How to Establish a Computer Science Teacher Preparation Program at Your University? – The ECSTPP Workshop

This paper presents a workshop on the establishment of computer science teacher preparation programs. The workshop is designed for the potential initiators of such programs – computer scientists and computer science curriculum developers – who do have computer science teaching experience, either in academia or in the high school, but lack knowledge about the actual construction of such programs. We suggest that such a workshop may stimulate the establishment of additional computer science teacher preparation programs, meeting the need identified in 2007 by the CSTA.

1 INTRODUCTION

In this paper we present the rationale, structure and contents of the Establishment of a Computer Science Teacher Preparation Program (ECSTPP) workshop, targeted at computer scientists and computer science (CS) curriculum developers who wish to launch CS teacher preparation programs at their universities but lack knowledge about the actual construction of such programs.

The rapid changes and development in the field of CS pose a huge challenge for designers of high school CS curricula and, consequently, for universities who wish to offer teacher preparation programs. This fact is amplified due to the fact that in most countries no CS teacher preparation programs are offered [Ericson et al., 2008], and further, no requirements for CS teaching certificates are defined.

In this spirit, the CS education (CSE) community has expressed its awareness of the need for designated CS teacher preparation programs. For example, a report written by a special Computer Science Teachers Association (CSTA) task force states that “Teachers must acquire both a mastery of the subject matter and the pedagogical skills that will allow them to present the material to students at appropriate levels.” [Tucker et al., 2004, p. 18]. This report also recommends defining standards for CS teaching license entitlement, a fact that, in itself, will eventually determine the contents of CS teacher preparation programs. The message sent by the 2004 CSTA report is also reinforced in another CSTA report that states that “The lack of consistent and readily available information concerning certification requirements make it almost impossible to determine how one should go about preparing [to] such a career” [Stephenson et al., 2005, p.20].

We suggest that although the need for CS teacher preparation programs has already been acknowledged, universities whose CS faculty members wish to establish such programs may still face difficulties since such faculty members are usually not familiar with the high school CS curriculum, with the research in CSE, nor with the actual knowledge of how to go about establishing such teacher preparation programs.

The objective of the ECSTPP workshop outlined in this paper is to promote the closing of this gap, at least partially, first, by
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presenting the workshop participants with key guidelines for the construction of CS teacher preparation programs, and second, by enhancing the creation of a community of practitioners who will proceed together through this process of program construction and learn from each other’s experience.

2 THE ECSTPP WORKSHOP

2.1 Rationale

The rationale of the ECSTPP workshop is based on the Israeli model for high school CSE [Hazzan, Gal-Ezer and Blum, 2008]. The model consists of the interrelationships between four key components (see Figure 1):

- A well-defined CS curriculum, including written textbooks and teaching guides;
- The Ministry of Education’s requirement for a mandatory formal CS teaching license;
- Teacher preparation programs, including at least a bachelors degree in CS and CS teaching certificate studies;
- Research in CSE.

Figure 1: A model of a high school CSE program [Hazzan, Gal-Ezer and Blum, 2008]

One of the ideas that this model highlights is the central role of CS teacher preparation programs in the Israeli structure of high school CSE, as is explained in what follows. Teacher preparation programs should include some research elements, such as reading assignments of papers that deal with CSE research, and mini-research projects carried out by the prospective CS teachers themselves. Instructors of CS teacher preparation programs must, therefore, be familiar with the research in CSE, and the community of practitioners who are interested in CSE research is consequently expanded. In turn, the existence of a CSE research community, with its accumulative experience, can ease and guide the development process of CS curricula and syllabi. The existence of CS teacher preparation programs and of CS curricula and syllabi may enhance policy makers’ decision to require a mandatory CS teaching license.

Based on the central position of CS teacher preparation programs in the Israeli model, and due to the fact that the Israeli model is considered to be one of the leading high school CS curricula in the world, we suggest countries/states that wish to adopt the Israeli model facilitate the ECSTPP workshop as one possible mechanism for boosting the application of the model, by fostering the establishment of CS teacher preparation programs.

2.2 Population

The ECSTPP workshop is designed for the following two groups of CS practitioners:

- Computer scientists who wish to establish a CS teacher preparation program in their universities, but are not familiar with the practice of teaching CS in the high school and with the research in CSE;
- Designers of high school CS curricula who lack the background in CSE research. It is important that these practitioners participate in the workshop since any university that wishes to establish a CS teacher preparation program is likely to recruit them to teach some of the courses in the program.

2.3 Objectives

The workshop’s objectives are derived from the specific populations for which it is designed. Specifically, the workshop participants

- become familiar with the typical structure of CS teacher preparation programs;
- become familiar with the research in CSE;
- become reflective practitioners as educators of high school CS teachers.

2.4 Structure and contents

The ECSTPP workshop comprises three consecutive stages: the Common Ground stage, a 3-day seminar, and the Action stage. The Common Ground stage and the Action stage take place at the participants’ institutions before and after the seminar, respectively.

Stage 1: Common Ground

The Common Ground stage has two main purposes: first, to prepare the ECSTPP workshop participants for the seminar by increasing their awareness to meaningful themes in high school CSE, from both the pupil’s and the teacher’s perspectives; second, to create a common knowledge basis for the workshop participants on high school CSE, which serves as the basis for the seminar.

To achieve these purposes, the CSSTPP workshop participants are asked to complete the following assignments prior to their arrival at the seminar:

- Become familiar with their national high school CS curriculum (if such exists) or with another high school CS curriculum on which they intend to base their CS teacher preparation program;
- spend at least 6 hours in high school CS classes (specifically, at least 3 consecutive hours in 2 classes) and summarize their observations and insights;
- write a reflective essay about their own acquisition of CS concepts during their entire professional development.
Stage 2: Three-day seminar

The seminar consists of twelve 1.5-hour sessions, preferably scheduled for three consecutive days (for example, first day – 4 sessions; second day – 5 sessions; third day – 3 sessions).

The seminar contents are organized in four layers:

- **Layer 1 – Introduction**: This layer addresses the rationale and structure of CS teacher preparation programs.
- **Layer 2 – The Methods of Teaching CS (MTCS) course**: The MTCS course is one of the central components of any CS teacher preparation program. In the MTCS course, the prospective CS teachers become familiar with the CS pedagogical context knowledge (PCK) [Shulman, 1986], which is the pedagogical knowledge specifically relevant for teaching CS.
- **Layer 3 – High school practicum**: The practicum is also a vital component of any CS teacher preparation program. During the practicum, the prospective CS teachers get their first experience in high school CS teaching.
- **Layer 4 – CSE research**: This layer includes an overview of the research in CSE, discussions of specific CSE research works, familiarity with common CSE research methods, and a preliminary experience in CSE research.

Table 1 presents the topic of each session, as well as the layers to which it belongs.

**TABLE 1. THE SCHEDULE OF THE ECSTPP SEMINAR**

<table>
<thead>
<tr>
<th>Layer</th>
<th>Topic</th>
<th>#</th>
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<tbody>
<tr>
<td>Introduction</td>
<td>Gathering, introduction and creating a community of learners</td>
<td>1</td>
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<tr>
<td>Introduction</td>
<td>The structure of a CS teacher preparation program</td>
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<tr>
<td>MTCS course</td>
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<td>CSE Research</td>
<td>Introduction to research in CSE</td>
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<tr>
<td>MTCS course</td>
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<td>CSE Research</td>
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<td>Practicum</td>
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<td>Practicum</td>
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<td>CSE Research</td>
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<td>Integration of the four layers</td>
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In order to highlight the interrelations between the layers, they are intertwined throughout the seminar. For the reader’s convenience, however, the following description of the contents of each session is organized according to the four layers.

**Layer 1: Introduction**

The two first sessions establish the basis for the continuation of the seminar.

The aims of the first session are:
- To form a community of learners who will work together after the seminar is over, when they will, most probably, face similar questions and challenges;
- To create a knowledge basis on CSE that is common to all of the seminar participants.

These two targets are achieved by asking the participants to work in groups on different activities related to high school CS teaching, based on the tasks they performed in the Common Ground stage.

In the second session of this layer, the general structure of a CS teacher preparation program is described. In many cases, this structure comprises of:
- i. Disciplinary CS studies;
- ii. General pedagogical studies, such as psychology and general teaching skills;
- iii. Studies related to the CS PCK, mainly the MTCS course (Layer 2 of the seminar);
- iv. Practicum in teaching high school CS classes (Layer 3 of the seminar).

**Layer 2: The Methods of Teaching CS course**

Three sessions of the seminar are dedicated to the MTCS course (Sessions #3, #5, #6). In addition to presenting the objectives and general structure of the MTCS course, illustrative lessons from the MTCS course are presented. Specifically, the importance of including the respective topics in the MTCS course is addressed and the actual details of the lessons are outlined.

The lessons selected from the MTCS course for presentation in the ECSTPP seminar should illustrate the multifaceted nature of high school CS teaching (e.g., teaching a specific CS topic, preparation and evaluation of exams, different programming environments, guiding high school students in project development in the lab, and teaching soft CS ideas). In order to let the ECSTPP seminar participants to experience the essence of the MTCS course as well as the variety of teaching methods employed in the course, we recommend conducting at least part of the MTCS course activities with the seminar participants.

For a detailed description of the MTCS course, see Lapidot and Hazzan (2003) and Ragonis and Hazzan (2008).

**Layer 3: High school practicum**

During the practicum, the prospective CS teachers gain their first CS teaching experience in the high school, before becoming actual CS teachers. The practicum is usually performed under the guidance of two mentors: an in-school mentor, who is a CS high school teacher who trains the prospective teacher and guides him or her during the practicum; and a university mentor who is a faculty member in charge of the academic aspects of the practicum. When the prospective CS teachers are physically in the school,
they accompany their in-school mentor, observe lessons taught by the mentor, assist in various activities, and, of course, at a certain stage, begin teaching themselves. (For more details, see Hazzan and Lapidot, 2004.)

During the two sessions of the ECSTPP seminar that are dedicated to the practicum (#8 and #10), the seminar participants become familiar with the guidance process of this first teaching experience. For this purpose, different activities are facilitated in the seminar, such as an analysis of scenarios taken from real practicum lessons; formulation of guidelines on how to give feedback to prospective CS teachers after a lesson; examination of a tutoring framework as a friendly environment for a first teaching experience [Ragonis and Hazzan, 2009]; and a discussion about the relationships between the in-school mentor and the university mentor as well the responsibilities of each mentor.

Layer 4: CSE research

The relatively high attention given to the CSE research layer in the ECSTPP seminar (4 sessions) stems from the following two reasons. First, the “research in CSE” component of the Israeli model presented above is strongly related to the “CS teacher preparation programs” component of the model. Second, in order to support the establishment of CS teacher preparation programs after the seminar, we suggest that workshop participants conduct an action research (see below) in CSE; for this purpose, they must become familiar with the essence of research in CSE.

In order to expose the workshop participants to the vast literature on CSE, the first session on CSE research (Session #4) introduces the seminar participants to topics, journals, and classic papers in CSE research. This familiarity will help them later, among other things, in the actual design of tasks for the prospective CS teachers enrolled in their future programs.

Research methods in CSE are presented in the second session of this layer (Session #7). Although we do not expect seminar participants to transition into a full-time research career in CSE, it is important that they become familiar with the research methods employed in the field in general, and those presented in the research papers they are exposed to in the seminar, in particular.

The third session of the CSE research layer (Session #9) is dedicated to reflection in general, and to the reflective practitioner’s perspective [Schon, 1983] in particular. The idea is to increase the awareness of the ECSTPP workshop participants to this important professional skill which prospective CS teachers in their programs should acquire in order to continuously improve their teaching proficiencies.

The fourth session on research in CSE (Session #11) is about action research [Lewin, 1948]. Action research is the research arena in which researchers study the domain within which they work, employing a systematic and criticized research process. This research approach is usually adopted in cases in which researchers wish to improve their understanding of an action they perform, identify problems, find solutions to these problems, and examine the application of these solutions in order to improve the process undergone in the research field.

Accordingly, action research seems perfectly fitting as a process that is to accompany the establishment of a CS teacher preparation program. In this spirit, ECSTPP workshop participants are expected to apply the method of action research during the establishment process of a CS teacher preparation program in their own universities. In addition, they are expected to educate prospective CS teachers in their future program to conduct action research in order to improve their own teaching process.

Stage 3: Action

The last session of the seminar (Session #12) is dedicated to the launching of the Action stage which begins right after the seminar ends. The purpose of this stage is to support and guide the participants of the CSSTPP workshop in the actual establishment of CS teacher preparation programs in their respective universities. For this purpose, the participants of the ECSTPP workshop are offered the following two activities:

- Participate in an online forum with other CSSTPP workshop participants to maintain the spirit of the learning community created during the seminar itself. **The forum will enable participants to share their experience, to learn from each other’s experience, and to discuss problems they encounter during the establishment of the CS teacher preparation program in their own universities.**

- For more details, see Hazzan and Lapidot, 2004.)
Conduct two kinds of research:

- Mini-research in high school CS classes in order to improve their understanding of high school CS teaching.
- Action research about their own process of constructing a CS teacher preparation program.

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3 SUMMARY

We present a workshop that focuses on the construction of CS teacher preparation programs. The purpose of the workshop is to enable its participants to return to their respective institutions with the basic knowledge needed to start this construction process. We suggest that such a workshop has the potential to help initiate the construction of CS teacher preparation programs that, in turn, according to the Israeli model, may foster the creation of the needed infrastructure for high school CSE.

References