Closing report for the NTNU Toppundervisning project: Adaptive Learning Analytics to Support Information Technology Education (Adapt-IT)

Project leader: Michail Giannakos
Other participants: Zacharoula Papamitsiou, Boban Vesin, Katerina Mangaroska, Kshitij Sharma

Organization

The project has been led by project manager Michail Giannakos, with the following researchers participating: Zacharoula Papamitsiou, Boban Vesin, Katerina Mangaroska, Kshitij Sharma. Main collaborators have been professor Alf Inge Wang and Hallvard Trætteberg, IDI/IE, NTNU. In addition, several students were employed for a small period to support the project.

Abstract: This report describes the "Adaptive Learning Analytics to Support Information Technology Education (Adapt-IT)" project that was currently implemented in the context of NTNU Teaching Excellence initiative[1]. The goal of this project is to utilize adaptive self-assessment quizzes in the context of IT education at IDI/IE, NTNU.

Background

In IT education, programming is a central part of different study programs. The increased number of students and popularity of programming courses introduced multiple challenges and opportunities in offering assessment and feedback on programming assignments. Introductory programming classes occasionally have more than 500 students (e.g., IT Grunkurs has 3.000, my Web Technology course has 300), which makes it difficult for the teacher to provide timely, thorough and unified assessment. Therefore, automated adaptive assessment methods can provide efficient and high quality feedback to support both, students (e.g., timely, unified) and teachers (e.g., detailed reports about students' progress and misconceptions). In addition, adaptive systems have the capacity to automatically adjust difficulty of the educational content and recommend the most appropriate content for each of the students.

An adaptive assessment system allows us to visualize the state of individual student's knowledge and present this information to them (see Figure 1), by doing this we allow students to facilitate their learning. Our goal in this project is to support all students and each one of them individually, based on their personalized needs, and promote equity in learning, by mitigating the knowledge differences.

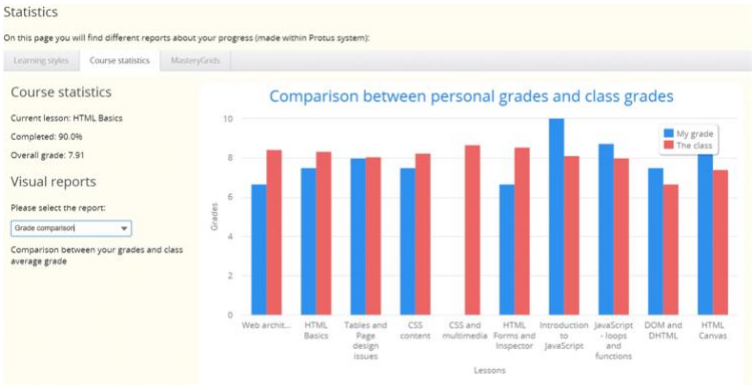

Figure 1: Visualization of students' progress (Vesin et al., 2018).

[1] NTNU Teaching Excellence Initiative: https://www.ntnu.edu/teaching-excellence

Implementation

The project is implemented at the Department of Computer Science (IDI) and in collaboration with the teachers of relevant IT subjects. The project is based on previous attempts, named video-based active learning (Giannakos, Krogstie & Aalberg, 2016; Giannakos, Jaccheri & Krogstie, 2016) and smart learning content (Vesin, Mangaroska & Giannakos, 2018). The initial system allows students to access various materials (e.g., hypertext, videos, tests), captures students' interactions with the learning material and presents adaptive feedback to them (figure 2).

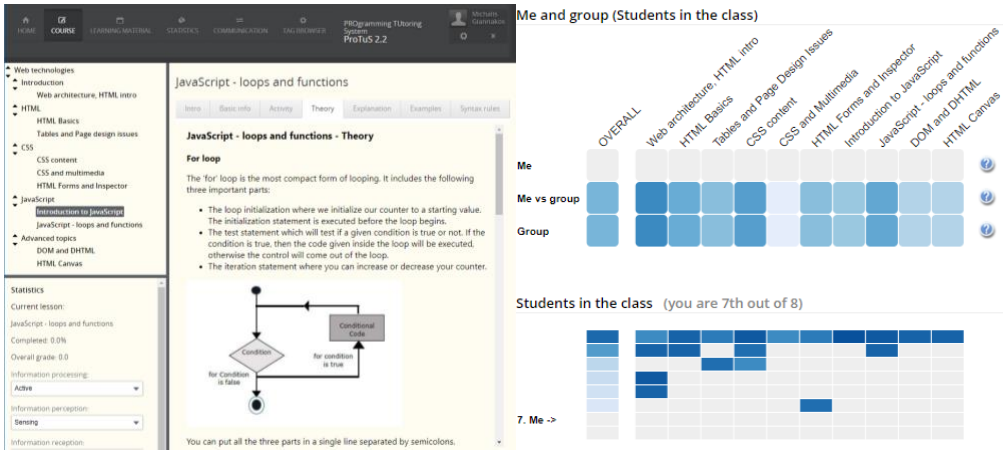

Figure 2: Interface (left); Adaptive learning analytics (right).

The pilot study run in this semester (i.e., Spring 2019). In particular, students took a self-assessment quiz using the SmartU system (https://smartu.idi.ntnu.no/smartu/smartu/). The study was conducted as part of the IT Grunkurs (https://www.ntnu.no/studier/emner/TDT4110) and Web Technologies (https://www.ntnu.no/studier/emner/IT2805) courses. In these courses, the instructors typically employed gamified quizzes (Kahoots!) in the beginning of each lecture, to link the previous lecture with the current one and engage the classroom in the lecture. When the quizzes are gamified, the students can be motivated to improve their learning performance by engaging in competitions that are exciting and fun. Shifting the focus, the adaptive self-assessment quizzes were introduced in the middle of the semester to assist students' learning, and were designed with a focus on facilitating students' self-preparation before the final exams, and helping them track their progress and align with their learning goals, by providing adaptive content and immediate feedback. The feedback about the correctness of the response was provided along with the option to show the correct answer to the questions that the students had submitted a wrong answer, to initiate students' self-reflection and self-evaluation processes, and to amplify their engagement. The scores that the students achieved on the self-assessment tests had no participation to the student's final course grade (i.e., no rewards as external motivation). Below you can see the interface of the system (figure 3), thus far more than 1.000 students have taken an adaptive quiz. Currently IDI provides the needed infrastructure (e.g. servers support) to support this endeavor, with the goal to scale it up to other courses.

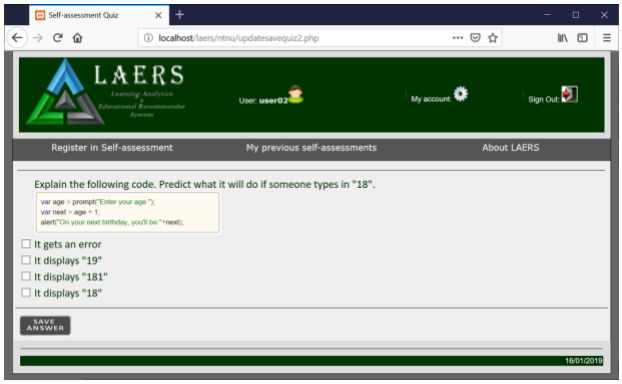

Figure 3: The interface of the adaptive self-assessment system.

The system and approach is designed for other instructors and departments to be able to utilize it and implement adaptive learning and assessment in their courses. This will allow them to gain important insights about the knowledge status, progress, effort and misconceptions of their students. In particular, the technologies developed (i.e., ProTuS[2] and SmartU[3]) can support various programming languages courses, like Java, Python and JavaScript; covering various IT courses, IDI alone has more than 2.000 students who can use the system.

Results

As aforementioned, 1.000 students have taken an adaptive quiz, and more than 3.500 tests were taken (see figure 4, right). Given that this was not a mandatory test and students had to take it during their free time, the fact that approximately 35% of the students took it indicates students' positive stance on this practice. In addition, from the almost 1.000 students who took the test, we see that 2 out of 3 tried it more than one times, this also indicates the fact that most of the students find this practice useful (see figure 4, left). When it comes to the more qualitative data collected from the students. From our observations, discussion and emails; the students were very positive and would like to see similar tests in other subjects. The adaptive self-assessment appeared to be a learning resource that on its own promotes and facilitates learners' engagement.

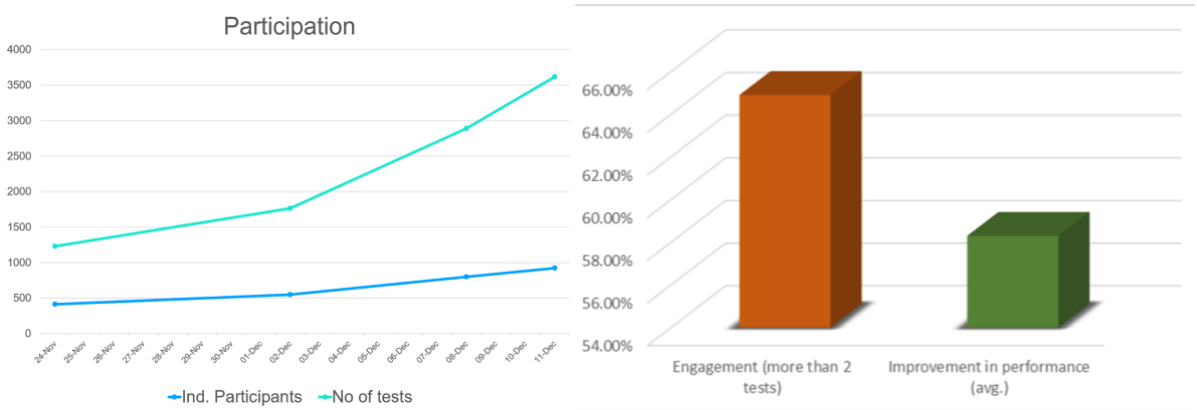

Figure 4: Students' participation over-time (right); overall engagement (i.e., more that 2 tests) and average improvement in performance (right)

Reflections for future work

The main goals for the future are: 1) designing and developing an intuitive and user-friendly interface, based on data collected from students' feedback and our own experience; 2)

[2] Programming Tutoring System – ProTuS: https://protus.idi.ntnu.no/
[3] SmartU: https://smartu.idi.ntnu.no/smartu/smartu/

establishing and fostering collaboration between instructors across departments, faculties and campuses, by allowing other subject teachers to use this adaptive assessment service and benefit from its adaptive mechanisms, as well as supporting content exchange between similar subjects.

The updated interface (see Figure 5 for the different interfaces of the system) will provide more information to students and allow them to navigate through the different modules of the system (e.g., if you retaking a test you will be getting information about your improvement, we can modularize the content of a course and students can select specific sub-category).

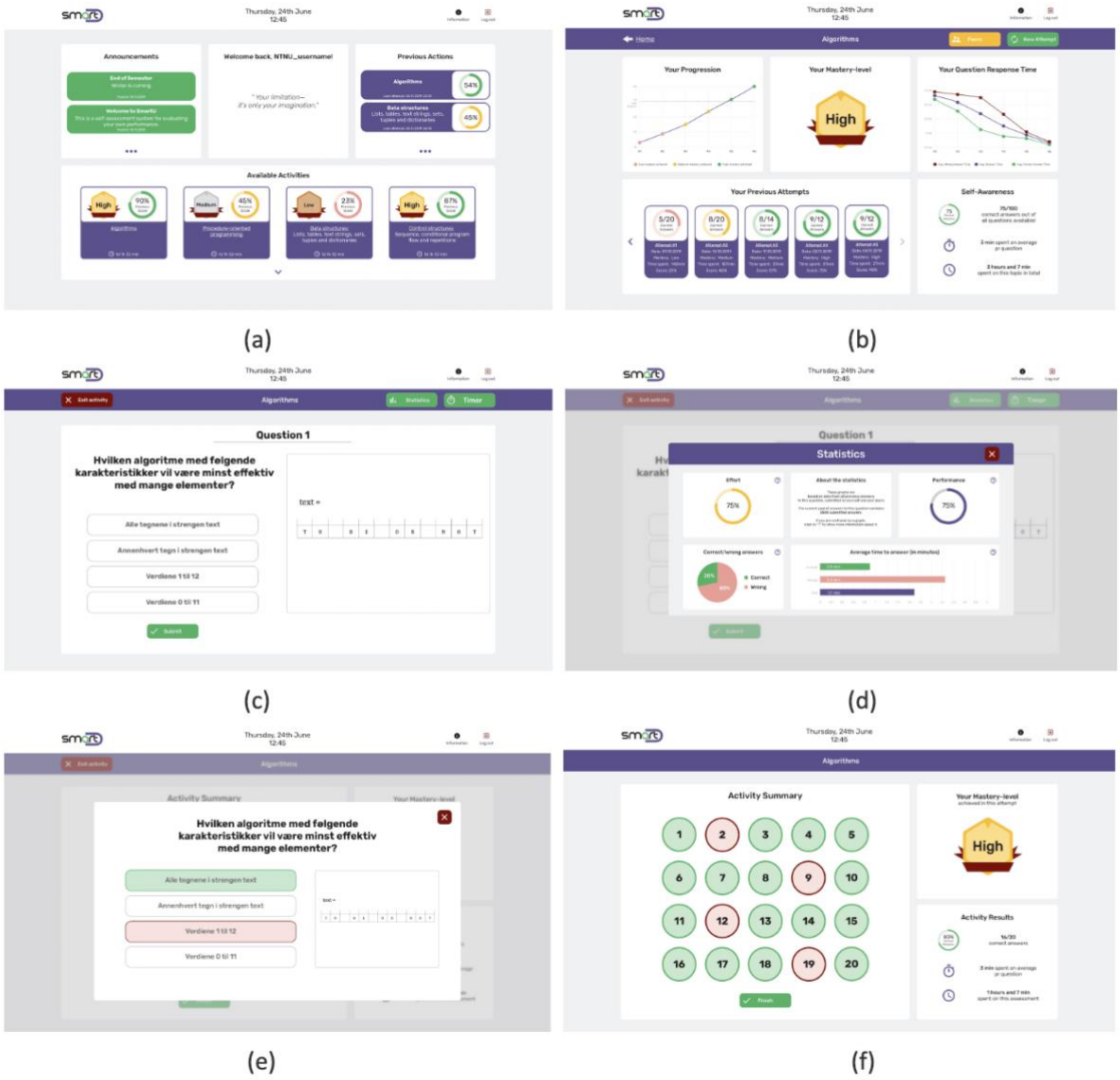

Figure 5: Landing page (a), selection of available activity (b), indicative self-assessment question (c), analytics about this question from all other students who have answered it so far (d), feedback on the correctness of the question (e) and summary of results (f). Thanks to the master students, Jakob Westermoen and Martin Lunde, who designed and developed the interfaces.

Publications

Vesin, B., Mangaroska, K., & Giannakos, M. (2018). Learning in smart environments: user-centered design and analytics of an adaptive learning system. Smart Learning Environments, 5(1), 24.

Sharma, K., Papamitsiou, Z., & Giannakos, M. (2019). Building pipelines for educational data using AI and multimodal analytics: A "grey-box" approach. British Journal of Educational Technology, 50(6), 3004-3031.

Mangaroska, K., Vesin, B., & Giannakos, M. (2019, March). Cross-platform analytics: A step towards personalization and adaptation in education. In Proceedings of the 9th International Conference on Learning Analytics & Knowledge (pp. 71-75).

Papamitsiou, Z., Pappas, I.O., Sharma, K., Giannakos, M.N.: Utilizing multimodal data through an fsQCA approach to explain engagement in adaptive learning. IEEE Trans. Learn. Technol. (forthcoming).

Dissemination

ERCIM News article: Boban Vesin, Katerina Mangaroska, Michail N. Giannakos: Learning Introductory Programming with Smart Learning Environment. ERCIM News 2020 (120) (2020).

Organization of 3 studies, recruiting: 25 students (series of workshops in 2018), 40 students (in IT2805 in 2018) and approx. 1.000 students (IT Grunkurs, distance study).

Organization of the 2nd Learning Analytics Research Symposium (LARS) on November 28-29 2019 at IDI (more than 30 participants).