Developing knowledge and skills in the area of computing education research

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Abstract: In this essay, I will examine, analyze, and interpret some of the research topics presented in Excited Summer School on Research in computing education to compare their stance with my own. This requires a synthesis of a sub-selection of the source material (Syllabus) and original opinion for topics related to my current research interest.

The summer school research topics included an overview of Computing Education as a Research (CER) field with its history and politics. These topics covered a wide area of CER on the individual-, group- and larger-scale levels. This essay aims to develop knowledge and skills in the following specific areas: Interactive e-books and adaptive learning tools, which are directly applicable to my current e-learning courses being conducted. Another goal is to discuss the parallel between computing education in the UK and Norway for K-12 and relate these to my teachers' programming courses. And finally, I will examine and discuss "research methods" concerning my research on developing a flexible learning trajectory course.

This essay will also briefly discuss the topics I believe are not directly connected to my current research activities but are essential in computing education research.

INTRODUCTORY PROGRAMMING AND ADAPTIVE PARSONS PROBLEMS

Parsons problems are a programming exercise where students modify jumbled code blocks of a solution program back into its unique structure. It is generally executed as a supplement or option compared to conventional programming practices like code-tracing and code-composing (Du et al., 2020). An electronic book, also known as an e-book or eBook, is a book publication made available in digital form, consisting of text, images, or both, readable on the flat panel display of computers or other electronic devices. Although sometimes defined as "an electronic version of a printed book" (Yalçintas Sezgin et al., 2017). E-books, including interactive elements, are rapidly becoming more popular and are likely to largely replace traditional textbooks at university level education (Pollari-Malmi et al., 2017). Pollari-Malmi et al. (2017) changed their static PDF textbook into an interactive e-textbook. They set up direct links from the assignments to the corresponding e-textbook chapters expected to support self-studying. They wanted to explore whether these differences affected students' motivation factors and learning results. They are reporting several positive results in their study, both in motivation and learning results.

Currently, there are several sites providing eBooks. The Runestone Interactive tools create compelling interactive learning resources used by hundreds of Colleges, Universities, and High Schools worldwide. (Miller et al., 2014). OpenDSA (Shaffer et al., 2011) is infrastructure and materials to support courses in a wide variety of Computer Science-related topics such as Data Structures and Algorithms (DSA), Formal Languages, Finite Automata, and Programming Languages (Shaffer et al., 2011). University of Waterloo (2020) has created a website to teach Python programming basics in a semi-interactive fashion (Waterloo, 2020). E-Books can provide practice, and practice is essential for learning. Ericson et al. (2018) report that their study of "Evaluating the Efficiency and Effectiveness of Adaptive Parsons

Problems" provides evidence that solving either adaptive Parsons problems or non-adaptive Parsons problems is a more efficient, but just as effective, form of practice than writing the equivalent code. It also found that solving adaptive Parsons problems led to a significant learning gain compared to the control group (Ericson et al., 2018).

I'm working on the development and design of an online flexible learning trajectory course where students are in-service teachers with varied level of programming knowledge, interests, and different application need. The course's primary learning objective is to provide in-service teachers with insight into how programming can create digital solutions. This course is using online resources available for students. Giving access to e-books available on, e.g., Runestones (Miller et al., 2014) to students in this course could increase their motivation factors and learning results. Some of these interactive resources provide assignments on code execution (including debugging) directly in the textbook and Parsons problems, which I believe will positively affect this group of students.

COMPUTING EDUCATION IN SCHOOLS

During the last few years, the focus of computer science education (CSE) in primary and secondary schools has reached a significant turning point (Garneli et al., 2015).

Computer science in UK schools has been on a roller-coaster journey (Waite et al.). In the 1990s and early 2000s, computer science and programming slowly vanished from UK schools. However, in the past five years, computer science has begun a dramatic resurgence that sees it poised to become mandatory for pupils in England from age five upwards. The argument that has been presented is that computing develops useful transferable skills (often referred to as "computational thinking" (Wing, 2006)) as well as valuable principles for a modern, digital world and thus is of benefit to all students (Brown et al., 2014).

Several initiatives, among these, an influential interest group, Computing At School (CAS), were formed to help promote computing in schools (Crick et al., 2011). CAS became recognized as the official subject association for computer science in the UK.

The year 2012 thus became a breakthrough year in the UK. The UK Department for Education thus declared the re-introduction of computer science teaching into English schools an official goal, with the ICT curriculum to be rewritten and supported by the development of “new, high-quality Computer Science [qualifications]” (Brown et al., 2014).

In Norway, Kunnskapsløfte ("The knowledge promise" or "the lifting of knowledge") was introduced in August 2006. The reform entailed several changes in the principles for national management of primary education, including changes in the content, structure, and organization from the first stage of primary school to the final stage of upper secondary education (Sivesind, 2013).

The Norwegian government's message says: "The curriculum will be renewed so that it reflects the current school life and the challenges children and young people face today" (Berge, 2017).

Norwegian Directorate for Education and Training (Utdanningsdirektoratet) is working on renewing all the curricula in primary and secondary education, which will be implemented from 2020 onwards (Bjørnestad et al., 2013). The purpose of renewing (“The knowledge promise" or "the lifting of knowledge") is to make children and young people able to meet and find solutions for today’s and future challenges. The pupils will develop relevant expertise and good values and attitudes that reflect the individual, in a society characterized by greater complexity, great diversity, and speed change" (Buland et al., 2011).

RESEARCH METHODS

Design science research is a "lens" or set of synthetic and analytical techniques and perspectives (complementing positivist, interpretive, and critical perspectives) for performing analysis in IS (A. Hevner et al., 2010). Design science research typically involves creating an artifact and design theory to improve the current state of practice and existing research knowledge (Baskerville et al., 2018). Iivari (2007) 's essay is an essential and insightful contribution to a clearer understanding of the design science research paradigm's fundamental properties—ontology, epistemology, methods, and ethics. The IS research framework emphasizes three inherent research cycles: The Relevance Cycle, the Design Cycle and the Rigor Cycle (A. R. Hevner et al., 2004).

My understanding is that Design Science Research is the backdrop when researching in the field of information technology. During the summer school sessions, several topics related to research methods were discussed. These topics will briefly be discussed in the following paragraphs.

Borrego et al. discuss research methods quantitative, qualitative, or mixed and suggests in their paper that no particular way is privileged over any other. Instead, the choice of practice must be driven by the research questions. Quantitative methods are a good fit for deductive approaches, in which a theory or hypothesis justifies the variables, the purpose statement, and the direction of the narrowly defined research questions. Qualitative research is characterized by the collection and analysis of textual data (surveys, interviews, focus groups, conversational analysis, observation, ethnographies (Olds et al., 2005), and by its emphasis on the context within which the study occurs (Borrego et al., 2009).

Another definition is that qualitative research is empirical research where the data are not in the form of a number (Punch, 2013). Quantitative research analysis gathers data in a numerical form that can be put into categories, rank order, or measured in measurement units. This type of data can be used to construct graphs and tables of raw data.

There are several plausible explanations for why engineering education researchers appear to prefer quantitative methods strongly. Creswell et al. (2017) list three criteria for selecting from among quantitative, qualitative, and mixed methods approaches: (1) the research problem, (2) the personal experiences of the researcher, and (3) the audience (Borrego, Douglas, & Amelink, 2009).

The three most common qualitative methods:

- Participant observation (appropriate for collecting data on naturally occurring behaviours in their usual contexts).
- In-depth interviews (optimal for collecting data on individuals' personal histories, perspectives, and experiences, mainly when sensitive topics are being explored).
- Focus groups (effective in eliciting data on a group's cultural norms and generating broad overviews of issues of concern to the cultural groups or subgroups represented).

Each method is particularly suited for obtaining a specific type of data (Mack, 2005).

Sampling is central to the practice of qualitative methods but compared with data collection and analysis; its processes have been discussed relatively little. A four-point approach to sampling in qualitative interview-based research is presented and critically discussed in this article, which integrates theory and process for the following: (1) defining a sample universe by way of specifying inclusion and exclusion criteria for potential participation; (2) deciding upon sample size, through the conjoint consideration of epistemological and practical concerns; (3) selecting a sampling strategy, such as random sampling, convenience sampling, stratified sampling, cell sampling, quota sampling or a single-case selection strategy; and (4) sample sourcing, which includes matters of advertising, incentivizing, avoidance of bias, and ethical concerns pertaining to informed consent (Robinson, 2014).

Thematic analysis is a method for identifying, analyzing, and reporting patterns (themes) within data. It minimally organizes and describes your data set in (rich) detail. The process is divided into the following

phases: Familiarizing yourself with your data, Generating initial codes, Searching for themes, Reviewing themes, Defining and naming themes, and producing the report (Braun et al., 2006).

Both qualitative and quantitative methods can be applied to my current research on designing a flexible learning trajectory course on introductory programming. There are different types of data available: the use of questionnaires, reflection notes, and interviews.

Qualitative and quantitative research methods can be applied to data gathered using questionnaires.

We will use thematic analysis (qualitative) on reflection notes and sampling in Interview-Based Qualitative Research for analyzing the interview data.

CONCLUSION

The school offered an arena for developing knowledge and skills in the area of computing education research, which I found very relevant to my current research activities. I have discussed and reflected on some of the topics which are directly related to my recent research: Interactive e-books and adaptive learning tools, the parallel between computing education in the UK and Norway for K-12 and "research methods" concerning my research on the development of flexible learning trajectory course. In this course, I also learned how to define exact research questions and use research methods applicable to them. Further work is to get a deeper understanding of the topics discussed in this session and other topics covered by the summer school program to improve my research capabilities.

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