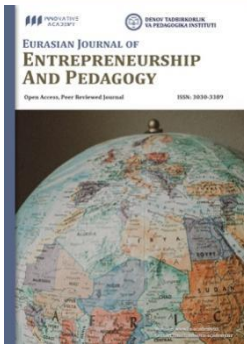


# DEVELOPING GENERAL CULTURAL COMPETENCIES OF PRESCHOOL EDUCATION TEACHERS BASED ON STEAM TECHNOLOGIES

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**ABSTRACT**

*This article explores the integration of STEAM (Science, Technology, Engineering, Arts, and Mathematics) technologies in preschool education to enhance general cultural competencies among teachers. It presents an overview of innovative pedagogical approaches such as Project-Based Learning (PjBL), Universal Design for Learning (UDL), LEGO Education, interactive technologies, and multisensory models. These methods have demonstrated significant improvements in teachers' critical thinking, creativity, inclusiveness, and problem-solving skills. Through literature analysis and case studies, the paper highlights effective models and strategies for teacher development, emphasizing the importance of structured training, cultural adaptability, and continuous professional development. The findings support the adoption of STEAM methodologies to create engaging, inclusive learning environments that prepare educators and children for 21st-century challenges.*

## Introduction

The integration of STEAM (Science, Technology, Engineering, Arts, and Mathematics) technologies in preschool education has become a critical area of focus, as it prepares young children for the challenges of the 21st century. This section explores the various STEAM technologies and methodologies employed to enhance teacher competencies in preschool education, drawing on insights from recent research papers.

## STEAM Education and Teacher Competencies

STEAM education is an interdisciplinary approach that integrates science, technology, engineering, arts, and mathematics to foster critical thinking, creativity, and problem-solving skills. In the context of preschool education, STEAM technologies are not only tools for teaching but also vehicles for developing teacher competencies. Research indicates that teacher training programs play a crucial role in preparing educators to effectively implement STEAM education (Dinh Lan Anh, 2024; Segarra-Morales Andrea Katalina & José Marcelo Juca Aulestia, 2024).

One of the key findings from the literature is the importance of a structured approach to teacher training. For instance, a study by Author proposes a teacher training model that considers three dimensions: pre-professional, professional, and expert(Segarra-Morales Andrea Katalina & José Marcelo Juca Aulestia, 2024). This model emphasizes the need for a logical and systematic sequence to implement STEAM education, mediated by emerging technologies. Similarly, Author highlights the development of a competency framework

tailored to early childhood education students, which aims to improve the quality of teaching and prepare educators for the challenges of contemporary educational environments (Dinh Lan Anh, 2024).

**Technologies and Methodologies**

Several technologies and methodologies have been employed to develop teacher competencies in STEAM education. These include:

**1. Project-Based Learning (PjBL) Model**

The PjBL model has been effectively used to enhance early childhood educators' proficiency in implementing STEAM methods with loose-part materials. This approach involves a seven-step process: initial idea identification, fact analysis, general planning, implementation, observation, evaluation, and idea improvement. Research has shown that this model significantly improves teachers' competencies, with 80% of participants reaching the minimum success indicator (Khairul Amri et al., 2024).

**2. Universal Design for Learning (UDL)**

The UDL framework has been applied to promote equity and access to STEAM education in inclusive classrooms. This approach emphasizes intentional planning and practice, ensuring that all children, including those with disabilities, can participate in STEAM activities. The framework provides a four-step approach to planning and implementing STEAM pedagogy, which has been successfully applied in various educational settings (Clarissa Bunch Wade et al., 2023).

**3. LEGO Education Methodology**

The LEGO education methodology has been widely recognized for its effectiveness in promoting STEAM skills in preschool children. This approach combines play with educational elements, fostering creativity, problem-solving, and collaboration. Research has shown that children willingly choose LEGO blocks during free play, indicating the methodology's effectiveness and practical usefulness (Birute Autukeviciene & Goda Stonkuvienė, 2022).

**4. Interactive Technology**

Interactive technology has been employed to create an interactive learning environment that enhances preservice teachers' STEAM competencies. This approach includes the use of online surveys, focus group discussions, and experimental studies to assess the impact of interactive technology on teacher development. The results indicate a significant positive impact on the development of critical thinking, collaboration, and communication skills among preservice teachers (Areej ElSayary et al., 2022).

**5. Multisensory Model**

The multisensory model has been used to strengthen teacher competencies in STEAM education. This approach integrates multiple senses to enhance learning experiences, with a focus on hands-on activities and real-world applications. Research has shown that this model is effective in improving teachers' understanding and implementation of STEAM concepts, with an average score of 82.3% for trainees (Khikmah Novitasari et al., 2022).

**Case Studies and Practical Implications**

Several case studies have demonstrated the effectiveness of STEAM technologies in developing teacher competencies. For example, a study conducted in Indonesia involved the introduction of STEAM-based educational games, which significantly improved teachers' skills in creating interactive learning materials (Qonitah Faizatul Fitriyah et al., 2023). Similarly, a study in Estonia explored the impact of online STEAM training programs, which resulted in improved digital competencies among early childhood teachers (Janika Leoste et al., 2022).

Another notable case study is the implementation of the LEGO education methodology in preschool institutions, which highlighted the benefits of integrating STEAM skills through play. The study revealed that children developed teamwork, conflict management, and problem-solving skills, while educators noted the effectiveness of the methodology in fostering creative

freedom and holistic growth (Birute Autukeviciene & Goda Stonkuvienė, 2022; Nancy K. DeJarnette, 2018).

**Table: Comparison of STEAM Technologies and Their Impact on Teacher Competencies**

| Technology/Methodology | Purpose | Citation |
|---|---|---|
| Project-Based Learning (PjBL) | Enhances teachers' proficiency in implementing STEAM methods with loose parts | (Khairul Amri et al., 2024) |
| Universal Design for Learning (UDL) | Promotes equity and access to STEAM education in inclusive classrooms | (Clarissa Bunch Wade et al., 2023) |
| LEGO Education Methodology | Fosters creativity, problem-solving, and collaboration through play-based learning | (Birute Autukeviciene & Goda Stonkuvienė, 2022) |
| Interactive Technology | Develops preservice teachers' STEAM competencies through interactive learning | (Areej ElSayary et al., 2022) |
| Multisensory Model | Strengthens teacher competencies through hands-on, multisensory activities | (Khikmah Novitasari et al., 2022) |

**Future Directions**

Future research should focus on the following areas:

1. **Longitudinal Studies**: Investigate the long-term impact of STEAM technologies on teacher competencies and student outcomes.
2. **Cultural Adaptations**: Explore the adaptation of STEAM technologies in different cultural and educational contexts.
3. **Technological Innovations**: Develop and evaluate new technologies that can further enhance STEAM education in preschool settings.
4. **Professional Development**: Design and implement comprehensive professional development programs to support teachers in effectively integrating STEAM technologies.

By addressing these areas, the field of STEAM education can continue to advance, ensuring that teachers are well-equipped to prepare young children for the challenges of the 21st century.

**Conclusion**

The integration of STEAM technologies in preschool education has proven to be an effective strategy for developing teacher competencies. By employing methodologies such as project-based learning, universal design for learning, LEGO education, interactive technology, and multisensory models, educators can create engaging and inclusive learning environments that foster critical thinking, creativity, and collaboration. As the field continues to evolve, further research is needed to explore the long-term effects of these technologies and their scalability across diverse educational settings.

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