

Review the Impact of Experiential Learning (Innovative Pedagogical Approach) on Problem Solving in STEM Education

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HOW TO CITE:

Tarun Pratap Singh, N. P. S.
Chandel, Asmita Sharma, Sarla
Mehra, Meenu Singh (2026).
Review the Impact of Experiential
Learning (Innovative Pedagogical
Approach) on Problem Solving in
STEM Education
International Journal of Special
Education, 41(21s), 1654-1666

ABSTRACT

In the context of 21st-century teaching and learning, problem-solving is an essential and fundamental skill. Problem-Solving is one of the skills of HOTS (Higher Order Thinking Skills). Problem-solving closely aligns with STEM (Science, Technology, Engineering, Mathematics) education. In the present Literature review, the researcher explores how the experiential learning approach enhances and develops the problem-solving competencies in STEM classrooms. The method of the present study is a Theoretical Literature Review. To fulfil the purpose of the present study, the researcher reviews the 50 researches of Experiential Learning, STEM education, and Problem-solving. The researcher reviewed researches from the following databases: ERIC, Google Scholar, Research Gate, Sodhganga, and Scopus. Drawing from educational theories and current research, the paper highlights how hands-on experiences, inquiry-based learning, and collaborative tasks enhance students' ability to analyse, evaluate, and solve problems. It also discusses key pedagogical strategies such as project-based learning, guided inquiry, and reflective practice that align with STEM goals. The review emphasizes the importance of creating learner-centred environments where students actively construct knowledge and apply it in meaningful contexts. In this paper, the researcher reviews that how Experiential Learning promote active learning, enquiry-driven learning, and enhance problem solving skills of the students through hands-on activities. **Keywords:** artificial intelligence (AI), autonomy, ethical implications, memory, privacy

Keywords - STEM education, Problem Solving, and Experiential Learning, et

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Introduction

1.1 Contextualization

India has a long tradition of holistic and multidisciplinary learning from universities like Takshila and Nalanda to the extensive literature of India, combining subjects from various fields. The integration of arts with science, technology, engineering, and mathematics (STEM) has consistently shown positive learning outcomes, including problem-solving abilities. Research in the field of education is enhanced through a holistic and multidisciplinary educational approach (Government of India, 2020).

During the previous decades, STEM (Science, Technology, Engineering, Mathematics) Education's main aim was to develop 21st-century skills in the students to fulfil the present needs of society. STEM education prepares the programme to develop integrated STEM education techniques to help the students solve problems and link the information with multiple STEM domains (Mentzer, Ryu & Knobloch, 2019).

One of the most significant developments of the twenty-first century has been the emergence of problem-solving ability as a prominent and influential field of education. Problem-solving ability has consistently shown remarkable work in fields across the arts, humanities, language, science, social sciences, professionals technical, and vocational fields (PISA, 2018; Organisation for Economic Co-operation and Development, 2019). School education has recently emerged as an important component of the overall education system, with the potential to significantly contribute to both individual and national development processes (United Nations Educational, Scientific and Cultural Organization, 2015; Government of India, 2020).

1.2 Objective of the study

This study examines the impact of Experiential learning on 21st century skills specially problem solving in STEM education.

1.3 Theoretical Background and Conceptual Framework

1.3.1. Experiential Learning

Experiential learning (EL) integrates knowledge and experience through critical reflection. EL activities are actively created and evaluated. They help learners improve individual and collaborative skills, including complicated problem-solving, professional practice, and teamwork. Critical reflection on these activities promotes higher-order thinking and challenges one's perspectives. The EL process helps students to become active citizens and thrive in a complicated environment (University of Calgary 2020, Experiential Learning Plan 1654-1666).

Experiential learning involves reflecting on one's own actions, as opposed to rote or didactic methods. Experiential learning is not synonymous with other terms such as experiential education, action learning, adventure learning, free choice learning, cooperative learning, or service learning. Although there are similarities between these education ideas, but differences also Experiential learning prioritizes the individual's learning process, as opposed to experiential education, which focuses on the teacher-learner relationship. Experiential learning involves interacting with an environment, such as visiting a zoo, rather than simply reading about animals in a book (David Kolb, 1984)

Kolb (1984) expostulates that learning is a sequential process that generates knowledge via the transformation of experiences. Six basic things characterized a learning as experiential learning are:

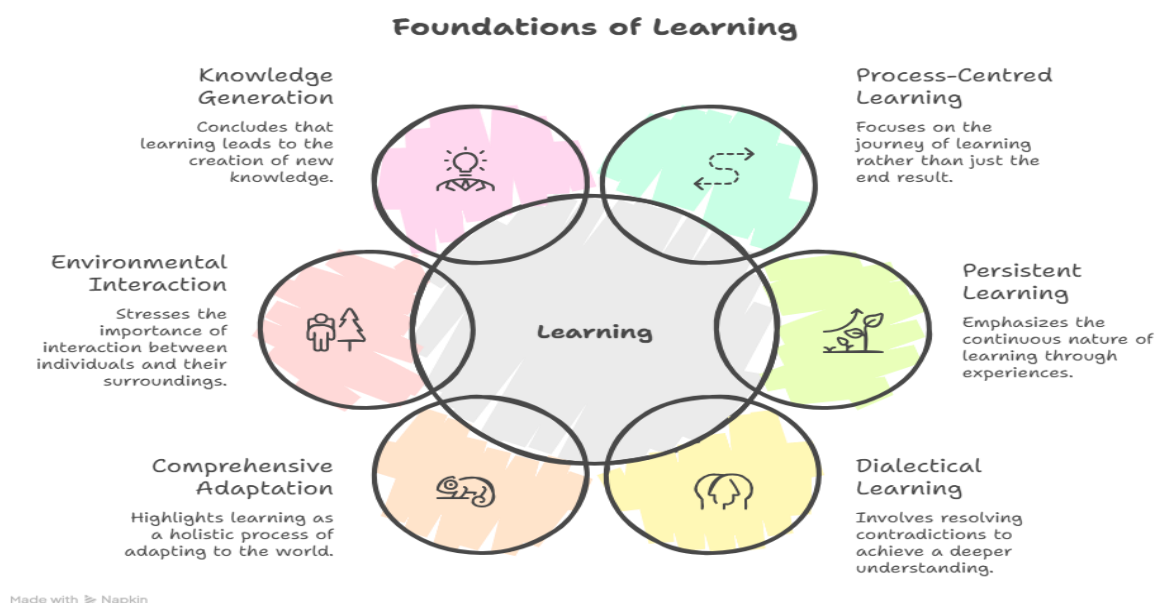


Fig.1 Characteristics of Experiential Learning Kolb (1984)

Experiential Learning in NEP 2020

In order to explore the connections between *learning experiences*, experiential learning—which includes hands-on activities, integrating the arts and sports, and using storytelling as a teaching method—will be used at all stages as standard pedagogy in each topic. Classroom interactions will shift to competency-based teaching in order to close gaps in learning outcomes. For every subject and class, assessment tools—which include assessment "as," "of," and "for" learning—will be in line with the designated learning outcomes, abilities, and dispositions. (Ministry of Education, 2020) (paragraph 4.6, page 13)

1.3.2. Problem Solving

Problem-solving is a cognitive process that comprises discovering, analysing, and solving problems. Problem-solving helps in overcoming obstacles and resolving issues. Problem-solving is the process to get the solution through various practices or experiments. Problem solving includes systematic operations and can be used to assess an individual's critical thinking abilities. Problem-solving is the higher level of

cognitive process that necessitates the modulation and control of fundamental skills (Dewey, 1933; Gagne, 1985; Pólya, 1957).

Dimensions of Problem Solving in reference to STEM education

In the following table, the dimensions of problem solving and their description in the STEM education context are given. These dimensions include cognitive dimensions, metacognitive, affective dimensions, collaborative tasks, creative thinking, etc.

1.3.3. STEM Education

STEM education, as conceptualized by William (2011), represents an instructional framework that integrates engineering and technology to actively engage learners, thereby enhancing their comprehension and achievement in science and mathematics. Lantz (2009) further characterizes STEM education as a transdisciplinary approach that dissolves traditional disciplinary boundaries, fostering a more holistic understanding of the world. Similarly, Sahin et al. (2014) emphasize that STEM education adopts a comprehensive educational paradigm aimed at cultivating individuals' capacity to approach problems from interdisciplinary

perspectives by equipping them with integrative knowledge and skills.

Historical Background of STEM

The STEM term was introduced by the NSF (National Science Foundation), United States, in 1990 as an abbreviation for “Science, Technology, Engineering, and Mathematics” (Sanders, 2009). According to the United States Department of Education (2007), STEM education is an educational program with the study of science, technology, engineering, and mathematics embedded in its core objectives, in order to strengthen the education. The “S” in STEM represents science, which primarily focuses on exploring and understanding the natural world. It emphasizes cultivating students’ ability to think and operate like scientists by encouraging inquiry, hypothesis formulation, and the application of established scientific methods during investigations (Kelley &

Knowles, 2016). The “T” denotes technology, which involves the purposeful transformation of the natural environment to fulfil human needs and desires. “E” for Engineering, stands as a profession in which knowledge of maths and practical things of any profession. “M” for Mathematics is defined as the science of patterns and relationships that provide the exact language for technology, science, and engineering (Dugger, 2010).

Strategies for Integrating STEM into the Classroom

Integrating STEM into the classroom creates an engaging teaching-learning atmosphere that enhance and improves students’ creativity, problem solving abilities, and prepares them for a future driven by technology and innovation. The major strategies for integrating STEM into the classrooms are as follows:

S. No.	Strategy	Key Points	Example	Benefits for Students
1	Emphasize Real-World Connections	Connect STEM concepts with real-life applications and different industries	While teaching geometry, explain how architects use geometric principles to design buildings and engineers use mathematics to build bridges	Helps students understand the importance of STEM and inspires them to explore STEM careers
2	Promote Hands-on Learning	Encourage students to participate in experiments, projects, and practical problem-solving activities	Organize a robotics competition where students build and program robots to complete tasks	Improves practical skills, teamwork, creativity, and problem-solving abilities
3	Foster Collaboration and Teamwork	Encourage students to work in groups and combine their skills to solve complex problems	Students design and build a sustainable model city using STEM concepts like energy efficiency and urban planning	Develops communication skills, teamwork, leadership, and learning from different perspectives

4	Integrate Technology	Use digital tools, simulations, apps, and technology-based activities in STEM lessons	Use coding platforms to teach programming or interactive simulations to explore science concepts	Makes learning more engaging and helps students develop future technology skills
5	Encourage Inquiry-Based Learning	Allow students to ask questions, explore ideas, and find solutions independently	Present a real-world problem and ask students to create innovative solutions using STEM knowledge	Builds critical thinking, creativity, analytical skills, and independent learning

Problem-solving in STEM through Experiential learning

In STEM education, experiential learning encourages the learners to think creatively, real-world problem solving, develop a scientific attitude, gain hands-on experiences,

group work, and project work, etc. In the following table, some skills of STEM education, the impact of experiential learning situation and how experiential learning fosters these skills in problem solving are given in the following table (**National Research Council, 2012**).

Table 2: STEM skills and context of Experiential learning (NRC 2012)

STEM Skills	Impact of Experiential Learning
Knowledge application	Learners apply their scientific and mathematical concepts in real life situation.
Analytical Thinking	Learner breaks down the problem in parts and analyse for the solution
Innovation and designing	Encourage the learners for creative thinking and designing functional prototypes
Decision Making	Students evaluate evidence and justify solutions based on experience
Communication and Collaboration	Problem solving improve through group learning task and peer discussion

3.0. Method of the Study

In this theoretical review the researcher reviews the study from various data bases. **Webster & Watson (2002)** were the first to introduce a structured process for writing what's now known as a 1“theoretical” literature review.

3.1. Search Strategies of researches

The articles identified from the Scopus, Google Scholar, ResearchGate, ERIC, Sodhganga. The researcher identifies research articles of the several discipline (Management, Education, Psychology, Mathematics, Science and etc.) form these databases.

3.2. Selection and extraction of the

researches

The researcher delimited the study to Educational Research. The sample of the researches is 50 between the year 2021 to 2025 (Last 5 years).

4.0. Review of Literature

To fulfil the aims of the present study, the author reviewed the research on Problem Solving, STEM education, and Experiential Learning. The researcher includes the

researches of year between 2021 and 2025. The classification of the reviewed research into the following heads,

(I) Database-wise classification of the studies

To fulfill the purpose of the present study the research reviewed the researches from 5 databased as Shodhganga, Researchgate, Google scholar, ERIC, Scopus. the dewtail of reviewed researches given in the table 3.

Table 3 Database wise classification

Database	ERIC	Google Scholar	ResearchGate	Scopus	Shodhganga
No. of Researches	15	10	15	5	5

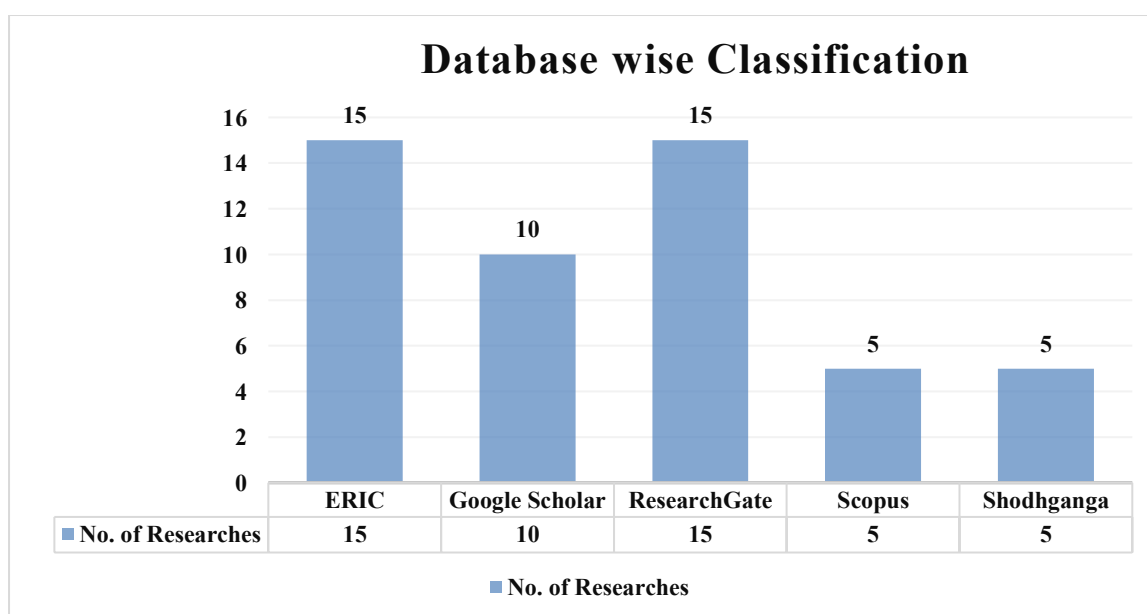


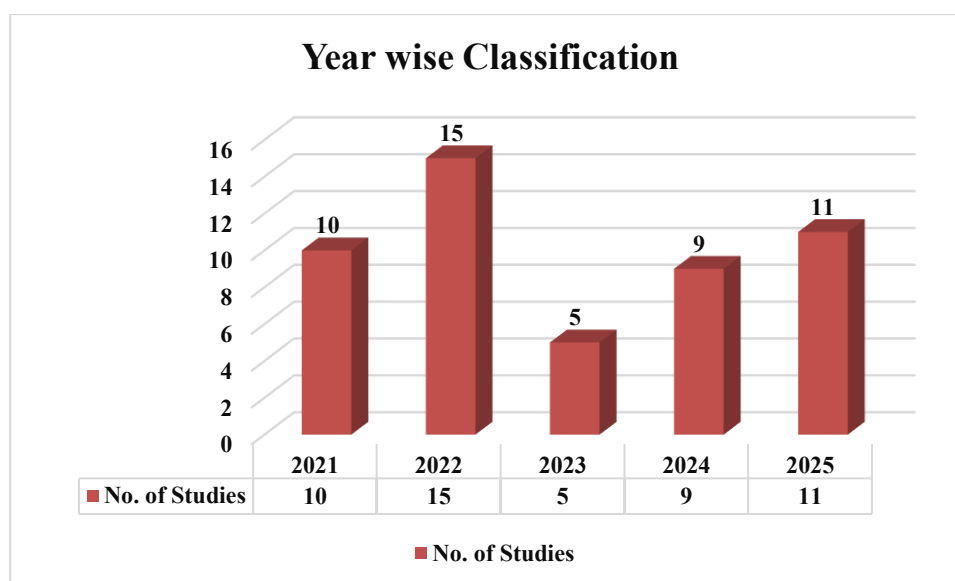
Fig. 2 Database wise classification

(II) Year-wise classification of the studies

In the present classification of the study the researcher included researches between year 2021 to 2025. The total no of studies is 50 of all the variables.

Table 4 Year wise classification

Year	2021	2022	2023	2024	2025
No. of Studies	10	15	5	9	11

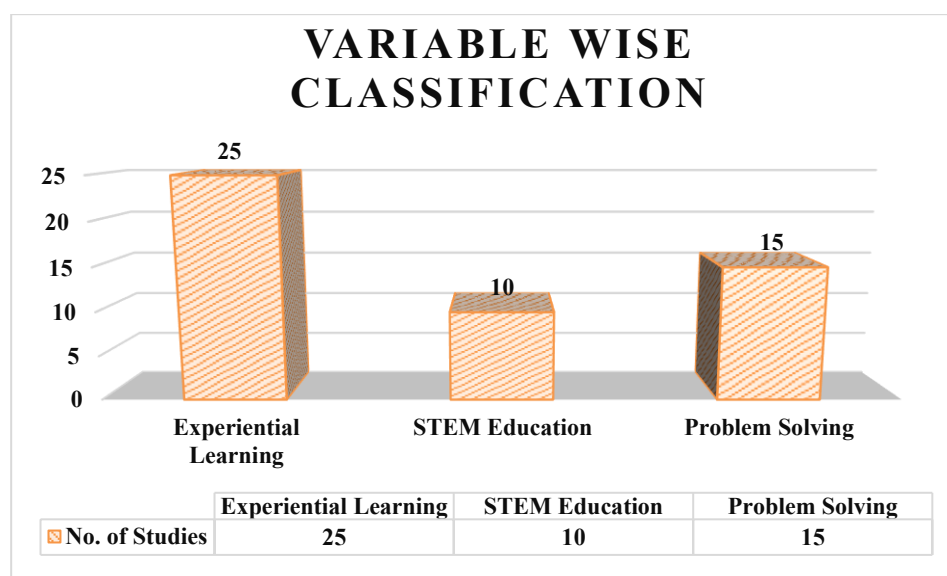


(III) Variable-wise classification of the studies

Variable wise distribution of the researches given in the table 5.

Table 5 Variable wise classification

Variables	Experiential Learning	STEM Education	Problem Solving
No. of Studies	25	10	15



Fig, 3 major findings of the study

4.1. Reviewed Studies and their findings

The researcher reviewed the 50 studies related to all three variables; to fulfill the aim of the present paper the researcher selects 15 researches for the discussion of the result and findings of the present review paper. These all researches directly connected to the aim of the paper.

Table 6 Studies and findings

Sr. No	Author (Year)	Title of the study	Research Method, Stage and Sample of the study	Findings of the Study
1	Ceyhun Uzun & Kamil Uygun (2022)	The Effect of Simulation-Based Experiential Learning Applications on Problem Solving Skills in Social Studies Education	Experimental research, Secondary School stage (42 students)	Simulation-based experiential learning significantly improved students' problem-solving skills compared to traditional teaching methods.
2	I. F. Lestari (2021)	Experiential Learning Using STEM Approach in Improving Students' Problem Solving Ability	Pre-experimental design, Senior Secondary School (40 students)	Experiential learning with STEM approach significantly increased students' problem-solving ability; highest improvement in problem description and planning solutions.
3	Jacinta Bwegyeme & John C. Munene (2021)	Experiential Learning: Learning Abilities that Enhance Problem Solving Ability	Cross-sectional survey design Higher Education (103 Administrator)	Kolb's experiential learning abilities (especially abstract conceptualization and active experimentation) significantly predicted and enhanced problem-solving ability.
4	Parno, Estianinur & Eny Latifah (2021)	The Increase of Problem-Solving Skills of Students through STEM Integrated Experiential Learning with Formative Assessment	Mixed method Senior Secondary School (36 students)	STEM-integrated experiential learning with formative assessment significantly increased students' problem-solving skills with medium N-gain and strong effect size.
5	Rosalie W. Ambasa & Denis A. Tan (2022)	Student Mathematics Performance and Problem-Solving Skills in an Experiential Learning Environment	Quasi-experimental design Secondary School Mathematics (92 students)	Students exposed to experiential learning environment showed significantly better problem-solving skills, although mathematics performance between groups was similar.

6	Jin Kang, Noemi M. E. Roestel & Audrey Girouard (2022)	Experiential Learning to Teach User Experience in Higher Education in Past 20 Years: A Scoping Review	Scoping Review / Literature Review Review Higher Education level studies	Experiential learning in user experience education improves student knowledge, job marketability, and student satisfaction in higher education.
7	Rupali Dave, Thomas Walker, H. Grant-Peterkin, R. Fisher & F. Rohricht (2022)	Evaluation of a Drama-Based Experiential Learning Group Programme for Multidisciplinary Staff and People with Lived Experience in Psychiatry	Program evaluation / experiential learning intervention, Multidisciplinary staff, individual with lived experience	Drama-based experiential learning improves personal well-being, empathy, understanding of others' perspectives, and interpersonal skills.
8	C.Knoblauch (2023)	Concepts of Experiential Learning in Digital Collaboration: New Perspectives for the Higher Education Sector	Conceptual / Theoretical analysis Higher Education	Experiential learning in digital collaboration environments positively influences student learning experiences and supports effective digital or blended learning in higher education.
9	Mund, P. (2024)	Improving Integrated Science Process Skills of Ninth-Grade Students through Experiential Learning	Mixed Method (Quantitative and Qualitative) Secondary Students	Students initially had low scientific process skills; experiential learning based on Kolb's model improved understanding of scientific processes and promoted better learning and social skills.
10	A., Akhtar, S., & Ahmed, S. Z., (2024)	Problem-solving based learning in STEM education: Role of epistemological and motivational beliefs along with self-regulated learning strategies	Qualitative Method Teacher Educators (120)	Teachers believed that students' attitudes, motivation, and self-regulated learning strategies toward STEM education play an important role in enhancing their engagement and problem-solving skills.

11	Almujaddid, S. A., Yuliati, L., & Widodo, H. (2025).	Experiential Learning with STEM-Computational Thinking (STEM-CT) Approach to Develop Students' Problem-Solving Skills.	Quasi Experimental Research Secondary Stage students (60)	The result of the study indicated that the STEM-CT with Experiential Learning enhance the problem-solving ability of the students.
12	Bharti, P. & Soni, C. (2025)	Perspective of teachers towards teaching of science and Mathematics through STEM educational initiatives	Descriptive Survey School Teachers (1654-1666 class)	A number of factors, including a lack of parental support, a lack of learning resources and tools, a lack of knowledge of STEM education, and the necessity of teacher training programs, contribute to teachers' feelings of difficulty in teaching STEM subjects.
13	Nguyễn, L.C., Hoa, L.Q., & Hien L.H. (2025)	Integrating design thinking into STEM education: Enhancing problem-solving skills of high school students	Experimental Research High School Students (334 students)	The iteration between stages helps students continually refine and improve their solutions while developing their observation, creativity, and self-evaluation skills.
14	Ondes, R.N. (2025)	Effects of STEM Practices on Students' Problem-Solving Skills: A Meta-Analysis	Meta-Analysis Secondary data (Web of Science, SCOPUS and ERIC databases)	STEM practices can have a substantial positive impact on the development of students' problem-solving skills, with certain approaches, educational levels, and durations demonstrating particularly strong effects.
15	Rahman, T.F., Zakariah, Z. B., & Anuar, N. B. (2025)	The impact of STEM activities on Students' knowledge and Project development skills	Quantitative Approach Lower secondary students	More efforts need to be placed on project development skills as some of the respondents are still standing at a novices' stage in problem solving techniques.

Discussion

Objective of the present study

This study examines the impact of Experiential learning on 21st century skills specially problem solving in STEM education.

Major Findings of the Study

On the basis of the given review of literature its finds that The Experiential Learning enhance the learner's motivation, their classroom engagement, their academic

performance, their knowledge retention (**Jin Kang, Noemi M. E. Roestel & Audrey Girouard 2022**) their Science processing skills (**Mund,P. 2024**), higher order cognitive skills (HOCS) , problem solving (Almujaddid, S. A., Yuliati, L., & Wisodo, H. 2025., **Rosalie W. Ambasa & Denis A. Tan 2022 , Ceyhun Uzun & Kamil Uygun 2022**) reflective thinking and also promote group learning (**C. Knoblauch 2023**).

Conclusion

Problem-solving in STEM education is a critical competency that extends beyond content mastery, requiring the development of higher-order thinking skills, creativity, and real-world application. Grounded in constructivist and experiential learning theories, effective STEM instruction engages students as active participants in their learning process. Activities of Experiential Learning such as

guided inquiry, collaborative learning, and hands-on experiences empower learners to construct knowledge meaningfully and apply it in novel situations. This study highlights that How Experiential learning frameworks not only enhances students' problem-solving abilities In STEM learning but also fosters motivation, critical thinking, Knowledge retention and real-world experiences

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Funding

The research received no external funding. The study was conducted independently without financial support from any external organization or funding agency.

Conflict of Interest

The author declare that they have no competing interests or conflicts of interest related to this study.