EVALUATING STUDENTS' PROGRAMMING SKILL BEHAVIOUR AND PERSONALIZING THEIR COMPUTER LEARNING ENVIRONMENT USING "THE HOUR OF CODE" PARADIGM

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ABSTRACT

One of the most intriguing objectives when teaching computer science in mid-adolescence high school students is attracting and mainly maintaining their concentration within the limits of the class. A number of theories have been proposed and numerous methodologies have been applied, aiming to assist in the implementation of a personalized learning environment that approaches these objectives. In this paper, an empirical study is performed with the support of the "Hour of Code" initiative which took place for a second consecutive year at the end of previous year. The initiative was presented to a number of high-school students as a motivation for teaching computer programming to them. An evaluation of the students' programming skills is attempted with the aid of a questionnaire and a simple personalization framework is presented in order to adapt to the students' personal needs.

KEYWORDS

Teaching programming, evaluation, Hour of Code, personalization framework, adaptation

1. INTRODUCTION

School as a learning organization [9] but primarily as a social environment [1] and the educator as carrier and imparter of knowledge are daily facing many challenges in their attempt to shape the "school of the future", where knowledge is not only statically presented but transferred as part of a dynamically and evolving procedure. Within such an environment computer science plays one of the most important roles. Computer science depicts not only as a static and tiresome lesson, but also as a continuously effort to present and transfer useful knowledge and moreover assist students in their quest for critical evaluation of the information presented.

Teaching computer science to high school students clearly should be enlisted to Bruner's pedagogical paradigm for constructivist learning approach where students are encouraged to enrich what they learn from the tutor with previous acquired knowledge from their past, in order to formulate new ideas or concepts [2]. Combining this educational procedure with Piaget's model for cognitive learning where students are taught something, think about it and then try to express it in their own words [8], lead to a hybrid teaching model for computer science in classroom.

Moreover, computational thinking theory as introduced by S. Papert [7] and later presented by J. Wing [11], advocate that algorithmic thinking is a fundamental skill which everyone can realize (and not only computer scientists). In addition, J. Wing argued for the significance of bringing computational thinking in other aspects of life.

Within this educational environment, bringing computer science and teaching programming lessons to high school students not only encourage their way of understanding through computational thinking and cognitive learning, but also promotes their personal skills and influence them in an alternative way of acquiring and using the knowledge learned.

All of these aspects described above are widely recognized and were included and applied in an innovative idea which took place worldwide during the 2nd week of December (8-14 Dec. 2014) which was named "Hour of Code" [12]. The "Hour Of Code" initiative firstly introduced in the United States of America, as an opportunity for mid-adolescence students to be taught "just one hour of code". The campaign was quickly spread all over the world and moreover promoted from numerous powerful and influential people, including the president of the United States, founders of big IT companies and other individuals from sports and arts. The success of the initiative was significant and students throughout the world were taught and enjoyed an hour of code for a consecutive year.

In the remainder of this paper, the "Hour of Code" initiative is briefly described in section 2 and the three-step teaching methodology which we applied in section 3. Furthermore a short evaluation of the students understanding of simple programming concepts with the aim of an additional example is given in section 4, along with a questionnaire filled by each student. Finally, we extend our previous work [6] by proposing a simple framework which aims to help us personalize the computer learning environment for each student and adapt our teaching methodology to their specific skills and needs.

2. THE HOUR OF CODE

2.1 Description of "The Hour of Code" Initiative

The most significant objective of the "Hour of Code" initiative as this is presented by the originators of the idea is to bring closer all students to computer science and programming, through the presentation and accomplishment of the "one hour of code" paradigm. The idea initially originated in the United States of America from an non-profit organization (code.org) which then turned into a public charity.

The significant importance of the initiative and the successful results which were obtained, are demonstrated by the numbers presented in the first page of their website. Namely, almost 5.2 billion lines of code have been written till today and more than 100 million students have learned at least one hour of code. The campaign of the initiative, as well as the programming examples which are presented, have been endorsed by great personalities of all the important aspects of social life. Moreover, even the president of the United States supported actively the project and encourages every student to actively participate and complete at least an hour of code because "…learning these skills isn't just important for your future, it's important for our country's future.."[10]. All these factors demonstrate the noteworthy significance of the initiative and exhibit many of the reasons which made the DG connect European Commission to organize a similar event within the boundaries of the European Union during the 3rd week of October 2014 with excessive success.

3. TEACHING METHODOLOGY

3.1 Methodology of Teaching "Hour of Code" in the Classroom

Within this context and the "Hour of Code" as the triggering event, we decided to actively participate in the initiative and teach the very first tutorial of the webpage to 3 different classes of high-school students aged 14-17 years old. Most of the students had no previous experience in the field of computer programming (with the exception of a few of them who having been learning computer algorithms as part of a course in their curriculum) and mainly live in rural neighborhoods.

The approach of teaching the computer programming hour is briefly explained in the 3 steps which follow and important characteristics are highlighted throughout this description.

3.1.1 Introduction – Explaining the Importance

The initial teaching approach which was selected in order to evenly introduce the importance of computer science (and more generally computers) to the students, was a 3-minute brief introduction on the recent innovations on the computer science field (tablets, touch-screens, mobile devices) and the numerous

applications which nowadays all of us are daily using. In addition the students were encouraged to imagine their parents' life 30 years ago in the decade of 80's when the presence and use of computers were insignificant.

3.1.2 Career Opportunities in the Computer Science Field

Following the initial approach presented to the students for the context of computer science, another step which introduced career opportunities in the CS field was presented. A brief discussion in the form of questions-answers took place with the students showing a lot of curiosity for the working conditions and mainly the annual salary of professions relating to computers. A very short demonstration was made with pictures taken from the web which illustrated the new offices of Apple Inc., Google and Facebook. Students were excited to learn the middle IT computer annual salaries and the benefits which arise when working for a big IT company.

At this point a short video from the "Hour of Code" webpage was showed, where a number of personalities analyzed the importance of computer science and programming. Students were impressed to learn that a considerable number of the top-100 wealthiest people on earth are working in the IT industry.

3.1.3 Demonstrating the 20 Steps Example

The most important step of the teaching methodology followed was the demonstration to each class of the first example of the webpage with 20 steps. This example was carefully chosen from the organizers of the initiative to include the basic steps of programming, conditions (if-statements) and loops (repeat and repeat-until statements).

Students enjoyed the demonstration (in a single PC with the image projected to a board) and the main reasons for this success were the simplicity of the examples (cartoon characters were chosen for the 20 steps) and the built-in video explanations of each group of paradigms from well-recognized celebrities.

After the first few steps, each of the three classes was able to solve the additional steps roughly effortless and most of the students found the solutions to each step relatively quickly. The very last steps of the examples were more difficult and a few number of the students lost their attention throughout the whole hour.

4. EVALUATION OF THE INITIATIVE FROM THE STUDENTS

In order to evaluate the student's perceptive of the programming patterns presented and their basic programming skills and potential programming talents, we performed a two phase evaluation approach.

Initially, another example (Lightbot) of the initiative was given for each student to complete alone (without the educator's assistance) during another teaching hour of the Computer Science course (one pc per student).

The purpose of this phase was for the educator to quietly evaluate the student's progress in the puzzle, for the proper usage of condition statements and loops. The example was more difficult than the one presented and a significant amount of the students did not accomplish it (till the end). All these results and the overall progress of each student separately, were recorded in an independently designed evaluation sheet.

For the second phase of the evaluation, a specifically designed questionnaire was given to each student (in all 3 classes) with a few questions. The purpose of the questionnaire was for the student to evaluate the initiative, record their experiences in programming and their interest in computer science. Among the questions, one was specifically chosen to ask for their opinion of the initiative and give an estimate of their level of understanding of the programming patterns presented (all of them, many, few and not-at-all). The results obtained from this question are presented in Table I.

Table 1. Level of understanding (according to students opinion)

Understanding of each step	**Number of students (49)**			**Percentage**
	1st class (age 15)	**2nd class (age 16)**	**3nd class (age 17)**	
All	5	6	3	28,57%
Many of them	13	6	7	53,06%
Few of them	4		4	16,33%
None	1			2,04%

Another noteworthy fact which was inferred from the questionnaire given was the wide acceptance of computer science among the students and their motivation for a future career in the IT field. Almost 3 out of 4 students envision a profession in the computer science field (according to their understanding of computer science). Among them, there subsist a few which yearn for the hardware industry and few of them in the computer programming field (Table II below).

Table 2. Possible future career in the IT industry

Career in the IT field	Number of students (49)			Percentage
	1st class (age 15)	2nd class (age 16)	3nd class (age 17)	
Yes	12	9	6	55,1%
No	11	3	8	44,9%

5. PERSONALIZING THE COURSE – ADAPTING TO EACH INDIVIDUAL CLASSROOM REQUIREMENTS

The assessment performed and the results obtained from both the evaluation sheet and the questionnaire given, motivated as to start designing a personalized system in order to improve the quality of teaching programming to these students and adapt our methods to their specific needs.

Our goal was to personalize the learning environment for each individual and provide personalized material and exercises for the course of computer studies in high school.

The necessity for a personalized education environment has been pointed out in numerous cases both in the past [4] as well as nowadays [3], [5]. The principal advantage for a personalized approach from a student's perceptive is the ability to create an adapted learning environment with personalized notes and exercises which will guide the student to learn at its' own pace. Therefore, our approach was to firstly design and in a later phase implement, a simple personalized learning environment in order to provide our students an enhanced learning experience. The implementation of our system is still in a premature phase; consequently we present here snippets of the initial design.

In the first phase of our design of this personalized teaching environment, a simple user profile was created for each student. The profile comprised of basic characteristics for each student (name, age, gender) and two other fields (scienceedu and understand). Both of these fields were given with a decimal numeric score (0 to 1) which was obtained from the evaluation phase earlier described. The sciencedu field illustrate the student's tendency to math/science and the understand field our estimate evaluation of the student's understanding of programming.

In the next phase, we are planning to create personalized material and small tests for three categories of computer programming. The material should be carefully chosen to illustrate specific components of programming, for three categories (beginners, intermediate and advanced) and adapt to each student's requirements.

The main idea of this design is to support each student by assessing his/her skills and automatically placing them in one of the three categories. This classification will be based on the evaluation results obtained by the given questionnaire combined with the user profile's numerical fields.

Finally, a simple automated system will be designed and implemented in order to generate and present personalized material according to the age/gender of the student and ranking of the student. The proposed personalized system could initially perform a basic preliminary test for each student. The results obtained could identify potential weakness and errors that a student has and automatically generate the appropriate material which a student should study.

This simple framework is in the process of design and implementation and any further results obtained should be tested in an experimental environment within the classroom.

6. CONCLUSIONS AND FUTURE WORK

Evaluating teaching performance and students' learning behavior and skills are very challenging tasks which require effort and time. The opportunity to teach and assess students' programming skills was given with the "Hour of Code" initiative. In this paper, a brief description of the initiative was given, along with the teaching methodology which was followed.

The evaluation of the students' learning behavior and the interest they expressed, motivated us with the idea to adapt our methodology and teach computer programming according to their specific needs. Therefore, a simple personalized framework is under design and implementation which aim to provide a personalized learning environment for the computer programming education.

The work presented is an ongoing project with a number of open questions and challenging ideas. The framework presented just finished the implementation phase and a number of ongoing questions acquired our attention. The design is simple, but will provide us with enough material to teach for the remainder of the semester.

Therefore, a new framework will encapsulate all those concepts and a design of an adaptive and personalized learning management system will assist instructors of algorithmic and programming courses.

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