students who think this task is important for future success are more likely to participate in their assignments, regularly monitor their progress, and make real-time adjustments as needed.

In the control stage, the learner adjusts the learning strategy based on the information obtained from the previous monitoring stage and adjusts the cognitive effort to achieve the goal. Motivation plays a important role at this time. [34]

Students with high self-efficacy, that is, those who believe they can succeed on their own, tend to change their learning strategies positively.[35] For example, medical students with high self-efficacy may actively seek feedback to practice more in simulation labs or improve their skills. In addition, students who recognize the importance of tasks are also often actively coordinating their strategies. For example, medical students who know that certain skills are essential for clinical practice will flexibly adjust their strategies to achieve their goals. On the other hand, students with low motivation, especially those with low self-efficacy or low value of tasks, are less likely to try to change.[35] If medical students have difficulty acquiring difficult concepts or procedures, asking for help or not modifying their learning strategies can negatively affect learning outcomes.

In the final stage, learners take time to reflect on and evaluate their performance and think about how they can improve in the future.[34] They can shape the strategies needed for their next learning by figuring out what went well and where they struggled in this process. Motivation in this process has an important impact on how learners respond to performance. [34] Mastery-oriented students see mistakes as an opportunity for growth, and for example, medical students with poor test scores may try to analyze their study methods to apply more effective learning methods or improve time management. [34] On the other hand, students with high performance-oriented or low self-efficacy may feel frustrated with their failures and have less motivation for future tasks. They are likely to give up their self-regulated learning behavior, blaming them for their lack of ability.[36]

In Pintrich's SRL model, motivation deeply affects how students set and work on their goals, monitor progress and adjust their strategies, and reflect on their overall performance. This model provides framework for understanding the interaction of motivation and self-regulation, especially in healthcare education.[34]

Medical students with high self-efficacy and high value of tasks are more likely to participate in self-regulated learning behavior, but students with high self-doubt or low value of tasks may perform poorly due to insufficient efforts to learn.[35]

Educators can leverage Pintrich's model to encourage students to have mastery goal orientation, increase the importance of learning tasks, and instill confidence in students to motivate them. In addition, they can create a supportive learning environment and provide feedback that increases motivation to grow successfully through self-regulation in their academic and clinical careers.

4.5. Hadwin, Järvelä, and Miller’s SRL Model in the Context of Collaborative Learning

The self-regulated learning model of Hadwin, Järvelä, and Miller extends the existing concept of self-regulated learning by incorporating a collaborative learning environment.[9] While most SRL models focus on individuals setting goals and strategizing to manage outcomes, this model highlights the social aspects of learning. It addresses how learners regulate cognition and emotions through co-regulation and shared regulation in a group environment, and can be particularly useful in contexts such as healthcare education where teamwork is critical.[39]

The model highlights the importance of communication, sharing goal setting, and emotional regulation through experience of collaborative learning in medical school settings where students solve problems together or practice clinical cases.[9]

Individual Self-Regulation in Collaborative Learning: In group settings, individual self-regulation is crucial. Each member must manage their learning goals, monitor progress, and adjust strategies to contribute effectively. In collaborative learning environments, such as medical education, students work together on complex cases.[39] Students are responsible for understanding the case, finding solutions, and sharing their insights. Individual self-regulation involves setting personal goals for their contribution and monitoring their understanding to prepare for group discussion.

Co-regulation: Hadwin, Järvelä, and Miller's model emphasizes co-regulation in group learning, where individuals support each other's learning through sharing strategy and providing feedback.[9] Group members actively engage in other’s self-regulation processes. One group member may notice that another is struggling with a concept and offer help or suggest a helpful strategy.

In medical education, co-regulation is important for working together in activities like group discussions, simulations, or lab work.[36] In medical education, students often work in teams to diagnose patients and solve clinical problems. They help each other by sharing knowledge, asking questions, and giving feedback. If a student is unsure about a diagnosis, another group member can step in to explain or clarify a concept, aiding their peer's learning. Co-regulation in a group means managing the team dynamics, keeping everyone engaged and focused, and making sure all members contribute to the shared goal.[9]

Shared Regulation of Learning: In shared regulation, the group collectively manages their goals, strategies, and progress, take responsibility for regulating process as one unit.[9] Shared regulation is important for team tasks like clinical rotations and group projects. For example, medical students need to work together about making right treatment plan. They must set common goals, track progress, and ensure everyone contributes equally.[38] Shared regulation means that everyone communicates openly, sets common goals, agrees on strategies, regularly checks alignment, and reflects on their performance as a group. This skill is very important in medical settings to ensure effective patient care.

The Role of Emotion in Collaborative Learning: In a group environment, emotions such as frustration, anxiety, and passion can greatly influence a group's ability to control learning. Just as individuals manage their emotions, group members also need to recognize and coordinate the overall flow of emotion and keep group emotions in balance. [9, 37]

Emotions impact productivity of group setting. In a medical education, student's emotional state in challenging case discussion can affect group dynamics. Recognizing and addressing these emotions is vital for maintaining a productive learning environment. This may involve offering support, taking a break, or helping the student regain confidence. Group members must manage emotions in high-pressure fields like medicine to maintain a positive learning environment.[37]

Application in Medical Education: This model is useful in healthcare education settings, where collaboration is critical.[38] Medical students often have to work as a team to solve complex problems, diagnose patients, and make treatment plans. In order to succeed in such an environment, it is important for each student to understand how to cooperate and support his or her colleagues while still maintaining good control of his or her learning.[39]

In clinical simulations, for example, medical students team up to evaluate, diagnose, and execute treatment plans. In this process, team members set rules together, share roles, and monitor the overall progress of the team together. Each team member contributes by controlling where necessary, preparing and focusing to perform their role well.[40]

In a clinical setting, collaboration between medical professionals has a significant impact on a patient's treatment outcomes, so the ability to jointly set goals and orient themselves together during the learning process is crucial. Medical students with these abilities are better prepared to work effectively on real-world medical teams.

The model provides a comprehensive framework for learners not only to control individual learning, but also to understand how they can work with others and coordinate their goals within the team.[9,41]

5. Application of SRL Strategies in Medical School

Self-regulated learning plays an important role in healthcare education because it helps students manage their own learning process on their own. Through SRL strategies, students can actively participate in the curriculum, check their own learning process, and steadily improve their academic and clinical skills.[42]

5.1. Incorporating SRL in Curriculum Design

Incorporating self-regulated learning into the medical school curriculum is essential to making sure students accept goal-setting, self-monitoring, and reflection as the everyday processes of learning. [42] For example, many medical schools have introduced a flipped classroom model where students study concepts autonomously before they join a group discussion class. This way, it motivates students to prepare for learning before class, create questions, and be responsible for their own learning. Research indicates that students in flipped classrooms who actively utilize SRL strategies, such as seeking assistance from peers or instructors, achieve better academic results.

Problem-Based Learning (PBL) is widely used in medical school curricula to promote SRL.[44] In PBL, students work together in small groups to solve complex clinical problems and simulate real-world medical decisions. This approach involves students participating in self-directed learning by investigating and integrating the information needed to solve a problem, while simultaneously reflecting on their performance and receiving feedback from colleagues and facilitators. According to studies, PBL helps to enhance critical thinking and clinical reasoning skills, all of which can be reinforced through self-regulated learning. [43,44]

In medical education, portfolio-based evaluation methods are often used to help students engage in reflective practice. Many medical schools have students record clinical experiences, examine their skills, and keep a reflection journal to set learning goals that will develop in the future. This structured reflection process not only strengthens the SRL principles, but also contributes to emotional resilience and professional growth through constant self-assessment. [29]

5.2. Teaching SRL Skills to Medical Students

In medical schools, it is important to effectively guide medical students within the curriculum so that they can develop self-regulated learning skills. It is important to provide a variety of learning support methods to help medical students effectively acquire self-regulated learning skills.[45] Methods for this include workshops, mentoring programs, and peer-learning opportunities.

The workshop provides opportunities for students to understand and practice self-regulated learning skills in depth. For example, students can practice setting goals, or learn how to effectively monitor their progress through specific examples. The workshop has the advantage of sharing each other's experiences, giving feedback, and learning how to apply learned theories to real situations.

Mentoring programs provide more individual learning support. Experienced professors or clinical teachers can participate as mentors, so that students can set academic and clinical goals and give them the advice they need to achieve them. Through regular meetings with mentors, students can monitor their progress in learning, make necessary adjustments, and have the opportunity to practically hone their self-regulated learning skills.

Peer learning opportunities create an environment where students can learn, encourage, and grow from each other within their peer groups. Students can naturally develop self-regulated learning skills by setting goals together, sharing their learning experiences, and solving difficulties. Peer-to-peer feedback is a great opportunity for students to check and improve their learning style, and mutual support within groups helps to motivate and increase responsibility for learning. These various learning support methods are a useful tool to help students apply self-regulated learning skills well to their studies and clinical practice.

Medical schools should help medical students learn to set specific and measurable goals.[46] For example, curriculums should instruct students to clearly set the necessary competencies in certain training courses, such as mastering physical examination skills or improving communication skills with patients.[47] By setting clear goals, students can focus on their learning and track their performance, which increases their immersion and learning effects.

Furthermore, medical schools should teach students the importance of reflection. Through the process of recording clinical experiences in a journal or sharing them with mentors, students become aware of what they did well and what they need to improve. These reflection activities help students take feedback deeply, adjust their learning style, and gradually improve their clinical skills.

The importance of mentoring and feedback requests should also be taught. [46] Students who have learned to actively seek feedback from mentors or colleagues will have the confidence to self-coordinate their learning approach. This goes a long way in helping students consistently improve their performance in the clinical field.

5.3. Faculty Development

Faculty members must receive training in SRL principles to effectively promote self-regulated learning among students.[40] Faculty development programs are specifically designed to provide instructors with the necessary knowledge and tools to create an environment conducive to SRL. These programs focus on teaching faculty how to encourage active learning, provide structured feedback, and promote reflective practices.

Faculty members are trained to create assessments and activities that are in line with SRL principles. For example, they may ask students to assess their own work and reflect on it before getting feedback from the instructor. It is important for students to think about how they learn before relying on external evaluations. Faculties should create learning environments that encourage independence and working together. Both of these are important parts of self-regulated learning.[7]

During clinical rotations, faculties are trained to lead students in reflective discussions about their clinical decisions instead of just giving them answers. This training helps students learn to adjust their learning in real-time, which is important in fast-changing healthcare settings. They also have to learn to help students by gradually increasing the difficulty of tasks. This helps students become more confident and independent in their decision-making.

Faculty development programs place a lot of emphasis on teaching students how to provide meaningful feedback. This is because effective feedback plays an important role in helping students view their performance objectively and further develop their self-assessment and learning strategies.

Faculty members learn how to provide specific, actionable feedback that students can actually improve, thereby helping them look back on their performance and get a chance to grow. According to studies, students who receive structured feedback are applying it to their learning strategies, performing better in their studies and clinical practice. The ability of faculty to provide these effective feedbacks is a key factor in strengthening students' self-regulated learning, and helping them grow and succeed. [8]

The use of self-regulated learning strategies in medical education, from designing the curriculum to developing faculty, creates an environment where students can take active control of their learning. Medical schools encourage independent and reflective learning by integrating SRL into curriculum structures such as flipped classrooms, problem-based learning(PBL), and reflective assessments. Teaching SRL skills helps students develop habits of lifelong learning, while faculty development ensures that instructors can effectively support SRL. Together, these strategies prepare medical students for academic success, clinical practice complexities, and lifelong professional development.[44]

6. Application of SRL strategies in Clinical Practice

Self-regulated learning (SRL) strategies are becoming an increasingly required skill for healthcare professionals in clinical settings.[36] Healthcare is a field where knowledge and technology are rapidly changing, and healthcare professionals must make decisions about patient care in real time, apply knowledge and demonstrate skills to fit the situation. In this process, self-regulated learning goes beyond just accumulating knowledge, helping clinicians clearly set goals for learning, continuously assess current progress, and adjust approaches when needed. The SRL strategy plays an important role, especially in the lifelong learning and autonomous growth of healthcare professionals.[19] Drawing on the lessons learned from clinical experience, it enables continuous absorption of new knowledge and refinement of existing techniques. This allows healthcare professionals to respond flexibly to the unpredictable situations that occur at the practice site.

Studies have shown that healthcare professionals who practice SRL tend to manage their learning independently and check and improve their knowledge and practice whenever necessary.[19,21] This self-regulated learning ability promotes continuous professional growth and helps healthcare professionals maintain the adaptability and attitude of lifelong learning.

6.1. SRL in the Transition to Clinical Practice

At a time when students and early-career healthcare professionals are transitioning to clinical practice, self-regulated learning (SRL) goes a long way toward preparing for complex patient care situations. SRL allows students to reflect on their clinical experiences, identify their strengths and weaknesses, and adjust their learning style as needed. [19] This means substantial improvements in clinical skills beyond knowledge and skills.

An important element of SRL is goal setting and self-assessment. In a clinical setting, setting clear goals, such as increasing diagnostic accuracy or mastering specific procedures, and prioritizing them to realize them are key[48]. For example, a medical student in a cardiology rotation may set a goal to improve his or her auscultation skills. To achieve this goal, the student will track developments through the process of asking for feedback from his or her physician, reviewing relevant literature, and reflecting on his or her interactions with the patient.[49]

These SRL strategies are essential for students to be more proactive in managing their learning and systematically developing the core skills needed in real-world clinical practice. Research has shown that learning with SRL plays an important role in steadily advancing students' learning and clinical skills, and advancing them into professionals who can provide more effective healthcare through self-directed growth.[19,48]

Time management is an essential SRL strategy in clinical practice. Students and young physicians need to balance patient care, learning, and administrative duties. Applying SRL helps them manage their time effectively, plan patient rounds, and ensure they have enough time to reflect on clinical cases.[19] For instance, in high-pressure environments like the emergency room, individuals trained in SRL may set time-related goals for efficient patient assessment and allocate time for reviewing cases and learning from patient outcomes.

6.2. Continuous Learning and Adaptation

Continuous learning is increasingly important in clinical practice. In healthcare, it is essential to stay informed about the latest treatments, technologies, and medical research. SRL encourages clinicians to set learning goals for their clinical practice and helps them achieve them through continuous learning.[50] For example, a family physician might set a goal of providing patients with up-to-date information on the latest diabetes management protocols. To do this, they can use SRL strategies to stay current with new guidelines, seek out relevant continuing education (CME) opportunities, and integrate new knowledge into their patient care.

In clinical practice, SRL also greatly facilitates learning and adaptation during patient care.[24] SRL allows clinicians to reflect on past experiences and improve their approach to improve patient outcomes.[27] For example, a surgeon who experiences a complication during a procedure might use SRL strategies after the procedure to review the case, identify potential errors, and modify their technique for similar procedures in the future. This ongoing process of reflection and adjustment is essential to reducing errors during surgery and improving the quality of patient care.

Intensive care units (ICUs) in particular require rapid decision making. Clinicians who utilize SRL can quickly assess the success of clinical decisions and make immediate adjustments when necessary. These SRL strategies provide a foundation for clinicians to continuously learn and adapt to provide the best care, even in complex situations.[32] For instance, an ICU doctor can review a recent patient case where early intervention was crucial and, through reflection, pinpoint areas where faster diagnostic responses could have led to better outcomes.

6.3. Enhancing Professional Development

Self-regulated learning (SRL) is an effective approach to the long-term growth and development of healthcare professionals.[50] In healthcare, it is important for professionals to continually update their skills and knowledge to stay current and proactively respond to the changing healthcare environment. SRL is a useful tool to help healthcare professionals engage in lifelong learning, allowing them to set their own learning goals, seek out additional educational opportunities, and develop their own competencies.[50] For example, physicians in a particular specialty may utilize SRL strategies to learn new clinical procedures or gain a deeper understanding of complex diseases. In the process of setting these goals, finding and learning the necessary resources, and applying them to their clinical practice, SRL provides the foundation for physicians to enhance their self-directed learning abilities. Through SRL, they can actively participate in reflective learning by monitoring their progress and seeking feedback from mentors or colleagues.[49] As a result, SRL can help healthcare professionals maintain and improve their professionalism and contribute to providing better care to patients.

Reflective practice is a widely used SRL strategy for professional growth in clinical practice. [47] Clinicians who regularly reflect on their clinical encounters can more clearly recognize their strengths and areas for improvement, which can help them develop more effective treatment plans for their patients. For example, after managing a complex case with multiple comorbidities, a clinician can reflect on their diagnostic process and identify areas for improvement, which can greatly help them develop a better approach in similar situations. This reflective practice is an important part of clinicians' ongoing learning and clinical judgment, and serves as a foundation for providing optimal care to patients. This process helps refine clinical reasoning skills over time. [20]

In clinical practice, self-regulated learning (SRL) and team-based learning are important elements that enhance teamwork in healthcare settings.[17] In healthcare settings, multidisciplinary teams are structured so that people from different specialties work together to care for patients, and each member must perform well in their roles and fulfill their learning and responsibility. For example, if a team sets goals for shortening patient recovery time or improving communication during shifts, each team member can use SRL skills to reflect on their contributions, reflect on their interactions with colleagues, and adjust as needed based on feedback. SRL strategies are helpful to healthcare professionals as they enter the clinical field and gain experience. Through reflective practice, clear goal setting, and continuous adaptation, SRL can further develop skills, improve patient outcomes, and provide a framework for lifelong learning.[17] By naturally incorporating SRL strategies into clinical practice, healthcare professionals can stay current and adaptable in a constantly changing healthcare environment, and grow into more professional healthcare professionals.

7. Challenges and Limitations of Implementing SRL in Medical Education

Self-regulated learning (SRL) has shown great potential to significantly advance medical education, but its implementation is hampered by several challenges and limitations. Although many medical schools around the world are making efforts to integrate SRL into their curricula, the complexity of SRL and the rigorous nature of medical education remain obstacles.[51]

One of the greatest challenges to implementing SRL is the varying levels of preparedness among medical students. Not all students enter medical school with SRL skills like goal setting, time management, and reflective practice. This makes it difficult for some students to actively engage with SRL and may require more support to learn these skills. Many medical students, especially in their early years, may have yet to gain previous exposure to SRL strategies, making it difficult for them to adapt to more independent learning environments. [22]

Additionally, motivation levels can differ significantly between students. Studies found that students who are intrinsically motivated tend to effectively engage in self-regulated learning, while those who are extrinsically motivated by factors such as passing exams may find it difficult to incorporate SRL techniques in meaningful ways. This presents a challenge for educators, as SRL demands a high level of student autonomy and responsibility. [23]

The structure of medical education presents a challenge for implementing SRL due to time constraints and curriculum overload. Medical students often have heavy workloads, leaving limited time for reflective learning and applying SRL strategies.[51] It is no easy task for students to balance academic responsibilities with the additional effort required for self-regulated learning, such as setting personal learning goals or reflecting on clinical experiences. In particular, excessive curriculum burden can be a factor that hinders SRL. When students are expected to learn a lot of content in a short period of time, they tend to rely on superficial understanding rather than deep learning, which is not in line with the reflective and deep learning style that SRL aims for. Additionally, excessive pressure to perform well on exams can impede the use of SRL by causing students to focus on short-term memorization rather than long-term self-directed learning.

Another obstacle to introducing SRL is the lack of preparation of faculty and potential resistance to new teaching methods.[50] Successful integration of SRL into medical education requires faculty to be prepared to create learning environments that support independent learning, reflection, and self-assessment. However, many medical faculty have been trained through traditional lecture-based teaching models and may lack the skills or motivation to integrate SRL into their curricula. This makes retraining and supporting faculty to implement SRL essential, which will help create a more self-directed learning culture.

Faculty may also resist the shift in roles required for self-regulated learning, which involves moving from a directive teaching style to one that emphasizes student independence and self-reflection. This resistance can hinder the development of a supportive SRL environment and restrict students' opportunities to practice self-regulation.

Another problem is the lack of sufficient structured feedback and opportunities for reflection for students. For self-regulated learning to be effective, structured feedback mechanisms are essential to help students evaluate their own learning and make necessary adjustments to strategies. However, in many medical education environments, feedback is often infrequent or provided too late for students to actually use it. In addition, the emphasis on grades and summative assessment in medical school can make it difficult for students to focus on the formative and reflective processes that are central to self-regulated learning. [24]

In addition, medical students often have little opportunity for systematic reflection in their busy clinical practice schedules.[48] During the practice, treatment and learning are given priority, so it is difficult for students to secure time for reflection to look back on their experiences and find areas for improvement. This can lead to missing the opportunity for deep reflection and growth required by self-regulated learning. Reflection is an essential part of SRL, but the fast-paced environment of clinical work and the emphasis on immediate patient care can result in limited opportunities for students to thoughtfully evaluate their own performance and learning methods.

Roadblocks to bringing SRL into medical education arise from various factors, including differences in student readiness, heavy workloads, faculty resistance, and inadequate feedback structures. To overcome these obstacles, medical schools need to invest in faculty training, establish structured opportunities for reflection, and develop curricula that enable students to actively participate in self-regulated learning. Over-coming these challenges is essential to ensure the full integration of SRL into medical education, ultimately promoting lifelong learning and clinical competence among future healthcare professionals.

8. Future Directions and Recommendations

As Self-Regulated Learning gains more attention in medical education, there are significant opportunities to further develop and enhance its implementation.

Strengthening Curriculum Integration: A key focus is to weave self-regulated learning more seamlessly into medical school programs. While some schools do include SRL strategies like reflection and goal-setting, these practices are often applied unevenly across the curriculum. SRL should be a central focus at all levels of education, from early courses to clinical rotations. One effective approach is to incorporate SRL into existing learning activities such as problem-based learning (PBL) and clinical simulations. The use of PBL allows students to practice clinical skills and receive real-time feedback, which can help foster SRL habits through the process of reflection and adjustment. For example, after finishing a clinical simulation, students could participate in a guided reflection session where they review their performance, set goals for improvement, and receive personalized feedback from faculty. This approach makes SRL core part of learning experience. Medical school could apply digital tools like e-portfolios to assist students for monitoring their learning progress. This would enable students to record their advancement, establish personal objectives, and contemplate clinical experiences. Similarly, learning management systems could support continuous self-assessment and reflection, helping students to better track their growth.

Individualized Learning Pathways: Medical students have varying strengths, learning styles, and levels of motivation.One of the challenges with SRL strategies is that they may not be equally effective for all students. Different students may have different intrinsic motivations and self-efficacy levels, and thus may perceive SRL strategies differently. Therefore, it is needed to study how to adapt SRL strategies to each student's characteristics. In particular, it is needed to find out which methods are effective depending on differences in motivation and cognitive demands. Using something like an adaptive learning platform, can adjust content and learning methods to match each student's strengths and weaknesses.

An adaptive learning platform tracks students' progress and provides customized resources that meet each student's needs. If a student is struggling with a particular subject, the platform can help students catch up by providing additional case studies or practice problems on that topic. The platform can continuously monitor students' progress and gradually adjust the difficulty level so that students feel a sense of accomplishment and appropriate challenge in their learning.

Faculty and mentors need to constantly monitor and manage students' acquisition of SRL skills. They should observe individual students and guide them to set specific and achievable goals, provide tailored feedback, and help students reflect on their learning through individual consultations.

Faculty training and development: To effectively teach SRL, medical schools should invest in faculty development programs. Faculty should be taught about the importance of SRL and how to create learning environments that promote SRL. Because many faculty may not be familiar with the specific elements of SRL, specialized SRL instruction programs are needed to teach them. Faculty with a deep understanding of SRL can model SRL behaviors for students and play a critical role in establishing a culture of self-regulated learning within medical schools.

For example, faculty development programs can teach educators how to provide tailored feedback to students. Rather than simply providing answers to learning questions, faculty should help students think critically about their learning process and identify areas for improvement.

These programs should also emphasize teaching SRL in clinical settings, where real-time feedback and reflection are vital. Faculty members can receive training to help students reflect on patient interactions, discuss areas for improvement, and set future learning goals to enhance their clinical competence.

In addition, educators can learn how to model SRL behaviors themselves. By demonstrating self-reflection, setting personal learning goals, and seeking feedback, they can show students how to engage in lifelong learning.

Bridging the Gap Between Preclinical and Clinical Learning: When students enter the actual clinical environment after medical school education, they feel the greatest environmental change. In addition to simple knowledge learning, various new abilities such as communication with patients, understanding hospital management, and quick response in emergency situations are required. Medical schools should provide various programs from undergraduate school to help students adapt to this great environmental change and provide sufficient practice. [27]

Medical schools can provide clinical simulation programs to students so that they can learn what abilities are needed in actual clinical settings. Through simulation, students can practice SRL skills required in the clinical environment, such as setting specific learning goals, performing, evaluating, and reflecting. Simulation can help students refine SRL skills required in the actual clinical environment. If practicing simulations in groups, they can set common goals in addition to individual goals, and hold systematic reflection sessions after executing the plan to give and receive feedback on the target results and improvement plans with their peers.

Reflective journaling and feedback sessions during clinical rotations can also help students stay on track. Through these activities, students can reflect on their performance, receive feedback from mentors and peers, and set improvement goals. The experiences learned through regular reflective journaling and feedback sessions will serve as a great stepping stone for solving future emergencies or problems that may arise in real clinical settings. This continuous feedback loop can be flexibly utilized throughout a physician’s career.

Leveraging Technology for SRL: Physicians’ medical skills can be greatly improved through continuous reflection, assessment, and learning management. Students can develop these skills while they are undergraduates by utilizing mobile apps and learning platforms. There are a variety of study applications available today, and schools should actively encourage their use. Students can use virtual reality (VR) and simulation-based applications to set specific goals, monitor their progress at any time, and receive feedback. These tools provide immediate access to learning resources, quizzes, and real-time feedback, allowing students to develop SRL skills without constraints of time and space. These technologies allow students to assess their performance in a safe and controlled environment before applying their skills to real patients. This promotes a continuous learning cycle of practice, reflection, and improvement.

Long-Term Research and Monitoring: Although self-regulated learning has been shown to be effective in improving academic and clinical outcomes, more research is needed to determine which SRL strategies are most effective for medical students and professionals. Future research should track how different SRL strategies affect clinical competence over time. Longitudinal studies tracking students' SRL skills from medical school through residency and into practice could provide insights into how SRL supports lifelong learning and professional development.[28]

Additionally, research should focus on how social and environmental factors that influence SRL, such as peer support, mentorship, and institutional culture. [29] Understanding these influences can help educators design more supportive environments that encourage SRL.

In the future, self-regulated learning in medical education should focus on integrating the curriculum more effectively, creating personalized learning paths, providing faculty development, and improving transition strategies for clinical learning. By following these recommendations, medical education can ensure that SRL enhances academic performance and supports healthcare practitioners' ongoing professional development. With further research and innovation, SRL has the potential to become a fundamental aspect of effective medical education and patient care.

9. Discussion

The application of self-regulated learning in medical education has shown significant benefits, but essential aspects still require further discussion to maximize its impact. SRL allows medical students to take control of their learning, promoting independence, adaptability, and continual improvement. However, challenges persist in its consistent application, the level of faculty support, and its long-term effectiveness in clinical environments.

SRL is effective in helping students develop self-awareness of their learning needs, especially in fields like medicine. It helps students set goals, monitor progress, and adjust strategies, making them adaptable to healthcare demands. SRL enhances academic performance, particularly in assessments like OSCEs, and supports the development of clinical reasoning skills essential for effective patient care. [30]

A key challenge is how to teach SRL differently to students with varying levels of readiness, from those who are highly self-regulated to those who struggle. In addition, faculty attention, support, and training in SRL strategies are needed to effectively guide and mentor students to develop self-regulation skills.

To address these challenges, medical schools need to provide systematic support to students and faculty. One way to do this is to offer workshops on SRL skills from early grades. This allows students to think about and discover which SRL skills are right for them. Faculty can teach students to become independent learners by offering elective courses that teach SRL. Faculty should also actively utilize modern technologies such as e-portfolios, mobile apps, and virtual simulations in their classes to guide students to learn SRL more easily using a variety of learning tools. Digital platforms can provide more personalized and adaptive teaching by tracking learning progress and providing targeted resources to help students bridge knowledge gaps. While SRL can clearly help develop independent and reflective learners, there are still challenges to fully utilizing it in medical education. Faculty need to reduce their resistance to new technologies, adopt an attitude of active use, recognize the importance of SRL, and constantly think about how to teach it to their students.

10. Conclusion

In conclusion, this paper confirmed that SRL has a significant impact on medical education through an established self-regulated learning (SRL) model and its practical application cases. SRL helps medical students set learning goals, monitor their learning progress, and adjust their strategies as needed, which is essential not only for academic success but also for a smooth transition to clinical practice. This paper discusses how the SRL models of Zimmerman, Boekaerts, Hadwin, Järvelä, and Miller can be applied in actual medical education. Zimmerman's cyclical model enables students to develop their own learning strategies through an iterative process of planning, monitoring, and reflection. Boekaerts' model emphasizes the importance of emotional regulation and properly prioritizing motivation to learn. Hadwin, Järvelä, and Miller expanded the concept of SRL from individual learning to group learning by emphasizing the role of social interaction. Since repeated monitoring, emotional regulation, and teamwork are essential in the medical environment, these models can be usefully applied to help students develop the competencies necessary to become physicians. This paper also emphasizes the importance of schools' active interest and investment in SRL. Schools should provide an environment in which students can acquire SRL skills by including various methods, such as problem-based learning (PBL), flipped classes, and use of electronic portfolios, in the medical curriculum. Problem-based learning encourages students to actively participate in education through real-life scenarios, helping them develop critical thinking and problem-solving skills essential for clinical practice. Flipped classes provide a personalized learning experience by having students review material independently before participating in interactive hands-on sessions, allowing students to identify their weaknesses and focus on where they need to be. E-portfolios can be used as a platform for students to record their learning progress, reflect on their learning experiences, and receive feedback.

In addition, this paper identifies and introduces the latest educational technologies that are continuously released, such as mobile applications and VR, to inform students of ways to develop SRL skills more happily and easily. By utilizing these learning tools, students become more active participants in their learning and further improve their critical thinking, problem solving, and self-reflection skills.

However, several challenges exist in effectively teaching SRL in medical education. Because students' environments and readiness levels vary, it is difficult to apply the same SRL strategies to all students. Some students may lack basic self-regulation skills, such as time management or goal setting, while others may have difficulty regulating their emotions, such as stress management. Additionally, a heavy curriculum can make it difficult for students to find the time needed for reflection and self-directed learning within their tight schedules, which can negate the importance of SRL. To address these barriers, medical schools should take a proactive approach to faculty development and student-tailored programming. Faculty need to educate students early on to recognize the importance of SRL, which can make a big difference in their future learning outcomes. It is important for educators to actively learn skills that foster learning environments that encourage independence, reflection, and adaptability, provide students with systematic opportunities to set goals, self-assess, and provide feedback, and directly model SRL behaviors. Faculty can also effectively support SRL by utilizing digital tools and learning management systems to track students' learning progress and provide resources for access to personalized learning materials. Despite these challenges, SRL offers great potential for medical education. By creating a culture of independent and reflective learning and nurturing students' ability to adapt to ongoing change, it can develop future medical professionals who can flexibly respond to the needs of the ever-evolving medical field. The benefits of SRL extend beyond academic success to lifelong careers. Critical thinking, decision-making, and effective collaboration within teams are essential competencies for medical professionals. Therefore, future research should explore ways to educate SRL tailored to individuals and observe how such tailored SRL leads to outcomes when students become physicians. Hope that this paper will contribute to the interest of many medical schools, professors, and medical students in SRL and to actively research and utilize it.

11. References

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