A Study on the SW Coding Education Method Using Arduino in the Age of Internet of Things

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Abstract. With the advent of the Fourth Industrial Revolution, education suitable for future society is important. In general, the talent required in the future society is a person with problem-solving skills and creativity. In developed countries like the United States, various educational methods are studied to improve these abilities. A typical education is computer software education. In particular, with the development of the Internet of Things, computer coding education using hardware is becoming more and more important. So this paper tries to study the SW coding education method using Arduino, the representative educational hardware. The results of the study are as follows. SW coding education should develop into a problem-solving curriculum. In particular, a curriculum should be developed to solve problems that can be found in our real lives. The results of this study can be basic data for computer software education related to the Internet of Things.

1. Introduction

1.1. Research Background and Purpose
With the recent development of artificial intelligence, interest in proper education in future society is increasing. Many experts argue that creativity is important in the future. To develop this creativity, many researchers study future education methods. In addition, such education will be conducted in public education. So in the United States, software education is important to increase creativity. A representative area of software education is coding education. And many educational institutions are trying to provide coding education. But there are not many teachers who can teach complicated coding class. In addition, students are simply trained in coding skills, and students lack the training to actually connect coding and hardware. And students often lose interest in computer programs easily. Moreover, public educational institutions do not have an environment to handle complex computer programs. To solve this problem, coding education based on open source is drawing attention. Arduino is one of the most popular open sources. Arduino is a free program and has very low material costs. Therefore, schools can provide future coding education at a very low cost. This paper analyzed coding education using Arduino in advanced countries such as the United States. Based on this analysis, this paper tried to present the optimal method of coding education to increase creativity. The results of this study can be used as theoretical basis data in developing future methods of education.

1.2. Literature Review
In the era of the Fourth Industrial Revolution, there is a growing demand for convergent talent that
combines engineering thinking and humanities. Thus, in developed countries, teaching methods are presented in which learners use practical physical hardware coding. In this situation, coding education using Arduino is important. So this paper analyzed the methodology of Internet of Things and coding education using Arduino. First, this paper analyzed the prior research related to coding education using Arduino. Cha Jae Gwan (2017) studied the development of coding education based on Arduino, which was cheaper and generally available for universal using [1]. Kim byung doo (2019) prepared for the fourth industrial revolution in the process of solving the real life problem using the Arduino board and to develop a STEAM education program applicable to after-school science specialty aptitude class in elementary school [2]. Lee Jun Hyeong (2018) designed a physical block coding module capable of education so that learners can concentrate on the programming Computational Thinking skills without regard to the specific environment [3]. Shim Kyu Heon et al. (2014) proposed and evaluated a STEAM curriculum that can draw the interest and attention of students [4]. Kim Hae Jin et al. (2016) studied the effect of the creative problem solving abilities on the middle school students by adopting Arduino, a physical computing device, in the Scratch programming education [5]. Kim Won Woong & Choi Jun Seop (2016) researched Arduino platforms that have been actively applied in the field of educational activities of creative and convergence, and also to design an Actuator Module Based on Arduino so that they can naturally acquire IT (Information Technology) based hardwares and softwares [6]. Heo Gyeong Yong (2019) described the implementation details of FRUTO kit and software to use it, which satisfied the proposed design criteria [7]. Hur Kyeong (2019) proposed and analyzed the evaluation method of the understanding of SW structures and the evaluation problems developed in this course [8]. Most existing papers have been studied on coding education methods used in very difficult computer programs. But it is very difficult for novice learners to study. Therefore, this study presented the Arduino coding education methodology for beginners. And these findings can be used as basic data for future education.

2. Research Method

This paper studied the future education methodology of learning coding through Arduino to students. Based on the research, it aimed to develop textbooks that can be used in public education. This study used the design thinking method which is to improve creativity. First, this study conducted a literature study related to Arduino and SW coding. In the literature study, papers, magazines, and books were reviewed. And this study analyzed the current methods of Internet of Things and SW coding education using Arduino. Then it analyzed the problems of current education. Based on these results, this study presented appropriate SW coding education methods for students who are not familiar with computers. These findings can be the theoretical basis for SW-coding education using Arduino.

3. A Theoretical Study

3.1. Arduino

Arduino is a device that processes and performs human commands, such as a computer (figure 1). It is also a computer platform that anyone can use by combining software and hardware. And Arduino can control the output devices such as motors through switches and sensors. Arduino is a program developed by Italian design schools for students who are not proficient in computers. In particular, students can learn how to express their works through coding, a computer program, by connecting software and hardware. Now, Arduino is an open source, so anyone can use it easily. Also, it is actively used for artificial intelligence education at public educational institutions because of its low price. Arduino can generally develop a variety of products, such as robots and drones. Currently, Arduino is also widely used in the Internet of Things. Devices such as Arduino connect the real world with the computer world [3]. Computers are usually connected to the real world through a mouse or keyboard. However, physical computing, such as Arduino, is a system that connects to the real world through signals such as light, sound, and motion without using a mouse or keyboard. And Arduino has various advantages over other physical computing. First, there are various component parts in Arduino.
These component parts include LEDs, motors, etc [4]. Therefore, these component parts can be used to allow learners to enter various commands. Second, Arduino is connected to the computer via USB and is relatively easy to upload. Third, Arduino can be used in various operating systems such as Android and OS as well as Windows [4].

Figure 1. Fundamental Principles of Arduino [2]

3.2. SW Coding Education

SW coding is the process of ordering computers to solve problems by human logical thinking [5]. To solve these problems, humans need a high-level process of thinking to give computers proper commands through computer language. For this reason, education on computer software has recently become crucial for students. Therefore, in some advanced countries such as the United States, computer software coding classes have been mandatory since elementary school. The coding education is used as a tool to solve current problems. But most coding programs are very difficult for beginners to learn. So computer scientists try to develop simpler programs. One of these programs is block coding. Block coding is a way for beginners to produce results by combining blocks that are already coded, and can also improve problem-solving and creativity for beginners. Currently, the typical block coding is scratch developed by MIT in the United States [3]. Scratch can learn easily without learning a difficult computer language. It helps learners improve computer thinking, not just learning from a technical point of view. In addition, the results of Scratch can be connected to Arduino to implement students’ creative ideas. There is a lot of research on these methods of education.

4. Coding Education Using Arduino

4.1. Current Education Status and Problems

The current coding education is as follows (figure 2). Most of the students are taught separately from coding and physical tools. And after students learn coding, they probably even don’t know how to use coding. Some educational institutions also use difficult programs such as C++ rather than block coding for SW coding education. In doing so, learners are often not interested in computer programs. In order to solve these problems, Arduino has been proposed as a new alternative to coding education. For coding education, it is very important for learners to use Arduino to solve problems. In particular,
learners find problems themselves and solve them using coding and Arduino. Therefore, in order to provide such education, learners should find their own problems in real life and find solutions through coding and Arduino. Therefore, advanced countries are studying various coding education methods using Arduino. However, no specific SW coding education method has been proposed using Arduino [4].

Figure 2. Current Status of SW Coding Education [1]

4.2. Arduino Course
The characteristics of the course are as follows (figure 3). First, students learn by exchanging information with each other through group study. So far, most of the courses have been centered on teachers. However, it is important for students to develop their own problem-solving skills in order to inspire their creativity. So this paper tries to present a course in which students are oriented. This paper also studied in a way that students could develop convergent thinking skills. It is not appropriate for students to learn in a set order in the era of the Fourth Industrial Revolution [4].

Figure 3. Education Program Using Arduino [2]

The coding education courses are as follows. In the first class, teachers explain to students theoretical content such as Arduino and Coding, which is to give students a lecture on the theory. Therefore, students can understand the relationship between Arduino and the Internet of Things. In
addition, teachers give students theoretical knowledge about electronic components such as electrical circuits and Cds. In the second class, teachers use Arduino to show students an example of coding. Through these examples, students can understand the relationship between Arduino and Coding. In this stage, students practice using LED lights through coding (figure 4).

![Electronic Components](image1)

**Figure 4.** Electronic Components [4]

In the third class, students find practical problems around themselves. During this time, students should deal with issues of interest. Also at this stage, students discover problems and make presentations in front of other students. Other students listen to the speaker’s opinions and study how computers can be used in real life. This step is very important. SW coding education is not just about acquiring a computer program language. Through this process, students develop the ability not only to communicate and share with others, but also to identify and solve problems [7]. In the fourth class, students find their own solution to the problem. In this step, students find a solution to the problem that has been decided, and team members can come to a solution through various discussions. Students decide how to code by creating algorithms to solve problems according to the teacher’s guidance. Teachers help students solve problems on their own. In the fifth class, students make models through Arduino. This model is controlled by motors, etc. Students can also adjust the speed of the motor by using scratch coding. Students can also adjust their models through the Bluetooth function. The main module of Arduino is generally used for Arduino Uno. Arduino Uno has 14 digital I/O pins and 6 analog I/O pins [3]. Arduino Uno solves the problem by connecting various sensors. For example, in the case of Arduino light sensors, resistance may vary depending on the amount of light. A sound sensor also takes sound as an electrical signal. Therefore, students solve the problem by combining Anui-no and coding through these various sensors (figure 5).

![Arduino Uno](image2)

**Figure 5.** Arduino Uno [4]
In the sixth class, students present solutions. Students make presentations in front of other students on the process of solving problems. And other students can exchange ideas by asking the presenter questions. This course could be used as a regular curriculum in schools.

5. Effect and Development Direction of Arduino

Students will solve problems and can develop scientific thinking and creative imagination on their own through this curriculum that is based on self-motivated problem-solving. And teachers should help students solve problems on their own. Therefore, the process of coding education is more important than the result. In addition, education using Arduino is expected to give students fun and interest in computers.

6. Conclusion

With the development of the Internet of Things, education on computer programs using Arduino is becoming important. So in this study, it is about computer program training using Arduino, a representative educational hardware. The Arduino course in this paper presented a class centered on students. It also studied in a way that students could develop their convergent thinking skills. The result of this study will be theoretical basic data in computer program education using Arduino. In subsequent studies, the results of this study need to be applied to educational institutions in substance. The effectiveness of the results of this study should also be verified through statistical methods.

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