Computer Science (CS) and Computational Thinking (CT) - International Perspectives on Developing Student and Teacher Competencies

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Abstract

Our proposed panel represents a variety of viewpoints on Computer Science (CS) and Computational Thinking (CT) in higher education teacher preparation programs. The goal of our panel discussion will be to present our varied research in the field so that the audience can experience cross disciplinary viewpoints on CT and CS. We are interested in facilitating a discussion on how CS and CT competencies can be interpreted for K12 students, in-service and pre-service teacher educators across content areas and in global contexts. This panel will discuss how educators and researchers in the US and Germany are focusing on addressing these crucial needs in CS education to meet pre-service and in-service teachers needs as well as examining student understanding.

In October of 2014 the members of this proposed panel attended the KoKoHS “Development of Joint Research on the Assessment of Higher-Education Competencies” research conference funded by the German Ministry of Education and Research. This panel on Computational Thinking (CT) is a product of our discussions and research at the conference. Aman Yadav, Leigh Graves Wolf and Jon Good represent Michigan State University and a practitioner perspectives for integrating computational thinking principles into teacher professional development in the United States. Melanie Margaritis represents the University of Paderborn and Marc Berges represents the Technische Universität München, both situated in Germany. They present a research perspectives on computer science teaching and teacher preparation. Petra Fisser, our discussant, offers yet another perspective as an ICT Research & Advisory consultant with the Dutch Ministry of Education.

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Panel Abstracts:

Aman Yadav & Leigh Graves Wolf: In-service teacher understanding of Computational Thinking
Over the past 3 years, The Master of Arts in Educational Technology (MAET) program at Michigan State University has been integrating computational thinking (CT) (Wing, 2006) into curricular objectives. While we are pedagogically rooted in the TPACK (Mishra and Koehler, 2006) framework, we have been searching for a framework that will prepare our in-service teachers to successfully navigate technological change. The framework of CT programmatically gives us a foundation in problem solving that will set our students and graduates up for success in an ever-changing technological environment. With the publication of the CSTA CT Standards, we have been able to ground our work in a widely accepted set of competencies laying the foundation for the development of a larger CT framework for pre-service and in-service teachers.

We will discuss theoretical and practitioner perspectives on our approaches to integrating CT standards into the following online and face-to-face courses: Learning Technology by Design (CEP 817), Creativity in Teaching and Learning (CEP 818), Special Topics: Computational Thinking and Problem Solving (CEP 891).

Melanie Margaritis - Computer Science Pre-service teachers competencies for Pedagogical Content Knowledge (PCK)

In our study, we investigated what PCK CS pre-service teachers acquire during their education at university before they enter the second step of their educational training and teach independently.

The questions which accompany our study are:

- Are pre-service teacher able to transfer their knowledge when they are standing in front of a class?
- Do they know how to plan a class, react in a specific situation, or evaluate a class?
- Is the PCK that they acquire at university sufficient for teaching a class?

For our study, we used the PCK competencies model, developed by the KUI-project group (Hubwieser et al. 2013) as a basis. This model shows, what PCK CS teachers should have to teach computer science in secondary school level. By means of interviews about typical and critical school situations we measured what PCK CS pre-service teachers have in theory. In addition, we video-recorded these students during one school lesson to see, if they were able to transfer their knowledge.

Jonathon Good - Computational Thinking & Digital Fabrication in Teacher Education and Professional Development

The process of digital fabrication provides a unique setting for both students and teachers to develop and enact computational thinking concepts. Through both the physical process of fabrication and the mental process used to refine the final product, the student is exposed to situations demanding extensive problem solving (Smith, 2013). This process echoes the interaction between formal and concrete thinking as theorized by Seymour Papert (1980). When computational thinking is defined as a problem solving approach (Yadav, Mayfield, Zhou, Hambrusch, & Korb, 2014), the use of digital fabrication can be theorized to support the development of CT skills in the classroom. One such fabrication technology, 3D printing, is unlike traditional fabrication in that the user can repeat the process quickly, with nearly identical results, the technology encourages customization for the students’ own environment, and the automation allows for focus on the abstraction just as much as the process of fabrication. Michigan State University’s Master of Arts in Educational Technology (MAET) and Educational Psychology and Educational Technology (EPET) programs are in the early stages of integrating digital fabrication, specifically 3D printing, into curricular objectives. We will specifically discuss of how 3D printing was used in our MA in STEM and Leadership teacher certificate program. Our goal is to begin a conversation with the community on how this collection of fabrication technologies can best be used to complement the development of CT skills.
Marc Berges - Investigating Novice Programming Abilities with the Help of Psychometric Assessment

In 2008, a working group in the computer science department at Technische Universität München School of Education piloted an optional 2 ½ day experience that took place just before the first undergraduate lecture in computer science. This experimental project was a unique attempt to assess prior knowledge and programming skills for new CS students. The research team used item response theory on source code for 21 fundamental coding concepts in an attempt to assess novice programming skills. The responses were transferred to a Rasch Model which allows personal parameters to be assessed. Now that a metric has been validated for the coding ability, we are seeking to further our work by attempting to evaluate other core programming competencies. Originally, the complexity of the programming task was of central interest, we are seeking to further our work by creating a multidimensional assessment of problem solving abilities as well as coding abilities represents the different facets of these skills. How many dimensions are there and what do they look like?

List of panelist titles and authors

Chair: Petra Fisser, SLO Nationaal expertisecentrum voor leerplanontwikkeling, National Institute for Curriculum Development (Netherlands)

Leigh Graves Wolf & Aman Yadav, Michigan State University (USA)
In-service teacher understanding of Computational Thinking

Melanie Margaritis, University of Paderborn (Germany)
CS Pre-service teachers competencies for pedagogical content knowledge (PCK)

Jonathon Good, Michigan State University (USA)
Computational Thinking & Digital Fabrication in Teacher Education and Professional Development

Marc Berges, Technische Universität München School of Education (Germany)
Assessment of Object-oriented programming Abilities

Outline of how the panel will be organized

(5 minutes)
Leigh Wolf and Aman Yadav will provide introduction to the landscape of Computational Thinking

(20 minutes total)
5 minute presentations from panelists

(5 minutes)
Brief remarks from Petra Fisser inviting conversation

(30 minutes)
Facilitated discussion
We will solicit ideas from the audience for furthering our individual investigations, asking them to identify common threads between the projects presented, and invite them to share stories of their work in the realm of computational thinking.

References
