Designing creative and innovative learning environments that foster creativity and innovation

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Introduction

A project task-based teaching approach is evaluated regarding creativity. Elements promoting creativity are collaboration, open-ended problems, research connection, varied teaching, non-instructive lab exercises and asking for creativity. Discussions will be initiated based on a student evaluation.

Background

In 2012 and 2020 pedagogical development projects were initiated for the remodeling of an engineering course on automation and robot engineering at Uppsala University. A new course structure was developed around real-world project tasks and based on active learning connecting theory to practice within open-ended problems. This is achieved through project tasks taken directly from our research and implemented as a simplified work-life structured project in the course.
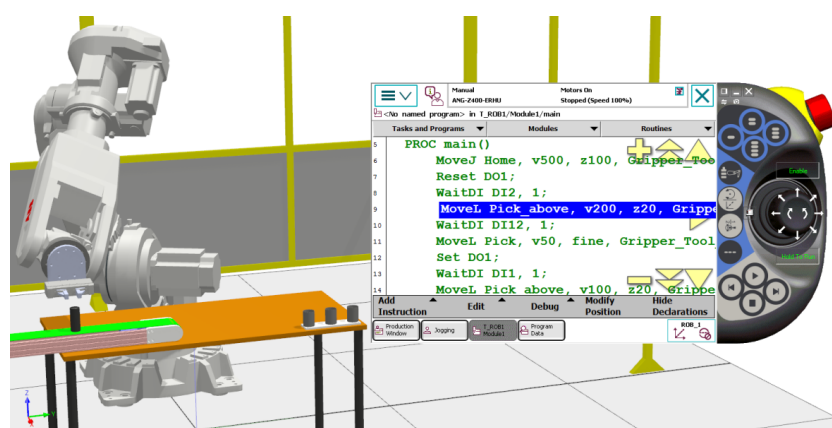

Figure from [2]

Part I - pre-study

Course introduction	Course structure explained
Project tasks introduction	Demonstration, creativity emphatized
Lectures part 1	Theory for project part I
Lab exercise 1 - introduction	First experience of a robot
Project supervision	Project group work with supervision
Project seminar 1 + report	Pre-study presented

Part II - practise

Lectures part 2	Theory for project part II
Sustainability seminar	Discussion/practise related to project tasks
Pre-lab test	Preparation for project lab exercises
Lab exercise 2 - projects	Project tasks practised in robot lab

Part III - evaluation

Lectures part 3	Theory for project part III
Guest lecture and study visit	Industry connection
Lab exercise 3 - projects	Project tasks evaluation in simulation
Project supervision	Project group work with supervision
Project seminar 2	Pre-study evaluated and discussed

Part IV - end course

Lecture summary	Theory repetition
Online test	Online interactive examination
Written examination	Written examination
Course evaluation	Data analysed in this work

The overall outcome of the investigated course is previously evaluated in [1] and [2]. The outcome regarding creativity has however not been evaluated in detail before.

An important aspect of this pedagogical approach is the ambition to foster creativity, recognized as an important competence for the modern engineer [3]. Creativity can for example be stimulated by teamwork projects, provided that the students are given influence over the task design and solution [3,4]. Varied teaching methods is also important, as fixed roles and patterns can be a barrier to creativity [5]. Furthermore, encouraging and stating that creativity will be rewarded can increase creativity in the end product [6].

Real-world project tasks

- Integrated part of the course
- Connects theory to practise and work-life

- Three manual assembly tasks taken from previous research projects
- Students choose project and form groups

- Design their own robotized solutions, present pre-studies to each other
- Creativity is empathized from teachers

- Lab exercises with existing equipment
- Non-instructive labs, test and fail, long time provided and supervisors present

- Lab experiences are used for modifying the student solutions

- Seminar discussion and sum-up

Figure from [1]

Results
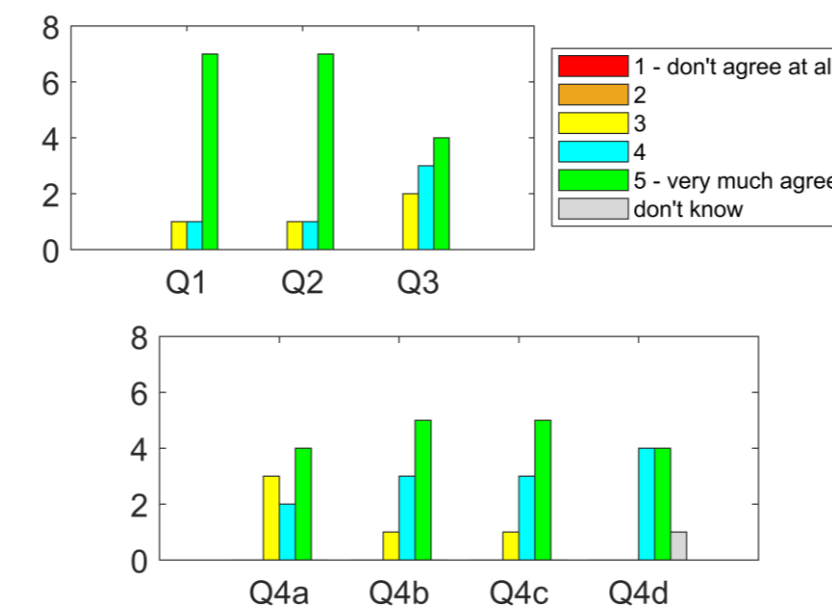
Student evaluation (nine responses) on a Likert scale 1-5 (disagree – agree):

Encouraged to be creative (Q1)   4.7/5
Good opportunities for creativity (Q2) 4.7/5
Taken the creativity opportunity (Q3)   4.2/5

Elements developing my creativity (Q4):
    a. The course structure   4.1/5
    b. The project tasks   4.4/5
    c. The lab exercises   4.4/5
    d. The research connection   4.5/5

Free text student comment (one response):

"I really got to try my hand at it, which was good as you learn more from mistakes, for example when programming the robot online"

To discuss

- Success in the student evaluation, but: How to evaluate actual creativity skills?

- Could the same pedagogical approach be used for other courses?

- How can we help students to be even more creative and innovative?

- Could VR / metaverse be utilized to practise/promote creativity?

Acknowledgments

List of references

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3. C Zhou (21012). Fostering creative engineers: a key to face the complexity of engineering practice. European Journal of Engineering Education 37(4):343-353.
4. AS Blicbau, J M Steiner (1998). Fostering Creativity Through Engineering Projects. European Journal of Engineering Education 23(1):56-65.
5. RA Beghetto (2010). Creativity in the Classroom. In: J C Kaufman, RJ Sternberg, eds. The Cambridge Handbook of Creativity. Cambridge University Press, pp. 447-464.
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