Learning in Multidisciplinary Teams in a Challenge-Based Learning Course

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Abstract

This research was conducted in the context of a new **challenge-based learning (CBL) course** where applied physics and mechanical engineering students worked in multidisciplinary teams. **A case study was conducted to:** a) explore learning experiences and b) identify facilitators of and barriers to successful multidisciplinary teamwork. Data included interviews, observations, and design products. The results indicated knowledge improvement mainly in engineering related concepts and methods. The findings also yielded **major factors that influence multidisciplinary teamwork:** a) setting strong disciplinary connections to the challenge, b) receiving tutor guidance, c) prior knowledge, and d) exchanging science and engineering perspectives. Implications contribute to future research and thinking about designing similar learning environments while improving student learning in multidisciplinary teams.

Introduction and Research Questions

Multidisciplinary teamwork and approaching overarching problems with the knowledge and methods of multiple disciplines lie at the core of CBL courses (Membrillo-Hernandes et al., 2019; Ktoridou et al., 2016).

This study addressed the need to identify **factors influencing multidisciplinary teamwork** in a new CBL course. The second goal was to investigate perceptions about **learning in multidisciplinary teams** in the context of the course.

The research questions were: 1) To what extent does multidisciplinary teamwork contribute to student learning and development in the CBL course? and 2) what factors influence multidisciplinary teamwork in the CBL course?

Figure 1. Framework for CBL characteristics (Gallagher & Savage, 2020, p. 15).

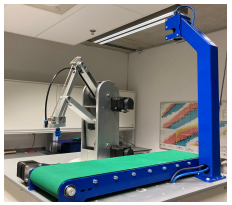

Figure 2. Robot arm in the lab.

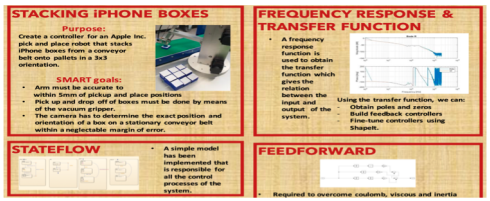

Figure 3. Selected team poster.

Method

Research design: An instrumental case study approach (Creswell, 2015) was adopted to investigate multidisciplinary teamwork in its real-life setting; a CBL course. **See Table 1 for data collection and participants.**

Context: Five multidisciplinary teams worked on the design challenge: "*designing and implementing a real-time controller using a pick-and-place robot*" **(See Figure 2).** The problems that the teams formulated focused on e.g., waste management, stacking phone boxes **(see Figure 3).**

Data analysis: A content analysis method (Miles & Huberman, 1994) was followed to analyze the interview transcripts and the reflection reports. Findings were complemented by an evaluation of the design products and video transcripts.

Trustworthiness: Triangulating student and teacher perspectives, comparison of interview responses, course products, and video recordings.

Table 1. Data collection

Method	Participants	Research question(s)
Student interviews	4 applied physics (AP) and 8 mechanical engineering (ME) students.	1, 2
Teacher interviews	2 teachers and 3 tutors.	1, 2
Design products	Posters and videos of all 5 teams.	1
Observations	Video recordings of a team with 2 AP students.	2
Reflection reports	All students in the course (n = 30).	2

Results

Research question-1: **Figure 4 summarizes** the results of the student and teacher interviews in two categories: a) increased content knowledge and b) perceived skills and competencies.

Interview results and evaluation of the design products together show the knowledge gained mainly on control theory, transfer function, and kinematics, object detection using Simulink and Matlab, and approaching problems with a different perspective.

Research question-2: **Table 2 presents** the findings for factors; awareness on general skills (e.g., robotics), communication in the team, making interim team presentations, and tutor guidance **are found to facilitate teamwork.** Limited knowledge on control theory and the greater connection of the design challenge to engineering concepts **are revealed as barriers.**

Table 2. Factors to influence multidisciplinary teamwork in a CBL course

Personal factors	Team factors	Course factors
Knowledge on control theory (61%)	Effective communication (41%)	Disciplinary connections (54%)
General skills (22%)	Presentations (16%)	Tutor guidance (29%)

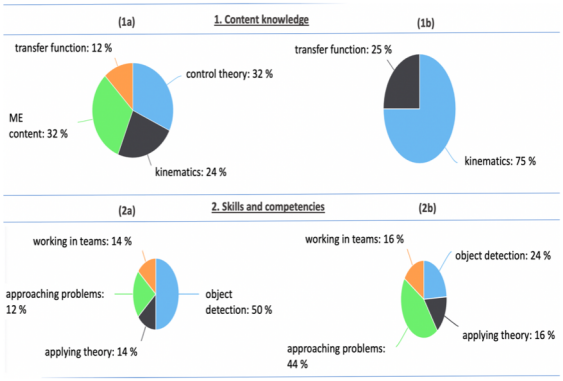

Figure 4. Interview results for learning: (1a & 2a) AP students; (1b & 2b) ME students.

Discussion

Results indicate **higher gains** in theory and application of engineering concepts and methods (e.g., control theory). Both department students perceived an improvement in **approaching problems from a different perspective.**

Results suggest **design challenges** that draws on equally from both disciplines (MacLeod & van der Veen, 2020).

The study contributes to the emerging line of research for **multidisciplinary teamwork of science and engineering students with the identified factors**: theory- and practice- oriented perspectives, awareness on general skills, tutor guidance, effective communication in the team.

Conclusions

Key conclusions for researchers and practitioners are:

- **multidisciplinary teamwork can contribute to** students' deepening their disciplinary knowledge while acquiring knowledge of other disciplines in a CBL course,
- students can collaboratively **apply different disciplinary knowledge** to perform experiments and create design solutions,
- science and engineering students' **unique ways of thinking and approaching problems** support teamwork, and
- the disciplinary connections to the design challenge, students' prior knowledge, tutor guidance, interim team presentations should be considered for **effective multidisciplinary teamwork in CBL courses with science and engineering students.**

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