

Enhancing Engineering Design Skills through Activity-Based STEM Learning with Environmental Problem-Solving Focus among Vocational Students

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1. Introduction

The Challenge:

Developing Engineering Design Skills (EDSs) is crucial for vocational students, yet many struggle to transfer theoretical knowledge to real-world problem-solving especially for Thai vocational school context.

The Approach:

This study implements Activity-Based STEM Learning (mainly focussed on the Engineering Design Process or EDP) using environmental monitoring stations to foster EDSs.

Objective:

To investigate the development of 4 key EDSs components (Defining problems, Developing solutions, Optimizing, and Presenting) through the Engineering Design Process (EDP).

2. Methodology

Participants:

12 first-year High Vocational Certificate students in Mechatronics and Robotics

Intervention (6 Weeks): 2 Phases Engagement

Phase 1 (Weeks 1-2):

Foundational concepts (STEM Concepts, Sensors, Microcontrollers, Environmental Issues Discussions)



Phase 2 (Weeks 3-6):

Station-based activities using the Engineering Design Process (EDP):



Station 1: Sound
Decibel measurement & Alarm system



Station 2: Soil
Moisture measurement & Irrigation system



Station 3: Air
PM2.5 monitoring & Filtering system



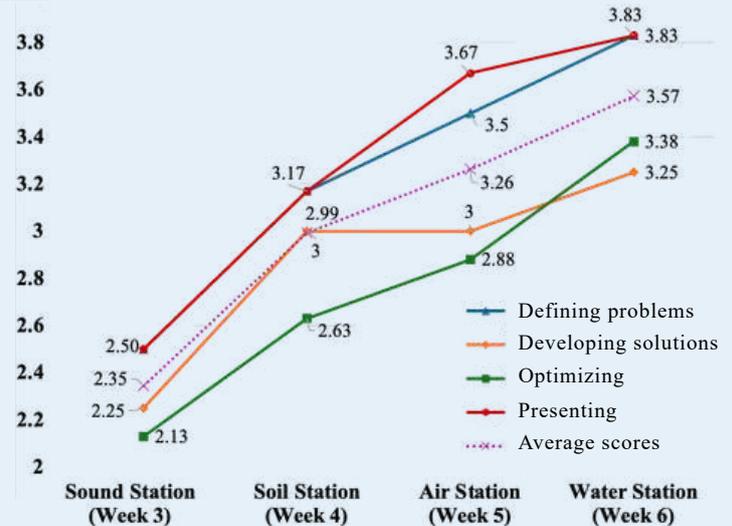
Station 4: Water
pH measurement & Control system

Assessment:

Mixed-methods (Rubric scoring, Observation, Product assessment, Oral and written reports)

3. Results

Quantitative Findings:



Consistent Improvement:

Overall EDSs mean scores increased significantly from 2.34 (Week 3) to 3.57 (Week 6) (Scale 1-4).

Growth Across All Skills: 4 EDSs

- Defining Problems: 2.50 → 3.83
- Developing Solutions: 2.25 → 3.25
- Optimizing Design: 2.13 → 3.38
- Presentation: 2.50 → 3.83

Qualitative Observations:

Early Stage:

Students relied on trial-and-error and needed instructor guidance.

Later Stages:

Students gradually demonstrated improvement in systematic testing, independent problem-solving (evidenced during hands-on and heads-on tasks), and stronger environmental awareness (particularly seen from the oral presentation part).

4. Conclusions

- **STEM Station-Based Learning Works:** Repeatedly practice across different environmental contexts significantly strengthened EDSs.
- **Shift in Skills:** Students moved from "trial-and-error" to "systematic engineering design" (through EDP).
- **Additional Benefit:** The approach not only builds technical skills but also fosters awareness of sustainable environmental issues.

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