Assembly Robots for Modular Integrated Construction: An Interdisciplinary Teaching Activity

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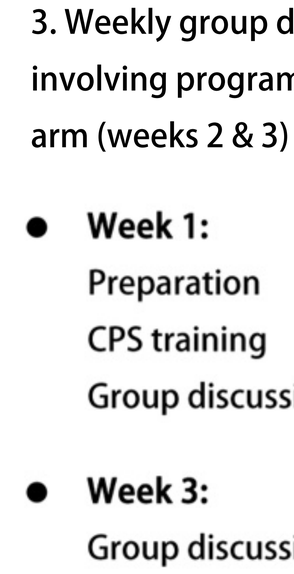
1 Background

Modular Integrated Construction (MiC) is transforming the building industry by relocating fabrication to controlled environments. Yet, on-site assembly processes such as alignment and installation remain labor-intensive and hazardous (Song et al., 2024). Facing this challenge, robotics is increasingly recognized as a transformative driver for safer and more efficient site operations (Pan et al., 2022). However, many students in civil-related disciplines are unfamiliar with the capabilities and limitations of robotics, which can lead to misconceptions or even avoidance of robotics-enabled solutions in interdisciplinary contexts. Moreover, teamwork and efficacy are critical to success in the high-tech workplace of the new era (Leavy et al., 2023). To better prepare students for this new era of interdisciplinary collaboration, we designed a team-based learning activity that offered in-depth experiences with robotic technology. The activity integrated conceptual foundations with authentic, practice-based challenges, while also fostering transferable skills such as teamwork and problem-solving.

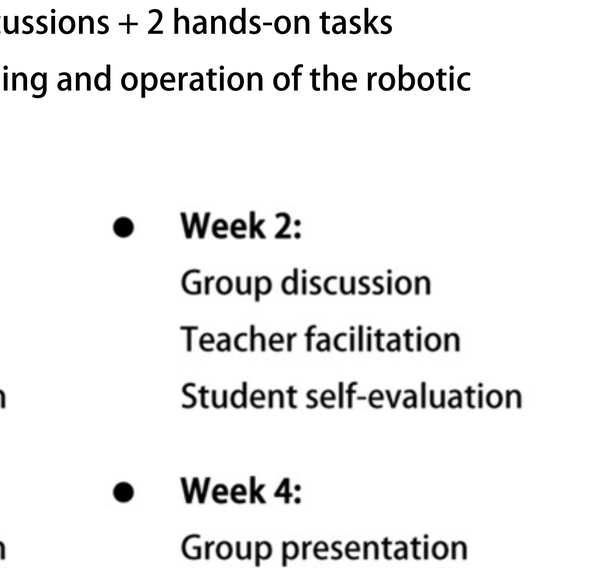
2 Teaching Program

1. 30 participants
(14 Female, 16 Male; Ave Age = 25, SD = 2.15)
2. Six groups
(5 students per group, with at least 1 expert student)
3. Weekly group discussions + 2 hands-on tasks involving programming and operation of the robotic arm (weeks 2 & 3)

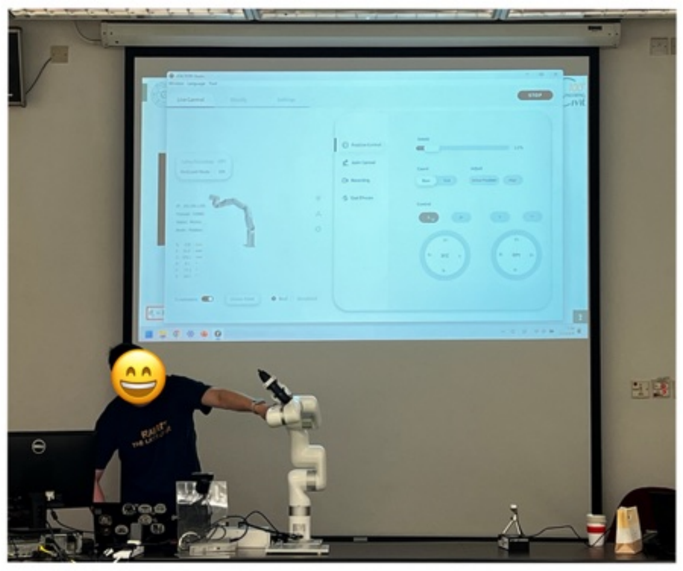
- **Week 1:**
  Preparation
  CPS training
  Group discussion
- **Week 2:**
  Group discussion
  Teacher facilitation
  Student self-evaluation
- **Week 3:**
  Group discussion
  Teacher facilitation
  Student self-evaluation
- **Week 4:**
  Group presentation
  Teacher feedback



Robotic Arm



Group Discussion Board



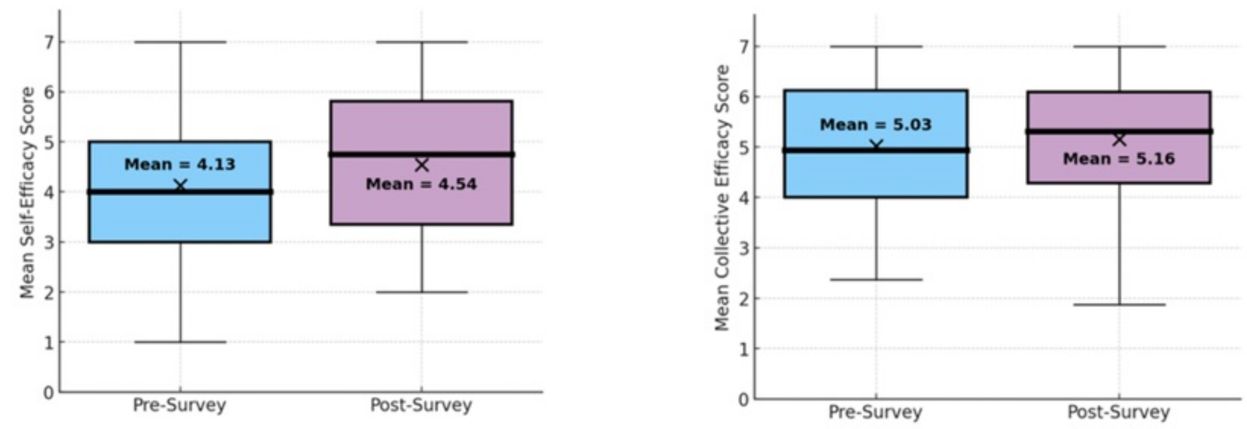
Teacher-led demonstration

Hands-on Activity

3 Evaluation

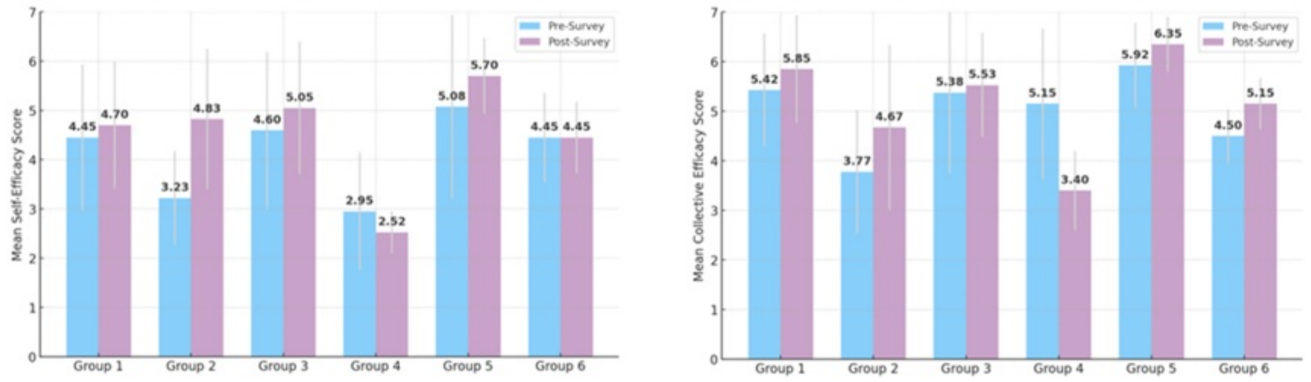
Evaluation combined knowledge checks, pre- and post-surveys on self- and collective efficacy, rubric-based classroom observations, and reflective discussions.

4 Key Findings



Pre- and Post-survey Results of Students Efficacy

(L) Self-efficacy scores from pre-survey (M = 4.13, SD = 1.61) to post-survey (M = 4.54, SD = 1.47), t(29) = 1.18, p = 0.25.
(R) Collective efficacy scores from pre-survey (M = 5.03, SD = 1.42) to post-survey (M = 5.16, SD = 1.42), t(29) = 1.18, p = 0.25.



Group-level Analyses of Self- and Collective Efficacy

(L) self-efficacy (p = 0.056) (R) collective efficacy (p = 0.061)

Although statistical tests showed no significant differences in mean self-efficacy and collective efficacy, group-level analyses revealed notable variation among teams.

Interview Results

The activity enhanced students understanding of robotic technology, encouraged more effective teamwork, and strengthened confidence in solving unfamiliar technical problems. Students also highlighted that interdisciplinary collaboration broadened their perspectives and deepened curiosity about robotics potential in their own fields. Situated within MiC scenarios and integrating theory with practice, the activity produced measurable learning gains and offered a replicable model for developing both technical and collaborative competencies essential for next-generation construction professionals.

Acknowledgement:
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Reference:

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Song, C., Li, X., Du, Q., Jiang, R., & Shen, Q. (2024). Hybrid pose adjustment (HyPA) robot design for prefabricated module control in modular construction assembly. Automation in Construction, 168, 105798. https://doi.org/10.1016/j.autcon.2024.105798