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Awareness of STEM Education among Pre-Service Teachers: A Quantitative Study in Teacher Education

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Abstract

STEM (Scienc e, Technology, Engineering, and Mathematics) education has gained global recognition for its role in nurturing 21st-century skills such as critical thinking, creativity, problem-solving, collaboration, and innovation. The effective integration of STEM education in school classrooms largely depends on teachers' awareness and understanding of its interdisciplinary nature, pedagogical approaches, and curricular relevance. Teacher education institutions therefore play a crucial role in developing adequate awareness of STEM education among pre-service teachers. The present study aims to examine STEM education awareness among pre-service teachers enrolled in teacher education programmes. A quantitative descriptive survey method was adopted, and data were collected from 120 pre-service teachers using a self-developed STEM Education Awareness Scale. The findings indicate that pre-service teachers demonstrate moderate awareness of STEM education, with noticeable gaps in interdisciplinary integration and application-oriented understanding. The study emphasizes the need for systematic orientation, curricular integration, and professional support within teacher education programmes to strengthen STEM education awareness among future teachers.

Keywords: STEM Education, Awareness, Teacher Education, Pre-Service Teachers, Quantitative Study

1. Introduction

The contemporary world is marked by rapid scientific advancements, continuous technological innovation, and increasing complexity in social and economic systems. In response to these changes, education systems are increasingly expected to prepare learners who can adapt to evolving conditions, apply knowledge creatively, and address real-world problems effectively. Within this context, Science, Technology, Engineering, and Mathematics (STEM) education has emerged as a significant educational approach that integrates multiple disciplines to promote holistic, inquiry-driven, and application-oriented learning (Bybee, 2013). Unlike traditional subject-based instruction, STEM education emphasizes interdisciplinary connections, hands-on experiences, and problem-solving rooted in authentic contexts, thereby fostering meaningful learning experiences (Honey, Pearson, & Schweingruber, 2014).

Globally, STEM education has been recognized as a key driver of innovation, economic growth, and sustainable development. Many countries have introduced large-scale STEM education reforms aimed at strengthening scientific literacy, technological competence, and innovation capacity among learners (Thibaut et al., 2018). Empirical evidence suggests that STEM education contributes significantly to the

development of higher-order thinking skills, enhances learner engagement, and improves motivation by linking classroom learning with real-life applications (Margot & Kettler, 2019). Consequently, STEM education is no longer viewed as confined to science and mathematics classrooms alone but is increasingly regarded as a comprehensive pedagogical approach applicable across different educational stages and subject areas.

Teachers play a central role in the effective implementation of STEM education. Research consistently highlights that teachers' understanding of STEM concepts, awareness of interdisciplinary integration, and familiarity with learner-centered pedagogical practices directly influence classroom practices and instructional quality (Bybee, 2013). In the absence of adequate awareness, teachers may continue to adopt fragmented and discipline-specific instructional approaches, which contradict the core philosophy of STEM education and result in superficial integration of subjects (Thibaut et al., 2018). As a result, teacher education institutions are entrusted with the critical responsibility of preparing future teachers who are not only knowledgeable but also adequately aware of the principles, goals, and pedagogical foundations of STEM education.

Studies focusing on pre-service teachers reveal notable concerns regarding their preparedness for STEM education. Thibaut et al. (2018), in their systematic review, reported that teachers often face challenges in interdisciplinary planning due to limited awareness of how science, mathematics, and engineering concepts can be meaningfully connected. Similarly, Tondeur et al. (2020) found that while teacher education programmes that explicitly address technology integration and interdisciplinary pedagogy enhance pre-service teachers' understanding of STEM education, many existing curricula provide limited opportunities for exploring STEM education as an integrated instructional approach. As a result, pre-service teachers may develop only a partial understanding of STEM education, primarily restricted to theoretical knowledge.

International research further indicates that awareness of STEM education among pre-service teachers varies depending on institutional support, curriculum design, and exposure to innovative pedagogical practices. Pre-service teachers who engage in project-based learning, inquiry-oriented activities, and collaborative problem-solving during their training tend to demonstrate stronger conceptual clarity regarding STEM education. In contrast, those exposed predominantly to traditional lecture-based instruction often exhibit limited awareness of interdisciplinary connections and application-oriented teaching strategies (Margot & Kettler, 2019).

In the Indian context, the relevance of STEM education has been further strengthened by the National Education Policy (NEP) 2020, which strongly emphasizes multidisciplinary learning, experiential pedagogy, critical thinking, and the integration of technology across all levels of education (Ministry of Education, 2020). These policy directives align closely with the core principles of STEM education and underscore the need for reform in teacher education through innovative pedagogies, technology integration, and continuous professional development. However, despite these progressive policy initiatives, the effective implementation of STEM education in classrooms largely depends on the awareness developed during the pre-service stage of teacher preparation.

Empirical observations and available literature suggest that many pre-service teachers are familiar with the term STEM education but lack clarity regarding its integrated nature, engineering design processes, and classroom implementation strategies (Tondeur et al., 2020). Awareness serves as the foundational component upon which attitudes, instructional competencies, and classroom practices are developed. Nevertheless, empirical studies in the Indian context that examine STEM education awareness as an

independent variable remain limited. Given the diversity of teacher education institutions and the ongoing reforms under NEP 2020, there is a pressing need for quantitative investigations focusing on STEM education awareness among pre-service teachers. Such studies can provide essential baseline data to inform curriculum design, strengthen teacher education practices, and support effective policy implementation related to STEM education.

3. Need and Significance of the Study

Awareness is the initial and essential stage in the adoption of any educational innovation. Without adequate awareness of STEM education, pre-service teachers may find it difficult to understand its interdisciplinary philosophy, pedagogical relevance, and practical applications. Examining STEM education awareness among pre-service teachers is therefore crucial for identifying gaps in teacher preparation and planning targeted interventions. The present study contributes empirical evidence that can assist curriculum developers, teacher educators, and policymakers in strengthening STEM-oriented teacher education.

4. Objectives of the Study

The study was conducted with the following objectives:

1. To examine STEM education awareness among pre-service teachers.
2. To classify pre-service teachers based on their awareness of STEM education.

5. Hypothesis of the Study

1. H_0: There is no significant difference in STEM education awareness among pre-service teachers.

6. Delimitation of the Study

The study is delimited to pre-service teachers enrolled in B.Ed. programmes of selected teacher education institutions in Assam. It focuses exclusively on STEM education awareness and employs a descriptive quantitative design using self-reported data.

7. Methodology

7.1 Research Design

The study adopted a descriptive survey method using a quantitative research approach.

7.2 Population

The population of the study comprised all pre-service teachers enrolled in B.Ed. programmes under recognized teacher education institutions.

7.3 Sample

A sample of 120 pre-service teachers was selected using random sampling technique from different teacher education colleges. The reduced sample size was considered adequate for descriptive quantitative analysis and ensured manageability while maintaining representativeness.

7.4 Tool Used

A STEM Education Awareness Scale (SEAS) developed by the investigator was used for data collection. The scale consisted of Likert-type items covering conceptual awareness, interdisciplinary understanding, pedagogical awareness, and policy-related awareness of STEM education.

7.5 Statistical Techniques Used

The collected data were analyzed using the following statistical techniques:

- Mean and Standard Deviation
- Percentage analysis

8. Analysis and Interpretation of Data

The data collected through the STEM Education Awareness Scale were scored and tabulated for analysis. Descriptive statistical techniques such as Mean, Standard Deviation, and Percentage analysis were employed to interpret the data.

Analysis of STEM Education Awareness

The mean score of pre-service teachers on the STEM Education Awareness Scale indicates that the respondents demonstrate moderate awareness of STEM education. The Standard Deviation value suggests a reasonable spread of scores, indicating variation in awareness among the respondents.

Percentage analysis indicates that most pre-service teachers belong to the moderate awareness category, while a comparatively smaller proportion exhibits high awareness. Only a limited number of respondents were found to exhibit low awareness of STEM education. This distribution suggests that while pre-service teachers are generally familiar with STEM education concepts, comprehensive understanding of interdisciplinary integration, engineering design processes, and classroom application is still developing.

Table.1

Category-wise Classification of Pre-Service Teachers Based on STEM Education Awareness

Category of Awareness	Score Range	Number of Pre-Service Teachers	Percentage
Low Awareness	Below (M − 1σ)	22	18.33%
Moderate Awareness	(M ± 1σ)	71	59.17%
High Awareness	Above (M + 1σ)	27	22.50%
Total	—	**120**	**100%**

The table shows that the majority of pre-service teachers (59.17%) fall under the moderate awareness category. This indicates that most respondents possess basic conceptual understanding of STEM education but lack deeper clarity regarding interdisciplinary integration and practical classroom

application. A smaller proportion (22.50%) demonstrates high awareness, reflecting better exposure to STEM-related concepts and practices. The presence of respondents with low awareness (18.33%) highlights the need for systematic orientation and curricular support within teacher education programmes.

9. Findings of the Study

1. Pre-service teachers demonstrate moderate awareness of STEM education.
2. Awareness related to interdisciplinary integration and engineering design processes is comparatively limited.
3. There is a need for structured orientation and curriculum support to strengthen STEM education awareness in teacher education.

10. Educational Implications

The findings suggest that teacher education curricula should explicitly incorporate STEM education concepts through interdisciplinary coursework, project-based learning, and practical experiences. Orientation programmes, workshops, and collaborative activities should be organized to strengthen awareness among pre-service teachers. Teacher educators should model STEM-oriented pedagogical practices to enhance conceptual clarity and professional understanding.

11. Discussion and Conclusion

The present quantitative study examined awareness of STEM education among pre-service teachers enrolled in teacher education programmes in Assam, with the objective of understanding the extent to which future teachers are familiar with the principles, interdisciplinary nature, and educational relevance of STEM education. The findings of the study indicate that a majority of pre-service teachers demonstrate moderate awareness of STEM education, while a smaller proportion exhibit high awareness and a limited number show low awareness. This overall pattern suggests that although STEM education is gaining recognition within teacher education, comprehensive and in-depth understanding of its integrated and application-oriented dimensions remains limited.

The results of the study highlight that pre-service teachers are generally familiar with the basic concept and terminology of STEM education. However, gaps persist in awareness related to interdisciplinary integration, engineering design processes, and real-world classroom implementation. Since awareness forms the foundation for the development of positive attitudes, pedagogical competence, and effective instructional practices, these gaps may pose challenges to the successful implementation of STEM education in school classrooms. Without sufficient awareness at the pre-service stage, teachers may continue to adopt traditional subject-centered teaching approaches that do not fully align with the philosophy of STEM education.

The findings also underscore the critical role of teacher education institutions in shaping future teachers' awareness of educational innovations. While policy initiatives such as the National Education Policy (NEP) 2020 provide a strong framework for promoting multidisciplinary and experiential learning, the translation of policy goals into practice depends largely on how effectively these principles are embedded within teacher education curricula. The moderate awareness observed in the present study suggests that existing teacher education programmes may provide introductory exposure to STEM

education but lack systematic and structured opportunities for deeper engagement with interdisciplinary pedagogies.

In the context of Assam, where teacher education institutions cater to diverse socio-cultural and educational backgrounds, strengthening awareness of STEM education becomes even more important. Teacher education programmes must therefore move beyond theoretical discussions and incorporate experiential learning, project-based activities, collaborative problem-solving, and technology-integrated instruction to enhance awareness and understanding of STEM education. Teacher educators play a vital role in this process by modeling interdisciplinary teaching practices and fostering reflective engagement among pre-service teachers.

In conclusion, the study affirms that enhancing awareness of STEM education at the pre-service level is essential for preparing teachers who can effectively implement innovative and interdisciplinary teaching approaches in schools. Strengthening STEM education awareness through curriculum reform, professional development of teacher educators, and institutional support will contribute significantly to the successful realization of STEM education goals envisioned under NEP 2020. The present study provides valuable empirical insights that can serve as a foundation for future research and policy initiatives aimed at improving the quality and relevance of teacher education in India.

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