Individualized Assessment and Automated Feedback in Undergraduate Computer Science Education

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Abstract: This study examines modalities of generating and providing automated formative feedback to Computer Science undergraduate students' and their experiences with the system and the received feedback. A software for automated feedback has been developed and used in this study in order to both support the students learning process, and to test how a set of elaborated assessment criteria can contribute to the students better understanding of their own knowledge and learning. The findings show that providing the students with explicit feedback in addition to regular summative evaluation (grades and point sum) stimulated their understanding and awareness of their knowledge level and exam performance. Besides, it triggered ideas and reflections related to their future learning steps and approaches, which follows the principles of feedforward.

Introduction

This contribution presents case studies of the development and use of a software program and criteria for providing automatic feedback in a Computer Sciences undergraduate program. Feedback is viewed as a pedagogical strategy in teaching-learning environments that has potential to facilitate the students' learning in a meaningful manner (Jansson, 2006). Greenhow's (2015) argues for the inclusion of a formative component when developing digital environments for providing feedback. The increase in student population and the ever-evolving knowledge to be conveyed makes the task of providing feedback and assessment that has a formative value becomes quite difficult. Usually, the automatic feedback in a digital assessment system is given by a short indication of whether the answer is wrong or right. A number of studies examined the effectiveness of providing formative feedback for summative computer-aided assessment, by giving individualized feedback derived from each of the five results sections of the assessment was provided to each student (Lewis & Sewell, 2007), or how an automated short-answer marking system can be effectively used to improve teaching and learning at university level (Siddiki et al., 2010). In the latter, the system did not allow features that can provide detailed statistical analysis of students' performances for both lecturers and students so that each may adjust or modify their teaching or learning approach for the course.

Our study addresses these issues and aims to provide a better understanding of how a software program developed for providing automatic formative feedback in a Computer Sciences undergraduate course was implemented, how the automated feedback contributed to improved learning and how the students experienced both the use of the system and receiving feedback in this manner. Whether students engage productively with feedback, whether it enhances their learning and performance, and whether automated feedback can have meaningful role in these processes are questions that require empirical examination. For the feedback process to be productive, learners need to make meaning of the relevant criteria and standards, how their performance compares against them and what they can do to improve against those standards. This is achieved collaboratively between students, teachers, tools, course activities. From a socio-material perspective, the tools can facilitate conveying the feedback, that is, they mediate the process. In this case, the automated feedback software becomes an entity and a meaning-making resource intertwined in the interaction between students, teachers, and standards for learning and assessment, which has potential to lead to a better understanding of own process and performance.

Methods

The studies presented in this paper were conducted in the context of Computer Sciences program at a large university in Norway. Dataset from two courses are included in this paper. In each course, lectures, labs weekly assignments and course compulsory assignment were part of the course design. Feedback was provided on the submitted assignments. The software program (Mirmotahari, 2016) was initially developed to facilitate exam assessment, but it gradually displayed great potential for being used to give formative feedback. The program was designed with several stakeholders and users in mind, namely (i) exam evaluators; (ii) students,; and (iii) the teachers. The program can provide both the arguments for the grade as well as an individual formative feedback. If the evaluator or the teacher chooses to provide students with both arguments for their grade and an

individual formative feedback, the first part of the feedback will consist of the arguments for each assignment and grade. The second part will be an individual formative feedback based on feedforward principles. The main component of the assessment program is the generation of the criteria, their weight in measurement and the textual phrases linked together. A taxonomic model (inspired roughly by Bloom's taxonomy) was used to develop a set of criteria that focused on the students' learning understanding of abstract knowledge and the way to employ this in solving computing problems. The back-end of the program is constantly monitoring and analyzing the evaluator's choice and overruns. The results of these analysis lead to individual feedback to each student. The feedback consists of three main parts; (i) academic feedback and discipline-based justification of grade, (ii) personal feedforward and finally (iii) a profiling for the learning outcome. The length of the feedback is entirely dependent on the amount of choices the evaluator has made and the accumulated sum of the weights of the criteria throughout the whole assignment. The accumulated sum for each criterion is normalized to the classes and based on predefined thresholds groups the results. All the students' hand-in assignments were scanned and automatically uploaded into this assessment program. After each iteration, the students were asked to answer an online questionnaire. The average response rate has been 77%. Different questionnaires have been used to collect in answer regarding one or more of these topics: questions about the assignment; perception of the feedback received; evaluation of the technical aspects of the assessment program (computer program, usability, and time usage); development in relation to the professional domain; their experience of being a peer reviewer; learning outcome for the students as a participants and a peer-reviewers. The results from the questionnaires were also discussed in the qualitative interviews. Since the questionnaire was anonymous, there was no opportunity to connect the questionnaires with the interviews. We have conducted qualitative interviews with 15% of the enrolled students.

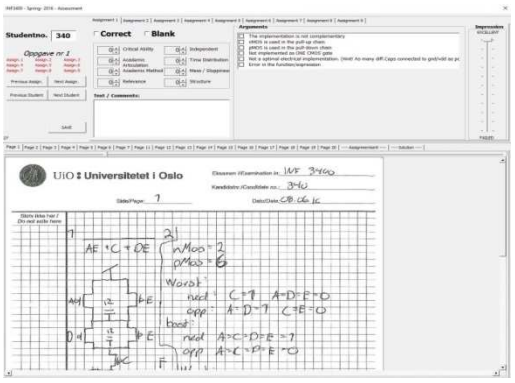

Figure 1. Software program interface.

Findings and relevance

The findings indicate positives experiences and students benefiting from the feedback. In line with arguments made by Greenhow (2015) and Siddiki et al. (2010), the findings show that providing the students with explicit feedback in addition to regular summative evaluation (grades and point sum) stimulated their understanding and awareness of their knowledge level and performance. The program supports providing feedback specifically aimed at the students' professional skills, triggering focused alternatives for future learnings steps and reflections related to their future learning steps and approaches. The study also provides insights into how automated feedback generated through the use of criteria can be organized by means of a dedicated software program. At the level of practice, the method employed provides an innovative available for the teacher and the sensor to provide the students feedback. The developed system involves teacher's work to define in writing what given values of criteria mean and the different feedback will make it easier to calibrate the evaluators across the subject. That way, not only the students benefit from this approach, but also the teachers/evaluators gain better understanding of what is required of the students for the various assignments and future learning. Follow-up studies are recommended in order to examine the quality of feedback not only based on the students perceptions, which have a subjective nature, but also based on quality criteria distilled from specialist literature.

References

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