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Pre-Service English Teachers' Knowledge of Integrating Science, Technology, Engineering, Art, And Mathematics (STEAM) In English Language Teaching (ELT)

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ABSTRACT

The research examines the pre-service English teachers' knowledge levels of integrating STEAM (Science, Technology, Engineering, Arts, and Mathematics) in English Language Teaching (ELT). The study was conducted at Universitas Muhammadiyah Purwokerto and involved 27 respondents from the 8th-semester English education program. The research utilized a quantitative approach, employing a questionnaire based on the Guttman scale to assess knowledge levels. Findings reveal that most respondents (22 out of 27) possess a high level of knowledge regarding STEAM integration in ELT, with scores ranging from 76% to 100%. Three respondents demonstrated medium knowledge (56% to 75%), while two exhibited low knowledge (below 56%). The average knowledge score among participants was 89.8%. This indicates that more than half of the sample has a high level of STEAM knowledge.

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1. INTRODUCTION

English Language Teaching (ELT) plays an essential role in equipping learners with linguistic competence needed to participate in an increasingly globalized and interconnected world. In the 21st-century educational context, language learning is no longer limited to developing grammar, vocabulary, and communication skills. It is also expected to foster critical thinking, creativity, collaboration, problem-solving, and the ability to use language in meaningful real-world contexts. Therefore, innovative pedagogical

approaches are needed to make English learning more contextual, interdisciplinary, and relevant to students' future needs (Zubaidah, 2019).

One approach that has received increasing attention in education is STEAM, which stands for Science, Technology, Engineering, Arts, and Mathematics. STEAM was developed from STEM by adding the element of Arts, emphasizing that creativity, expression, and design thinking are important components of learning (Connor et al., 2015). The inclusion of Arts in STEAM allows learning to move beyond technical and scientific knowledge by encouraging students to explore ideas creatively and view problems from multiple perspectives. STEAM has also been described as a transdisciplinary educational approach because it integrates different fields of knowledge to solve complex problems (Bertrand & Namukasa, 2020). Through this approach, students are encouraged to enhance technical ability, apply problem-based learning, conduct investigations, and engage in collaborative problem-solving by considering science, technology, engineering, arts, and mathematics (Murnawianto et al., 2017; Tan & Lee, 2022).

STEAM learning is relevant to current educational needs because it provides opportunities for students to connect knowledge from different subjects with real-life situations. By using STEAM, students can apply skills and information from various disciplines in project-based activities, develop creativity, and improve cognitive as well as soft skills such as teamwork and critical evaluation (Ridwan et al., 2021). Previous studies also indicate that the STEAM approach can positively influence students' scientific knowledge, encourage active and creative problem-solving through technology, bridge abstract mathematical concepts into science and art, and help students apply learning outcomes in daily life (Riyanti et al., 2020). However, implementing STEAM also presents several challenges. Teachers often need deeper expertise to integrate STEAM effectively, some teachers feel that they do not have sufficient time to include STEAM in lesson planning, and there is still a misconception that STEAM requires expensive or high-tech materials (Lee, 2021).

In the context of ELT, STEAM integration offers a promising opportunity to enrich language learning. ELT traditionally focuses on language proficiency and communication skills, but it can benefit from the integration of STEAM elements because students are able to use English in authentic and meaningful contexts (Feyza & Seyda, 2023). Integrating STEAM in English language classrooms allows learners to connect language use with scientific exploration, technological tools, engineering tasks, artistic expression, and mathematical reasoning. This integration can create a learning environment in which language skills and content knowledge develop simultaneously. As Miralimovna (2022) explains, STEAM in English classrooms can support meaningful language experiences by connecting language acquisition with practical activities and real-world applications.

The integration of STEAM into ELT is not merely an additional activity in language teaching. Rather, it aims to create a synergy between language learning and interdisciplinary content. For example, English lessons can include project-based learning activities in which students read, discuss, design, present, and reflect on topics related to science, technology, engineering, arts, and mathematics. In this way, students not only practice English but also develop higher-order thinking skills and interdisciplinary awareness. STEAM can also support inclusive learning because it provides various forms of participation, including analytical, creative, technical, and collaborative tasks (Zubaidah, 2019). Thus, STEAM has the potential to make ELT more dynamic and meaningful for learners.

The successful integration of STEAM in ELT depends greatly on teachers' knowledge and readiness. In this regard, pre-service English teachers have an important role because they are future educators who will design and implement learning activities in English classrooms. Pre-service English teacher education is intended to prepare prospective teachers with pedagogical competence, professional knowledge, and instructional skills required in the teaching profession (Ghufron et al., 2022). Exposure to innovative teaching approaches during teacher education programs can influence pre-service teachers' beliefs, attitudes, and future classroom practices. Therefore, their knowledge of STEAM integration is an essential factor in determining whether they are prepared to apply interdisciplinary and innovative learning in ELT (An, 2020).

Several previous studies have examined STEAM education in different contexts. Lim and Oh (2015) investigated elementary pre-service and in-service teachers' perceptions and demands regarding STEAM education. Their study found that most respondents had heard about STEAM education and considered it necessary. Indriyanti et al. (2021) explored pre-service teachers' perceptions of integrating STEAM into chemistry learning and found that many pre-service teachers did not yet understand STEAM in depth and experienced difficulties in selecting chemistry topics suitable for STEAM integration. Sit (2022) examined childhood education teachers' knowledge and experience of STEAM education in Indonesia and found that training improved teachers' knowledge and helped them select appropriate methods and affordable media for STEAM learning. In addition, An (2020) showed that STEAM integration influenced pre-service teachers' disposition and knowledge, while Gökçe Tekin (2023) emphasized that teachers' basic knowledge level of STEM or STEAM education is important for effective implementation.

Although these studies provide valuable insights into STEAM education, most of them focus on general teacher perceptions, chemistry learning, early childhood education, or broader teacher knowledge. Research specifically addressing pre-service English teachers' knowledge of integrating STEAM into ELT remains limited. This indicates a research gap in the context of English teacher education, particularly in understanding how prospective English teachers comprehend STEAM concepts and their application in language teaching. Since ELT has its own characteristics, namely using language both as the object of learning and as a medium for constructing meaning, it is important to examine STEAM integration specifically within English language teaching.

Based on this background, the present study aims to examine pre-service English teachers' knowledge levels of integrating STEAM in ELT. Specifically, this study focuses on their knowledge of STEAM concepts, STEAM integration in English language teaching, approaches to STEAM learning, and the impact of STEAM on students. This study is descriptive in nature and does not formulate a hypothesis. The findings are expected to contribute to English teacher education programs by providing information about pre-service English teachers' readiness and knowledge regarding STEAM integration. Furthermore, the study may support curriculum development, teacher training, and pedagogical innovation in preparing future English teachers to implement interdisciplinary learning that meets the demands of 21st-century education.

2. METHOD

This study employed a quantitative descriptive design to examine pre-service English teachers' knowledge levels of integrating Science, Technology, Engineering, Arts, and Mathematics (STEAM) in English Language Teaching (ELT). A quantitative approach was used because it enables the collection of measurable data through a structured instrument and allows the results to be analyzed statistically (Ahmad et al., 2019). The descriptive design was selected to present the respondents' knowledge levels in numerical form, particularly through frequency, percentage, and category (Ali, 2021).

The study was conducted at Universitas Muhammadiyah Purwokerto. The participants were eighth-semester students of the English Language Education Department, Faculty of Teacher Training and Education. They were selected using purposive sampling because the sample was determined based on specific characteristics relevant to the research objective (Isaac, 2023). The participants were final-year students who had completed most of their teacher education coursework. The questionnaire was distributed to 50 students, but only 27 responses were returned and analyzed in this study.

The data were collected using an online questionnaire distributed through Google Forms via WhatsApp. A questionnaire was used because it allows respondents to answer written questions based on their understanding of the topic being studied (Riyanti et al., 2020). The instrument consisted of demographic information and 20 knowledge-based items adapted from Lim and Oh (2015). The items covered four aspects: awareness and understanding of STEAM, STEAM integration in ELT, approaches to STEAM learning, and the impact of STEAM on students.

The questionnaire used the Guttman scale with two answer options, namely "True" and "False." Each correct answer was scored 1, while each incorrect answer was scored 0. This scale was used to obtain firm answers and to measure the respondents' knowledge levels systematically (Rahardja et al., 2023). The instrument was adapted and modified to suit the context of STEAM integration in ELT. Its validity was supported by the alignment between the questionnaire items and the aspects of STEAM knowledge measured in the study, while its reliability was supported by the consistent scoring pattern of the Guttman scale.

The data were analyzed using quantitative descriptive analysis. In quantitative research, statistical procedures are used to process and interpret data systematically (Ilham et al., 2023). Descriptive statistics were applied to summarize the data through frequency, percentage, and average score (Mishra et al., 2019). The percentage descriptive technique was used to describe the level of pre-service English teachers' knowledge of integrating STEAM in ELT because it allows conclusions to be drawn based on the proportion of respondents' answers (Riyanto, 2020). The percentage score was calculated using the following formula:

$$Precentage = \frac{correct\ number\ of\ values}{number\ of\ questions} \times 100\%$$

The percentage scores were then classified based on Arikunto's (2010) knowledge level criteria. Scores ranging from 76% to 100% were categorized as high, scores ranging from 56% to 75% were categorized as medium, and scores below 56% were categorized as low.

3. RESULT AND DISCUSSION

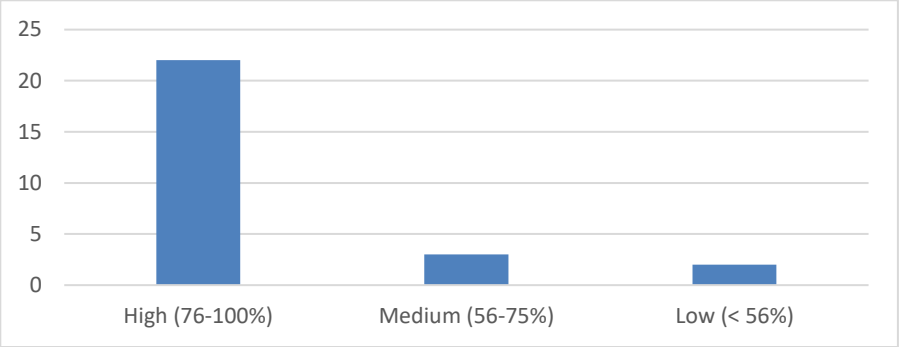
The study involved 27 eighth-semester students of the English Language Education Department at Universitas Muhammadiyah Purwokerto. The respondents consisted of 18 students from Class 8A, representing 66.7% of the sample, and nine students from Class 8B, representing 33.3%. Before measuring their knowledge of STEAM integration in ELT, the respondents were asked whether they had heard of STEAM. The result showed that 16 respondents, or 59.3%, had heard of STEAM, while 11 respondents, or 40.7%, had never heard of it. This finding indicates that although STEAM was not equally familiar to all respondents, more than half of them already had initial awareness of the concept.

Tabel 1. Respondent' Score

Respondent	Correct Number	Score in %	Category
AFM	10	50%	Low
DS	20	100%	High
MSS	20	100%	High
JPY	20	100%	High
SRNF	20	100%	High
LQN	20	100%	High
R	17	85%	High
RS	15	75%	Medium
ARK	15	75%	Medium
AN	18	90%	High
MS	19	95%	High
FKH	20	100%	High
AR	19	95%	High
RGF	20	100%	High
KL	20	100%	High
GIN	11	55%	Low
NEW	20	100%	High
MST	19	95%	High
SF	15	75%	Medium
DAR	20	100%	High
MR	19	95%	High
IMM	17	85%	High
DEP	20	100%	High
FRA	16	80%	High
CSI	18	90%	High
RAA	17	85%	High
HPP	20	100%	High

The respondents' knowledge levels were measured using 20 questionnaire items. Each correct answer was scored 1, while each incorrect answer was scored 0. The total score was then converted into a percentage and classified based on Arikunto's (2010) criteria: high, medium, and low. The result shows that most respondents had a high level of knowledge of integrating STEAM in ELT. Of the 27 respondents, 22 respondents were categorized as having high knowledge, three respondents were categorized as having medium knowledge, and two respondents were categorized as having low knowledge. The average

knowledge score was 89.8%, indicating that the respondents generally demonstrated a strong understanding of STEAM integration in English language teaching.



Graph 1. Respondent's level of knowledge results

The high percentage of respondents in the high category suggests that most pre-service English teachers in this study had sufficient knowledge of STEAM concepts and their possible integration into ELT. This result is important because the integration of STEAM in language teaching requires teachers to understand not only language pedagogy but also the relationship between language learning and interdisciplinary content. STEAM encourages learning that connects science, technology, engineering, arts, and mathematics in meaningful contexts, allowing students to develop creativity, critical thinking, collaboration, and problem-solving skills (Connor et al., 2015; Zubaidah, 2019). Therefore, the respondents' high scores indicate a positive foundation for implementing interdisciplinary English language teaching in the future.

The findings also show that initial awareness of STEAM did not fully determine the respondents' knowledge level. Although 40.7% of the respondents stated that they had never heard of STEAM before, most respondents were still able to answer the knowledge-based items correctly. This may indicate that some respondents were already familiar with the principles of integrated, contextual, creative, and project-based learning, even if they did not explicitly recognize the term STEAM. In ELT, such principles are relevant because language learning can be strengthened through authentic tasks, real-world contexts, and meaningful interaction. Miralimovna (2022) explains that STEAM integration in English classrooms can enrich language learning by connecting language acquisition with practical activities and real-world applications.

The result of this study is consistent with the idea that pre-service teacher education plays an important role in preparing future teachers to adopt innovative pedagogical approaches. Pre-service English teachers need pedagogical knowledge, interdisciplinary awareness, technological proficiency, creativity, and communication skills to integrate STEAM effectively in ELT (An, 2020). Ghufron et al. (2022) also emphasize that pre-service English teacher education is intended to prepare prospective teachers with the pedagogical competence needed to design and deliver effective instruction. In this study, the dominance of high knowledge scores suggests that most respondents had developed a basic readiness to understand STEAM-based English teaching.

Compared with previous studies, the present finding provides a more specific contribution to the context of English language teacher education. Lim and Oh (2015) found that many pre-service and in-service teachers had high awareness of STEAM education and considered it necessary. Similarly, the present study found that most respondents demonstrated high knowledge of STEAM integration in ELT. However, this study differs from Lim and Oh's work because it focuses specifically on pre-service English teachers and the application of STEAM within English language teaching. This specific focus is important because ELT requires teachers to integrate interdisciplinary content while maintaining the development of language skills.

The finding also differs from Indriyanti et al. (2021), who reported that many pre-service teachers in chemistry education did not yet understand STEAM in depth and experienced difficulties in choosing subject topics for STEAM integration. In the present study, most pre-service English teachers achieved high knowledge scores, suggesting stronger conceptual readiness among the respondents. Nevertheless, the existence of three respondents in the medium category and two respondents in the low category shows that knowledge of STEAM integration was not evenly distributed. These respondents may still need further support, particularly in understanding how STEAM elements can be translated into practical English teaching activities.

The need for further support is also aligned with Sit (2022), who found that training could improve teachers' knowledge and experience in implementing STEAM education. In the context of this study, teacher education programs may strengthen students' readiness by providing more structured exposure to STEAM-based lesson planning, interdisciplinary projects, and classroom simulations. Such preparation is necessary

because knowing STEAM conceptually does not automatically guarantee that pre-service teachers can implement it effectively in real classroom contexts. As Gökçe Tekin (2023) notes, teachers' basic knowledge of STEM or STEAM education is a key factor in supporting successful implementation.

The findings imply that English teacher education programs should continue to introduce STEAM not only as a theoretical concept but also as a practical pedagogical approach. Pre-service English teachers need opportunities to design STEAM-based English lessons, use digital tools, develop creative learning projects, and evaluate students' performance through authentic assessment. Through such experiences, they can better understand how science, technology, engineering, arts, and mathematics can be integrated into English learning without reducing the focus on language development.

Overall, the results indicate that most pre-service English teachers in this study had a high level of knowledge of integrating STEAM in ELT, with an average score of 89.8%. This finding suggests that the respondents had a positive knowledge base for applying STEAM-oriented English teaching. However, the presence of respondents in the medium and low categories shows that teacher education programs still need to provide targeted support so that all pre-service teachers are adequately prepared to implement STEAM in English language classrooms.

4. CONCLUSION

This study examined pre-service English teachers' knowledge levels of integrating Science, Technology, Engineering, Arts, and Mathematics (STEAM) in English Language Teaching (ELT). The findings show that most respondents had a high level of knowledge regarding STEAM integration in ELT. Of the 27 respondents, 22 were categorized as having high knowledge, three were in the medium category, and two were in the low category. The average score was 89.8%, indicating that the respondents generally had a strong understanding of STEAM concepts and their potential application in English language teaching.

These findings suggest that pre-service English teachers in this study had a positive knowledge base for implementing STEAM-oriented English instruction. However, the presence of respondents in the medium and low categories indicates that teacher education programs still need to provide more structured support, particularly through STEAM-based lesson planning, interdisciplinary projects, practical workshops, and teaching simulations. Such preparation is important to ensure that future English teachers are not only familiar with STEAM conceptually but also able to apply it effectively in classroom practice.

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