A Mobile Programming Course Based on Computational Thinking Process for Elementary IT-Gifted Students

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Abstract: In this research, we examined previous works on Computational Thinking (CT) to identify the essential stages of CT and developed a 6-week programming course with jQuery Mobile that follows the identified CT process. This CT process-oriented programming course aims to help IT-gifted students in the fifth and sixth year of primary school understand the problem solving process. In our mobile programming course, students mostly work with straightforward pre-built widgets and layouts rather than writing many lines of logical codes. After completing the course, feedback from the participated 34 students was gathered online. In their comments, words such as “making my own decisions,” “achievement,” “confidence,” and “more interested in the subject I chose” were commonly found. In addition, some students wrote that the experience of developing a web app that runs on their own smartphones makes them have the ambition to become a professional software developer.

Introduction

The advance of information and communications technology (ICT) and the widespread use of smart devices have brought large scale changes in our lives. In particular, pedagogical paradigms and methods are greatly influenced by today’s technological advancements. Countries are eager to train students and workers with creative and computational thinking to gain a competitive advantage in the global arena and 21st century society, and therefore they have put a lot of effort into integrating computational thinking (CT) into the educational environment. In the United States and UK, the curriculums and training programs are devised to help primary and secondary school students acquire CT skills. In Korea, students gain computer programming skills via a variety of educational programs provided in the public and private sectors.

Wing (2006) and the CSTA Standards Task Force (2011) pointed out that simply learning how to program along with the programming language syntax does not necessarily develop competencies in CT. CT is a problem solving process that encourages students to move toward a more powerful and creative use of ICT. It requires analyzing a large complex task at multiple levels of abstraction and formulating problems in a way that a computer and other tools can be used to help solve them.

In this research, we examined previous works on CT to identify the essential stages in CT process and developed a jQuery Mobile programming course that follows the identified CT process. This CT process-oriented course aims to help IT-gifted students in the fifth and sixth year of primary school build CT-based problem solving abilities. The educational implications of the developed course are discussed from the outcomes of the experiment with a group of students.

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The Study

Computational Thinking and Computational Thinking Process

Wing (2008) explained CT with two A’s. The first A is abstraction and the second A is automation. Wing stated that “Computing is the automation of our abstractions, and consequently CT is choosing the right abstractions and choosing the right computer for the task.” Barr & Stephenson (2011) described CT as “an approach to solving problems in a way that can be implemented with a computer.” Students become not merely tool users but tool builders. They use a set of concepts, such as abstraction, recursion, and iteration, to process and analyze data, and to create real and virtual artifacts. CT is a problem solving methodology that can be automated, transferred and applied across subjects. The CSTA Standards Task Force (2011) argued that “CT is a problem solving methodology that can interweave computer science with all disciplines, providing a distinctive means of analyzing and developing solutions to problems that can be solved computationally.” Further, Isaksen & Treffinger (2005) pointed that today’s creative problem solving framework calls for thoughtful and deliberate choices in which problem solvers select and use the methods and tools that will be most appropriate and helpful for their task.

Synthesizing these previous studies, we found that CT can be considered as a creative problem solving methodology that uses computational methods and tools. By using CT, students are able to learn to think computationally so that they can solve problems creatively and discover new questions that can be explored within and across disciplines. It involves identifying, analyzing and implementing possible solutions with the goal of achieving the most efficient and effective combination of steps and resources.

To incorporate CT into the programming education curriculum, we redefined CT process consisting of the three stages: problem identification and analysis, design and implementation (see Figure 1). In addition, each stage comprises the appropriate CT elements. Firstly the ‘problem identification and analysis’ stage utilizes analysis, representation, problem decomposition and abstraction to recognize and identify problems. Secondly the ‘design’ stage exploits algorithm and model validation to solve identified problems with computing tools and methods. Thirdly the ‘implementation’ stage uses automation and simulation of computing tools like scratch, appinventor, algodoo and etc.

Figure 1: The stages of CT process for the creative problem solving

Mobile Programming Course with jQuery Mobile for Elementary IT-Gifted Students

jQuery Mobile is a cross-platform framework for creating mobile web applications (web apps) accessible on all smartphone, tablet and desktop devices. It is built on top of jQuery, a JavaScript library designed to simplify client-side scripting, so it has a minimal learning curve for students already familiar with jQuery syntax. jQuery Mobile simplifies and enhances the development of mobile web apps by integrating...
HTML5, CSS3, jQuery and jQuery UI into one framework. The framework is compatible with all major mobile platforms as well as all major desktop browsers.

In our 6-week jQuery Mobile course, students learn the basics of jQuery Mobile programming during the first three weeks. During this period, students simultaneously select a problem and analyze it based on the collected information and data. In the last three weeks, the design and implementation of a jQuery Mobile application are carried out. Table 1 presents the plan of the CT process-oriented jQuery Mobile programming course. It is a 6-week course that teaches jQuery Mobile programming, and it took 2 hours per week over the period of May 2013 through June 2013. 34 IT-gifted students in the fifth and sixth year of primary school took part in the experimental course. The students were divided into two smaller groups: one group of 18 students and the other of 16 students.
### Weeks

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**Table 1:** A course plan of the CT process-oriented jQuery Mobile programming

### Experiment

The students had been motivated to be self-directed throughout the entire course. Each of them chose a problem to work on by himself or herself and created the result (i.e., a web app) according to his or her own design. In the identification and analysis of the problem stage, they collected and reviewed various supporting material to perform the abstractions of the problem. In the design stage, the abstractions of the problem were represented into a structured tree, and a storyboard for each element of the tree was created. In the implementation stage, a web app was programmed using jQuery Mobile.

Figure 2, 3 and 4 show an example of the web app created by the student. Figure 2 shows that the student made presentations of his or her idea on the basis of self-directed problem identification and analysis. They used classification and abstraction skills in this stage. Figure 3 explains that the student designed the structure of his or her idea and the hierarchical pages of web apps. In this period, they gave frames and shapes to their abstractive idea of former stage. Figure 4 presents that the student implemented the web app through programming. In this stage the idea of the student was translated into the codes of the jQuery Mobile widgets and HTML5. The QR codes that allow access to the web apps are presented on the right.

**Problem Identification and analysis stage**

![Problem Identification and analysis stage](image)

**Figure 2:** Problem identification and analysis stage
After completing the 6-week course, feedback from the participated 34 students was gathered online. In their comments, words such as “making my own decisions,” “achievement,” “confidence,” and “more interested in the subject I chose” were commonly found. In addition, some students wrote that the experience of developing a web app that runs on their own smartphones makes them have the ambition to become a professional software developer.

Conclusions

The ultimate goal of our CT process-oriented mobile programming course is cultivating students’ problem solving ability as well as increasing their programming knowledge. Dijkstra(1971) pointed that programming is ‘a methodology of constructive reasoning’ applicable to any problem of algorithmic solution. Our experimental programming course allows magnifying the power of human thinking with the capabilities of CT and the computer. Self-directed works required to be performed throughout the stages of the course contribute to increasing students’ confidence and motivation. These are critical factors for successful accomplishments in both academic works and future job careers, and the influence of the CT activities on the dispositions or attitudes of school-age children needs to be investigated further.

In the jQuery Mobile programming course, students mostly work with straightforward pre-built widgets and layouts rather than writing logical codes. That is the reason that children of around 11-12 years old are able to produce web apps with three week’s learning. This work also showed that jQuery Mobile is an effective tool to teach young students basic programming skills. Additionally, it is worth studying other types of classroom practices that exploit jQuery Mobile to strengthen students’ CT ability.
References


