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Evolution of a continuous assessment and feedback concept in a computer science 101 course

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Abstract

Teaching first semester students in fundamentals of computer science is challenging due to the heterogeneous group. For the last three years we explored different methods of continuous assessment in the course. One main goal for this group of students is to encourage participation in the classroom while also being able to continuously monitor the learning outcomes of the most recent topics. All three methods: repetitive oral assessment, partial exam and online quizzes received good evaluation results from the students, showed an increased engagement and better examination results. However, continuous assessment also increases the workload for both groups: the students and the teachers. The combination of a partial exam (midterm) and continual online quizzes showed a good compromise with respect to the effort on both sides and reveals good examination results. This work describes a fine granular technical and didactical workflow of the lecture suitable for first semester students and discusses the evaluation results.

Keywords: *Computer science education; continuous assessment; online quiz.*

1. Introduction

Teaching first semester students is a special joy and challenge because they start a new chapter in their life and teachers have the chance to offer new methods of learning. For the last three years a continuous assessment and feedback approach with different methods has been used to encourage participation in the classroom and to increase learning outcome in a foundational computer science 101 course. Continuous assessment (CA) works for both groups in the class room – the students must engage with the materials longer and on a regular basis and teachers are able to monitor the process and can guide the learning process in a timely manner (Sun, 2018). However, continuous assessment also increases the workload of the lecturers (Serrano et al., 2018). Therefore, this work shows how a combination of methods leads to more engagement and class room attendance on the students side resulting in better exam grades and describes a fine granular technical and didactical workflow to achieve the above mentioned goals. Furthermore, the feedback of students' course evaluation reveals indicators how the teaching concept can be adapted to other courses.

According to da Silva Burke (2022) CA is an integral part of the Bologna process with the focus on increasing students' engagement and distributing the workflow from a single examination phase to a continuous learning and assessment phase. Different methods of CA have evolved and been established in higher education, like a portfolio of homework assignments, partial exams, exercise assignments, online quizzes, presentations, compare e.g. Day et al. (2018), de Sande and Murphy (2014). In STEM education, traditionally lab courses request a continuous engagement of students and, as Wolf (2010) proposes, modern concepts offer virtual labs for training and/or additional assessment. Without doubt, CA increases the engagement of students, but there is no general agreement in research, that CA is beneficial for all types of curricula and students. Several studies show, that CA is especially supportive for better performing students, while less good performing students might be overwhelmed by the workload during the semester compare e.g. Day et al (2018), Merello and Zorio-Grima (2018). A CA based approach therefore shall be adjusted to find the right balance of work load throughout the semester. An important factor for a successful implementation of CA is the feedback given to the students. While the correction of written homework assignments and partial exams might be time consuming and leading to a delayed feedback, the use of an automated test and feedback system helps to report immediate individual feedback and to lower the workload of the lecturer. As Baleni (2015) emphasizes, such tests can be performed in a much shorter period allowing an immediate monitoring of the students' achievments. We examined different methods of CA, starting with continuous oral assessment at the beginning of the course and now using a mixture of real-time formative assessment through online quizzes and assessment by a partial exam (midterm) with a focus on the feedback to the students.

2. Lecture Setup

2.1. General Setup

Every year about 70 students start their studies of electrical engineering and computer science at our faculty. The students are divided into two groups and taught a foundational computer science course two times per week for 90 minutes. The lecture setup is as follows: Twelve different topics are covered during the semester, for example, introduction to computer arithmetics, data structures, basics of computer networking, operating systems and computer architectures. Additionally five lab exercises are given.

2.2. Course Assessment

Each lecture starts with revision questions covering the subjects of the last lecture. During the Covid Pandemic in 2020 and 2021 these revision questions were given directly by the lecturer and oral participation and correct answers were awarded. For exam preparation a list of all questions without solutions were given to the students. Similar questions are part of the final exam. The differences in the course setup over the years are shown in Table 1.

Table 1. Different methods for continuous assessment from 2020 to 2022.

Year	2020	2021	2022
List of Quiz Questions	Orally discussed in classroom	Orally discussed in classroom	Converted to online quizzes
Quiz Conduction (at beginning of lecture)	ca. 15 min. oral discussion	ca. 15 min. oral discussion	ca. 5 min. online plus 2-5 min. discussion
Assessment of Quiz Questions	**Answers graded**	Answers not graded	Answers not graded.
Written Midterm Exam	None	30 min. **Graded**	30 min. **Graded**
Feedback	Directly by the lecturer during oral quiz	Directly by the lecturer during oral quiz and graded midterm	Direct quiz feedback via LMS and graded midterm

Due to the smaller groups because of hybrid teaching during the pandemic it was feasible to orally discuss and grade these revision questions in a timely and fair manner. This proved to be more difficult with a full classroom in 2021, therefore answers were not graded then. In 2022 the questions were converted into more structured online quizzes, which will be described in section 2.3. The students can access the quizzes with a mobile device, tablet or

laptop via the learning management system (LMS). The online quizzes take about five minutes each and are not repeatable but the questions and (correct) answers remain visible for the students throughout the semester. The students and the lecturer receive the results instantly and can use the results for a short discussion about knowledge gaps or misconceptions.

After half of the semester a voluntary midterm exam is conducted, enabling the students to collect points towards the final exam. Within a week the students receive individual feedback of their midterm results.

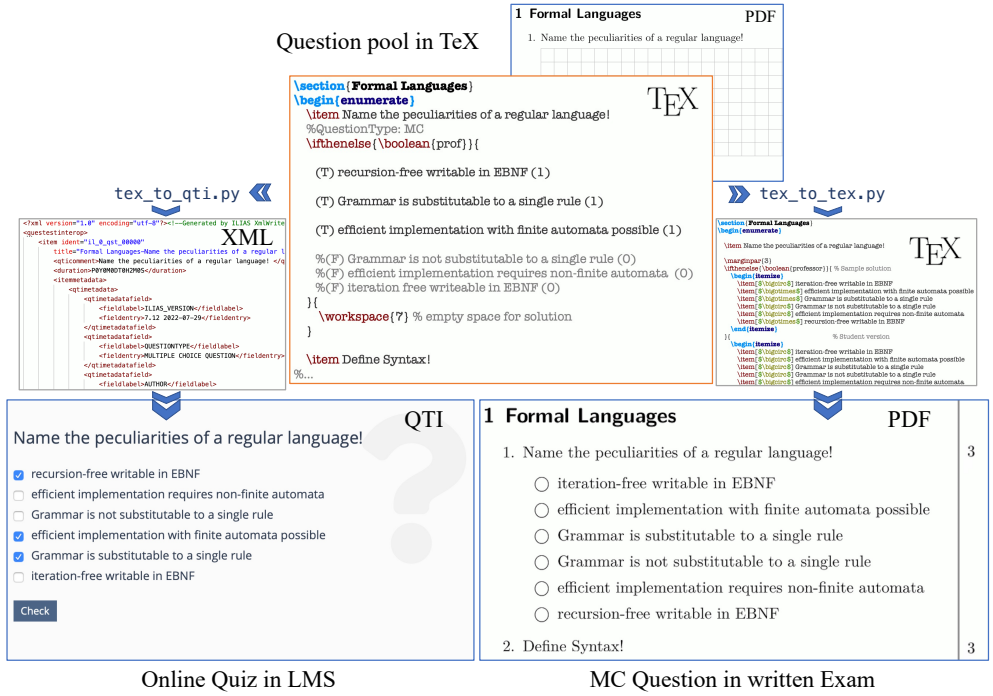

Figure 1: Technical flow – Conversion of questions from LaTeX via QTI import into LMS as online quiz, as standard PDF or as a MC question for the exam.

2.3. Technical Setup

Figure 1 shows the technical flow for creating the different document types for the questions and quizzes. An important goal was the independence of the underlying LMS achieved by the following setup: Starting point for all quizzes is a pool of questions written in LaTeX. This document has two display options: a students' version with a space left to write their solutions and a teacher's version with a sample solution. Converted to pdf format the students' version can be applied to discuss questions in classroom and solutions can be added by the teacher using e.g. a tablet connected to the video projector. For the online quizzes we

defined a fixed format for the sample solution in order to convert the questions automatically into a corresponding XML file necessary for the *IMS Question and Test Interoperability* (QTI) format, which is required for the import into the LMS. For single or multiple choice (SC/ MC) questions, the proper answers are prefixed with a `(T)`, whereas wrong answers are marked as a LaTeX comment starting with `%(F)`. Points or negative points can optionally be given in rounded brackets. The question itself is marked with a comment defining the question type. A python script `tex_to_qti.py` converts the questions from LaTeX to QTI. Other supported questions types are: cloze questions, numerical answers, short answers, text matching, sequencing/ordering. Another python script `tex_to_tex.py` generates a proper LaTeX output that can be included in the final exam. Although questions can be created and maintained directly in the LMS, setting up questions and maintaining the questions in LaTeX significantly simplifies the work flow, especially as the same questions can be used in different formats and use cases. Furthermore, the LaTeX documents can be managed and maintained in a version control system.

3. Evaluation

3.1. Course Evaluation Methodology

In addition to a standardized online course evaluation in week 10 of the semester, an online evaluation of the course's assessment (midterm and online quizzes) has been conducted in the last lecture using the LMS. The evaluation period for both evaluations was scheduled for a week, but for a better response rate both online evaluations were conducted during the lecture. The response rate were about 60 % and 58 % respectively.

3.2. Evaluation Results

An important result of the standardized online evaluation is that 74 % of the students perceive the workload of the course adequate as defined in the module description. Only 5 % state a too high workload, which is comparable to other course evaluations in the first semester. With respect to the evaluation of midterm and online quizzes, all participants of the evaluation agreed or fully agreed that the voluntary midterm exam should be graded and account to the final grades as well in the future. "Midterm is a valuable concept and helps to assess current learning outcome" is one of the open feedback results in the evaluation.

Figure 2 shows an excerpt of the students evaluation with respect to the online quizzes. The opinions differ with respect to grading the online quizzes. While about 50 % would like the possibility to voluntarily collect points for the final exam (Q1), 50 % disagree on a mandatory grading of the quizzes (Q2). The majority (60 %) agree to continue with the quizzes mainly as a self-monitoring tool (Q3). Some students even stated in the open feedback question, that they would not like the quizzes to be graded as the cloze questions a hard to answer properly.

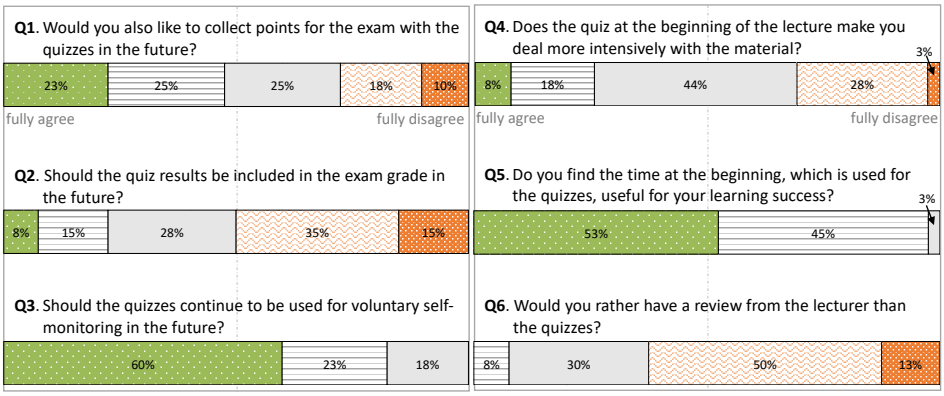

Figure 2: Students' evaluation results for the appliance of quizzes in the course (5 point Likert scale).

In opposite to our expectation only 26 % of the students stated that they prepared more for the lecture due to the tests (Q4). About 98 % of the students agreed or fully agreed that the time used for the online quizzes are useful for their learning success (Q5). Only a small group of students (8 %) would rather prefer a review by the lecturer instead of doing the online quizzes (Q6). Quotes from the evaluation confirm this impression. Several students wrote in the free form of the evaluation that doing online quizzes was fun and a good repetition. Critical responses came with respect to technical improvements of the LMS necessary to run the tests on some mobile operating systems and partly, that questions were too easy.

4. Discussion

Figure 3a) depicts the participants in the class over the course of the semester in 2021 (blue dots) when the tests were given orally and discussed directly in class. The orange crosses indicate the actual participants of the online quizzes at the beginning of the lectures in 2022. Both curves show a decline in the number of participants. The slope of the curve in 2022 is actually flatter than in 2021 and for both curves we see a decline after the midterm exam. With the online quizzes in 2022 more students attended the lecture and the quizzes compared to the year before where only a minority of the students actually participated in the classroom discussion. So it can be concluded that higher involvement in the class, as well as more continuous and intense work with the course materials can be achieved through continuously conducting online quizzes. In Figure 3b) we can see a generally high level of the actual quiz results with an overall mean value of 74 %. Although we tried to provide a proper distribution of questions types and consistent difficulty level for each quiz, the average results vary from quiz to quiz. One reason is certainly that on some mobile devices the text matching questions did not work properly, and another, that cloze questions and short answers allowed only for

small spelling mistakes. Interestingly there is no rising trend during the course and towards the exam but rather a constant moving average.

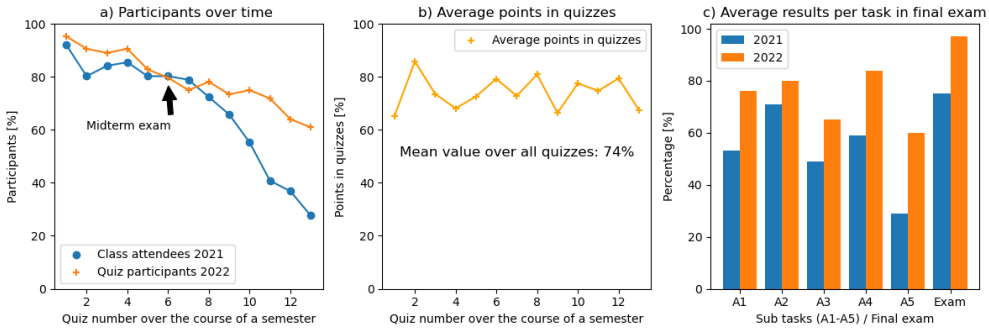

Figure 3: a) Participation vs. Class Attendance b) Average Points in Quizzes c) Exam results per sub task A1-A5 and overall exam pass rate.

Table 2 Overview of the received average grades and pass rates of the last four years.

Year	2018	2020	2021	2022
Final Grade [1.0 = best, 5.0 = failed]	3.7	3.4	3.3	2.4
Final Grade with Midterm	-	3.4	3.1	2.2
Average Grade of Midterm Exam	-	3.0	3.1	2.2
Percentage of Students passing the Exam	64%	76%	82%	97%

Table 2 shows the development of the exam and the midterm exams and the percentage of students passing the exam since 2018 while Figure 3c) details the average results of the final exams in 2021 and 2022. Throughout the years the structure of the exams and its grading scheme has been identical. The only difference between the last two exams (comp. Fig. 3c)) was that we used two multiple choice questions in the first sub assignment which were similar to the questions the students saw during their quizzes. This accounted for an average of two more points for this sub assignment which is only 3 percent of the total reachable number of points in the exam. Notably, every exam sub task in 2022 showed better results than the year before. It also has to be considered that there are always differences between the years regarding the level of achievement of the particular group of students. We see that over the course of three years the average grade of the midterm and final exam improve by nearly one grade. Additionally, the pass rate of the final exam increases with the introduction of CA.

5. Conclusion

On a more personal level, after two years of online and hybrid teaching setups, both students and the lecturers were happy to be back in the classroom. With the evolution of the course

through the online quizzes enabled by the technical workflow shown in Figure 1 more interaction and engagement with more students were possible. The technical workflow enabled an independence from the current learning management system while keeping maintenance of the pool of questions on low administrative level and putting the focus on the content of the quizzes. The concept proves to be valid for first semester students, who are entering the university system and can be guided into the learning methods that are necessary here, compare Jimaa (2011). We conclude that continuous assessment through online quizzes and the midterm exam supports developing continuous studying habits, which is a major achievement for first semester students. The positive development of the exam results over the years indicate improved understanding of the topics by the students.

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