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THE EFFECTIVINESS OF THE STEM APPROACH IN IMPROVING THE QUALITY OF LEARNING IN ELEMENTARY SCHOOL

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Abstract: The STEM (Science, Technology, Engineering, and Mathematics) approach is a relevant learning innovation in addressing the demands of 21st-century education. This review article aims to examine the effectiveness of implementing the STEM approach in improving the quality of learning elementary schools through an analysis of various previous studies. The method used is a literature review, examining scientific sources in the form of national and international journals related to the implementation of STEM in elementary education. The study results indicate that the STEM approach can improve the quality of learning, as indicated by increased critical thinking skills, creativity, collaboration, and problem-solving skills in students. Furthermore, STEM-based learning can also increase student motivation and active participation through contextual and project-based learning activities. However, several challenges in its implementation exist, such as limited facilities, teacher preparedness, and a lack of ongoing training. Thus, the STEM approach has proven effective in improving the quality of learning in elementary schools, but requires optimal support from various parties for optimal implementation.
Keyword: STEM, elementary school learning, learning quality, 21st-century skills, literature review.

INTRODUCTION

Improving the quality of learning in elementary school is an urgent need to face the challenges of the 21st century. The rapid development of science and technology requires student to master not only basic knowledge but also higher-order thinking skills, such as critical, creative, collaborative, and communicative thinking. Elementary schools, as the foundation pf education, play a strategic role in developing these abilities from an early age. Thefore, quality learning needs to be systematically designed to meet the increasingly complex demand of the times.

However, learning practices in elementary schools still face numerous challenges. One major issue is the continued dominance of conventional, teacher-cantered learning. In this model, the teacher is the primary source of information, while student tend to passively receive the

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material. The learning process emphasizes memorization over conceptual understanding, leaving student with limited opportunities to explore, ask questions, or develop their own ideas. As a result, learning becomes less meaningful and fails to optimally develop students potential.

Another emerging issue is students low critical thingking and problem-solving skills. Many students struggle when faced with question requiring analysis, evaluation, and logical reasoning. This indicates that ongoing learning has not fully trainbed students to think deeply and systematically. Furthemore, their ability to connect knowledge to real-life sutuations is still limited, leaving students ill-prepared for real-word challenges.

To address these issue, an innovative, student-centered learning approach is needed. This approach emphasizes active student involvement in the learning process through exploration, discussion, experimentation, and problem-solving. One approach deened relevant to the demands of the 21st century is the STEM (Science, Technology, Engineering, and Mathematics) approach.

The STEM approach is a learning approach that integrates four disciplines-science, technology, engineering, and mathematics-into a unified whole. STEM learning focuses not only on mastering concepts but also on applying those concepts to solving real-world problems. Through this approach, students are encouraged to think critically, collaborate, innovate, and develop contextual problem-solving skills. Thus, STEM can help students understand the interrelationships between disciplines while enhancing their readiness to face the changing times.

The urgency of implementing STEM in primary education is growing, given the need for adaptive and competitive human resources in the era of globalization. Early introduction to STEM is expected to foster students interest in science and technology and foster logical and systematic thingking. Furthermore, this approach can improve the quality of learning by making it more enganging, relevant, and meaningful, for students.

Based on this description, the purpose of this article is to examine the effectiveness of the STEM approach in improving the quality of learning in elementary school. This study is expected to provide an overview of STEM's potential as an innovative solution to address learning challenges and as an effort to improve student competencies in line with the demands of the 21st century.

Description of the STEM Approach in Elementary School Learning

The STEM (Science, Technology, Engineering, Mathematics) approach in elementary school learning is an ingrate learning approach that integrates four disciplines science, technology,

engineering, mathematics into a single, contextual and meaningful learning enviroment. This approach does not teach these four fields separately, but rather connects them through real-word problem relevant to students' daily lives. Thus, STEM learning emphasizes thinking processes, problem-solving, and the application of concepts in real-life situations, rather than simply mastering theory.

The main characteristics of the STEM approach in elementary school learning include student-cantered, contextual learning, emphasizing critical and creative thinking skills, and encouraging collaboration and communication. STEM learning principles position student as active subjects directly involved in the process of discovering, designing, testing, and evaluating solutions of problems. Teachers act as facilitator who guide student in the learning process, not as the sole source of information.

The integration of science, technology, engineering, mathematics in elementary school learning can be implemented through simple activities appropriate to students developmental levels. Science elements are demonstrated through observing, classifying, and understanding natural phenomena. Technology elements are implemented through the use of simple tools, media, or technology to support the learning process. Engineering elements emerge when student sre invited to design or create a simple product as a solution to a given problem. Meanwhile, mathematics elements are used to calculate, measure, compare, and analyse data obtained during learning activities.

Examples of the application of the STEM approach in elementary school learning can be seen in project-based learning activities, such as designing a simple bridge from straws to learn the concepts of force and balance. In this activity, student learn the scientific concept of force, use technology in the form of simple tools, apply engineering by designing and building a bride, and use mathematics to measure the length and strength of the bridge. In addition, STEM can also be applied through contextual problem solving, for example finding solutions for waste management in the school environment, or through simple experiments such as water filtration experiments to understand the concepts of changes in state and environmental pollution. Through these activities, learning becomes more meaningful because students can connect the subject matter with real experiences in everyday life.

Advantages of the STEM Approach (Pros)

The STEM approach has several advantages that make it relevant and effective for elementary school learning. One of its main advantages is its ability to enhance students critical thingking and problem-solving skills. Through problem-based and project-based learning, studensts are trained to analyze problems, seek relevant information, formulate solutions, and evaluate the results. This process incourages students to not simply passively receive information but to actively construct knowledge through meaningful learning experiences.

In addition to critical thinking, the STEM approach also fosters student creativity. In STEM learning activities, students are given the opportunity to design, create, and modify a product or solution based on their ideas and imagination. These activities foster, creative thinking skills and the courage to explore various alternative solutions. STEM learning also emphasizes group work, enabling students to develop their collaboration and communication sklills optimaly. Student learn to discus, share roles, express opinions, and value the ideas of their peers as they complete collaborative tasks.

Another advantage of the STEM approach is its ability to increase student motivation and interest in learning. Learning connected to real-life problem helps students feel that what they're learning has immediate benefits. Practical and challenging activities, such as simple experiments and projects, make learning more enganging and enjoyable. This results in increased student engagement throughout the learning process.

The STEM approach also helps students understand learning concepts more deeply. The integration of science, technology, engineering, and mathematics allows students to see the interconnectedness of concepts, ensuring that the knowledge gained is not isolated. This holistic understanding makes it easier for students to apply concepts to also on the thinking process and conceptual understanding.

Overall, the STEM approach makes a significant contribution to developing 21st century skills in elementary school students, such as critical thinking, creativity, collaboration, communication, dan technological literacy. These skills provide the foundation for student to face future challenges and adapt to the incresingly rapid developments in science and technology.

Disadvantages of the STEM Approach (Cons)

Despite its many advantages, the STEM approach also presents several drawbacks and challenges in its implementation in elementary schools. One major obstacle is the limited availability of learning support facilities and infrastructure. Ideally, STEM implementation requires teaching aids, practical materials, learning media, and access to specific technology. However, not all elementary schools have adequate facilities, often preventing the implementation of STEM experiments or projects from being optimal.

Furthermore, teacher readiness and competency are significant challenges in implementing the STEM approach. Not all elementary school teachers have a deep understanding of STEM concepts and how to integrate science, technology, engineering, and mathematics into a single learning activity. Teachers are also required to design creative, contextual, and problem-based learning, which requires specialized training and experience. Without adequate professional development support, STEM learning has the potential to become little more than simple practical activities without clear conceptual integration.

Limited learning time also poses a barrier to implementing the STEM approach in elementary schools. STEM activities generally require longer periods of time because they involve planning, implementation discussion, and reflection. Meanwhile, the allocation of learning time in schools is often limited and must be adjusted to meet curriculum demands and competency achievement targets. As a result, teachers struggle to manage their time effectively to ensure all strages of STEM learning are implemented effectively.

Anouther challenge is the difficulty in designing integrated learning. Combining various subject into a single STEM learning activity equires careful planning to achieve each competency in a balanced manner. Teacher need to ensure that elements of science, technology, engineering, and mathematics are are truly integrade, not simply presented separately, This design process is often considered complex and requires advance planning skills.

In addition to these obstacles, there is also a potential gap in the implementation of the STEM approach between schools in urban and rural areas. Urban schools generally have better access to facilities, technology, and teacher training, allowing for more optimal STEM implementation. Conversely, schools in rural areas often face limited resources, both in terms of facilities and training support, which prevents STEM implementation from being implemented evenly. This situation highligts the need for ongoing policy support and mentoring to ensure the equetable and effective implementation of the STEM approach across all elementary scools.

Comparison of the STEM Approach with other Learning Approaches

The STEM approach differs significantly from other leraning approaches commonly used in elementary school, such as conventional learning and thematic learning. In conventional learning, the learning process tends to be teacher-centered. The teacher serves as the primary source of information, primarily receive material through explanation, lectures, and practice excercises. The interactions are one-way, resulting in relatively limited student involvement in the learning process. Consequently, student learning,outcomes often emphasize lower- level conitive aspects, such as remembering and understanding without fostering the development of higher-level thngking sklills.

Unlike conventional learning, the STEM approach places students the center of learning. Teachers act as facilitators, guidinng, directing, and supporting students learning process. In the STEM approach, student actively engage in observing, designing, experimenting, and solving problems through project-based learning or real world problem solving. The learning process is collaborative and interactive, providing students with the opportunity to develop critical and creative thingking sklills, as well as communication and collaboration skills.

Coppared to thematic learning, the STEM approach shares similarities in terms of integration between subjects. However, thematc learning generally focuses on delivering material based on a specific theme and does not fully emphasize in depth problem solving. Minewhile the STEM approach emphasize the application of concept in real world contexts through simple experiments, project, and design activities. Integration in STEM not only connects subject matter but also relates it to everyday life problems, challenging students to think and act in real world contecxts.

In terms of its impact on learning outcomes, the STEM approach is considered more capable of creating active, contextual, and meaningful learning. Students not only gain knowledge but also understand how these concepts are applied in everydat life. This helps foster a deeper understanding of concepts and encourages students to apply their knowledge in new situasion. Therefore, compared to other learning approaches, the STEM approach has the advantage of creating a comprehensive and relevant learning axperience for elementary school students.

Conclusion

The STEM approach has proven effective in improving the quality of learning in elementary schools because it creates an active, contextual, and meaningful learning process for student. Through the integration of science, technology, engineering, and mathematics, STEM learning encourages students to think critically and creatively, as well as to collaborate and communicate effectively. The main advantage of this approach lies in its ability to connect subject matter to real life problems, thus deepening students conceptual understanding and enhancing their understanding.

However, the implementation of the STEM approach in elementary schools still faces various challenges, such as limited facilities and infrastucture, varying teacher readiness and competency, limited learning time, and the complexity of designing integrated learning. Furthemore, there is still a gap in STEM implementation between schools in urban and rural areas due to differences in access to facilities and training. These challenges require attention to ensure optimal and equitable implementation of STEM.

The implications of implementing the STEM approach for learning practices in elementary schools demonstrate the need for a paradigm shift in learning from teacher centered to student centered. Teachers are expected to act as creative and innovative facilitators in designing STEM based learning activities. Therefore, it is recommended that teachers continously improve their competencies through training and professional development. Schools are expected to provide support in the from of facilities and infrastructure, as well as flexible learning times. Meanwhile, educational stakeholders need to provide policies, mentoring, and ongoing support so that the STEM approach can be effectively implemented to improve the quality of learning in elementary schools.

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