Integrating Computing Education to Teacher Education

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ABSTRACT
This paper briefly presents emerging ideas for research about integrating computing educational practices, such as inquiry-based STEAM workshops merged with digital fabrication, into teacher education to foster student teachers’ professional agency. Potential outcomes and benefits for both fields are discussed.

CCS CONCEPTS
• Social and professional topics  →  Computing literacy; • Applied computing  →  Interactive learning environments;

KEYWORDS
Computing education; Teacher Education; STEAM; professional agency

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1 INTRODUCTION
Currently, policy makers and educational stakeholders are investing on the uses and researching possible formats of employing technological appliances on education [3]. The most popular nowadays, thanks to the reappearance of the Maker Movement, is the application of digital fabrication into primary schools [12].

Because of this (probably lasting) trend, student teachers must enter working life prepared to face new curriculum demands due to digitalization of education and work [10, 15]. In other words, they need to continuously develop lifelong learning skills to counter the new challenges of contemporary schools [6]. At the same time, they are under risk of obsolescence of human and digital capital [14]—and employability—if they lack agency to continue improving their professional competences.

Therefore, this paper discusses the potential of integrating computing educational practices, such as computational thinking, engineering, learning by trial and error method, familiarizing with software and hardware systems, into Teacher Education (TE) to develop future teachers’ professional agency that supports them to tackle such difficulties. Additionally, this paper proposes a method to accomplish it by implementing inquiry-based STEAM (Science, Technology, Engineering, Arts and Mathematics) workshops merged with digital fabrication during TE.

2 A 21ST CENTURY PROPOSAL OF TEACHER EDUCATION
In this section we discuss actual applications of digital fabrication into schools, student teachers’ professional agency, and the relevance of developing it during TE. Then, we propose how they can be fostered by merging digital fabrication with inquiry-based STEAM education.

2.1 Applications of digital fabrication in schools
Digital fabrication consists of building an artifact mediated by computational processes, such as programming a 3D model to be printed, or modeling the parameters for a laser cutter to make the final product. Research has been developed to explore varied applications of digital fabrication in primary education, considering the educational objectives of sourcing pupils with such materials [3, 5]. The most relevant theoretical support for its application is the constructionism of Papert, according to which learning happens through building and transforming mental structures while applying it on the making of real things. Moreover, learning happens when abstract and concrete actions relate contextual factors with personal demands [12].

Therefore, digital fabrication becomes a strategic means to achieve this goal by materializing mental models, and integrating the learning process of children within their social contexts and personal interests. However, applying digital fabrication into classrooms has to be integrated to a curriculum framework in which this practice fosters digital literacy and ICT competences, together with collaboration and problem solving skills. These competences should support not only the consumption of digital materials, but allow pupils to comprehend, navigate and transform them [5]. One of the most suitable way to apply digital fabrication in school according to these principles is through inquiry-based STEAM approach, in which children learn motivated by their own inquiries while making meaningful and contextualized products [3, 7].

2.2 Fostering professional agency in teacher education
Teachers who actively learn in work have strong “teacher professional agency”—the capacity of managing the own process of learning by activating three main interrelated elements: motivation to learn, efficacy beliefs about learning, and learning strategies [13]. Teachers with high levels of professional agency develop efficient
and long-term strategies to continue improving their professional competences [9]. Thereafter, TE should foster an active posture that supports teachers’ development throughout their careers to face work challenges due to digitalization of education [8, 11].

2.3 Integrating inquiry-based STEAM approach to teacher education

Inquiry-based STEAM approach merged with digital fabrication consists of an educational setting that poses challenges for student teachers, because of the need of specialized computing know-how, which might cause a general mystification around the difficulty level of dealing with electronics, programming and technology [1]. Hence, this methodology consists of a potential environment to promote professional agency competences for demanding motivation to learn new knowledge and skills, efficacy beliefs of one to be able to learn new things, and learning strategies to do so. Lastly, this environment allows to observe how they emerge into practice.

Additionally, it has been shown that inquiry-based learning emphasizes student-centered learning and social-driven skills [4], which in turn are valuable pedagogical principles in educational curricula in many countries [10]. Therefore, this educational approach builds coherence between TE and teacher practices [13].

3 METHODOLOGY

This research design proposes to develop a mixed method of follow-up quantitative and qualitative approaches. Inquiry-based STEAM workshops merged with digital fabrication will be offered for student teachers at the TE program of the University of Eastern Finland. The workshops will be offered in two modalities: control group and experimental group. In the experimental group, the inquiry-based STEAM workshop merged with digital fabrication will be offered with concrete use of hardware, software, programming, electronics and technology. In the control group, solely a theoretical lecture about inquiry-based STEAM and digital fabrication will happen. Pre- and post-tests will be applied to measure effects of the workshops on student teachers’ professional agency. The workshops will be offered for three years. Student teachers of different levels of their TE programs can participate. This will enable to collect data of participants in different moments of TE, allowing for a follow-up research design.

4 DISCUSSION

This research has potential to bring relevant computational concepts and practices to humanity sciences, such as computational thinking, engineering, learning by trial and error method, and familiarization with software and hardware systems. Such competences are becoming more pertinent in education and related fields. Consequently, this can increase teachers’ interest to promote such skills for their pupils and students, which in turn can raise youths’ aspirations to join technological fields in the future. Additionally, stronger connections between educational and computer sciences can bring pedagogical practices to computing education that are not applied in this field, but are promising to raise interest, motivation and student-centered principles in computing education. Such effect would benefit the area against high drop-out rates of students during their studies at university [2].

At an educational level, such research endeavor would reveal how inquiry-based STEAM approach merged with digital fabrication can promote student teachers’ professional agency. Second, it can provide evidence that when student teachers are trained within this kind of learning environment, they will be more prone to promote student-centered and inquiry-solving activities at school, as well as help students to effectively live into technological societies. Moreover, TE programs can experience an increase on their social and economic values by integrating technologies for learning and development in their official curriculum.

At economic and entrepreneurial levels, this research would provide policy-makers and stakeholders evidence of effective teacher and computing education activities, increasing the return of investments on such programs. Second, expertise in research/practice with technologies for learning and development can integrate them better to educational, technological and market fields.

5 CONCLUSIONS

The authors believe that discussing about these topics, integrating teacher education with computing educational practices, can bring long-term benefits for educational systems.

REFERENCES