International Research Journal of Educational Psychology
e-ISSN: 2456-8198 | Vol.09 | No.01 | Jan-Jun 2025 | pp. 23-29

RESEARCH PAPER

Double-Blind Peer Reviewed/Refereed Journal

STEAM-Education: A Vital Pedagogical Innovation for the Contemporary Age

*[1]Neena Kumari and [2]Prof. G.N. Tiwari

[1]Ph.D. Research Scholar, Department of Teacher Education, Nagaland University, Nagaland
[2]Supervisor& HOD, Department of Teacher Education, Nagaland University, Nagaland

Abstract

The purpose of this article is to highlight the importance and role of STEAM-based education at all levels to enhance the learning experiences of learners. The STEAM is an acronym that stands for science, technology, engineering, arts, and mathematics. This is a multidisciplinary approach that is helpful to prepare students for an increasingly complex world. However, STEAM education has a great significance in developing the 21st-century skills such as creativity, problem solving, bridging theory and practice, and collaboration. Besides this, there are many challenges for its implementation, like a lack of resources, collaboration across disciplines, and trained teachers. This paper was a review study about STEAM education as a vital pedagogical innovation for the contemporary age. The study concluded that to implement STEAM education effectively in our education system, both pre-service and in-service teachers must be aware of STEAM education and should be trained properly.

Keywords: *STEAM-Education, Pedagogical Innovation, Significance, Challenges*

Article Publication

Published Online: 30-Jun-2025

***Author's Correspondence**

Neena Kumari

Ph.D. Research Scholar,
Department of Teacher Education,
Nagaland University, Nagaland

nk29121981@gmail.com

Introduction

Education is a weapon that can eradicate any evil from any society. It makes the person civilized and helps them to learn how to live a balanced life. From the end of 20th century many new technologies, innovations, and approaches have been developed to make education effective, by different educationists, experts, and our scientists. Different types of computers, mobiles, smart classes, and interactive boards, all these are the technologies that are used to make teaching- learning system interesting and effective. These kinds of technologies aim to develop the interest of learners. And everyone knows that when we do something with interest then the results of that are fruitful. This interest of the learner in their learning helps them to develop different skills like problem-solving ability with critical thinking and analyzing ability. And all these capabilities will somewhere make them able to cope with different problems of their life. One of the approaches, which helps the learners to develop all these capabilities is STEAM-Education. Earlier STEAM was STEM. STEAM originated from STEM. STEM and STEAM both are the interdisciplinary approaches.

Existing literature on the significance of STEAM education and the challenges for the implication of STEAM education provides the author with remarkable insights into the area of study at hand. Torlakson (2014) states that the STEAM approach is a perfect match between the problems that occur in the real world and the problem-based learning. Whereas, Utomo et al. (2020) proved the effectiveness of STEAM-based biotechnology module equipped with flash animation for biology learning in high school. Besides this, Bertrand and Namukasa (2020) conducted a study on STEAM education: student learning and transferable skills. They carried out a qualitative case study which they conducted interviews, observations and data analysis of curriculum documents. The main

findings on student learning focussed on students developing preservance and adaptability, and then learning transferable skills. Further, Perals and Arostegui (2021) investigated that the integration of the arts and humanities into the core of curriculum along with the sciences and technological disciplines is an emerging issue in educational research. This study seeks to contribute to this research and curricular approach, for which they analyze the emergence of the STEAM movement, its implementation in class and its social, economic and educational consequences.

Kruger and Chiappe (2021) conducted a review study on the topic 21st century skills and their relationship to STEAM learning environments. The study was developed as a systematic literature review based on abstracting and in-depth reading of 153 scientific articles published in journals indexed in Scopus and Scielo. The result of the study suggests that, in order to guide the development of 21st century skills, it is convenient to consider issues when designing a STEAM learning environment. Also, Paint, Luitel, and Pant (2021) stated that STEAM pedagogy as an approach is useful for pre-service as well as in-service school teachers to develop multidisciplinary ways of knowing and solving real world problem. Lynch (2022) commented on the subject of STEAM and while discussing on its main objectives of development and implementation in order to prepare students for real life opportunities and to help them grow and adapt in later life. Wu, Liu and Huang (2022) explored continuous learning intention in STEAM education through attitude, motivation and cognitive load. The findings of this study revealed that critical factors affect students' learning attitudes and intentions regarding STEAM education. Perumal and Chary (2022) stated based on their study that awareness and perception of female teacher trainees about STEAM education were higher than male trainees, and the implication of the STEAM schooling technique is valuable for children with special needs.

Asih and Yulianti (2023) stated that STEAM-based module can be used in the learning process to improve creative thinking skills in the material for healthy blood circulation of grade 5 students. Arpaci et al. (2023) proved that the implementation of a STEAM-based module in science education is effective. In a study about possibilities and challenges of STEAM pedagogies, Milara and Orduna (2024) stated that STEAM encourages multidisciplinary, student-centered approaches like project- based and inquiry-based learning, promoting real-world problem-solving. However, significant challenges arise in implementing STEAM, particularly for teacher who often lack interdisciplinary training and face rigid school structures. Pandey (2024) explored the major themes of research in STEM education in the last three years which can provide a base for futuristic practices. The focus of education in India has remained largely 'retrospective' despite the aspirational 'prospective' goals set for it in policy statements. STEAM offers a way to address this issue by promoting creative and critical thinking and inquiry-based and hands on learning (Ratnam, 2024).

In nut shell, STEAM as a pedagogical innovation is a process reinvents teaching practices, with the goal of better supporting student learning. It also means transforming the spaces in which teaching takes place, and experimenting with new, ever more innovative methods. It represents a profound shift in the usual paradigms of knowledge transmission, with the aim of fostering the professional development of teachers and integrating students into the process. Its main objective is to develop the information skills, learning and innovation skills, communication skills, life and career skills of all learners in the basic education program.

Methodology

The present study is descriptive in nature and is based on secondary data from published papers, articles, reports, and journals by various authors. The main objective of the study was to gain a panoramic perception of STEAM education. The research papers, articles from different journals, and websites were explored and studied by the research scholar and the relevant information was collected, analyzed, and organized in view of achieving the objective of the present study.

Evolution of STEAM

In the present time, STEM and STEAM education seem to be crucial for making teaching and learning effective at all levels. It is observed that STEAM education is prominent from the school level to higher levels, but its

implementation is a big challenge. To overcome this challenge, teachers should be trained in STEAM implementation. Now let us discuss the origin and evolution of STEM and STEAM education. STEM is an acronym that stands for science, technology, engineering, and mathematics. Here, four disciplines are integrated to make the learning meaningful. Zhan and Niu (2023) in their study found that STEM education originated from higher education, but the main emphasis is gradually shifting to the K-12 stage.

Stein (2023) observed that during the beginning of human civilization, STEM learning was experiential and focused around apprenticeships. For the first time, formal schools for learning were created by the ancient Greeks. Their educational institutions emphasized critical thinking and mathematics. The renowned mathematician Euclid's "Elements", a treatise on geometry, was written during this period and remains a foundational work in STEM education. The industrial revolution in the late 19th century is considered as the beginning of modern STEM education. The period of late 19th and early 20th centuries was the time of rising the vocational schools. During the mid 20th century space race began between united states and the Soviet Union. In 1957, with the launch of sputnik, the US government recognised the need to strengthen its STEM education program which led the creation of National Science Foundation (NSF) of the U.S. NFS plays a pivotal role in funding and conducting research on STEM education.

MEULABS (2024), highlighted that Judith (2001) of the National Science Foundation coined STEM as an acronym for the academic disciplines of science, technology, engineering, and mathematics. The aim to find these fields together under one term was to encourage proficiency across these interrelated subjects versus excellence in any single domain. When STEM became a buzzword in the field of education, a new and very similar term, STEAM emerged. Addition of "A" in the term STEM is STEAM. Where element "A" stands for Art. Steamtruck Organization (2020), reported that the integration of element "A" in acronym STEM is a progression, which has allowed educators to expand the benefits of hands-on education and collaboration in a variety of ways, promoting creativity and curiosity at the core. "Incorporation of ART in STEAM brings in personal expression, empathy, meaning making, and the purpose of what we are learning," explains Dr. Kristin Cook, associate dean of Bellarmine's Annsley Frazier Thornton School of Education and longtime science educator. "Art is the humanising piece of transdisciplinary and interdisciplinary instruction." Gunn (2017) stated that the STEM education movement advocates moving away from segmented content areas, emphasizing technology to connect the subject and relating teaching to the outside world. Lynch (2006) realised the benefit of turning STEM into STEAM as the creativity and innovation the art brings to STEM are invaluable. Later, in June 2008 John Maeda, former president of the Rhode Island school of design championed the STEM to STEAM movement, campaigning to add "art" to STEM and bringing the initiative to the forefront of educational policymakers. The Rhode Island School of Design is the birthplace of the modern STEAM educational movement (Space Foundation, 2022). (Historytool.org. 2024) By the late 1990s, the term "SMET" was initially used to combine the four disciplines, but it lacked the catchiness. Then in 2001, the National Science Foundation unveiled "STEM," it immediately rolled across sections.

India Today (web desk, 2019) reports STEAM education as an innovative approach to learning, where children are provided with a deep understanding of concepts. It is an experiential form of learning whose focus is to develop the skills in children and provide a deep understanding of the concepts. STEAM education is finding a strong innovation culture in India, which will help us to become innovators and creators. India STEM-Foundation (2024) indicated that STEAM education will help to improve the ability to learn and communicate. Art involves both verbal and visual expression of ideas, where effective and clear communication of difficult ideas is required. Initiatives like the rural education programmes offered by the Agastya International Foundation are the prime examples of how STEAM is being applied practically in India. Through interactive STEAM modules, this foundation reaches rural children, teaching science concepts through art and practical activities. It has significantly improved educational outcomes and inspired students to pursue higher education in STEAM fields.

Significance of STEAM Education

Katherine et al. (2021) indicated in a study that it is vital to provide kids enough time to prepare for an increasingly complicated world. STEAM is a multidisciplinary approach that has emerged as a promising tool in this challenge. However, applying STEAM in the classroom can be difficult for educators because it may necessitate teamwork across disciplines, rather than workload, and a comprehension of the nature of STEAM integration. STEAM professional development experiences increase teachers' enthusiasm in implementing STEAM in the classroom and their satisfaction of teaching STEAM classes. Furthermore, studies of STEAM professional development opportunities have identified positive pedagogical benefits for participants, such as increased confidence in planning and implementing STEAM lessons, incorporating technology into instructional approaches, using authentic assessment, and connecting with resources and experts outside the school building to support STEAM instruction. According to a study of intense STEAM interventions in teacher populations, STEAM can improve the classroom atmosphere and instructors' pedagogical dissatisfaction when they receive enough, continuous assistance.

The primary goal of the global education system is to obtain 21st century skills, so that citizens as a whole can adjust appropriately to the labor market and, more broadly, to society. According to Wilson Kruger and Andres Chiappe (2021), in order to guide the development of 21st century skills, it is useful to consider when designing STEAM learning environments issues such as changing assessment to a more formative experience, the inclusion of collaborative and social environments, the use of research-based learning strategies, and gamification and games, among others. According to 21st Century Ed (2025), one of the most subtle contributions of STEAM to education is its capacity to break down traditional subject silos. STEAM fosters the integration and promotes the merging of science, technology, engineering, art, and mathematics. This method reflects how the real world operates. STEAM is a cross-disciplinary strategy that helps pupils grasp each discipline while illustrating its interconnectedness. STEAM promotes a variety of vital skills, including teamwork, adaptability, and communication. STEAM education helps students to build modern professional skills, critical thinking, and problem-solving abilities by immersing them in real-world issues. STEAM incorporation into educational strategies is also a response to the changing demands of the labor market. As businesses rely more on automation and technology, employers prioritize abilities that combine technical knowledge with creativity and emotional intelligence. Various sectors, such as digital media, biotechnology, renewable energy, and artificial intelligence, require professionals who can think critically, communicate effectively, and solve complicated challenges. STEAM education efficiently prepares students for such tasks by providing them with a wide and creative skill set that goes beyond the scope of traditional study.

Benefits of STEAM Education

According to Irwanto and Ananda's (2024) study, education in the twenty-first century promotes teachers to enhance students' abilities and competences in response to industrial needs, such as fostering technical progress and economic development. Students' 21st century skills and competencies include learning and innovation skills, life and career skills, and information and media literacy abilities, all of which are expected to be relevant in the future and can be implemented in their community. Aside from making learning more meaningful, the usage of methods, approaches, and learning models allows students to exhibit their ability or talents. The STEAM approach, which stands for science, technology, engineering, art, and mathematics, was one of the learning methods that met the students' 21st-century skills standards. STEAM learning will help students develop their creativity, invention, communication, and cooperation abilities as they solve problems and determine solutions through projects. This technique will assist students in achieving meaningful learning outcomes by allowing them to relate their learning to other disciplines and comprehend the concepts so that they may apply their knowledge through their projects. STEAM makes science classes more interesting by incorporating students' creativity in art and increasing their willingness to learn science.

According to ARDUINO (2024), the holistic and multidisciplinary approach of STEAM education, as well as a collaborative approach, is critical in the modern workplace. STEAM education takes a collaborative approach, encouraging students to work together rather than compete with one another. STEAM education enables pupils

to build their own problem-solving approaches. It encourages students to employ their imaginations as well as their technical skills. STEAM education not only encourages students' creativity, but it also improves their social skills. The STEAM curriculum improves kids' emotional intelligence and social skills because it takes a collaborative approach to learning. STEAM education teaches kids how to collaborate with others, be expressive, and become more socially adaptive. They learn to deal with a variety of personalities and cultural backgrounds. STEAM education aids in the development of the ability to evaluate the factual and logical merits of new information and generate a sensible and educated opinion on certain subjects. It is about rejecting irrelevant and misleading information. STEAM education fosters students' inquisitiveness and curiosity about a wide range of topics. Students learn not just theoretical and academic concepts, but also how to apply their knowledge and abilities in the real world. Students can learn how to apply abstract mathematical principles to real-world problems, such as household budgeting.

Bertnard and Namukasa (2020) also conducted research on student learning and transferable skills through STEAM education and discovered that STEAM education helps to develop character-building skills in students, allowing them to solve real-world problems, have more opportunities in the future, and have an impact on the world.

Challenges

As STEAM education is very important for the 21st century students but there are many challenges faced by educators when it comes to implement. Challenges faced during the implementation of STEAM education are:

Money matters, resources, and funding- Enough resources and funding are one of the greatest challenges in implementing STEAM education. A well-rounded STEAM program requires up-to-date technology and engaging materials that can inspire students. Such tools help them to grasp complex concepts. Unfortunately, not all educational institutions have the funds to provide these resources, which can make it difficult to offer high-quality STEAM lessons.

Herro, Quigley, and Cian (2018) in their study stated that, despite STEAM's popularity, little empirical data exists to guide effective instructional practices, and even very less is known about the challenges related with instruction. Student understanding of content and process, pacing, issues relating to planning concerns about school district policies, technology integration and issues related to assessment are some of main challenges.

Milara and Orduna (2024) observed that STEAM encourages multidisciplinary student-centered approaches like project-based and inquiry-based learning, promoting real-world problem solving. However, there are significant challenges that arise in STEAM implementation, specifically for teachers who do not have interdisciplinary training and face rigid school structures. STEAM outcomes assessment is also complex.

Perals and Arostegui (2021) reported that the inclusion of art into the core of curriculum along with technologies and science disciplines is an emerging issue in educational research. Despite neglecting the economic rationality in education, it is important to move ahead in order to accept completely a more democratic and social conception of schooling, trying to take advantage of this historical moment to transform education toward a more humanistic approach–without ignoring the scientific facet–that offers a well-rounded education to new generations while, at the same time, reflect to the social and economic demands of our current society.

Discussion

From the above discussion on "STEAM education," it is clearly visible that STEAM-education can build upon the economic drivers that characterize and boost STEM: an alignment of disciplinary areas that allegedly have the greatest impact on a developed country's Gross Domestic Product (GDP). On the other hand, the addition of the arts may point to the recovery of educational aims and purposes that exceed economic growth: for example, by embracing social inclusion, community participation, or sustainability agendas. Central to understanding the different educational opportunities offered by STEAM is the interrogation of the role and status of the arts in relation to STEM subjects. The term "art" refers, for example, to the arts as realms/domains of knowledge, such

as the humanities and social science disciplines, or to different ways of knowing and experiencing the world enabled by specific art forms, practices, or even pedagogies. In the face of such variety and possibilities, STEAM is a portmanteau term, hosting approaches that originate from different reconfigurations or iterative reconfiguring of disciplinary relationships. A critical discussion of the term "STEAM" thus requires an analysis of published literature alongside a review and discussion of ongoing practices in multiple fields. The research studies shaped and conducted in this field may be exemplary and respond to a variety of policy directions and cultural traditions in the new India. The outcome of the study will be a contribution to pedagogical innovation by the integration of STEAM education and may result as a main cause for a progressive revolution at all levels of education.

Conclusion

Besides making the education meaningful, STEAM education makes the learning process interesting for students. Here, students can learn at their own pace. This approach assists students to live confidently in society, as in STEAM, students learn to collaborate and communicate effectively with others. STEAM helps students to decide their career and enables them to earn their livelihood by getting different job opportunities of their interest. Despite playing a significant role in the development of different skills among students there are many challenges for the implementation of STEAM education in our educational institutions such as there is need of trained teachers, must know the components of STEAM education and this approach must be included in the curriculum of teacher training for its effective implementation. Moreover, its effective implementation requires sufficient funds and infrastructure, program consistency and well designed curriculum.

References

[1] ARDUINO.(2024). 8 Benefits of STEAM Education. https://www.arduino.cc/education/8-benefits-of-steam-education/

[2] Arpaci, I., Dogru, M.S., Kanj, H., Ali, N., & Bahari, M. (2023). An experimental study on the Implementation of a STEAM- based learning module in science education. https://eprints.utm.my/107304/1/MahadiBahari2023_AnExperimentalStudyontheImpleme ntation.pdf

[3] Asih, D.A.S., Sunyono, & Yulianti, D. (2023). Developing STEAM based e-module to improve creative thinking skill of grade 5 students on my blood circulation material. https://www.semanticscholar.org/paper/ Developing-steam-based-e-module-to-improve-creative-Asih-Sunyono/33c0e0920019e2d7 e5b5530bb7505a42e ca56ac3

[4] Bertrand, M.G., & Namukasa, I.K. (2020). STEAM education: Student learning and transferable skills. https://www.emerald.com/insight/content/doi/10.1108/JRIT-01-2020-0003/full/html

[5] Boice, K. L., Jackson, J.R., Alemdar, M., Rao, A.E., Grossman, S., Usseleman,M. (2021). Supporting Teachers on Their STEAM Journey: A Collaborative STEAM TeacherTraining Program.

[6] Herro,D., Quigley.,&Cian,H. (2018). The Challenges of STEAM Instruction: Lessons from the Field. https://www.tandfonline.com/doi/full/10.1080/01626620.2018.1551159

[7] INDIA STEM FOUNDATION. (2024). Integrating Arts into STEM: The Rise of STEAM Education in India. https://indiastemfoundation.org/blog/rise-stem-education/

[8] India Today Web desk.(2019). What is STEAM education? Here's how it has started to transform the Indian education system. https://www.indiatoday.in/education-today/featurephilia/story/4-ways-education-is-going-through-a-complete-shift-with-steam-education-1603910-2019-09-27

[9] Irwanto, I.,& Ananda,L.R. (2024). A systematic literature review of STEAM education in the last decade. https://pubs.aip.org/aip/acp/article-abstract/2982/1/040020/2933260/A-systematic-literature-review-of-STEAM-education?redirectedFrom=fulltext

[10] Lynch, M. (2022). What is a STEAM education? Pedagogue Connecting Educators. https://pedagogue. app/what-is-a-steam-education/#:~:text=It%20was%20in%202006%20 when%20researcher% 2C%20 Georgette%20Yakman%2C,and%20STEAM%20has% 20been%20full%20steam%20ahe ad%20since%21

[11] Mariano,K.,Wilson.,Chiappe.,Andres. (2021). 21st-century skills and STEAM learning environments. https://dialnet.unirioja.es/servlet/articulo?codigo=8205363

[12] MEULABS. (2024). "History and evolution of STEM/STEAM education". https://meulabs.org/blog/history-and-evolution-of-stem-steam-education/

[13] Milara, I. S., & Orduna, M. C. (2024). Possibilities and challenges of STEAM pedagogies. https://www.researchgate.net/publication/339618570_Possibilities_and_challenges_of_STEAM_pedagogies

[14] Pandey, P. (2024). Researches in STEM education: A trend analysis. In book; STEM education: Theory and practice (PP.76-81). Edition1st. chapter: 8. Regional Institute of Education, Bhopal NCERT. https://www.researchgate.net/publication/379840623_Researches_in_ STEM_Education_A_Trend_Analysis

[15] Pant, S.K., Luitel, B.C., & Pant, B.P. (2021). STEAM Pedagogy as an approach for teacher professional development. https://www.researchgate.net/publication/349074951 _STEAM_Pedagogy as_an _Approach_for_Teacher_Professional_Development

[16] Perales, F. J., & Arostegui, J. L. (2021). The STEM approach: Implementation and educational, social and economic consequences. https://www.researchgate.net/publication/354529543_The_STEAM_approach_Implementation_and_educational_social_and_economic_cons equences

[17] Perumal, B.V., & Chary, K.G. (2022). Awareness and perception of B.Ed trainees towards STEAM education implementation for children with special needs. https://eprints.utm.my /107304/1/ MahadiBahari2023AnExperimentalStudyontheImplementation.pdf

[18] Ratnam, T. (2024). STEAM education to unleash students, creativity and knowledge-building capacity: An Indian perspective sociology approaches to STEM education (PP. 19-43).

[19] Space Foundation Editorial Team. (2022). What is STEAM education and why is it important? https://www.spacefoundation.org/2022/06/22/what-is-steam-education-and-why-is-it-important/#:~:text=STEAM%20education%20is%20a%20holistic%2C%20interdisciplinary%20approach%20to,to%20foster%20creative%20problem-solving%2C%20collaboration%20and%20critical%20thinking.

[20] STE(A)M TRUCK. (2020). "The history and importance of STEAM education". https://www.steamtruck.org/blog/steam-education-history-importance

[21] Torlakson, T. 2014. Innovate: A blueprint for Science, Technology, Engineering, Mathematics in California Public Education. California State Superintendent of Public Instructions.

[22] Utomo, A.P., Hasanah, L., Hariyadi, S., Narulita, E., Suratno, & Umamah, N. (2020). The effectiveness of STEAM-based biotechnology module equipped with flash animation for biology learning in high school. https://www.researchgate.net/publication /340358232_The_Effectiveness_of_STEAM-Based_Biotechnology_Module _Equipped_with_ Flash_Animation_for_Biology_Learning_in_High_School

[23] Wu, C.H., Liu, C.H., & Huang, Y.M. (2022). The exploration of continuous learning intention in STEAM education through attitude, motivation, cognitive load. https://www.researchgate.net/publication/ 360537657_ The_ exploration_of_continuous_learning_intention_in_STEAM_ education_through_ attitude_motivation_and_cognitive_load

[24] Zehui Zhan & Shijing Niu, 2023, Palgrave Macmillan, vol. 10(1), pages 1-13, December. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.nature.com/articles/s41599-023-02303-8.pdf