Implementing Technology Enhanced Learning to impede the declining interest in Computer Science (CS) studies and careers in Europe

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Abstract. Technology Enhanced Learning (TEL) may have an important role in the strategies for attracting and retaining talent in Computer Science (CS) studies and careers. Contrary to the continuing growth of the informatics industry in Europe the number of CS experts (students, graduates, teachers, etc.) is declining [1]. This decline is producing negative consequences in the technology field that affect other sectors like business and education. The purpose of this PhD study is to determine if the strategic implementation of TEL is an effective means to counteract the declining trend. The research will: Identify the negative consequences of a declining interest in CS studies in Europe; determine the factors which motivate young Europeans to pursue or reject CS studies and careers; analyze CS curricula and how technology can enhance teaching and learning of the unique skills required to become a computer scientist, thus increasing the interest in CS studies and careers amongst young Europeans.

Keywords-component: CS studies, learning methods, teaching methods; Technology Enhanced Learning, CS management and economics.

1 Introduction

This paper presents progress in the PhD research "Implementing Technology Enhanced Learning to impede the declining interest in Computer Science (CS) studies and careers in Europe". The investigation will be an economic study, contributing to research in Technology Enhanced Learning which will be considered as a means to prevent the negative impact of fewer CS trained professionals on the economy. The paper is divided into seven parts: First, the formulation of the research question; Second, the identification of current economic factors that justify the timeliness of this research; Third, an overview of the state-of-the-art; Fourth, an overview of the research methodology; Fifth a presentation of the research work underway; Sixth the innovative nature of this study as compared to related research; Seventh, conclusions and future work.

2 Formulation of the Research Question

Can TEL impede the declining number of young Europeans interested in perusing CS studies and careers? Despite a growing demand for work in the Information Technology (IT) sector, the number of students enrolled in courses which prepare future professionals for these careers is decreasing [2]. Many studies have attempted to identify the reasons for this decline, pointing out that the training for skills required to work in information technology is not properly provided for in current educational activities and the poor quality of teaching [3] is to blame. Therefore we intend to investigate how technology might be deployed to enhance CS education and motivate increasing numbers of students to enroll in these studies. The research for this thesis is being conducted within the framework of a broader study underway at the Universitat Politècnica de Catalunya which aims to create strategies to attract and retain students in CS and among them that TEL can represent an effective means. Based on this research, the faculty of economics wishes to identify solutions for attracting students to CS which is primordial for the development of the European economy.

3 Identification of the Significant Problems in the Field of Research

There are several challenges related to the identification of TEL as a method to teach CS classes to motivate young Europeans to study CS thus preventing the risk of losing experts in the field and the negative consequences on the economy.

First, is the lack of scientific information determining the impact that a low number of computer scientists might produce on the economy. Hence the first contribution consists in identifying what would happen if the decline in the number of CS students persists.

Second, although there are a certain number of studies that tackle the problem of attracting talent to engineering in a general way, many of them only focus on gender issues [3]; there is a lack of information showing the reasons why students do not feel attracted to this field of study. Our research will provide a study among young Europeans to clarify these reasons.

Third, some studies illustrate how CS curricula are not perfectly matched to the skills required by practicing computer scientists [8]. Our study will identify the skills that are unique to CS and how TEL is offering opportunities to acquire these competencies.

4 State of the art: Outline of the problem

Technology plays a critical role throughout all industrial sectors in Europe. In France, for example, people spent a total of 7,9 million Euros on technology in 2008 [4]. For this reason, several investigations pointed out their concern about the number of

students enrolled in CS programmes. These studies emphasize the fundamental need to attract students in order to provide the professional talents in information technology required by the European economy [5, 6, 7, 8 and 9].

We suggest that identifying the reasons that prevent students from following CS will contribute to better understanding and controlling this phenomenon [10]. Among reasons identified in the literature: the degree of difficulty in the courses required to become a computer scientist (e.g. Math), the teaching techniques that are not perceived as ideal, and the lack of awareness about the crucial role that CS plays in society and the economy.

On the other hand, previous investigations have demonstrated that TEL can be implemented to enhance teaching and learning of almost any course, even courses like Chinese poetry [11] or music [12]. We can thus assume that CS studies can also benefit from teaching methods and alternatives provided by TEL.

There are already some initiatives to attract and retain talent to CS by sharing technology experiences [13] and by creating teaching and learning methods to support students with the help of information technologies such as effective video clips for learning Web-languages (like HTML) [20]; or using 3D animation environments to teach introductory CS courses [14].

5 Sketch of the Applied Research Methodology

The research is organized in the following way:

First, the context of the research work presents the official statistics revealing a declining interest in CS studies in Europe [15]. Based on these results, a qualitative investigation related to the negative consequences of this decline explains how this rejection is affecting different industries in Europe. This study highlights the necessity of finding solutions to protect CS careers and the benefits it represents for society [5].

Second, identifying the reasons why students reject this career by performing a quantitative study. A survey was conducted by Telecom & Management SudParis, and the Politechnique University of Cataluña with the participation of 26 European countries. This survey makes it possible to draw up a list of the factors that prevent students from choosing CS studies [18].

Third, compare and analyze different curricula in different fields in order to identify the skills that are unique to CS. We plan to support this investigation with qualitative studies organized in form of round tables and interviews among CS students in order better define and identify these skills.

Finally, identify how TEL can contribute to the acquisition of these skills and competencies and reviewing universities which are implementing this TEL successfully in their CS curricula.

6 Research Work and Results Achieved

This section presents the preliminary results achieved in relation to the planned methodology:

6.1 Context of the research work

The research achieved so far, demonstrates that there is a declining interest in CS studies in Europe [15]. The point of departure of our investigation was the key European Statistics published by Eurostat in 2008 which show a decline of CS studies and we propose to take TEL into consideration as a means to attract students [1]. A second analysis shows how this decline may be detrimental to the European economy [5]. This investigation highlights the imbalance in the number of students choosing CS as a domain of study in relation to the demand in industry pointing the impacts this phenomenon is having in the economic, social, political and pedagogical fields. The main results are listed below.

An increase in the price of local (EU) CS development: The economic model on elasticity affirms that the price of a product is determined by its offer in the market [16]. If the number of local technology developers decreases; then their products will become more expensive and scarce while the demand remains constant. Thus, it is crucial to maintain a number of experts in IT in order to keep development costs down.

Migration of CS development: The increase in the price of IT industry and the decrease of professionals to satisfy this demand is related to the initiative of the companies that migrate their labor forces to countries outside Europe where development is not only as efficient as in Europe, but also where there is a greater available production capacity at a lower cost [5]. "The concern is that misplaced pessimism will deter bright young people from pursuing careers in computing, and, in turn, would erode the skills in a field that is crucial to the nation's economic competitiveness" [6].

The need to learn cultures and languages from countries outside Europe: Because of the growing migration, there is an increasing need to learn other cultures and languages to succeed in negotiations with countries outside Europe. [7]. "As access widens, unique educational modules, courses and programs are being designed and evaluated throughout other regions, evidencing issues, challenges, opportunities and initiatives related to this education" [18].

Changes in learning programs and curricula: European curricula need to be strongly adapted in order to integrate the language exchanges and to reinforce the management courses that are being needed by industry [7].

6.2 Identifying the reasons

In order to create strategies to avoid the negative consequences mentioned above, we conducted a study to identify the motivations that both students and professionals

have to reject CS studies. The study is ongoing1. At the time we are writing this paper we have collected 170 responses from participants in 26 European countries [22]. The important results of this research are listed below:

High degree of difficulty: The fact that CS requires a strong background in mathematics and algorithms is a major fear which prevents students from enrolling.

Gender Gap: Women feel that scientific careers related to CS are difficult to accomplish because of the time required, the lack of other women that will accompany them throughout their career, the negative image the career has for many women, etc. [8].

Misconceptions and lack of awareness about careers in CS: Almost 40% of the students have no concept about the kind of jobs that computer scientist can hold in industry and society [10, 19]. Teenagers have incorrectly stereotyped the career or do not have clear models in their lives. Consequently they do not pursue the corresponding degrees (CS and Computing Engineering) because they do not see how it can be relevant for a future career [8].

7 Discussion: How is This Work Different from Others?

Some studies target strategies to attract talent to engineering; a large number of them are directed to attract women to the CS field [18]. This work helps us get some ideas about how to attract and retain people to this field of study. However, there are three areas of research that are missing: First, there is a lack of references to understand the possible consequences of a declining interest in CS and the negative impacts on the economy. Second, the decline in CS is recognized in research, but the reasons for this decline are not clarified. Third, the role of Technology Enhanced Learning as a strategy to reverse the declining interest in CS has not been studied. This Ph.D. investigation will contribute to these three areas.

8 Conclusions & Future Work

This document presented the declining interest in CS studies and its consequences, followed by the reasons that cause this decline. Following the methodology presented in this document, further investigations are needed to complete the work.

The next steps will be to identify the different skills needed to become a computer scientist. As mentioned before, the comparison between curricula in different domains will make this possible, and can be supported by round table interviews with the participation of students.

After this, the investigation will be completed by analyzing what TEL can offer to improve teaching and learning methods to acquire these skills.

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1 http://www.marcelaporta.com/survey

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