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The Role of Multimodal Strategies in Enhancing Cognitive and Meta-Cognitive Skills in Middle School Learners: A Psychological Exploration

Deepanjali Sharma[1], Dr. Anindita Das[2]

[1]Research Scholar, Department of Physical Education Pedagogy, Lakshmibai National Institute of Physical Education, Gwalior, Madhya Pradesh, India
[2]Associate Professor, Department of Physical Education Pedagogy, Lakshmibai National Institute of Physical Education, Gwalior, Madhya Pradesh, India
Email Id: lnipedeepanjali08@gmail.com
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ABSTRACT

This study explores the impact of multimodal strategies on enhancing cognitive and meta-cognitive skills in middle school learners. The research examines how integrating visual, auditory, kinesthetic, and digital modalities can address diverse learning needs and support the development of critical thinking, problem-solving, and self-regulated learning. By leveraging multiple sensory inputs and learning styles, multimodal approaches create a more engaging and effective learning environment. The study highlights the role of technology in facilitating personalized learning experiences and promoting collaborative learning. Additionally, it investigates how these strategies foster abstract thinking and meta-cognitive awareness, preparing students for the challenges of higher education and beyond.

Keywords: Multimodal learning, Cognitive skill development, Meta-cognitive awareness, Technology integration in education, Collaborative learning strategies

Introduction

The middle school years are a critical period for cognitive and meta-cognitive development, as students begin to engage in more complex learning tasks that require higher-order thinking skills. Cognitive skills, such as problem-solving, memory, attention, and reasoning, form the foundation for academic success, while meta-cognitive skills—awareness and control over one's own learning processes—allow students to plan, monitor, and evaluate their learning strategies. Both sets of skills are crucial for fostering independent learning and adaptability, which are essential in today's rapidly changing educational landscape. However, many middle school learners struggle with developing these skills, often due to the limitations of traditional teaching methods. Standard classroom practices, which tend to emphasize rote memorization and passive learning, do not fully address the diverse learning needs of students or engage them in ways that promote deeper cognitive and meta-cognitive growth (Jamil et al., 2021). This gap has led educators and researchers to explore more innovative and effective instructional strategies, including the use of multimodal strategies an approach that integrates multiple modes of learning, such as visual, auditory, kinesthetic, and digital modalities, to enhance student engagement and learning outcomes.

Multimodal strategies leverage the idea that students learn in different ways and that the integration of various sensory inputs can enhance understanding and retention of information. These strategies align with cognitive theories such as the Dual Coding Theory, which posits that the brain processes visual and verbal information separately, and when both channels are activated, it leads to better learning (Sinha et al., 2017). By using a combination of images, text, audio, and hands-on activities, multimodal strategies can engage multiple cognitive processes, making learning more effective and meaningful for middle school learners. In terms of cognitive development, multimodal strategies are especially beneficial. Cognitive development in middle school learners is marked by increasing abstract thinking, improved memory, and more advanced problem-solving skills. Multimodal strategies can support this development by providing varied and dynamic learning experiences that cater to different aspects of cognition (Jamil et al., 2021). For example, visual aids such as diagrams and charts can help students organize information, while auditory resources such as lectures or podcasts can enhance their listening and comprehension skills. Kinesthetic activities, where students engage in hands-on learning or movement-based tasks, help reinforce concepts by involving the body in the learning process, thereby promoting better retention.

Beyond cognitive skills, meta-cognitive skills the ability to think about one's own thinking—are equally vital during the middle school years. Meta-cognitive skills include planning how to approach a task, monitoring one's progress, and evaluating the effectiveness of the strategies used. These skills enable learners to become more self-directed, reflective, and adaptive in their learning. Multimodal strategies can enhance meta-cognition by encouraging students to reflect

on how different modes of learning help them understand material. For instance, students can be guided to recognize whether they retain information better through visual, auditory, or kinesthetic means, leading them to select and adjust their learning strategies accordingly. Moreover, the integration of digital tools in multimodal learning, such as educational apps, interactive simulations, and multimedia presentations, adds another layer to cognitive and meta-cognitive development (Jamil et al., 2021). Digital tools allow students to engage with material in a more interactive and self-paced manner, which can foster a greater sense of ownership over their learning. The use of digital platforms can also enhance meta-cognitive skills by providing opportunities for immediate feedback, self-assessment, and revision, enabling students to monitor their progress in real-time and make adjustments to their learning strategies as needed (Sinha et al., 2017).

Furthermore, multimodal strategies support social learning and collaboration, which are critical components of both cognitive and meta-cognitive growth in middle school learners. Group activities that involve multimodal approaches—such as collaborative projects that integrate visual presentations, oral reports, and hands-on activities—encourage students to articulate their thinking, reflect on their learning, and evaluate their peers' contributions. This kind of reflective practice not only enhances individual cognitive skills but also fosters meta-cognitive awareness as students consider how to improve both their own work and that of their group members (Salamanti et al., 2023). Multimodal strategies offer a holistic approach to enhancing cognitive and meta-cognitive skills in middle school learners. By engaging multiple sensory inputs and learning modalities, these strategies support the development of deeper cognitive processes, such as memory, attention, and problem-solving, while also fostering greater self-awareness and control over learning through meta-cognitive practices. As education continues to evolve in response to the diverse needs of learners, multimodal strategies provide a promising avenue for promoting more effective, personalized, and reflective learning experiences that prepare middle school students for the challenges of higher education and beyond(Salamanti et al., 2023).

Diverse Learning Needs

Middle school learners present a unique set of challenges and opportunities in the educational landscape, primarily due to the wide range of cognitive abilities, learning preferences, and developmental stages they encompass. Understanding and addressing these diverse learning needs is crucial for fostering an inclusive classroom environment that maximizes student engagement and achievement. Traditional teaching methods, often characterized by a one-size-fits-all approach, may not adequately cater to the varied learning styles and preferences of all students. As such, the integration of multimodal strategies into the curriculum has emerged as an effective means of addressing these diverse needs. Research has demonstrated that students learn best when instruction aligns with their individual learning preferences. Some learners are predominantly visual, benefiting from diagrams, charts, and videos that help them grasp complex concepts. Others may be auditory learners who thrive on lectures, discussions, and auditory resources (Bezemer & Kress, 2008). Kinesthetic learners, on the other hand, require hands-on experiences and movement to fully engage with the material. By incorporating multimodal strategies that integrate visual, auditory, and kinesthetic elements, educators can create a rich tapestry of learning experiences that resonate with each student. Moreover, the cognitive development of middle school learners can vary widely. Some students may exhibit advanced problem-solving abilities, while others may struggle with basic comprehension skills. This variation necessitates differentiated instruction that allows educators to tailor their teaching methods to meet individual needs. Multimodal strategies enable this differentiation by providing multiple entry points for students to engage with the content (Guo, 2023). For instance, a lesson on scientific concepts can include visual representations of experiments, audio explanations from podcasts, and interactive activities where students physically manipulate materials.

Additionally, social and emotional factors play a significant role in middle school learners' educational experiences. Students often face increased social pressures, self-identity exploration, and emotional challenges during this transitional phase. Multimodal strategies can address these factors by fostering a supportive classroom environment that encourages collaboration and peer interaction (Gillies et al., 2016). Group projects and interactive activities help students develop social skills, build relationships, and create a sense of belonging, which is essential for effective learning. Finally, as classrooms become increasingly diverse in terms of cultural backgrounds, language proficiency, and special educational needs, the implementation of multimodal strategies is paramount. These strategies can provide alternative ways for students to express their understanding and knowledge, accommodating English language learners and students with learning disabilities. By recognizing and valuing the diverse learning needs of all students, educators can create a more equitable learning environment that promotes success for every learner (Gillies et al., 2016).

Enhancement of Cognitive Skills

Cognitive skills are critical for academic success, especially during the middle school years when students face increasingly complex subject matter and expectations. Cognitive skills encompass a range of mental processes, including attention, memory, reasoning, problem-solving, and critical thinking. Enhancing these skills is vital for fostering independent learners who can navigate the demands of their education and prepare for future challenges. The implementation of multimodal strategies in the classroom offers an effective approach to improving these cognitive skills among middle school learners (Cerezo et al., 2020). One of the key benefits of multimodal strategies is their ability to engage students through various sensory modalities. By integrating visual, auditory, and kinesthetic learning experiences, educators can cater to different learning preferences while promoting cognitive engagement. For example, a science lesson on ecosystems might include visual components, such as videos or diagrams, auditory elements like podcasts or lectures, and kinesthetic activities, such as building a model or participating in a simulation. This diverse engagement stimulates multiple cognitive processes, making learning more effective and meaningful (Bezemer & Kress, 2008).

Research has shown that incorporating multimodal strategies can significantly improve attention and focus among students. Traditional lecture-based teaching methods often lead to passive learning, where students are less likely to remain engaged and attentive. In contrast, multimodal instruction actively involves students in their learning, fostering a sense of curiosity and motivation. By capturing students' interests through varied formats, educators can enhance their ability to concentrate and process information effectively. Moreover, multimodal strategies facilitate the enhancement of memory skills. Studies have demonstrated that information presented through multiple modalities is more likely to be retained than information delivered through a single mode (Guo, 2023). This phenomenon, known as dual coding, posits that using both verbal and visual representations creates stronger cognitive connections. For instance, when students learn about historical events through a combination of narrative text, visual timelines, and audio recordings, they are better equipped to recall and synthesize that information. Critical thinking and problem-solving skills are also significantly bolstered by the use of multimodal strategies (Emerson et al., 2020). Engaging students in collaborative projects that require them to analyze, evaluate, and synthesize information from various sources encourages higher-order thinking. When students work together on a multimodal project, they must negotiate different perspectives, develop arguments, and make decisions based on evidence. This process not only sharpens their critical thinking skills but also prepares them to approach real-world challenges with a more analytical mindset. Furthermore, the use of technology in multimodal strategies enhances cognitive skill development. Digital tools, such as interactive simulations, educational games, and multimedia presentations, provide immersive learning experiences that can captivate students' attention and promote deeper understanding. These tools allow students to explore concepts in a hands-on manner, reinforcing their cognitive abilities through active participation (Chen et al., 2012).

Development of Meta-Cognitive Awareness

Meta-cognitive awareness refers to the understanding and control individuals have over their own learning processes. It encompasses two main components: knowledge of cognition and regulation of cognition. Knowledge of cognition involves awareness of one's learning strategies, strengths, and weaknesses, while regulation of cognition refers to the ability to plan, monitor, and evaluate one's learning activities. The development of meta-cognitive awareness is particularly crucial during the middle school years, as students transition from concrete operational thought to more abstract thinking (Derry, 1992). Implementing multimodal strategies in the classroom can significantly enhance this vital skill set. One of the primary benefits of multimodal strategies is that they encourage students to reflect on their learning processes. By engaging with materials in various formats—such as visual aids, hands-on activities, and digital resources—students are prompted to think critically about how they learn best. For instance, after completing a lesson that incorporates different modalities, teachers can facilitate discussions that help students identify which strategies were most effective for them. This reflective practice cultivates self-awareness, as students begin to recognize their learning preferences and the techniques that enhance their understanding. Moreover, multimodal strategies promote self-regulation, a key aspect of meta-cognition. When students are exposed to diverse learning modalities, they learn to evaluate the effectiveness of different approaches in real-time. For example, during a group project, a student may notice that visual aids helped their peers grasp complex concepts more easily. This realization can lead to conscious adjustments in their own learning strategies, as they begin to actively select and apply techniques that align with their cognitive needs. By learning to monitor their progress and adapt their strategies, students become more autonomous learners, better equipped to navigate academic challenges (Bezemer & Kress, 2008).

The incorporation of technology within multimodal strategies further enhances the development of meta-cognitive awareness. Digital platforms often provide tools for self-assessment, allowing students to track their performance and reflect on their learning journeys. For example, educational software that offers quizzes and instant feedback enables students to identify areas where they excel and areas needing improvement (Wolfe & Flewitt, 2010). This immediate feedback loop encourages students to adjust their study strategies and fosters a proactive approach to learning. Additionally, collaborative learning experiences, which are integral to multimodal strategies, provide opportunities for students to engage in meta-cognitive dialogue with their peers. Working in groups allows students to articulate their thought processes, share strategies, and reflect on their learning experiences collectively. This social interaction not only enriches their understanding of the content but also reinforces their meta-cognitive skills as they learn from one another's insights and experiences. Finally, the emphasis on goal-setting within multimodal strategies can significantly impact the development of meta-cognitive awareness. By encouraging students to set specific, measurable, attainable, relevant, and time-bound (SMART) goals for their learning, educators foster a sense of purpose and direction. As students work towards these goals, they are prompted to regularly assess their progress and modify their strategies accordingly. This continuous cycle of planning, monitoring, and evaluating enhances their overall meta-cognitive awareness, empowering them to take charge of their learning (Azevedo et al., 2013).

Support for Abstract Thinking

Abstract thinking is a higher-order cognitive skill that allows individuals to process complex ideas, reason logically, and apply concepts to new situations. During middle school, students transition from concrete operational thought, where they focus on tangible and observable phenomena, to abstract reasoning, which involves manipulating ideas in their minds without relying solely on physical objects (Wolfe & Flewitt, 2010). This shift is crucial for their academic success, particularly in subjects such as mathematics, science, and literature, where understanding underlying concepts and relationships is essential. Multimodal strategies play a vital role in supporting and enhancing students' abstract thinking abilities. One of the primary ways multimodal strategies support abstract thinking is by providing diverse representations of concepts. By integrating visual, auditory, and kinesthetic modalities, educators create a rich learning environment that helps students grasp abstract ideas more effectively (Choi & Yi, 2016). For example, a mathematics lesson on geometry might involve visual

aids such as diagrams, auditory explanations from a teacher or video, and kinesthetic activities like building geometric shapes with manipulatives. This multifaceted approach allows students to visualize abstract relationships, enhancing their ability to comprehend and apply mathematical concepts. Moreover, multimodal strategies encourage students to connect new information to their prior knowledge, facilitating the development of abstract thinking. When students engage with content through various modalities, they are prompted to make connections between different ideas and concepts. For instance, a science lesson on ecosystems could incorporate visual representations of food webs, audio recordings of animal sounds, and hands-on activities like creating a miniature habitat. By exploring the interconnectedness of living organisms through these diverse modalities, students can better understand abstract concepts such as interdependence and ecological balance (Azevedo et al., 2013).

Additionally, multimodal strategies foster critical thinking and problem-solving skills, which are essential components of abstract thinking. Engaging students in collaborative projects that require them to analyze, synthesize, and evaluate information from multiple sources encourages them to think critically about the material (Choi & Yi, 2016). For instance, a project on historical events might involve researching different perspectives, presenting findings through visual presentations, and facilitating group discussions. This collaborative approach allows students to navigate complex ideas and develop well-reasoned arguments, enhancing their capacity for abstract reasoning. The integration of technology in multimodal strategies further supports abstract thinking. Digital tools such as simulations, interactive software, and online resources provide students with opportunities to experiment with abstract concepts in a controlled environment. For example, using simulation software to model chemical reactions allows students to manipulate variables and observe outcomes without the constraints of physical experiments. This hands-on exploration of abstract ideas fosters a deeper understanding of scientific principles and enhances students' ability to apply their knowledge in real-world contexts. Finally, the emphasis on reflective practices within multimodal strategies encourages students to think metacognitively about their learning processes (Leinhardt & Greeno, 1986). By regularly evaluating their understanding and the effectiveness of different strategies, students develop a greater awareness of how they think and learn. This metacognitive reflection is critical for abstract thinking, as it enables students to analyze their reasoning, identify gaps in their understanding, and adjust their approach to problem-solving.

Integration of Technology

The integration of technology in educational settings has transformed the way students learn, making it more interactive, engaging, and effective. In the context of middle school education, where students are navigating complex concepts and developing critical cognitive and meta-cognitive skills, technology plays a vital role in enhancing learning experiences. Utilizing multimodal strategies that incorporate technology can significantly support cognitive and meta-cognitive development, ensuring that students are well-prepared for future academic challenges. One of the primary advantages of integrating technology into multimodal learning strategies is its ability to provide diverse and dynamic representations of information. Digital resources such as videos, animations, and interactive simulations allow students to visualize abstract concepts and explore ideas in ways that traditional teaching methods may not offer. For instance, in a science class, students can use simulation software to model physical phenomena like chemical reactions or biological processes. This hands-on exploration not only makes learning more engaging but also deepens their understanding of complex concepts by enabling them to manipulate variables and observe outcomes in real-time. Furthermore, technology facilitates personalized learning experiences tailored to individual student needs. Educational software and applications often include adaptive learning features that assess a student's current level of understanding and adjust content delivery accordingly (Leinhardt & Greeno, 1986). This level of customization allows students to work at their own pace, focusing on areas where they need more practice or support. As students engage with technology in this manner, they develop greater meta-cognitive awareness by reflecting on their learning processes, identifying effective strategies, and making adjustments based on their performance.

The collaborative aspect of technology is also significant in enhancing cognitive and meta-cognitive skills. Online platforms, such as discussion forums, collaborative documents, and virtual classrooms, allow students to interact with their peers and teachers in meaningful ways. These platforms promote communication and teamwork, encouraging students to share their ideas, provide feedback, and co-construct knowledge. Collaborative projects that utilize technology not only enhance learning outcomes but also foster critical thinking and problem-solving skills as students navigate diverse perspectives and work together to achieve common goals. Moreover, the use of technology supports the development of essential digital literacy skills, which are increasingly important in today's digital world. By integrating technology into the classroom, students learn how to effectively search for information, evaluate online resources, and utilize various digital tools for research and presentations. These skills are not only vital for academic success but also prepare students for future careers in an ever-evolving job market that demands proficiency in technology. Finally, technology provides opportunities for immediate feedback and assessment, which are crucial for fostering meta-cognitive skills. Many educational technologies include features that allow students to receive instant feedback on quizzes, assignments, and interactive activities (Azevedo et al., 2013). This immediate response helps students recognize areas of strength and weakness, encouraging them to reflect on their learning strategies and make necessary adjustments. Such timely feedback empowers students to take ownership of their learning, enhancing their ability to monitor and regulate their progress effectively.

Promotion of Collaborative Learning

Collaborative learning is an instructional approach that emphasizes teamwork and social interaction among students as they engage in shared learning experiences. This approach is particularly effective in middle school settings, where students are developing their cognitive and meta-cognitive skills and

navigating complex social dynamics. The integration of multimodal strategies into collaborative learning not only enhances students' understanding of content but also fosters essential skills such as communication, critical thinking, and problem-solving. One of the key benefits of promoting collaborative learning is that it encourages students to take an active role in their education (Leinhardt & Greeno, 1986). When working in groups, students are required to articulate their thoughts, share ideas, and listen to their peers. This active engagement fosters deeper understanding of the subject matter as students learn from one another and explore different perspectives. For example, in a history lesson, a group of students might collaborate to create a multimedia presentation on a significant event. Each student can contribute their strengths—some may focus on research, while others work on design or presentation skills—leading to a richer and more comprehensive understanding of the topic. Furthermore, collaborative learning provides an opportunity for students to develop essential communication skills. As they navigate group discussions, students learn how to express their opinions respectfully, negotiate differing viewpoints, and reach consensus on decisions. These skills are not only valuable in academic settings but are also critical for success in future professional environments. By practicing effective communication and teamwork in a supportive setting, students become more confident in their abilities to collaborate in diverse contexts.

In addition to enhancing cognitive skills, collaborative learning promotes meta-cognitive development by encouraging students to reflect on their own learning processes. When working together, students can share their strategies for problem-solving and discuss the effectiveness of different approaches. This dialogue fosters meta-cognitive awareness, allowing students to evaluate their own understanding and adapt their learning strategies based on peer feedback (Leinhardt & Greeno, 1986). For instance, during a math project, one student might realize that their approach to solving a problem differs from their classmates'. By discussing these differences, they can reflect on their methods and potentially adopt new strategies that improve their understanding. Moreover, the use of technology in collaborative learning enhances the effectiveness of group work. Online platforms such as collaborative documents, discussion boards, and project management tools facilitate communication and organization among group members, regardless of their physical location. These tools allow students to collaborate in real-time, share resources, and provide feedback, making it easier for them to stay connected and engaged. For instance, a group of students working on a science project can use a shared digital workspace to compile their research, exchange ideas, and track their progress, all while enhancing their digital literacy skills. Finally, promoting collaborative learning through multimodal strategies can create a more inclusive classroom environment. By encouraging students to work together, educators can foster a sense of community and belonging, which is especially important for middle school learners who often face social pressures. Collaborative learning helps students build relationships and develop empathy as they interact with peers from diverse backgrounds and experiences. This social interaction not only enhances their learning but also contributes to their social-emotional development.

Conclusion

Multimodal strategies offer a comprehensive approach to enhancing cognitive and meta-cognitive skills in middle school learners. By engaging multiple sensory inputs and learning modalities, these strategies support the development of deeper cognitive processes, such as memory, attention, and problem-solving. Simultaneously, they foster greater self-awareness and control over learning through meta-cognitive practices. The integration of technology and collaborative learning experiences further enriches the educational landscape, providing students with diverse tools and opportunities to explore complex concepts and develop essential skills. As education continues to evolve in response to the diverse needs of learners, multimodal strategies provide a promising avenue for promoting more effective, personalized, and reflective learning experiences. These approaches not only address the immediate academic needs of middle school students but also equip them with the skills necessary for lifelong learning and success in an increasingly complex world. By embracing multimodal strategies, educators can create inclusive, engaging, and dynamic learning environments that prepare students for the challenges of higher education and beyond.

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