

A Study on the Development of Student Evaluation Standards for Unplugged Computing

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Abstract

With the development of information and communication technology, information literacy and utilization are emerging as basic skills necessary for modern people. Accordingly, information education is becoming a basic literacy education for a nation. Unplugged computing is in the spotlight as a major educational method of information education. The main advantage of unplugged computing is that it is easy to convey basic theories or principles of computer science to students through play activities without the help of special information devices such as computers and tablet PCs. However, studies on student evaluation on unplugged computing have been very insufficient. In this study, students' evaluation standards are developed to maximize the educational effect of unplugged computing. The evaluation standards consist of four areas: participation, interest, satisfaction, and understanding of concepts. The results of this study can be used as a basic study for student evaluation of unplugged computing in the future.

Keywords: *Unplugged Computing, Student Evaluation, Information Education, Education Standard, Educational Model*

1. Introduction

The development of information and communication technology is deepening the dependence on information and communication technology in the daily lives of modern people. In modern people's daily lives, the use of information devices such as smartphones and PCs is increasing day by day, and dependence on these devices is also increasing day by day. Therefore, knowledge and utilization of information is now becoming an essential ability for all modern people. The need to educate such information literacy and utilization ability early is increasing, and the need to expand information education is increasing day by day.

Various educational methods are being developed to effectively conduct information education, and in particular, unplugged computing is in the spotlight. Unplugged computing is a method of educating the main principles or theories of computer science through play activities without the help of information devices such as computers [1]. Unplugged computing has the advantage of being able to easily teach the concept of computer science that is difficult for students to understand through play activities without special tools. Unplugged computing is widely used as a major educational method of information education in various fields such as

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early childhood education, elementary and secondary education, and gifted education [2-6].

Unplugged computing is becoming a major means of information education along with physical computing education. In particular, according to the Software Education Operation Guidelines published in 2015, unplugged computing is currently recommended to be used as a major educational method of information education. Unplugged computing can be operated in a wide variety of ways in the actual educational field because it conveys the main theories or concepts of computation through play activities without using special devices. In other words, the same computer science theory can be expressed as a wide variety of play activities. Therefore, evaluation of unplugged computing is very important. In other words, it is very important to measure whether unplugged computing effectively achieves educational goals.

Unplugged computing is currently in the spotlight, but research on evaluation is very poor. In particular, there are few research works on student evaluation of unplugged computing. Therefore, this study proposes student evaluation standards for unplugged computing. In particular, this study proposes detailed evaluation standards from various perspectives on unplugged computing: participation, interest, satisfaction, and understanding of concepts.

The organization of this paper is as follows. Section 2 introduces the origin and design principles of unplugged computing. Section 3 presents student evaluation standards for unplugged computing. The last section describes the conclusions of this study and future research works.

2. Related Works

2.1. The Origin and Design Principles of Unplugged Computing

Unplugged in computer science began in the mid-1990s, led by Tim Bell, Mike Fellows, and Ian Witten in New Zealand. Unplugged computing plays a very effective role in conveying the basic principles and theories of computer science easily and without boredom through play activities. Currently, it is widely used in New Zealand and Korea, as well as the United States, Sweden, Japan, Australia, China, and Canada [7].

According to [8], there are 10 design principles for unplugged activities.

① No Computers Required

The first principle of unplugged activity is not to use computers. In other words, the main goal of unplugged computing is not to use computers while learning the principles and concepts of computation.

② Real Computer Science

Unplugged computing activities allow students to acquire algorithms, data structures, databases, and software engineering, which are basic concepts of computer science, through various activities. In other words, the unplugged computing is to understand various concepts of computer science, and the activity itself should include the main concepts of computer science.

③ Learning by doing

Learning by doing is based on progressive education. In other words, it is an educational activity based on constructivism in that learners can learn and acquire new knowledge or concepts by voluntarily participating in active activities with a sense of purpose, and students discover and acquire the principles and concepts of computer science on their own.

④ Fun

Unplugged activities should keep the necessary rules and principles by learning the concept of computer

science through various games and activities, gain fun through games, and make people feel a sense of accomplishment in activities. In other words, students should be given a spirit of challenge and competition, and a sense of accomplishment should be sufficiently provided in the process of solving problems.

⑤ No specialized equipment

The devices or materials used in unplugged activities can be various objects used in our lives. In other words, we do not use computers, and we can organize activities using items that can be easily obtained in our daily lives.

⑥ Variations encouraged

Unplugged activities can be developed creatively, and open thinking is respected to enable change and expansion for previously developed activities.

⑦ For everyone

Unplugged computing activities are applicable to all ages. In other words, in order to easily teach the principles of computer science, it can be used extensively from elementary school students to the elderly regardless of age. In addition, it is not subordinate to a specific country, culture, society, religion, or region, and can be used in various ways.

⑧ Co-operative

The main method of unplugged activity is cooperative activity. In other words, rather than solving the problem on their own, they solve the problem through various cooperative work with their colleagues, and discover the principles of computational science contained in it through various discussions and information sharing.

⑨ Stand-alone activities

The main goal of the unplugged computing activity is to acquire the concept of computer science inherent in the activity while performing activities that contain the basic concepts or principles of computer science. Therefore, individual activities should be able to be carried out, including one computer science principle.

⑩ Resilient

Unplugged computing focuses on activities that can convey the concepts or principles of computer science and is not focused on memorizing, so it is difficult to express all detailed and difficult steps. Therefore, even if there is a possibility of small mistakes or misconceptions, if it does not interfere with understanding the principles of computer science, it should be able to exercise acceptable resilience.

2.2. The Previous Works

There are very few existing studies on unplugged computing [7,9]. In this paper, the student evaluation standards of unplugged computing presented in [7] are introduced.

The following Table 1 is the student evaluation standards introduced in [7]. It has 10 evaluation standards as follows. The 10 evaluation standards are computer, interest, computer science theory, student participation, independent activity, experience study, open to everyone, background, safety and report, respectively. The proposed evaluation standards were developed according to the 10 general design principles of unplugged computing introduced before.

Table 1. Student evaluation standards

Evaluation Standard	Description
Computer	Are computers (including laptops, tablet PCs, or other electronic devices) required for activities?
Interest	Do activities interest students?
Computer Science Theory	Does activity provide students with the principles or theories of computer science?
Student Participation	Does the activity require the participation of all students?
Independent Activity	Does activity represent an independent computer science theory?
Experience Study	Do students learn through experience?
Open to Everyone	Can everyone participate in the activity?
Background	Does the activity require special academic background knowledge or completion of the prerequisite course?
Safety	Is activity safe?
Report	Should students submit reports as a result of the activity?

3. The Development of Student Evaluation Standards

This section introduces new evaluation standards for student evaluation in an unplugged computing environment. In this study, more comprehensive and detailed standards were developed based on the previously introduced studies.

The student evaluation standards are first composed of four areas. That is, it consists of participation, interest, satisfaction, and understanding of concepts, respectively. In the area of participation, it is evaluated whether anyone can easily participate. In other words, it evaluates whether there is a barrier to participation by evaluating whether cost, effort, or background knowledge is necessary to participate. The second area, the interest area, evaluates whether play activities induce interest in students participating. In other words, it tests whether participating students can actively participate without passive participation and also evaluates whether everyone can participate interestingly. In the third satisfaction area, the satisfaction is evaluated during or after the activity. In other words, it evaluates whether the activity was too difficult or too simple, and evaluates whether the activity was unsafe or required too much physical strength or waiting. Finally, the understanding of concepts area evaluates whether or not a student has a sufficient understanding of computer science theory and the ability to apply it through activities.

The following Table 2 introduces detailed evaluation standard for the area of participation. The participation area has 4 detailed standards. This area evaluates what restrictions students had in participating in unplugged computing.

Table 2. Evaluation standards of participation area

Area	Description
Participation	Do participants need special background knowledge?
	Is there a limit to participation according to gender or age?
	Do participants need special devices that are expensive or not readily available in their daily life to participate?
	Does the activity include discriminatory content that causes regional or ethnic conflict?

Table 3 shows detailed evaluation standard for the area of interest. This area has 4 detailed standards. This area evaluates whether the play activities of unplugged computing have provided sufficient interest for students to learn.

Table 3. Evaluation standards of interest area

Area	Description
Interest	Has the participants been provided with sufficient introductory materials for play activities?
	Has the participants been given sufficient time to prepare themselves to understand the play activities?
	Did the participants understand the play activities easily and sufficiently?
	Can participants easily carry out play activities?

Table 4 shows detailed evaluation standard for the area of satisfaction. This area has 4 detailed standards as follows. This area evaluates whether students feel satisfaction from various perspectives in unplugged activities.

Table 4. Evaluation standards of satisfaction area

Area	Description
Satisfaction	Did participants safely carry out their play activities without injury?
	Did the participants participate and carry out all the play activities fairly?
	Did the participants complete their play activities at the scheduled time?
	Were participants able to express their discomfort during the activity?

Table 5 shows detailed evaluation standard for the area of ‘understanding of concepts.’ This area has 4 detailed standards. This area evaluates whether students have fully understood and acquired the concepts or principles of computer science to be conveyed through unplugged activities.

Table 5. Evaluation standards of understanding of concepts area

Area	Description
Understanding of Concepts	Did the participants fully understand the computer science theory or principle suggested through the play activity?
	Did the participants submit a report or a brief summary as a result of the play activity?
	Did participants have an opportunity to discuss the meaning or consequences of play activities?
	Can participants apply the concept of play activities

4. Conclusions and Further Research Issues

Unplugged computing is currently in the spotlight as an important educational method of information education, and is widely used in special fields such as gifted education as well as public education such as elementary and secondary education. The advantage of unplugged computing activities is that can easily learn various principles or theories of computer science through play activities without the help or need of special equipment. Meanwhile, unplugged computing has some limitations. For example, it can be very difficult to convert play activities for the difficult theory of computer science.

While unplugged computing is widely used day by day, evaluation studies on unplugged computing are poor, especially for student evaluation. Therefore, in this study, the student evaluation standards for unplugged computing are developed. As for the evaluation standards proposed in this study, a total of 16 detailed criteria are developed in terms of four areas: participation, interest, satisfaction, and understanding of concepts.

The results of this study are expected to be widely used in the evaluation of unplugged computing in the future. Currently, information education is developing in the form of artificial intelligence education. It is expected that the student evaluation standards of unplugged computing proposed in this study can be applied to future AI service impact assessment [10].

On the other hand, the results of this study are conceptual research results that have not been evaluated by experts or teachers, and the future research task is to establish more sophisticated evaluation standards through expert surveys.

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