More than a substitute?
Digital exams with Tablets in Computer Science

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Abstract
As a result of the Covid-19 pandemic, not only did digital teaching get a massive boost, but also the delivery of digital exams was the subject of new developments. Although the design of digital exams offers the potential for new breakthrough opportunities, exam regulations and the need for short-term adjustments often stand in the way. Consequently, methods are being considered to transfer existing exam formats into the digital format. In computer science studies, paper-and-pencil exams are used because they are very suitable for many areas such as theoretical computer science. They often consist of a mixture of a selection of answer options, making sketches for automata and free text answers. The question, however, is how to translate this format to digital while still meeting the framework and still allowing students the same requirements as in the regular not digital approach. In this poster we will first discuss the requirements for an iPad exam in theoretical computer science and what possibilities there are to transfer this exam to the digital level. Second, we will describe an empirical approach, how to investigate the effects of the digital transformation on the examination process itself.

Keywords
Digital Exams, Tablets, Pre-Service Computer Science Teacher

1. Introduction

The Covid-19 pandemic has led to an increased implementation of digital exams at universities. This also applies to computer science. The focus here was on finding a replacement for paper-and-pencil exams as quickly as possible. Accordingly, digital exams were aligned with their analog counterparts. However, digital exams are accompanied by new possibilities as well as effects of testing, which will be addressed in this poster in the context of pre-service computer science teacher education and is driven by two questions of interest: *1. What possibilities does the use of iPads provide in exams on theoretical computer science in pre-service informatics teacher education? 2. How do these possibilities influence the examination process itself?* The aim of this poster is to show what framework conditions must be in place and what possibilities there are in terms of implementation. Furthermore we want to shed some light on a future study, that focusses on the effects of tablet exams from the student's perspective as well as on the exam results. Therefore the poster does not describe empirical results but intends to initiate a

discussion and provide possibilities.

2. Exams in Theoretical Computer Science

In this section we describe tasks, implemented in a paper-and-pencil exam in informatics as we used it in the subject of theoretical computer science. The given tasks are classical exam questions from the topics "Finite Automata" and "Formal Languages". They are taken from an exam on theoretical computer science, which is written as part of the pre-service teacher training (Undergraduate level) at the Karlsruhe University of Education. The competences required for the solution refer to central elements of theoretical computer science: automaton construction and transformation, transformation of transition tables into transition diagrams, connections between regular grammars and finite automata, and regular expressions as an alternative form of representation to languages accepted by finite automata. In the examples shown below in Fig. 1, subtask A1(a) requires a transition diagram as the solution. In subtask A2, on the other hand, a regular expression is sought. Both tasks make special demands on the student regarding the input of the solutions. In the first task the solution is sketched as a graph, in the second task it is given as a mathematical expression.
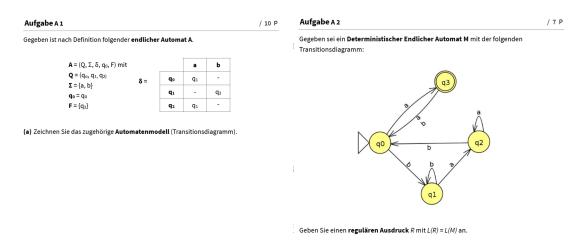

Figure 1: Example tasks from an exam on theoretical computer science.

3. Implementation of Digital Exams with Tablets

In this section, we briefly present the prerequisites for using tablets from the perspective of hardware and software.

3.1. Hardware Requirements

Although there is a wide range of manufacturers for tablets, we focus here on the iPad, which is used at our university. The use of iPads for exams is not new and has been addressed in the

literature such as in [1, 2]. In addition, numerous references to implementation possibilities can be found on the websites of universities[1]. In order to use the iPad for exams, certain requirements can be considered in advance: (1) The use of a protective film on the tablet to create the same writing feeling as on paper [3]. (2) The use of an additional keyboard (not the screen keyboard) to support input [2].

3.2. Software Requirements

With regard to software requirements the following recommendations for the use of iPads in exams can be made: (1) In our case Moodle can be used. The Safe Exam Browser of Moodle [1] and the question type of Moodle "freehand drawing" allow a mixed input via fields or selection options and additionally the possibility to make sketches in the Moodle exam environment. (2) For easier administration, a central management of the iPads via MDM/Jamf can be implemented.

4. Options for an iPad Exam in Theoretical Computer Science

Considering this, the following conclusions can be drawn for an iPad exam in theoretical computer science: (1) The combination of sketches and text input is an important requirement. For example, a sketch of a finite automate can be made first and then the regular expression can be written down. (2) Dynamic elements can be included in exams, e.g., finite automata animated. (3) Applying learning analytics and capturing the solution process in iPad exams can support a better unterstanding of the examination process itself. (4) It could also be supported by audio input: students describe "thinking aloud" their solution path in formative assessments, but also describe open questions and problems.

5. Further Steps

Paper-and-pencil exams and their digital counterparts have been compared in several studies in the past decades [4]. Although the conclusions are not consistent, the results indicate at better student performances with digital formats [4, 5, 6]. Moreover, according to psychological learning research, the way information is presented, for example as a text, picture or animation, has an influence on the cognitive representation [7]. Therefore we want to investigate in a future study, how the way the tasks are illustrated – e.g. in an interactive way on the iPad – influences the exam results and the understanding of the students. This intention comprises two perspectives: First, a quantitative analysis of exams with iPads, including learning analytics. Second, a qualitative access to the students' experiences in computer science exams.

6. Conclusions

Based on the interest of this poster "What possibilities does the use of iPads provide in exams on theoretical computer science?", the following conclusions can be drawn.

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[1]https://www.uni-rostock.de/universitaet/kommunikation-und-aktuelles/medieninformationen/detailansicht/n/mit-dem-fingertippen-durch-die-klausur

- With a suitable combination of iPad, keyboard, pen and protective film, an appropriate basis for the implementation of digital exams can be created.
- However, this also involves additional effort and expense that should not be underestimated.
- Nevertheless, if the integration of iPads into the theoretical computer science exams can be seen as more than just a substitution for paper-and-pencil exams, the additional effort may be worthwhile as it also provides new opportunities.
- If this technology is used to enrich a written exam with additional possibilities, iPads could enable new perspectives.
- In future work, we will compare the differences between traditional paper-and-pencil exams with the use of iPads in theoretical computer science and how these differences are interpreted in the students' perspective.

7. Acknowledgements

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