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On computer science major students' motivation in a practically oriented robotics course

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ABSTRACT
Educational robotics is considered to motivate students to learn principles of computing and computational thinking in many contexts. In this paper, we present the first experiences from our recent multimodal robotics course, that was given to more than 100 computer science major students at the University of Eastern Finland. Preliminary results show, aligned with suggestions from the literature, that hands-on robotics exercises and the course project work motivated students. Furthermore, results indicate that robotics would have a stronger role in our computer science curriculum.

CCS CONCEPTS
• Applied computing → Education → Interactive learning environments • Computer systems organization → Embedded and cyber-physical systems → Robotics.

KEYWORDS
Robotics; education; computer science curriculum; Arduino; Lego Mindstorms; students’ motivation

ACM Reference format:

1 Introduction
Robotics is often considered as a highly feasible tool for teaching computing concepts for students in all educational levels. Robotics has been seen to motivate students to learn various computing concepts not only in K-12 education [7], but also in tertiary level [4], and even in pre-school education [5]. Recent changes in K-12 curricula in many European countries (see for example [8]) and utilization of educational robotics to implement new curricula have increased interest and public awareness towards robotics.

In this article, we report our experiences from an elementary robotics course from two aspects. First, we describe what we learnt when organizing a highly hands-on course for a relatively big student cohort (n=135). Second, we present the first findings about how our students (computer science majors) perceived the course that was substantially different in topics and implementation when comparing to the previous courses they have been taking during their studies. The results presented in this paper are based on the initial findings from the qualitative research material that we collected during the course. The results set the ground for a more deep and systematic qualitative research process.

2 Students motivation in educational robotics settings
Usage of educational robotics learning environments in different contexts has been reported widely in research literature, and examples of conducted interventions can be found from all school levels. However, the amount of reliable empirical evidence confirming that robotics is generally an effective tool remains limited [2, 3]. However, based on the literature, a conclusion can be drawn that robotics environments do motivate students in specific contexts. Chin et al [3] used Instructional Materials Motivation Survey (IMMS) to assess an educational robotics setting in elementary education. The results show that, overall, educational robot-based system improves students’ learning interest and motivation. Similarly to this, Kaloti-Hallak et al. [6] report a study with middle-school students where they found out that students’ attitude to learn STEM and computer science subjects was increased when using robotics as a learning environment.

In the tertiary level, results by Apiola et al. [1] show that a practically oriented robotics learning environment triggers students’ motivation in a computer science course. The study by Apiola et al. [1] in particular has lot of common with our case. Whereas the abovementioned studies use quantitative or mixed-method approach, Apiola et al [1] took qualitative approach and used content analysis, observations, and student interviews as the research instruments. Furthermore, Apiola et al. [1] conducted
their study in a context similar to us, where material was collected as part of an experimental course in computer science studies in a higher education institution and the courses were experimental, hence free from strict and formal learning goals set by the institutions’ curricula.

3 Research setting
The School of Computing at the University of Eastern Finland is divided in two campuses about 120 km apart from each other, and course lectures are often delivered by video streaming from one campus to another. In our course, the student population was about 50/50 between the campuses. The course consisted of 12 hours lectures that were streamed from one campus to another. In addition, 16 hours of hands-on exercises were organized at both campuses locally.

The course evaluation was based on individual and group exercises and a course project work. Topics for undergraduate students’ project work included for example maze-solver and soccer robots, whereas Master level student groups did their project in more advanced topics such as self-learning robot navigation with artificial neural network. Lectures materials were complemented with examples with real hardware. This proved to be one of the challenges when trying to demonstrate a robot’s functions over the video connection to the distant campus. During the course, the students were given altogether five weekly lecture tasks to work with.

Course material was collected in the Moodle learning environment with the supplementary material for the different content modules. The students also returned their tasks to Moodle, and were able to discuss course issues at the Moodle discussion forums. Some external tools, such as TinkerCAD online circuit design environment were used to simulate and learn basic electronic connections and operations before trying them out with the real hardware. At the end, 25 student groups returned their course project work, and 115 students passed the course.

4 Initial findings
During the course, we collected a set of qualitative research material in different forms. These materials include observations, field notes, as well as the students’ project work reports and learning diaries. This article highlights some of the preliminary findings on computer science students’ motivation towards hands-on and practically oriented teaching. Despite the challenging teaching setting in two campuses for such a hands-on course, the students remained motivated throughout the course. This is especially evident from the learning diary entries.

“The course gave a good ground for robotics hardware and software. Many computer science courses are rather theoretical, so this course provided a good counterbalance.”

Furthermore, students express very clearly their viewpoint that the robotics courses could have a stronger role in our curricula.

“I wouldn’t see it as a problem if for example this course would be mandatory course for major studies.”

5 Conclusions
We have reported the key lessons learnt from organizing the course as follows. Aligned with research literature, we found that it is easy to motivate the students in a robotics learning environment. The big number of participants and distributed teaching arrangement require careful planning and preparation of videos and other multimodal content. However, it is important to allow the students to try out the presented concepts during face-to-face teaching activities. Students enjoyed working with real hardware and having concrete examples to balance some other, very theoretical courses they were taking on the same time. During the course, many of them realized the importance of their previously acquired knowledge for example in algorithm design and were able to utilize this knowledge when programming Arduino microcontrollers with a limited computing capacity. The students’ learning diaries highlight that our computer science curriculum would benefit from a regularly organized robotics course. The students would like to see robotics as more integrated and even mandatory part of the curriculum. More systematic and thorough qualitative analysis of materials, i.e. students’ learning diaries and project work reports, will be carried out as the next step of this research process.

REFERENCES

I. Jormanainen

“I think that robotics should be more prevalent in computer science studies, as it is a lot more relevant and important than most of the courses we have here.”