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High School CS Teacher Preparation: Key Elements, Structure and Challenges

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Extended abstract

The talk focuses on high school computer science (CS) education (use of the term Computer Science Education for Didactics of Informatics). Specifically, it aims at presenting a comprehensive picture of high school CS teacher preparation, addressing the structure of high school CS teaching preparation programs, key elements of such programs, i.e., the Methods of teaching CS course and the practicum, and a practical way of building such programs. These topics are briefly described in what follows and will be elaborated in the talk.

1. Introduction – A Model for High School CS Education

This section presents a model for high school CS education (see Hazzan, Gal-Ezer and Blum, 2008, for additional details). It is based on an analysis of the structure of the Israeli high school CS curriculum, considered to be one of the leading curricula worldwide. The model consists of four key elements – a well defined high school CS curriculum, a mandatory CS teaching license, teacher preparation programs, and research in CS education – as well as interconnections between these elements. Figure 1 presents the model.

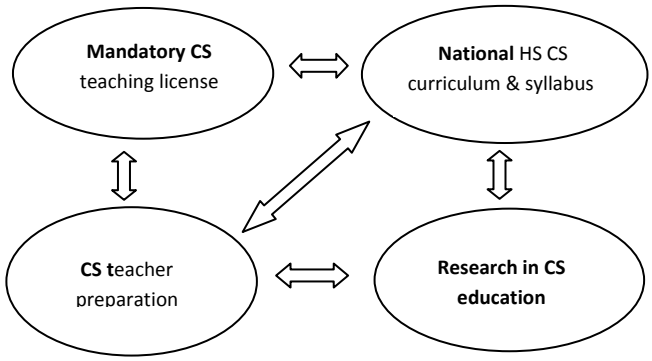

Figure 1: *A model for a high school CS education*

In what follows, the main characteristics of each component are outlined. The connections between the four components will be described in the talk.

National high school CS curriculum: This national curriculum describes the rationale for and structure of high school CS education and the contents of each of its (curricular) units. In addition, text books and teaching guides are provided for each unit. They specify pedagogical aspects of the given topics, such as, recommended lesson plans, additional problems to offer to the pupils, plausible learners' difficulties, and additional clarifications related to the material. Another nation-wide element of this curriculum is the matriculation exam that sets teaching standards and clarifies explicitly what pupils should learn.

Mandatory CS teachers' license: In Israel, in order to teach CS in high school, a teacher should have both a Bachelors degree in CS (in fact, a Masters degree is required for teaching any subject in the Israeli high school system. It is, however, difficult to meet these requirements and in most cases high

school teachers only have a Bachelors degree) and a teaching license in CS. Only then will he/she be authorized by the Ministry of Education to teach CS in high schools.

Teacher preparation programs: In most cases teacher preparation programs are taught in universities or colleges. The prospective CS teachers study for a Bachelors degree in CS while at the same time take teacher preparation program courses (which are equivalent to one academic year). A typical teacher preparation program includes general pedagogical courses (such as, psychology and educational philosophy), basic teaching skills, and specific courses about the teaching of CS. The two main elements which deal specifically with the teaching of CS – the Methods of Teaching CS in the High School course and the practicum in high school CS classes – are described in the continuation of this abstract.

Research in CS education: Intensive research in CS education is carried out by Israeli researchers who are usually involved in the development of the text books and the teaching guides of the nation-wide curriculum. In many cases, this research is carried out during the development process of the material. The purpose of this research is to guide the development process of the text books so that the final product fits high school CS pupils' level and that it will be possible to teach it during the given period of time. This process enhances CS education research in Israel beyond just research directly connected to the evaluation of text books and teaching guides.

2. The Methods of teaching CS course

This section presents a global perspective at the Methods of Teaching CS course. Additional details are available at Lapidot and Hazzan (2003) and Ragonis and Hazzan (2008A).

In most cases, the course consists of 112 hours of classes and training, divided into two semesters. Each week there are two 2-hour long lessons. Each of the two semesters is devoted to different high school curriculum units. Course participants are prospective CS teachers and they usually take the course during their third year of study (out of four years). The course's academic pre-requisites are relevant CS contents and a major part of the general education and teaching studies.

The main course objective is to train pre-service high school CS teachers. The specific objectives derived from this main objective, are to:

1. enhance prospective CS teachers' professional identity as CS teachers;
2. heighten prospective CS teachers' awareness to the uniqueness of CS education;
3. familiarize prospective CS teachers with the national CS curriculum;
4. expose prospective CS teachers to difficulties encountered by learners when learning different topics from the CS curriculum;
5. enable prospective CS teachers to master pedagogical skills for teaching CS considering different kinds of learners;
6. enable prospective CS teachers to master pedagogical tools for teaching CS, including the creation of a supportive and cooperative inquiry-based learning environment;
7. expose the prospective CS teachers to a variety of CS teaching methods;
8. expose prospective CS teachers to the research conducted in CS education and to its application in the teaching process.

In the talk, I illustrate, with specific activities facilitated in the course, how these objectives are achieved.

3. Practicum and Tutoring

Practicum: The practicum is one of the more important parts of CS teacher preparation (Hazzan and Lapidot, 2004). During this stage, the prospective teachers practice the teaching of CS in a high school setting, before becoming actual CS teachers.

The main objective of the practicum is to let the prospective teachers experience what real teaching is before becoming CS teachers. To achieve this goal, the practicum is usually performed with the guidance of two people: an in-school mentor, 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. During the period in which the prospective teachers are in the school, they accompany their in-school mentor, observe lessons taught by him or her, assist in various activities, and, of course, at a certain stage, begin teaching themselves. Sometimes, prospective teachers are asked to carry out additional activities such as conducting some research, attending a workshop at the university in parallel to the practicum, or participating in school faculty meetings.

In the talk I elaborate on the practicum as a bridge between theory and practice from three angles: the prospective teacher's perspective, the MTCS course perspective and the university mentor's perspective.

Tutoring: In this part of the talk I describe a tutoring model, to be implemented by prospective CS teachers, that provides the prospective CS teachers with an opportunity to experience teaching situations, especially coping with learners' difficulties with respect to problem-solving processes, and consequently, to improve their teaching skills (Ragonis and Hazzan, 2008B). The model is based on one-on-one tutoring sessions, in which the prospective teacher meets a novice undergraduate student taking an introductory CS course and guides him or her through problem-solving processes. A qualitative research that accompanied the application of the tutoring model indicated that the prospective CS teachers: (a) change their perspective with respect to teaching processes; (b) focus in their teaching on learners' difficulties; (c) increase their awareness to problem-solving processes and to the need to adapt different teaching approaches for different learners; (d) become reflective practitioners; and (e) increase their confidence with respect to teaching processes.

In the talk I focus on how the tutoring framework enhances the prospective CS teachers' reflective skills.

4. How to Establish a CS Teacher Preparation Program?

In this part of the talk I will present the rationale, structure and contents of the **E**stablishment of a **CS** **T**eacher **P**reparation **P**rogram (**ECSTPP**) workshop, targeted at computer scientists and CS curriculum developers who wish to launch CS teacher preparation programs at their universities but lack knowledge about the actual construction of such programs (for additional details see Hazzan, Gal-Ezer and Ragonis, in press).

The motivation for this workshop is the acknowledgement of the fact that although the need for CS teacher preparation programs has already been recognized, 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 CS education, nor with the actual knowledge of how to go about establishing such teacher preparation programs.

Accordingly, the objective of the ECSTPP workshop is to promote the closing of this gap, at least partially, first, by 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. It is suggested 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 CS education.

5. Conclusion

The aim of the presentation is to present an overview of high school CS teacher preparation. It starts with the presentation of a model for high school CS education and concludes with a practical proposal of how to initiate the model implementation.

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