

כנס מיט"ל השמונה- עשר, 2020

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תאריך	25.5.2020
שם ההצעה	Preparing Computer Science Preservice Teachers for Online Teaching
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# Preparing Computer Science Preservice Teachers for Online Teaching

**Abstract:** Due to its rapid changing nature, the field of Computer Science requires learners to develop self-directed online *learning* skills, and teachers to develop online *teaching* skills. In this paper, we describe the instructional approach we used in the Methods of Teaching Computer Science (MTCS) course, in which we utilized the task-centered instructional strategy within a blended learning course format for preparing preservice computer science teachers for online teaching. As COVID-19 forced all teachers in the world to go online, we believe that our method can be used for teaching online teaching in wider preservice teachers' programs and in-service professional development.

**Keywords:** instructional design, online learning, task-centered instructional strategy, teacher education, computer science education, asynchronous learning

## Introduction

Rapid advances in information and communication technologies (ICT) lead to rapid growth of ICT-based education formats such as Massive Open Online Courses (MOOCs), online, and blended learning (Siemens et al., 2015). Online education continue to grow, even though overall higher education enrollments is declining (Allen & Seaman, 2016). Nevertheless, while online learning is reported by academic officers to be strategic and comparable to face-to-face instructions, overall only 29.1% of chief academic officers believe that their faculty accept the legitimacy and value of online education (Allen & Seaman, 2016). One reason for this phenomenon could be faculty's lack of experience as learners in online learning environments and the role they should play as teachers in this context. As noted by Mishra and Koehler (2006, p. 1030), "The addition of a new technology ... often raises fundamental questions about content and pedagogy that can overwhelm even experienced instructors". As programming languages are constantly changing, requiring programmers to constantly update their knowledge and skills through online learning, we believe that pupils should be prepared for online learning as well, and to do that, teachers should be trained to teach online. The COVID19 pandemic has further emphasized the need to prepare pupils for online learning and teachers for online teaching.

In this paper we describe the instructional approach we used for teaching preservice computer science teachers online-teaching. First, we believe that in order to teach online, one should first experience online-learning as a *learner*. For that, we utilized asynchronous online learning to enable an online learning experience for the preservice teachers. Second, based on Merrill's First Principles of Instructions (Merrill, 2009), we used the Task-Centered Instructional Strategy, in which a progression of

complete tasks with increasing complexity is specified and serves as the backbone of instruction for teaching online-teaching. In the area of COVID19, we believe that this approach can be utilized in preservice teachers' education as well as in in-service professional development across subject matter.

### **Designing Instructions for Online Teaching**

In this section we will describe in details the implementation of our instructional approach. Fourteen preservice teachers (7 males and 7 females, age range 23-50) participated in the course “Methods for Teaching Computer Science”, which is one of the mandatory courses for receiving a computer science teacher certificate for high school, with 4 weekly hours over 13 weeks. The preservice teachers consented to participate in this study. The course covers pedagogical and technological methods (Hazzan et al., 2015) for teaching programming paradigms including logical programming and functional programming, computational models including finite state automata and Turing machine, and machine learning.

The instructional approach that we used to achieve the goal of preparing preservice teachers to teach online included: (a) hybrid course format, and (b) a progression of online teaching tasks, as will be described below.

#### **(a) Hybrid Course Format**

In order to *teach* online, we believe that one should first build a mental model of what it entails to *learn* online. Thus, we utilized a blended learning approach, where each F2F week was followed by two online-learning weeks. The F2F weeks, included active learning focusing on the course tasks and class discussions. The online learning weeks were fully asynchronous, and included: (1) videos, with approximately six 10-minutes videos per week, totaling to one hour of online instructions, (2) programming assignments that covered the topic of each week, (3) pedagogical assignments such as writing assignments, giving feedback to peers, designing a lesson, etc., and (4) discussion forums that covered pedagogical, content, and technological issues.

#### **(b) A Progression of Online Teaching Tasks**

While the preservice teachers gained experience as online *learners*, they were prepared for online *teaching* through a progression of tasks with increasing complexity (Merrill, 2007). We used a progression of online-teaching tasks, with an increasing complexity of integration between technology, pedagogy, and content knowledge (Mishra & Koehler, 2006), as described below:

##### **Task 1 – Recording the first online video**

The first task included a simple integration of technological, content, and pedagogical knowledge. As our preservice teachers had no prior experience in self-recording lectures, the first task was devoted to learning the basic technological skills: installing and operating a screen and video recording software,

editing the lecture video, and publishing it online. The video had to cover a simple problem that was already solved in the classroom.

### **Task 2 - Preparing online presentation for class peers**

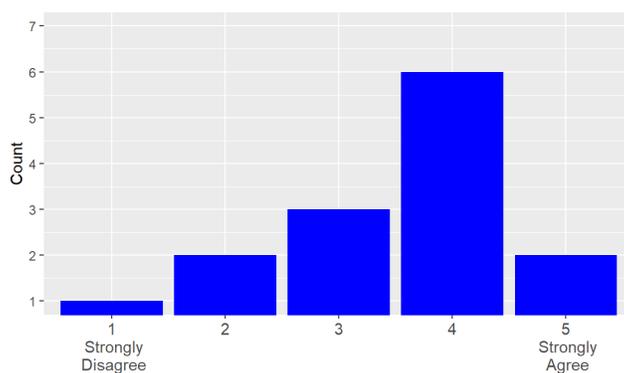
For the second task the preservice teachers prepared two asynchronous presentations, each one reviewing a twelve-grade computer science project that was developed in a school they visited. The goal of this task was twofold. First, the students were exposed to a variety of school projects presented by their peers' videos, and second, the students practiced online delivery of self-produced content in a supporting and nonjudgmental environment of their classmates.

### **Task 3 - Preparing online lecture for pupils**

The last task included a complex integration of technological, content, and pedagogical knowledge. The preservice teachers had to present a solution to a high school national exam question. The task was executed in 7 phases: (1) Selecting an exercise and solving it, (2) Presenting the solution F2F to a peer, (3) Improving the presentation of the solution based on the peer's feedback, (4) Self-recording the lecture, (5) Presenting the video to peers for additional feedback, (6) Revising the video, and (7) Publishing the second version on a video sharing web service that will be available to students.

## **Preliminary Results**

Overall, as learners in the course, the preservice teachers reported that online learning required more effort than F2F learning (see Figure 1). Nevertheless, when asked about what should be the ratio between online and F2F lessons, their overall preference was towards more online learning lessons than F2F lessons (see Figure 2). When asked to explain, one student said that “while online learning required more effort, it also saved travel time and was overall more efficient for learning”.



*Figure 1.* Preservice teachers' response to the question “Online learning requires more effort than F2F learning”

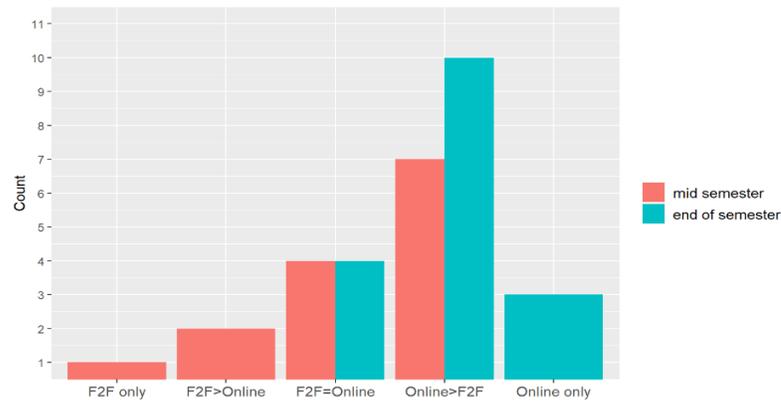


Figure 2. Preservice teachers' preference for the number of F2F vs. Online lessons.

In terms of confidence to teach online, while we found significant differences in students' confidence to teach the different topics taught in the course,  $F(4, 134)=6.19, p<.0001$ , we found no significant difference in students' confidence to teach F2F vs. online,  $F(1, 134)=0.7, p=0.4$  (see Figure 3). The differences in students' confidence to teach the different topics stemmed from the topics' perceived difficulty as reported by the students, which was significantly negatively correlated to their reported confidence ( $r=-0.43, p<.0001$ ).

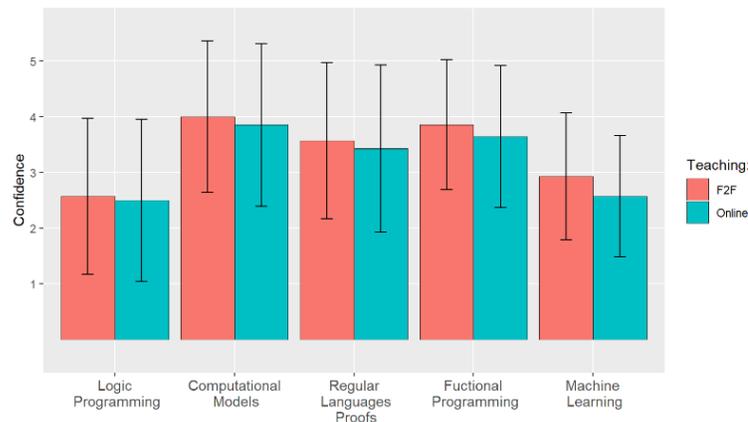


Figure 3. Confidence (from 1-very low to 5-very high) to teach F2F and Online in high school by course topics

## Discussion

As the prospective teachers had little experience as online learners and were novice in online teaching, we utilized an instructional approach that combined gaining experience as online learners while

gaining expertise as online teachers through a progression of online teaching tasks, with a gradual increased difficulty level of integration between technological, pedagogical and content knowledge. Our results indicate that even though the preservice teachers in the course had very little experience in online learning and teaching, by the end of the course they developed a preference for online learning as students, and their confidence to teach online was not significantly different than their confidence to teach F2F.

Our initial motivation for this approach stemmed from the rapid changing nature of computer science and programming languages, which requires the development of online learning skills. Nevertheless, these days, in the midst of COVID19, it is clear that developing online learning and teaching skills is critical across subject matter. We believe that one of the obstacles faced by teachers in the COVID19 time is their lack of personal experience as *learners* in online learning environments. While online teacher preparation programs existed prior to COVID19, these days all preservice teachers across academic institutes get to have a taste of what online learning entails. Nevertheless, while in-service teachers are experiencing online teaching, their ability to do that effectively may be limited by their lack of experience as online learners. We therefore believe that it could be extremely beneficial to develop online in-service professional development programs also post COVID19.

Yet, while essential, gaining experience as online learners is not sufficient to prepare for online teaching, just like being a student in F2F settings is essential but not sufficient for F2F teaching. Preservice and in-service teachers should be therefore prepared for the integration of technology, pedagogy, and content knowledge for online teaching. In our course, implementing a gradual progression of online teaching tasks, in the context of online learning was successful in developing preservice teachers' positive attitudes towards online learning and confidence in online teaching. We believe that this approach can be implemented across subject matter, in preservice teachers' education as well as in in-service professional development.

### **Future Research**

This era raises many questions that should be further explored through research. What should preservice education and in-service professional development look like post COVID19? The course described in this paper was conducted just prior to the beginning of the pandemic and enabled us to utilize a blended approach that included online and F2F learning modalities. These days this course has been converted to be fully online, with combination of asynchronous and synchronous learning. While we believe that there should be a combination of the two learning modalities, further research is needed to extract the optimal ratio of these modalities for preservice teachers and in-service professional development. Yet the biggest question in our opinion that remains open is what should K-12 education

look like? What learning modalities should be utilized in schools post COVID19? Should it return to what it was the day before the pandemic? Or could this pandemic serve as a catalysator for a paradigm shift at large?

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