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Research paper

Development of a C Language Education Instructor Training Course Using Animated Characters

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Abstract

The purpose of this study is to develop online lecture contents that can effectively teach C language to 5th, 6th grade or middle school students. Unlike existing cyber lectures, the proposed contents were created by using animated characters to help beginner level students learn C language through interesting storytelling, role playing games, and card games. This C language education contents were developed for teachers to effectively educate elementary and middle school students who are presumed to have no prior knowledge of C language. The proposed contents motivate young learners to learn the introductory concepts of C language through the animated characters based on storytelling, more than using mere focus on rote memorization.

Keywords: *Animated character. coding education, C programming language, storytelling*

1. Introduction

The technologies that will lead the fourth industrial revolution are within the areas of coding and design [1][2]. In 2015, the Korean government established guidelines for software education management aimed at fostering creativity and convergence in talented individuals who possess computing thinking skills. Coding education is now provided as a regular class at the middle school level as of 2018, and will be offered in elementary schools for grades 5 and 6 starting in 2019. The government has been training teachers for coding education since 2015, but there is still a shortage of those who will be responsible for coding education[3][4].

In order to increase the learning effect of young learners, it is important to stimulate and sustain learners' interest in the programming environment. However, the existing teaching methods have been centered on mechanically memorizing programming language syntax and coding techniques, which is likely to reduce the learning motivation and increase difficulties [5]. Recently, various studies have been actively carried out to create an educational environment where programming is easier and more fun to learn [6]. Typical examples are learning methods using visual-based programming languages such as Scratch and NXT-G. Since these programming languages are block-based, they have the advantage that learners can focus more on the problem-solving process without worrying about complicated technical concepts such as syntax, algorithm, flow charts, etc [7].

C language, a text-based, high-level language, is the most widely used programming language to develop various software as well as application software. Teaching and learning fundamentals of C language has been a great challenge to both teachers and learners. In fact, a majority of beginner level learners are reported to experience difficulties when they first learn C language due to its complex concepts, various rules, and flexible application [8]. However, the traditional C language teaching methods have not succeeded in achieving the expected learning outcomes, primarily due to teacher-centered teaching methods that have focused on syntax of C language, mechanical coding activities, and debugging [9]. These teaching methods reduce learners' interest in programming and motivation to learn, and as a result fails to develop the problem analysis ability, logical thinking ability, and procedural problem solving ability necessary for the computational thinking development.

In order to solve these problems, an increasing number of researchers have been adopting learner-centered approaches that reflect the learner's cognitive development stage and preference. Many research results show that the lessons composed of fun factors that can induce the learner's interest have a positive effect on the learner's participation in learning and the improvement of the computational thinking. Recently, functional games, robots, and storytelling have been increasingly incorporated to make C language education fun and easy to teach [10] [11].

Following the trends of the new C language education, this study introduces an online teacher training course developed to facilitate teaching C programming language to fifth, sixth graders and middle school students. This study proposes a C language teaching method that combines animated character elements, storytelling, and game elements in order to create an engaging learning environment which stimulates and sustains learners' motivation to learn C language.

In this paper, we first review the previous research applying animated characters and storytelling in educational contexts, and characteristics of C language. Finally, we present a teaching method that applies animated character-based programming teaching methods as a guide to teach C language easy and fun. The proposed teaching methods can be applied to an actual C programming course to minimize difficulties that learners may expe-

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rience due to complex programming terminology. It is expected to help young beginner learners to immerse themselves in the programming environment and eventually improve C programming skill.

2. Background

2.1. The Effects of Using Characters and Storytelling

The Animated characters used in multimedia education are known to have a positive effect in enhancing the learning effect by promoting the interaction with the learners. Particularly, animated characters appearing in educational games are effective in attracting the attention and improving the satisfaction of young learners. This is due to the competitive structure and rewards offered in the game which increases motivation and achievements of the engaged learners. Subsequently, the educational effects of the learners' involvement in their characters' stories are significant [12] [13].

Traditional learning contents transmit only the content of the event of information. However, storytelling does not simply convey knowledge or information, or take the form of argument, description or description. It describes events, characters, and backgrounds according to the flow of the beginning, the middle, and the end. Therefore, storytelling can facilitate active participation of learners by promoting learning commitment through a rich learning context.

In the educational field, storytelling is used to effectively communicate knowledge and information to learners [14]. Storytelling education can expand the ability to thinking and develop creativity while maximizing the educational effects through entertainment on the social, cultural, and emotional levels due to its interactive features [15]. Young learners tend to be emotionally attracted to stories and become intellectually stimulated when they encounter mysterious stories [16].

In e-learning contents, characters often appear as subjects leading a story. The use of characters in multimedia learning is known to increase the comfort and familiarity of the learning environment, facilitates interaction between learners and computers, and reduces the psychological distance to learning contents. In particular, when a character has an anthropomorphic image, learners tend to actively engage in interaction with the characters [17].

In fact, some websites for coding education have already adopted funny characters to engage learners in coding lessons through increasing intimacy with the characters. For example, Fig. 1 shows the Scratch website developed by MIT presents 'Scratch Cat' as its mascot in order for learners to create their own animations by combining their favorite characters, sounds, movements, dialogue, and images.

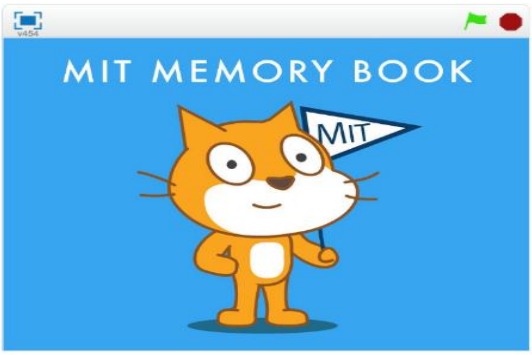

Fig. 1: Scratch Cat, a mascot of Scratch

In a similar manner, 'Star Wars' of Code.org presents the heroes and robots that appear in the film Star Wars. Familiar characters such as Obi Wan, Luke Skywalker, and Princess Lea guide learners to create their own code using Scratch.



Fig. 2: Banner image of 'Star Wars' coding program (https://code.org/starwars)

2.2. Cases of Applying Characters to Coding Education

There have been many attempts to introduce games into coding education. For instance, Nexon Korea signed a business agreement with the Connect Foundation, a non-profit educational institution, to provide intellectual property (IP) rights for the popular PC RPG 'Maple Story'. Through this business agreement, the Connect Foundation, which operates the software education platform 'Entry', hosted an 'Online Coding Party' at an online coding experience/educational event hosted by the Ministry of Education and the Ministry of Science and Technology.

At this event, various coding problems involving sound source and design were presented to pique the interest of attendees. This online coding party was software that consisted of "logic, sequence, repetition, condition, condition deepening". The program was designed to systematically teach basic principles involved in coding and design as participants played it. Participants are engaged in this computer game, moving to a target point, avoiding obstacles and traps, and seeing the appearance of monsters based on the theme of the main characters of Maple story.

In addition, Think Coding, a coding education business of Hanbit Soft (CEO Kim, Yoo-lae), recently completed a testing of 'Think Coding Junior', an elementary school coding education program. The results were favorable with many users expressing satisfaction. Think Coding Junior is a program designed to develop users' coding skills by providing entertaining content in the form of a humorous cartoon. Many of the users also found that the activities in the corresponding textbooks to be interesting with 'Dressing up the snow' and 'Scratch coding' garnering many positive responses. In fact, tester comments included, "I think I'll be good at coding when I'm using Think Coding Junior," and "I think studying will be spontaneous when I play." However, some content was deemed rather complicated during the game based on the level of difficulty, with commenter stating that it would be helpful to have explanations of certain parts of the program [18].

2.3. Advantages and Disadvantages of C Language

C is a basic programming language widely used in both industry and education due to the following advantages [8].

1. It is a program that can write system software such as an operating system, language processing system, editor, and so on.
2. C language is a special language that has both high-level language and low-level language. That is, software and hardware operations can be performed. Therefore, it is located between low-level language that controls system and hardware, and high-level language that is centered on user and software.
3. C language is a general-purpose programming language that can create various applications in word processors, games, and development tools that functions on operating systems as well as hardware-like programs such as operating systems.

Due to these advantages, C language is one of the most widely taught programming languages in universities or in specialized high schools that focus on hardware control in electric, electronic, and computer majors. However, it is difficult for the beginners,

especially for elementary and middle school students, to learn C programming due to its complex concepts, various rules, and flexible application [9]. Therefore, it is necessary to develop teaching methods that can facilitate learning by stimulating and sustaining learners' interest and motivation to learn.

3. Results

This section describes the instructional design and contents of the training course for C programming teachers who teach fifth, sixth graders and middle school students. The goal of the course is to facilitating C language education by introducing fun and easy teaching methods based on animated charters and storytelling. We first present instructional design of the course and then the development and application of the teaching method adopted in the course.

3.1. Instructional Design of the Course

The course consists of 13 classes, each of which is divided into three lessons, a theory-based lecture and two programming practice sessions. The main considerations in planning and designing the course are as follows:

1. Two types of the media type are employed so that the theory-based lecture and program practice sessions are balanced. However, the theoretical lecture is given in the first lesson, and practical exercises are carried out in the second and third lessons so that the students can spend sufficient time on actual programming exercises by applying what they learn in the lecture.
2. The practice sessions are designed in a way that enables learners to repeat practice exercises if they want until they fully understand the contents of the lecture through executing the programs they write.
3. The theory-based lecture is given using the electronic board where highlight function can be activated by using computer graphic subtitles and motion graphic so that learners can grasp the core contents of the lecture at a glance.
4. Practice sessions are conducted through Camtasia, an environment where C-language coding is possible, and the professor runs the program to demonstrate the execution process step by step (Fig. 3).
5. If there is a part to be emphasized during the practice sessions, special effects are applied such as insertion of video clip with the professor's explanations or enlargement of the written part.
6. The learning summary (Fig. 4) presents the main points of the lesson, reminds learners about the program practice screen, and finishes with introducing the contents of next class.



Fig. 3: Screenshot of a practice session

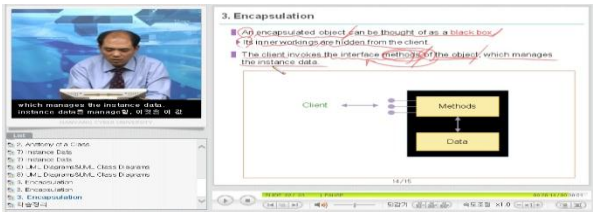

Fig. 4: Screenshot of learning summary

3.2. Creating a Storyline and Animated Characters

This class adopts a game-based digital storytelling structure composed of animated characters to teach C language without paying much attention to the explaining of C program grammar. For example, a very simple program to attain output "Hello!!" on monitor screen in C language is as follows

```
#include <stdio.h>

int main()
{
printf("Hello !!\n");

}
```

Fig 5: Outputs "Hello!!" on monitor screen in C language

Although this program is very basic, it is a time-consuming, difficult task for a teacher to explain the progress of the algorithm to young novice learners who are totally unfamiliar with basic concepts of C language. Without solid understanding of how to analyze and solve problems, students are not expected produce code for this program. Therefore, in order for the students to learn the progress of the algorithm in a fun and easy way, we first set up a storyline and defined the characters, event, and background. The background of the story was set as a battlefield where soldiers perform the mission of printing the word "Hello" according to the king's command.

As a second step, we developed animated characters that play the heroes of the story, and seven animated characters, whose names represent programming terms such as command words or control statements , were created in a form of card (Fig 6 to Fig 11) The basic structure of storytelling employed in the course is similar to the basic programming process of 'input-processing (iteration and branching)-output.' Learners are expected to learn C programming while solving the presented problems or challenges



Fig. 6: Captain of the MP



Fig. 7: A colonel



Fig. 8: stdio.h company



Fig. 9: Main I



Fig. 10: Soldier print



Fig. 11: Soldier start & finish

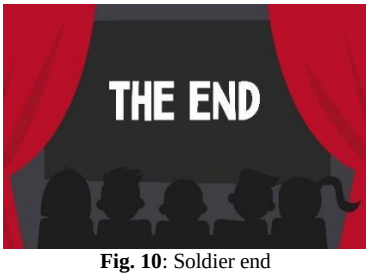

Fig. 10: Soldier end

3.2. A Sample Lesson Using Animated Characters

When the character cards were ready, the cards were distributed to students, and a storyline was presented which shows the progress of the algorithm step by step. The structure of storytelling begins with a teacher's question: What should a teacher do to have students print "Hello" on the screen? and students are requested to answer interactive questions in the following manner. When students move onto the next step, they are supposed to present a card relevant to each step.

1. Make sure that the MP # is in good working order.
2. What should be prepared? Ask.
3. Include a battalion of soldiers. This standard input team must be included.
4. Why should I include standard input companies? Ask.
5. You must include the standard input team in order to feed the soldier in the storytelling game.
6. There must be a soldier of major first class, in the program.
7. You must bring in the long-running ({) and ending (}) that will be responsible for starting and ending the program. Set these two as twins, emphasizing that an error will occur if neither of them is present.
8. Soldiers should include a dip. Emphasize printing the characters in the printer. \
9. Soldier at the end of the sentence (;) indicates the end of a command.

When learners completed programming following the storyline, they were asked to check whether the program was appropriately executed, and if an error message appears, they were asked to repeat the storyline until they succeeded in producing the output "Hello".

4. Conclusion

In this study, we have developed cyber lecture contents that teachers can use to instruct C programming language in easy and fun ways to elementary and middle school students. Since C language is the most advanced programming language for programming education, novice students experience many difficulties when they first learn C language. Existing C language classes tend to have focused on syntax and algorithms rather than problem solving, spending a lot of time on debugging. As a result, many learners lose interests in learning and fail to achieve the expected learning outcome.

The role of the teacher is important to successfully teach C language to young learners. Since most concepts of C programming are abstract, it is difficult for elementary school students to learn these concepts effectively. Therefore, it is important to create a programming environment that stimulates and sustains interest and the motivation. Recent studies have shown that employing fun elements such as functional games, robots, and storytelling is effective in increasing learner's participation in learning, cultivating computational thinking skill and problem solving ability. .

In line with these new trends in C language education, the proposed contents were created by using animated characters to help students learn C language through interesting storytelling, role playing games, and playing cards. These C language education contents were developed for teachers who are already involved with the subject matter to effectively educate elementary and middle school students. We believe the animated characters with storytelling setup can allow teachers to effectively educate students by motivating them to learn the introductory concepts of C language. The teachers need to continuously try to develop the teaching methods that can maximize the learning effect by minimizing the difficulties that the learner experience in the learning process.

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