

## IMPLEMENTING A STEAM-ORIENTED HANDS-ON CURRICULUM IN GENERAL EDUCATION COURSES

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### Abstract

This study was conducted within a general education course at National Taitung Junior College and aimed to design and implement an interdisciplinary, hands-on curriculum grounded in the principles of STEAM (Science, Technology, Engineering, Arts, and Mathematics). Through context-based learning and a design thinking approach, students were guided to integrate scientific inquiry, engineering design, mathematical analysis, and artistic creativity to address real-world problems, thereby fostering creativity, problem-solving skills, and interdisciplinary competencies. The curriculum was structured around thematic activities such as sensor system design, solar-powered vehicles, voice sensing applications, and water rocket system design. These activities integrated sensor applications, data collection and analysis, structural design, and aesthetic expression. Beyond functional implementation, students were encouraged to consider visual design, creative expression, and usage scenarios of their projects. The instructional process emphasized teamwork, iterative prototyping, and reflective revision, enabling students to comprehend abstract concepts through hands-on practice while developing communication and presentation skills through project demonstrations and oral presentations. The research methodology primarily employed a STEAM learning outcomes questionnaire and classroom observations to analyze students' learning interests, knowledge application, reasoning and analytical abilities, and creative performance. The results indicate a positive improvement in students' learning attitudes and engagement across all STEAM dimensions. In particular, students demonstrated significant learning gains in transforming mathematical and engineering concepts into tangible design outcomes and enhancing project completeness and expressiveness through the integration of artistic elements. Overall, the findings suggest that incorporating STEAM-based interdisciplinary practices and artistic design elements into general education courses not only enhances students' understanding of and interest in STEM learning but also contributes to the development of creative practice and real-life application skills. This study provides a practical and replicable model for promoting STEAM education and instructional innovation in technical and vocational higher education institutions.

**Keywords:** *STEAM education, interdisciplinary learning, general education, design thinking, hands-on learning.*

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### 1. Introduction

In recent years, STEAM education has emerged as a key approach to fostering interdisciplinary competencies and innovation in education. By integrating science, technology, engineering, arts, and mathematics, STEAM emphasizes real-world problem solving and holistic learning experiences (Yakman, 2008; Yakman & Lee, 2012). Compared with traditional STEM education, STEAM incorporates artistic design elements to enhance creativity and expressive capacity.

Previous research has indicated that STEAM-based learning can significantly improve students' motivation, engagement, and interdisciplinary competence, particularly in science and engineering domains (Herro et al., 2018). Furthermore, the integration of problem-based and inquiry-based learning approaches supports the development of critical thinking and collaborative skills (Barron & Darling-Hammond, 2008).

In technical and vocational education, general education courses play a crucial role in cultivating students' foundational competencies. However, traditional teaching approaches often focus on knowledge transmission, limiting students' ability to apply knowledge in real-world contexts. Therefore, this study introduces a STEAM-oriented hands-on curriculum to enhance students' learning motivation, interdisciplinary integration, and creative performance.

## 2. Design

STEAM education originated from STEM education initiatives in the 1990s and later incorporated artistic elements to form a more comprehensive interdisciplinary framework (Yakman, 2008). It emphasizes knowledge integration rather than isolated subject learning and highlights authentic contexts, interdisciplinary competence, and innovative design.

This study adopts both design thinking and problem-based learning as instructional frameworks. Design thinking involves five stages: empathize, define, ideate, prototype, and test (Brown, 2008). This process enables students to actively identify problems and develop solutions through iterative refinement.

The course was designed around four modules: sensor system design, solar-powered cars, voice sensing, and water rocket systems. These modules integrate real-life applications and combine scientific principles, technological tools, engineering design, mathematical analysis, and artistic creativity.

Students engaged in hands-on activities involving data collection, system construction, and iterative testing. The course emphasized teamwork, reflective learning, and project presentation to enhance communication and collaboration skills.

## 3. Objectives

The objectives of this study are as follows:

- (1) To develop a STEAM-oriented interdisciplinary curriculum for general education.
- (2) To enhance students' learning motivation and engagement.
- (3) To improve students' problem-solving and creative abilities.
- (4) To examine the role of artistic design in STEM learning.
- (5) To evaluate students' ability to apply interdisciplinary knowledge in practical contexts.

## 4. Methods

This study adopted a mixed-method approach. Participants were students enrolled in a general education course at National Taitung Junior College.

Data were collected through a STEAM learning effectiveness questionnaire, classroom observations, and interviews. The questionnaire measured learning interest, knowledge application, reasoning ability, and creative performance. Observations and interviews provided qualitative insights into students' engagement and learning processes.

Descriptive statistical analysis was conducted to evaluate learning outcomes, complemented by qualitative analysis to interpret students' experiences.

## 5. Discussion

The findings indicate positive improvements in students' learning attitudes and engagement, with mean scores ranging from 4.4 to 4.6 across STEAM dimensions. Most students expressed interest in the course and willingness to participate in similar learning experiences.

Qualitative data revealed that students were able to apply mathematical and engineering concepts to practical design tasks, such as voice recognition systems and water rocket projects. The integration of artistic elements enhanced the creativity and completeness of their work.

However, some students encountered challenges in mathematical calculations and technical implementation, suggesting the need for additional instructional support and scaffolding.

Overall, the results demonstrate that STEAM education effectively bridges theory and practice, promoting interdisciplinary learning and problem-solving skills.

## 6. Conclusions

This study demonstrates that STEAM-oriented hands-on learning can significantly enhance students' learning outcomes in general education courses. The integration of artistic design elements improves creativity and project quality, while contextualized learning and design thinking approaches support real-world application.

The proposed instructional model is practical and feasible, providing valuable insights for implementing STEAM education in technical and vocational institutions. It contributes to the development of interdisciplinary education and innovation in teaching practices.

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