

Teachers' Understanding and Preparedness towards STEAM Education

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Abstract

Education is continuously evolving in response to technological advancements and the changing needs of society. The emergence of Artificial Intelligence, robotics, big data, and digital technologies has created a need for innovative and interdisciplinary approaches to teaching and learning. In this context, STEAM (Science, Technology, Engineering, Arts, and Mathematics) education provides an integrated framework that promotes creativity, critical thinking, problem-solving, collaboration, and the application of knowledge to real-life situations. The National Education Policy (NEP) 2020 also emphasizes holistic, experiential, multidisciplinary, and skill-oriented education. The present study examines teachers' perspectives, understanding, attitudes, and preparedness towards implementing STEAM education in secondary schools.

The study adopted a quantitative research approach using a descriptive survey method. The sample consisted of 58 teachers from four CBSE schools in Lucknow, selected through a random sampling method. Data were collected using a self-constructed structured questionnaire based on a Likert scale. The questionnaire examined four major domains: teachers' understanding of STEAM education, their attitudes towards STEAM, preparedness to implement STEAM-oriented classrooms and laboratories, and professional development requirements. It also explored teachers' views regarding interdisciplinary collaboration, digital tools, infrastructure, and innovative pedagogical practices.

The study highlights the potential of STEAM education to enhance teachers' professional and pedagogical competencies. STEAM-oriented approaches can encourage teachers to adopt inquiry-based, experiential, project-based, and problem-solving pedagogies. Thus, integrating STEAM education in alignment with NEP 2020 can contribute to more innovative, inclusive, engaging, and future-oriented learning environments in secondary schools.

Keywords: Artificial Intelligence, Digital Technologies, STEAM Education, Multidisciplinary and Interdisciplinary Collaboration, Innovative Pedagogical Practices.

Introduction

Scientific and technological advancement has led rapid and profound changes across all spheres of life, as we navigate the complexities and opportunities of digital era. To keep pace with the technological and research advancements of other developing and developed nations, educational reforms were needed. As the Kothari Commission aptly puts it, "The destiny of India is built in the classrooms." Therefore, it's crucial to adopt new ways and means to educate children, keeping pace with global best practices and trends.

The integration of Science, Technology, Engineering, Arts, and Mathematics (STEAM) education has come up as a transformative pedagogical framework to address these evolving demands. Isolating disciplines can lead to learning experiences, making it difficult for students to connect classroom concepts to real-world applications (Escudeiro et al., 2024). Integrated STEAM approaches, on the other hand, promote holistic problem-solving skills, interdisciplinary collaboration, and innovative thinking – essential qualities for success in today's complex world (White & Delaney, 2021).

STEAM transcends conventional disciplinary silos by fostering an interdisciplinary learning environment that inculcates critical thinking, creativity, and problem-solving competencies. By synergizing the analytical precision of STEM (Science, Technology, Engineering, and Mathematics) with the creative and expressive dimensions of the arts, STEAM education empowers students to tackle multifaceted real-world challenges with innovative solutions (Amanova et al., 2025). In India, NEP-2020 envisions holistic development, equitable access to education, and the promotion of critical and creative thinking, aligning seamlessly with the principles of STEAM education (Ministry of Education, 2020). This study explores the perceptions, preparedness, and attitudes of CBSE secondary school teachers toward STEAM education, aiming to provide actionable insights into its implementation and alignment with national educational objectives.

STEAM education represents a paradigm shift in pedagogical approaches, encouraging students to engage with concepts through diverse perspectives. By integrating arts into STEM disciplines, it fosters creativity and innovation, enabling learners to approach problems with versatility and originality (Bequette & Bequette, 2012). Incorporating design principles into engineering projects or visual arts to explain scientific concepts can discover learning more engaging and impactful. This interdisciplinary learning methods not only enhances cognitive and technical proficiencies but also nurtures emotional and social competencies, resonating with NEP 2020's vision of holistic and multidisciplinary education (Ministry of Education, 2020). Within CBSE schools, where standardized curricula often emphasize rote memorization, STEAM education offers ways and means to reshape teaching and learning into a more experiential, student-centric process. However, the effective implementation of STEAM education also depends on teachers' understanding, preparedness, and willingness to embrace innovative pedagogies (Quigley & Herro, 2016).

Teachers serve as the best channel and transformer of educational policies into classroom realities. Their perceptions of STEAM education, confidence in leveraging digital tools, and readiness to engage in interdisciplinary collaboration are crucial to its success (Kim & Bolger, 2017). To comprehensively investigate these dimensions, this study employs a questionnaire titled "Conception and Insights of School Teachers towards STEAM Education," structured into four key sections. The first section examines teachers' understanding of STEAM education, emphasizing its role in enhancing digital literacy and fostering interdisciplinary learning.

The second section explores the attitudes of teachers toward STEAM, particularly their comfort with cross-disciplinary collaboration and its potential to enhance pedagogical effectiveness. The third section assesses the readiness of CBSE schools to support STEAM classrooms and laboratories, focusing on infrastructure, accessibility, and teachers' proficiency with digital technologies such as coding platforms and simulations. The fourth section investigates the need of professional development programs to equip teachers with the requisite skills for STEAM implementation.

This research paper holds particular significance in the context of CBSE schools, which serve a diverse student population across India. The CBSE curriculum, characterized by its structured and standardized

framework, provides a unique setting to explore the integration of STEAM education into existing systems (CBSE, 2023). By examining teachers' perspectives, this study seeks to identify barriers and opportunities in STEAM implementation, such as the need for robust infrastructure, targeted training programs, and inclusive learning environments.

Review of Related Literature

Yakman (2010) defined STEAM education, as a framework that purposefully integrates Science, Technology, Engineering, Arts, and Mathematics, encouraging a holistic learning. The research conducted by **Gaona and González (2022)** highlights significant findings regarding the development of STEAM skills through the creation of a digital robot. The study demonstrates a substantial improvement in students' skills, with an increase in high-level proficiency from 51.19% to 59.06% post-project implementation, indicating the effectiveness of the STEAM methodology. Additionally, the interdisciplinary nature of STEAM education, as emphasized in the study, promotes a more holistic learning experience by integrating STEAM, enabling students to consolidate knowledge across multiple domains.

The study by **Jantassova et al. (2023)** emphasizes the effectiveness of STEAM education in fostering critical and creative thinking among students, alongside professional communication and collaboration skills. This is seen as essential for preparing technical specialists, especially engineers, to solve complex challenges within their respective fields. The authors proclaim that these competencies are crucial in developing well-rounded professionals who can tackle real-world problems that require innovative solutions.

According to **Cheung (2024)**, STEAM encourages a mix of subjects to provide a well-rounded education. Cheung (2024) highlights that STEAM education focuses on innovation and problem-solving. Teachers are encouraged to use methods that improve students' ability to think critically and solve real-life problems. As the world changes quickly, these skills are important for helping students face challenges and succeed in various fields. By combining different subjects and promoting teamwork, STEAM education aims to develop the skills needed to tackle future issues. Cheung (2024) notes that creating a collaborative learning environment prepares students to handle emerging challenges and work well in diverse teams.

Hashmi et al. (2024) through their study revealed the development of a constructivist learning environment within the classroom. By adopting experiential learning methods, the study created an atmosphere where students actively engaged in the learning process. This participatory approach helped in fostering better retention and deeper understanding, lined up with constructivist theories enriched with experiences and interactions.

Zaqiah et al. (2024) found that while the STEAM education model effectively improved students' collaboration skills, it had a limited impact on critical thinking, creativity, and communication. Despite this, students responded positively to the learning experience, suggesting that their engagement and contentment with the model were valuable. This research highlights the significance of the STEAM approach to enhance its effectiveness in developing a broader range of 21st-century skills, while also recognizing the positive influence the model had on student attitudes toward learning.

Need of the Study

As per NEP-2020, STEAM education will be an integral part of school curricula. Therefore, teachers' insights and attitudes towards STEAM implementation are crucial. By doing so, teachers can seamlessly

integrate STEAM into their teaching practices, promoting holistic learning and nurturing the next generation of innovators and thinkers. Understanding secondary school teachers' conceptions and insights toward STEAM education is critical for:

- **Effective Implementation:** Teachers' perceptions play key role in STEAM lesson delivery, interdisciplinary approaches, and student-centred practices.
- **Targeted Professional Development:** Insights from teachers will help to investigate training gaps, workload issues, and resource needs, and help in planning of programs to boost teacher confidence and efficacy.
- **Improved Student Learning Outcomes:** Teachers' positive mindsets can enhance students' motivation, soft skills, and STEM career interest, aligning with global educational goals.
- **Informed Policy and Reform:** Understanding perceptions can guide curriculum alignment, resource allocation, and evaluation of teaching tools to support STEAM.

Objectives of the Study

1. To study the conception of the STEAM Education among CBSE secondary school teachers.
2. To analyse the attitude of secondary school teachers towards STEAM Education.
3. To analyse teachers' preparedness for STEAM classrooms.

Research Methodology

Research Design: In this proposed study, the quantitative method is used for collecting the data and Descriptive Survey method was used. The survey was conducted through a closed ended questionnaire. The Self-constructed close ended questionnaire consisting of 25 questions was designed to gather information on the basis of teachers' conception and insights of STEAM education.

Sampling: The Purposive Sampling technique was used for the selection of schools and the data was collected from a random sampling method. The total sample size consisted of 58 teachers from various arts and science disciplines. The survey instrument was the same for all teachers. The Likert Scale is used for the collection of data where three domains were included to know about the teacher's insights about STEAM education. The first domain is about understanding of STEAM framework. The second domain is about the attitude teachers towards STEAM educational framework. The third domain is about preparedness for STEAM classrooms and laboratories in schools. The fourth section investigates the need for professional development programs to equip teachers with the requisite skills for STEAM implementation.

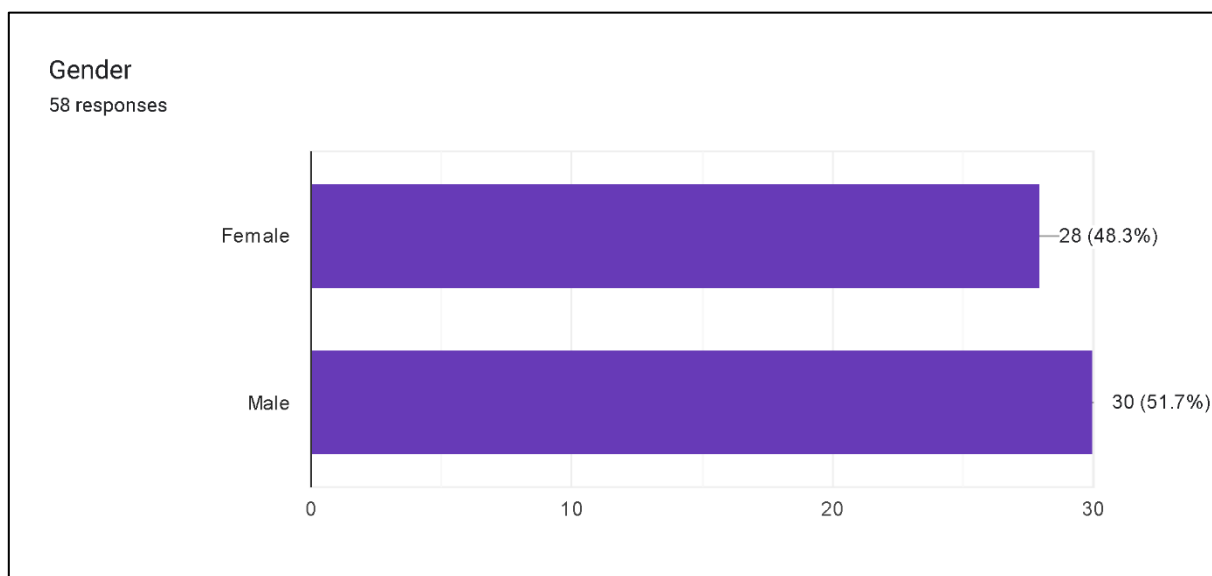


Result and Discussion

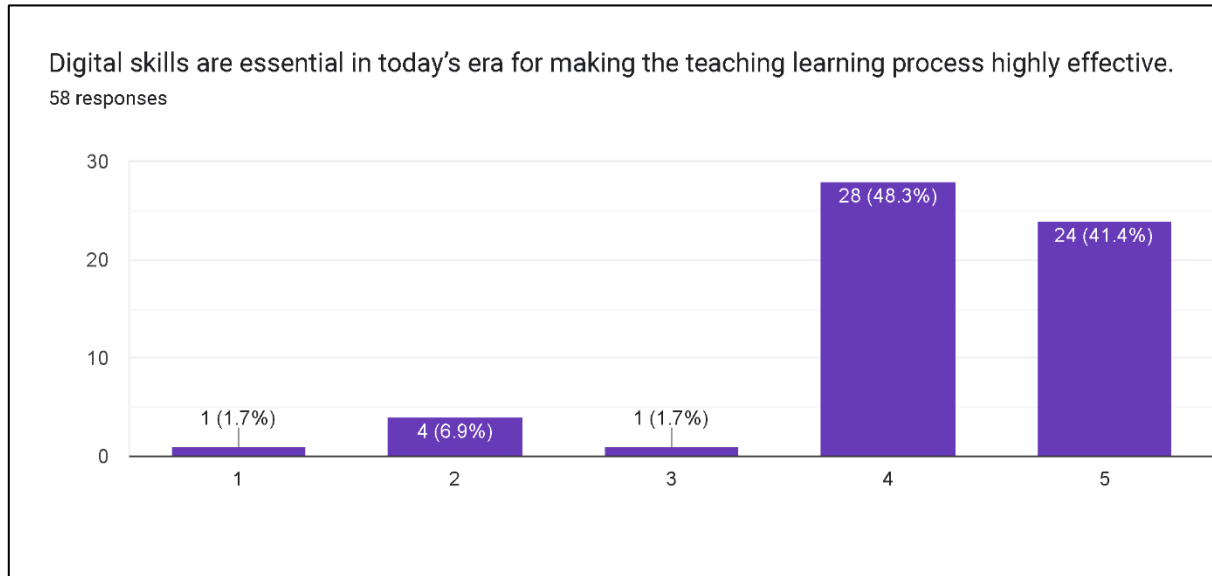
Research Objective 1. To study the conception of the STEAM Education among CBSE secondary school teachers.

Findings:

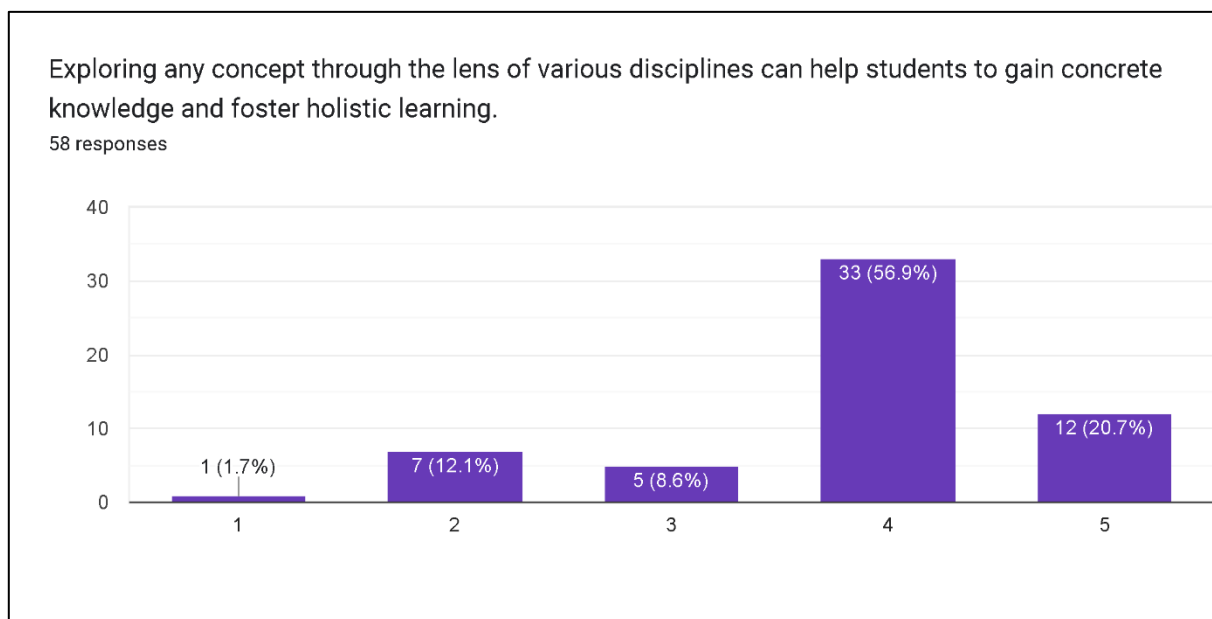
A total of 58 teachers completed the survey via using Google Form where 28 were females and 30 teachers were males.



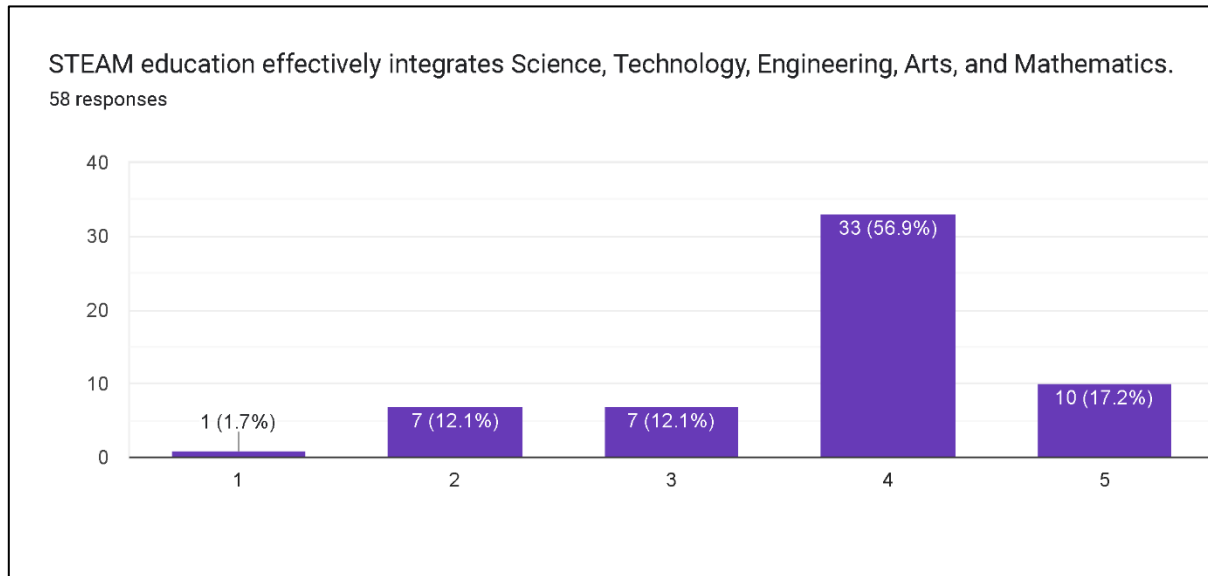
To gauge teachers' familiarity with STEAM, the questionnaire began by exploring their understanding on key concepts, such as the significance of digital literacy in modern classrooms and the potential benefits of integrating virtual and augmented reality into teaching.



The data indicates a high level of perception among school teachers regarding the essential role of digital skills in making the teaching-learning process highly effective. Over 89.7% of the teachers (48.3% + 41.4%) either agree or strongly agree, highlighting a strong approval for digital literacy and skills. The low percentages of disagreement and neutrality (1.7% + 6.9% + 1.7% = 10.3%) underscore that some of teachers are passive towards the need of digital skills in modern education. Digital resources significantly influence teaching and learning, but their effective use depends on teachers' digital competence (Pareek et al., 2025).

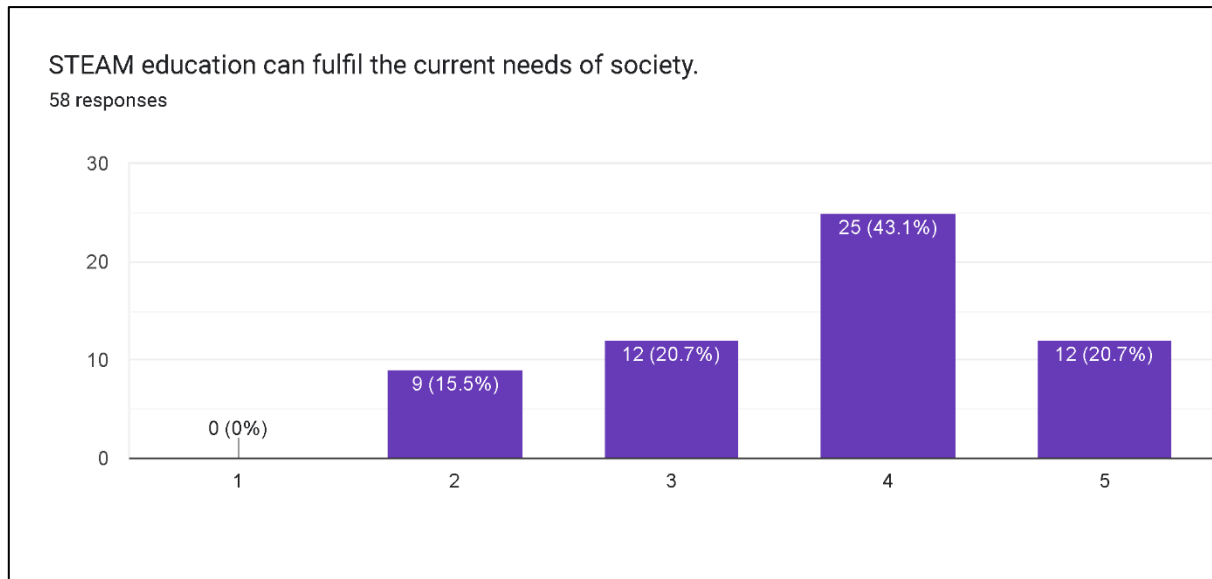


The data infers a generally positive conception of STEAM education's interdisciplinary approach among secondary school teachers, with 77.6% (56.9% + 20.7%) either agreeing or strongly agreeing. The result suggests that the majority of teachers understand and appreciate that exploring concepts across disciplines can enhance student learning and align with holistic educational goals (NEP, 2020). The combined percentage of disagreement and neutrality (1.7% + 12.1% + 8.6% = 22.4%) indicates that a minority of teachers may need further awareness or support to fully embrace this concept.



The data indicates a predominantly positive conception among teachers regarding the effectiveness of STEAM education in integrating diverse disciplines, with 74.1% (56.9% + 17.2%) either agreeing or strongly agreeing. This suggests that the majority of teachers view STEAM as a valuable approach combining STEAM. STEAM connects scientific inquiry, technological innovation, engineering design, mathematical reasoning, and artistic creativity within a common problem-solving framework. This integration helps learners move beyond disciplinary boundaries and develop creative, critical, collaborative, and practical approaches to real-world challenges (Yakman & Lee, 2012).

The 25.9% who disagree or are neutral may highlight areas for improvement, such as the need for better training, resources, or examples of successful STEAM implementation to address doubts and build confidence among this group.

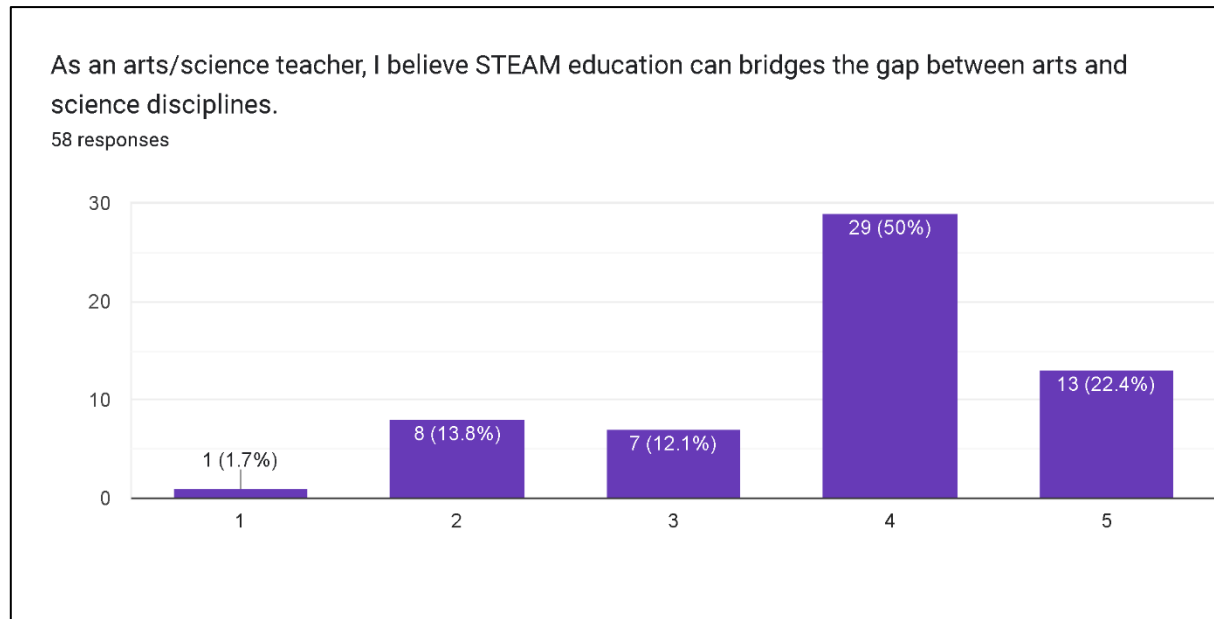


The data indicates a positive perception among teachers regarding STEAM education's ability to fulfil societal needs, with 63.8% (43.1% + 20.7%) either agreeing or strongly agreeing. The strong agreement (63.8%) aligns with the goals of STEAM education and NEP 2020, which aim to prepare students for real-world issues. STEAM-based curricula can move beyond purely neoliberal objectives and emphasize democratic values, critical thinking, and the holistic development of learners giving a meaningful response to the emerging needs of contemporary and future society. Such curricula can also contribute to the transformation and strengthening of educational institutions (Perales & Aróstegui, 2024). The absence of strong disagreement (0% at 1) is encouraging, but the 36.2% who disagree or are neutral may suggest a need for further dialogue, workshops, or seminars on STEAM educational framework.

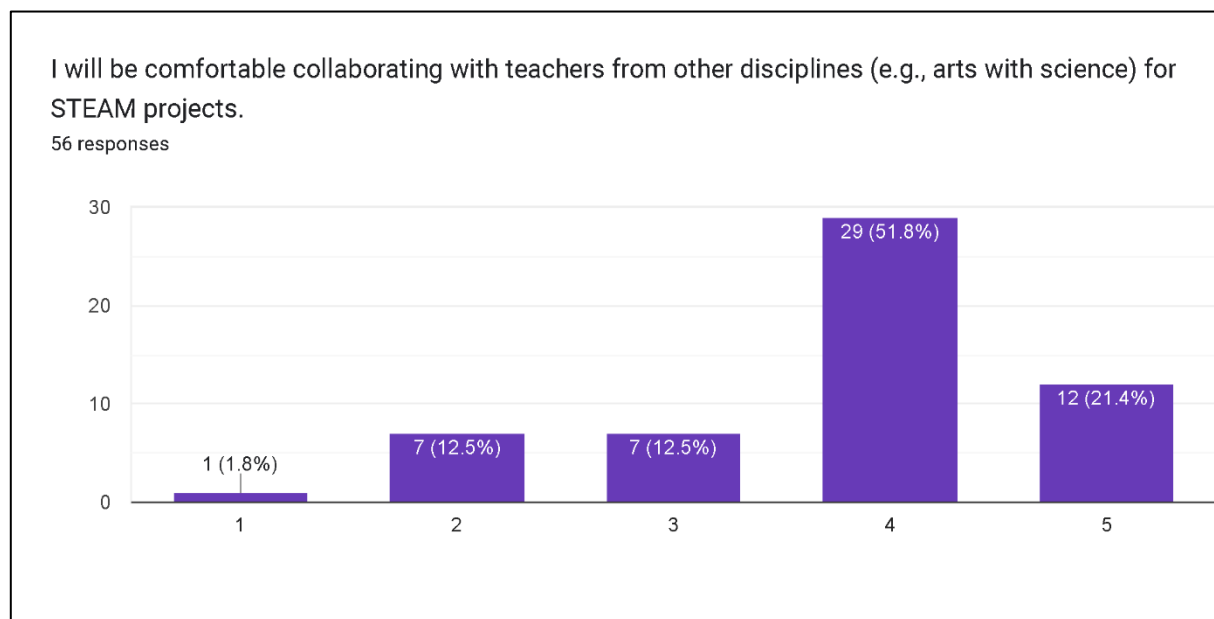
Research Objective 2. To analyse the attitude of secondary school teachers towards STEAM educational framework.

Findings:

The result of responses shared by the teachers related to analysis showed a positive attitude of teachers towards STEAM educational framework. Some of the questions with the discussion are given below in the form of bar chart.



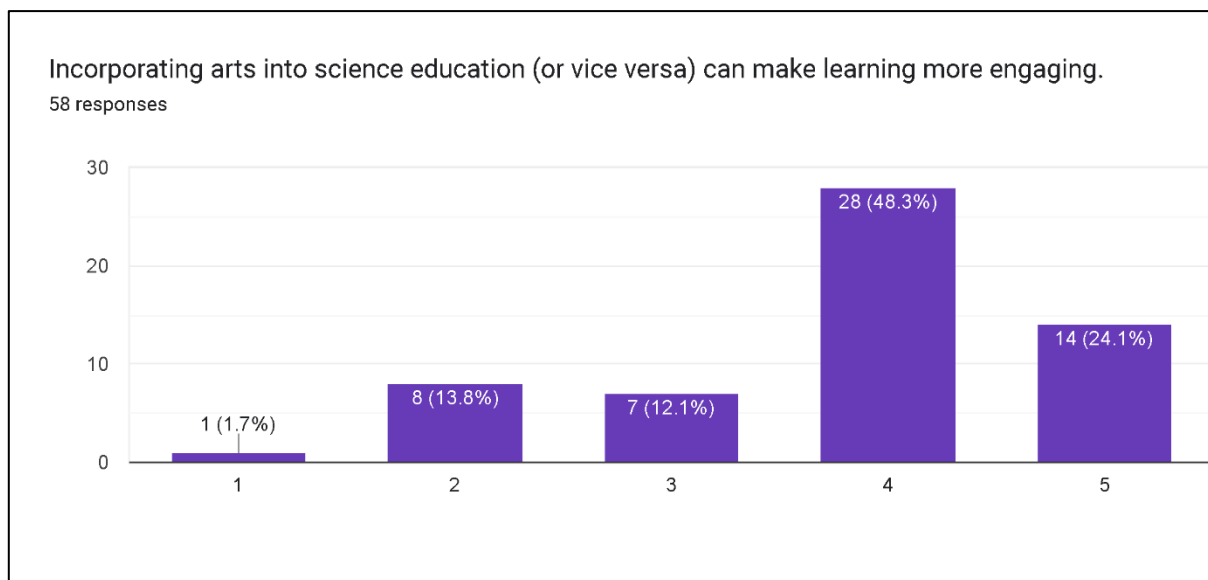
The data signals a positive insight among teachers for STEAM education's ability to bridge the gap between arts and science disciplines, with 72.4% (50% + 22.4%) either agreeing or strongly agreeing. This suggests that the majority of arts and science teachers recognize STEAM as a viable framework for interdisciplinary collaboration, aligning with its core principles. STEAM can be understood as a transdisciplinary framework that brings science and the arts together to foster innovative thinking and support the development of sustainable solutions for the future (Burnard & Colucci-Gray, 2021). The combined percentage of disagreement and neutrality (1.7% + 13.8% + 12.1% = 27.6%) indicates a need for further training or demonstration of successful interdisciplinary practices to address doubts and enhance confidence, particularly among those less convinced of STEAM's effectiveness in this context.



The 73.2% (51.8% + 21.4%) of teachers who agree or strongly agree demonstrate a readiness to engage in effective communication across disciplines. This is crucial for STEAM projects, where clear exchange

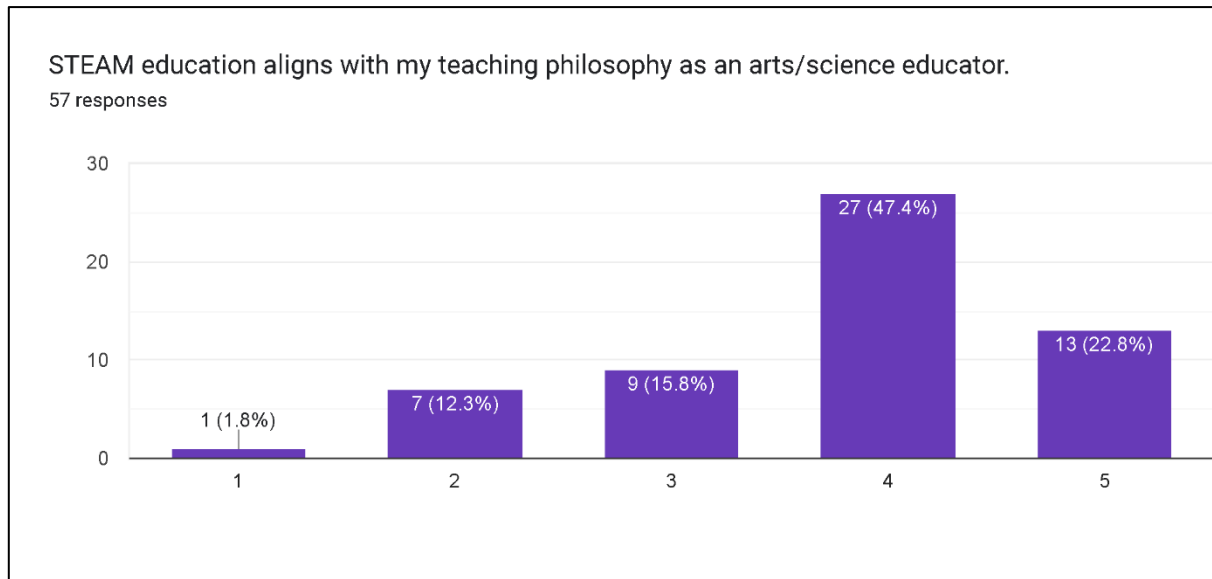
of ideas between arts and science teachers can enhance project outcomes. The 26.8% (1.8% + 12.5% + 12.5%) who disagree or are neutral may indicate potential barriers in communication skills, or teachers who are less comfortable and may lack experience or exposure to collaborative teaching models, pointing to the importance of structured opportunities to build these skills.

The majority agreement highlights a strong willingness to collaborate, a core component of STEAM education that requires teachers to work together to integrate diverse perspectives. This aligns with the interdisciplinary nature of STEAM, fostering a team-based approach. A cssssooperative teaching-based STEAM model can effectively support interdisciplinary learning and meaningful integration of different STEAM disciplines. The model addresses challenges such as limited STEAM teaching expertise through multi-teacher collaboration, scaffolding, familiar learning themes, and curriculum integration (Li et al., 2022).



The data infers positive perception among teachers regarding the impact of incorporating arts into science education (or vice versa) on student engagement, with 72.4% (48.3% + 24.1%) either agreeing or strongly agreeing. This suggests that the majority of teachers see value in this interdisciplinary approach, aligning with STEAM's goal of making learning more interactive and appealing. Integrating emerging technologies with Arts, through STEAM activities can significantly enhance students' perceived engagement.

Longer participation in STEAM learning associates with stronger behavioural, cognitive, emotional, and agentic engagement (Maričić & Lavicza, 2024). The 27.6% who disagree or are neutral may highlight a need for further evidence, training, or examples of successful interdisciplinary lessons to address doubts and build confidence. This could involve showcasing practical applications where arts enhance science learning (e.g., using visual arts to explain scientific concepts) to convince the remaining teachers of its benefits.

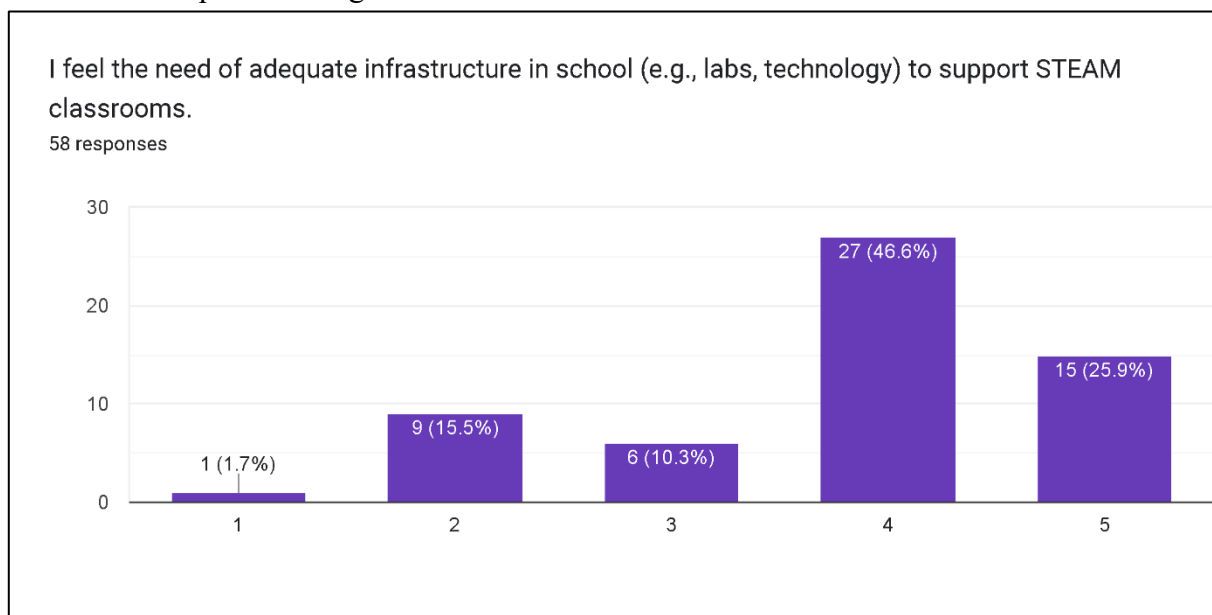


The data indicates a positive perception among teachers regarding the alignment of STEAM education with their teaching philosophy, with 70.2% (47.4% + 22.8%) either agreeing or strongly agreeing. This suggested that the majority of arts and science educators see STEAM as consistent with their pedagogical beliefs, which likely emphasize interdisciplinary, creative, and holistic learning principles central to STEAM based learning (NEP,2020). The 29.8% who disagree or are neutral may reflect diverse teaching philosophies or a lack of familiarity with STEAM's framework.

Research Objective 3. To analyse teachers' preparedness for STEAM classrooms.

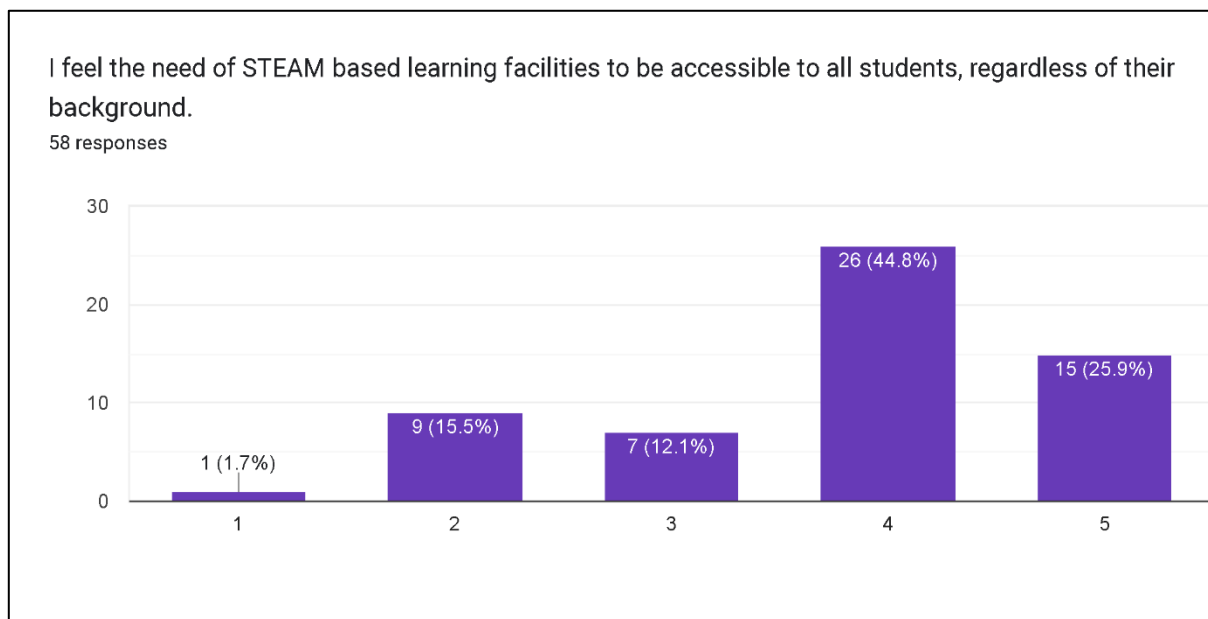
Findings:

The result of responses shared by the teachers related to analysis of teachers' preparedness for STEAM classrooms which also included the fourth domain of the questionnaire i.e. the requirement for professional development programs to equip teachers with the requisite skills for STEAM implementation. The discussion of some questions is given below.

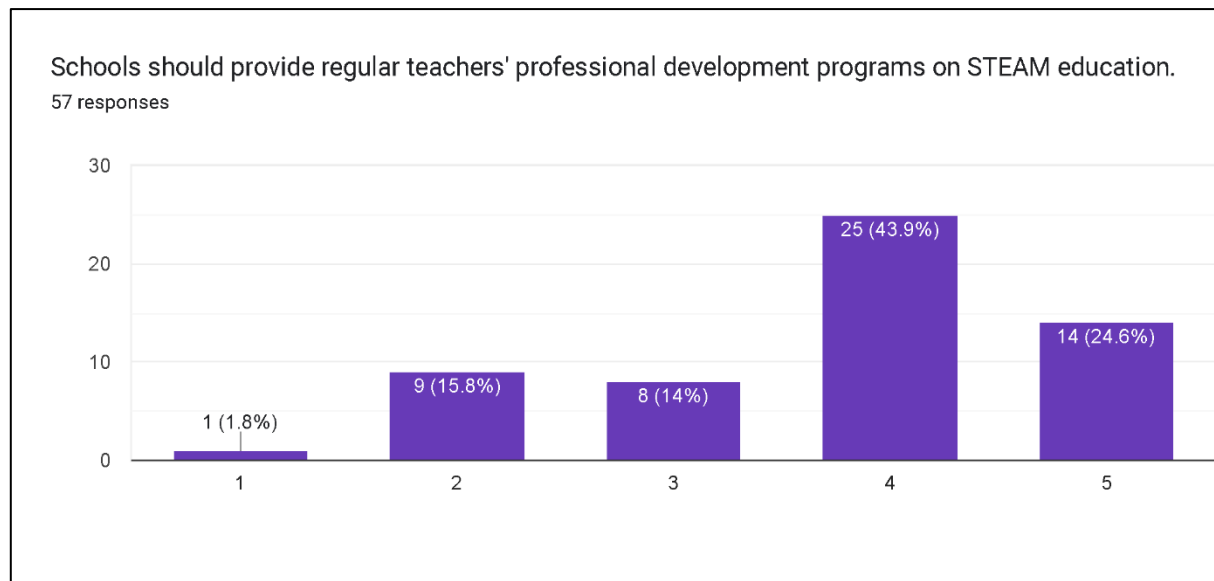


The data provides a strong agreement among teachers regarding the need for adequate infrastructure to support STEAM classrooms, with 72.4% (46.6% + 25.9%). This suggests that the majority of teachers believe that resources such as labs and technology are essential for effective STEAM education, aligning with its hands-on, interdisciplinary approach. A significant equity gap persists in education due to inadequate physical infrastructure, learning resources, and access to technology, particularly in government and rural schools (Praneeth & Banda, n.d.).

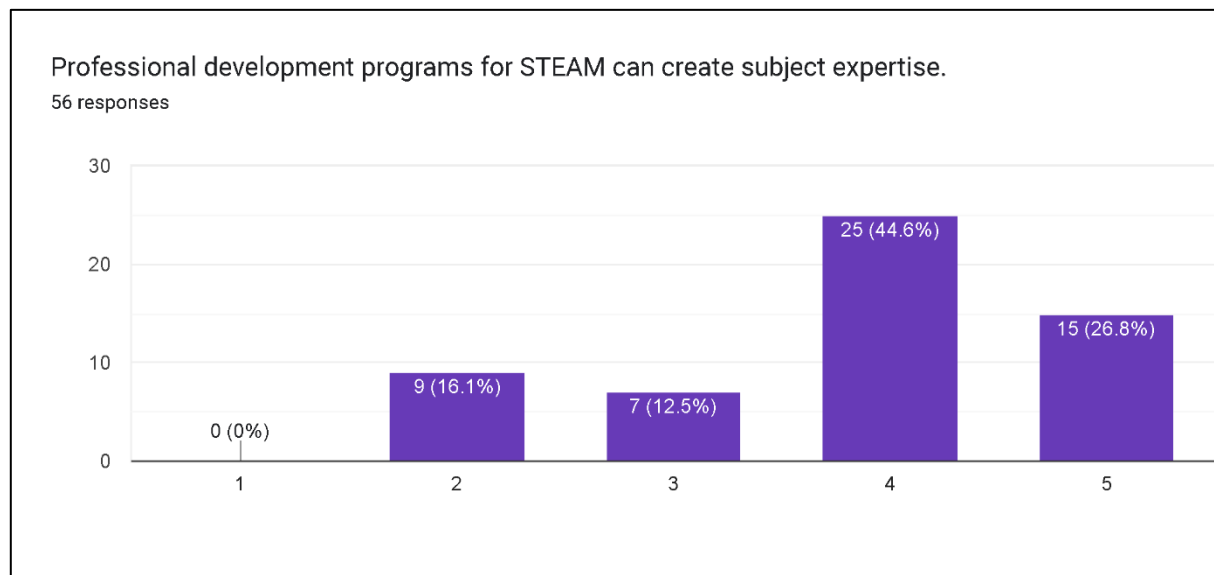
The combined percentage of disagreement and neutrality (1.7% + 15.5% + 10.3% = 27.5%) indicates that over a quarter of the teachers are either satisfied with current infrastructure or undecided suggests a need for targeted assessments and resource planning to address disparities and ensure all teachers can implement STEAM effectively.



The data shows a positive compliance regarding the need for STEAM-based learning facilities to be accessible to all students regardless of background, with 70.7% (44.8% + 25.9%) teachers are either agreeing or strongly agreeing. This suggested that the majority of teachers prioritize equitable access, aligning with the National Education Policy (NEP) 2020's focus on inclusivity and holistic development (Praneeth & Banda, n.d.). The 29.3% who disagree or are neutral may reflect varying experiences with current infrastructure or differing priorities, suggesting a need for targeted efforts to assess and address accessibility gaps, possibly through policy support or resource allocation, to fully realize STEAM's equitable potential.



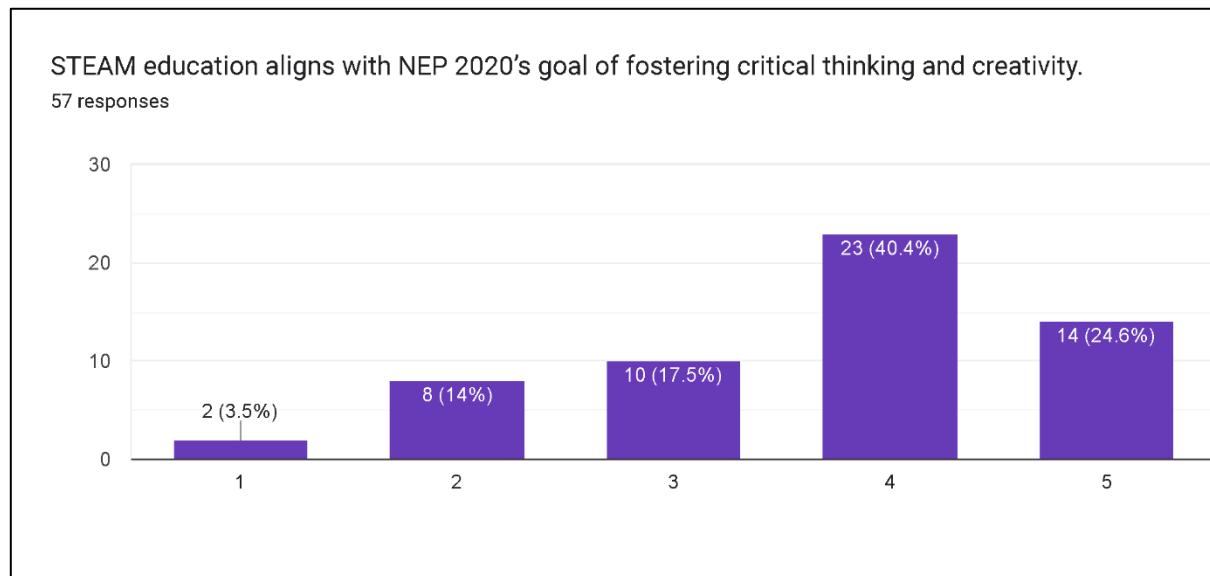
The data indicates a strong positive attitude among teachers regarding the need for professional development programs on STEAM education, with 68.5% (43.9% + 24.6%) either agreeing or strongly agreeing. This suggests that the majority of teachers believe ongoing training is essential to enhance their ability to implement STEAM effectively, aligning with the National Education Policy (NEP) 2020's emphasis on teacher capacity building. The 31.6% who disagree or are neutral may reflect confidence in existing skills, limited awareness of STEAM's demands, or resource constraints, suggesting a need for targeted outreach to assess training gaps and tailor programs to address diverse teacher needs effectively.



The data indicates a positive attitude of teachers regarding the ability of professional development programs to create subject expertise in STEAM, with 71.4% (44.6% + 26.8%) either agreeing or strongly agreeing. This infers that the most of the teachers are interested in professional training programs to deepen their knowledge and skills in STEAM, aligning with NEP-2020's vision on continuous teacher development. An effective STEAM teacher professional development includes interdisciplinary

collaboration, a shared pedagogical foundation, hands-on learning experiences with continuous support throughout the academic year is essential for helping teachers translate professional development into effective classroom practices (Boice et al., 2021).

The 28.6% who disagree or are neutral may reflect confidence in existing expertise, passiveness towards program quality, or limited exposure to effective training, suggesting a need for tailored initiatives. Schools could benefit from showcasing successful case studies or providing hands-on workshops to address these concerns and ensure widespread support for STEAM education.



The strong agreement (65%) supports the integration of STEAM education as a means to achieve NEP 2020's objectives, particularly in CBSE schools where critical thinking and creativity are prioritized. STEAM based blended learning can enhance students' critical and creative thinking skills, with improvements ranging from moderate to high levels (Putri et al., 2023). The 35% who disagree or are neutral may reflect varying levels of familiarity with NEP 2020 goals, differing teaching philosophies, or uncertainty about how STEAM practically fosters these skills. This suggests a need for awareness programmes, workshops, or examples of STEAM activities that demonstrate their impact on critical thinking and creativity, ensuring broader acceptance and effective implementation.

Analysis

The overall analysis shows a very strong positive response which suggests that most teachers are open to introduce STEAM approach in their teaching practices, and believe that exploring any concept through the lens of diverse disciplines not only make learning joyful but also help students in gaining concrete knowledge. Teachers show a positive inclination towards necessity of inclusion of Arts in STEAM framework for creativity and innovations. Arts in STEAM curricula can encourage students to face challenges with critical thinking and interdisciplinary collaborations. Most teachers feel the need of STEAM based learning pedagogy along with training programmes to manage STEAM laboratory equipment which can improve confidence among teachers in integrating digital tools (coding platforms, simulations) into STEAM lessons.

The data also indicated a strong willingness of teachers in cross-disciplinary collaborations for STEAM

projects and lesson plans. However, the small percentage of dissenting or neutral responses indicates a need for focused professional development and awareness programs for in-service and pre-service teacher to gain support of teachers to address effective understanding of STEAM in school curricula. STEAM based lesson plans along with required laboratory training should also be included in teacher education curricula. The analysis also reveals the need for adequate infrastructure (labs, digital libraries) and accessibility of STEAM facilities for all students, as well as the necessity of regular professional development programs to equip teachers with STEAM implementation skills. Schools STEAM initiatives can ensure equitable access to quality education for all students.

Conclusion

As the John Dewey said, “schools is miniature society”, reflecting its evolution and inevitably shaping its educational paradigms. Today, with the rise of artificial intelligence, robotics, sensors, and big data, our education system needs a big change. Instead of just preparing students for basic jobs, we should focus on creating innovators and skilled people. The STEAM approach offers a simple, all-around way to learn. It gives opportunity to the students to learn, experiment, apply and create solutions to real-life problems. When students can use and share what they learn outside the classroom, education truly reaches its goals. To achieve this, we must focus on teacher education, as teachers are the primary facilitators of knowledge development.

The STEAM framework can bridge the gap between science and arts, fostering a more collaborative and innovative learning environment. STEAM pedagogies promote joyful teaching-learning process, effective communication, and cooperation among teachers, leading to new discoveries and creativity. In today’s fast-moving world, teachers need to keep learning and growing. The STEAM framework is a great example of a new idea that supports and supplements teachers’ expertise. It gives them the tools to stay updated and provide the best learning experiences. With its fresh approach and teamwork spirit, the STEAM can rejuvenate teaching pedagogies and inspire a brighter future for teaching profession. The above methodology and survey stated, the need of STEAM based classrooms, modern labs, and training programs. Adding STEAM to education can make learning easier, more effective, and enjoyable, matching the goals of the NEP-2020. This shift takes teachers to new transformations in meaningful teaching practices, and will also help in building a new generation of flexible and creative educators.

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