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DOI: 10.53704/fujnas.v7i2.232

A publication of College of Natural and Applied Sciences, Fountain University, Osogbo, Nigeria.

Journalhomepage:www.fountainjournals.com

ISSN:2354-337X(Online),2350-1863(Print)

Assessment of Students' Comprehension of Binary Concept Using Computer-Science-Unplugged-Method in a Selected Secondary School in Ilorin, Kwara State

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Abstract

Computer-Science-Unplugged (C-S-Unplugged) is a method of teaching Computer Science in an interesting, engaging and entertaining way through collection of free learning activities without using a computer. Lack of computer facilities, inadequate computer systems and epileptic power supply in Nigerian Secondary Schools have deprived students of practical and hands-on activities. The C-S-Unplugged method can be used to teach computer studies concepts without using a computer. This study focused on assessment of students' comprehension of Binary concept using the computer-science-unplugged approach in a selected Secondary School in Ilorin, Kwara State. The study investigated the students' comprehension level of Binary concept using the C-S-Unplugged method performance test and determined students' Self-Assessment of their learning with it. The researchers demonstrated the use of this method with the teaching of the Binary concept by engaging students in class activities to ensure that they understand the concept of this method and assess their comprehension level before attempting the survey. The study adopted a mixed method design, which comprised of one-short case pre-experimental design and descriptive research design of survey type. Fifteen Senior Secondary School One students were purposively selected as an intact class from the selected school. Mean, standard deviation and percentage values were used to answer the research questions, while t-test with value of 1.04 was used to test the only hypothesis: Ho1. There was no significant difference between male and female students' self-assessment of learning with C-S-Unplugged method at 0.05 level of significance. These implied that students comprehended the Binary concept using this method and had a positive assessment of their learning with it. There were no gender differences on the students' self-assessment using Statistical Product and Service Solution. It was recommended, among others, that secondary school teachers should employ the C-S-Unplugged method since the students enjoyed learning with it.

Keywords: *Game-based learning, C-S-Unplugged method, Binary Concept, Computer studies,*

Introduction

The C-S-Unplugged takes an unusual approach of exposing students to the great ideas of computer science without using computers. It provides a mechanism for educators to exchange ideas,

including teaching methods and ways to integrate problem-solving activities into the curriculum.

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Among the principles of *C-S-Unplugged* is to engage students in fun and captivating activities, use domestic and inexpensive materials to improvise learning. It also motivates students through a sense of creative story to capture their interest and engage students in inquiry-based computational thinking (Adedokun-Shittu et al., 2016).

Many students hold incorrect ideas and negative attitudes about computer science (CS). To address these difficulties, a series of learning activities called *Computer-Science-Unplugged* was developed (Bell et al., 2009). These activities expose young people to central concepts in CS in an entertaining way without requiring a computer. The *C-S-Unplugged* activities have become more and more popular among CS educators, and several activities are recommended in the curriculum for Secondary schools. *C-S-Unplugged* is used worldwide and has been translated into many languages. The unplugged goal is to develop a community that can share good teaching practices and novel ideas that builds on the key idea of enabling students to explore computer science without learning program first.

C-S-Unplugged has varieties of formats which are video demonstrations, pictorial representations and flipped classroom style. Some of the concepts that have been taught through unplugged activities include deadlock and routing, network sorting, a binary representation, logic gates, error detection and a host of others (Bell et al., 2009).

The number of high-school and college students choosing to study computer science (CS) has shown some increase in recent years after many years of low enrolments. Nevertheless, it is important to continue to encourage students to study CS. Many students have incorrect ideas and negative attitudes about the field, which is perceived to be boring and tedious, requiring workers to spend many hours in front of the computer. To address these difficulties, a set of 24 activities called *Computer Science Unplugged* was developed by Tim Bell and his colleagues at the University of Canterbury in New Zealand. These activities are intended to expose young people and students (from elementary school to college) to central concepts in computer science in an entertaining and challenging way without the use of a computer. The main goal of *CS Unplugged* is to

attract students to study CS in high school and college.

The *C-S-Unplugged* contains activities on various topics in CS, such as how computers store information (the binary system and the representation of pictures as pixels), and algorithms (searching and sorting). Other interesting topics include cryptography and networks. The *C-S-Unplugged* activities demonstrate the above topics using games, magic tricks, and other entertaining methods that require only the simplest equipment, primarily worksheets. The *C-S-Unplugged* activities have become more and more popular among teachers (Bell et al., 2009). In addition, several CS Unplugged activities are recommended in the curriculum for elementary schools (Tucker et al. 2006). Initially, *C-S-Unplugged* was intended for outreach to the general public, but in some countries it is starting to be introduced into schools. *C-S-Unplugged* is used worldwide and has been translated into many languages (Bell et al., 2008).

The primary objective of the *C-S-Unplugged* is to change students' attitudes and intentions regarding CS so that they will find it interesting and will choose to study it (Bell et al. 2009). Specifically, the aims of the activities are to change students' views of the nature of CS, so that students will have a rough idea of what CS is (e.g., understand that important concepts of CS do not focus on the computer, CS is more than programming, and that CS requires a mathematical way of thinking); promote the view that CS may be a career for women also; change students' views about work in CS. The activities are expected to help students make an informed career choice (e.g., to view work in CS as cooperative, and to understand that the work in CS is more than "fixing computers"). Little research has been conducted on the implementation of *C-S-Unplugged* methods in schools. The effect of computer science concepts was examined in three activities (only one was a *C-S-Unplugged* activity) on fourth-grade students' interest in CS and mathematics, their confidence in mathematics, and their perceived cognitive skills. The researchers found that after participating in the activities, the students were more interested in CS, had higher perceived cognitive skills, and were more confident about computer studies.

Nishida et al. (2009) reported on middle- and high-school students who studied the C-S-Unplugged activities in Japan. They concluded that C-S-Unplugged enhanced students' motivation, thinking abilities and imagination. The program was introduced into a middle school, in order to increase students' interest in CS, some activities taught students how to learn by gamification, and some were the C-S-Unplugged activities. The researchers concluded that there was an improvement in the students' interest in CS. Taub (2009) taught 10 C-S-Unplugged activities over two semesters in a local high school. They checked the effect of the activities on students' interest in CS as well as on their understanding of what CS is, in general, and of specific concepts taught in the activities. The researchers report on no positive effect gained by the activities, either on the students' attitudes towards CS or on their perceived content understanding.

Taub (2009) reported that, following the participation in the C-S-Unplugged activities, students generally understood what CS is all about, but still thought that the computer is the essence of CS. He specifically checked five dimensions of views on what CS is. These five dimensions were reported as either views students hold on what CS is about, or as views experts hold on what CS is about. These dimensions are (a) CS as problem-solving, (b) CS as programming, (c) CS as how the computer works, (d) CS as fixing technical problems, and (e) CS as using the computer. The latter four dimensions put the computer in the centre of CS, while the first dimension emphasizes the aspect of problem-solving and considers the computer as a tool (although the second category, programming, also has important aspects of problem-solving, the main focus is the solutions on the computer. This is in contrast to the first category, problem solving, which does not focus on the computer at all.

Methodology

The study adopted a mixed method design which comprised of one-short case pre-experimental design and descriptive research design of survey type with two sets of self-designed instruments to elicit responses from the participants on their

comprehension level and self-assessment of their learning with the C-S-Unplugged method. The C-S-Unplugged Performance Test (CSUPT) was designed to gather information on students' comprehension level of binary concept using the C-S-Unplugged with its marking guide and also, the researcher-designed questionnaire was designed to gather information on students' self-assessment of their learning with C-S-Unplugged Method with response mode of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). Purposive sampling techniques was used to select a sample school and 15 participants were met in the class and actively engaged in the study, hence the reason for the use of the intact class. Most of the secondary schools in Ilorin take computer studies as a subject because it is part of their curriculum and they learn using traditional methods, but they have not been exposed to the C-S-Unplugged method. Among these secondary schools is a secondary school purposively selected for this study. The samples were drawn from the students offering computer studies and students from the senior secondary class one, since the topic chosen for the C-S-Unplugged (Binary Concept) is for upper basic curriculum. Data gathered from the instruments were coded on Excel spreadsheet; the analysis and interpretation of data obtained were subjected to descriptive statistics through the use of IBM Statistical Package for Social Sciences (SPSS) version 20.0 software.

Results

Research Question One: What are the students' comprehension level of binary concept using C-S-Unplugged method achievement test?

Table 1 showed the students' comprehension level of binary concept using the C-S-Unplugged method achievement test. Item 1 revealed that the students' comprehension level of binary concept using the C-S-Unplugged method achievement test was high with percentage score of 87.5%. Item 2 with a percentage score of 96.875% showed that the students' comprehension level of binary concept using the C-S-Unplugged method achievement test was high.

Table 1: Respondents' Comprehension Level of Binary Concept Using C-S-Unplugged Method Performance Test

S/NO	Students' ID	Scores (32)	Percentage	Level
1	A001	28	87.5	High
2	A002	31	96.875	High
3	A003	27	84.375	High
4	A004	31	96.875	High
5	A005	26	81.25	High
6	A006	28	87.5	High
7	A007	27	84.375	High
8	A008	32	100	High
9	A009	30	93.75	High
10	A010	26	81.25	High
11	A011	25	78.125	High
12	A012	30	93.75	High
13	A013	24	75	High
14	A014	32	100	High
15	A015	29	90.625	High

Item 3 also revealed that the students' comprehension level of binary concept using the C-S-Unplugged method achievement test was high with a percentage score of 84.375%. It could be deduced from the item 4 that the comprehension level of the students was high with the percentage score of 96.875. Also 81.25% percentage score on item 5 indicated that the level of comprehension of the student was high. It has been indicated on item 6 that the students' comprehension level was high with 87.5% percentage score. Item 7 showed that 84.375% score is an indication that the students' comprehension level was high. Item 8 also revealed that there was high-level comprehension of student on C-S-Unplugged achievement test with a percentage score of 100%. Item 9 discovered that the student comprehension level was high with percentage of 93.75% percentage score.

It was also revealed from item 10 that 81.25% score was an indication that the student's comprehension level was high. Item 11 revealed the fact that the comprehension level of the student on binary concept using the C-S-Unplugged achievement test was high with a percentage score of 78.125%. Item 12 with

93.75% percentage score was an indication that the student's comprehension level of binary concept was high. It was discovered from item 13 that 75% percent score was also an indication that the student's comprehension level was high. Item 14 revealed that student's comprehension level was high with percentage score of 100%. It was discovered from item 15 that 90.625% percentage score was an indication that student's comprehension of binary concept using the C-S-Unplugged method achievement test was high.

Therefore considering the ranges mentioned above, the result showed that students' comprehension level of binary concept using the C-S-Unplugged method achievement test was high since the percentage scores of all student were within 71% and above benchmark and overall percentage score was 83.125%.

Research Question Two: What are the Students' Self-Assessment of their Learning with the C-S-Unplugged method?

Table 2 showed student's self-assessment of their learning with C-S-Unplugged method, using a benchmark of 2.5 of a 4 point likert scale. It was revealed from item 5 with the highest mean score of 3.93 that the C-S-Unplugged highly increased students' thinking ability. Item 19 showed that the C-S-Unplugged method make students to be innovative with the lowest mean score of 3.2. It could be observed from item 8 that the C-S-Unplugged method helps in relating the binary number to the real life application with the average mean score of 3.53. It was also revealed from item 9 with another average mean score of 3.53 that the C-S-Unplugged increased the students' productivity.

Therefore, using a bench mark of 2.5, the result showed that the students enjoyed learning with the C-S-Unplugged method since the grand mean of 3.65 was greater than 2.5 benchmark. Hence, this implies that the students' self-assessment of their learning with the C-S-Unplugged method was positive.

Table 2: Mean and Standard Deviation of Students' Self-Assessment of their Learning with the C-S-Unplugged

S/N	Students' Self-Assessment of their Learning with C-S-Unplugged	Mean	Std. Deviation
1	C-S-Unplugged makes learning permanent in memory	3.47	.516
2	C-S-Unplugged helps to have a good retention of the binary concept.	3.8	.414
3	C-S-Unplugged helps in relating binary concept to different field	3.67	.488
4	C-S-Unplugged makes learning real and concrete	3.6	.632
5	C-S-Unplugged increases thinking ability	3.93	.258
6	C-S-Unplugged makes room for creativity	3.73	.594
7	C-S-Unplugged helps in better understanding of binary number	3.87	.352
8	C-S-Unplugged helps in relating the binary number to the real life application	3.53	.640
9	C-S-Unplugged increases students productivity	3.6	.632
10	C-S-Unplugged influences performance in academic	3.33	.724
11	C-S-Unplugged makes learning properly assimilated	3.47	.640
12	C-S-Unplugged makes learning easily imbibed	3.53	.640
13	C-S-Unplugged encourages learning collaboration	3.67	.488
14	C-S-Unplugged encourages students critical thinking	3.93	.258
15	C-S-Unplugged promotes interaction among students	3.73	.458
16	C-S-Unplugged develops problem-solving skills in students	3.87	.352
17	C-S-Unplugged encourages knowledge application	3.73	.458
18	C-S-Unplugged encourages team spirit	3.87	.352
19	C-S-Unplugged makes students to be innovative	3.2	.676
20	C-S-Unplugged increases students' computational thinking	3.6	.507
Grand Mean 3.65			

From Table 3, it can be deduced that there was no significant difference between male and female students' self-assessment of their learning with C-S-Unplugged method. This was reflected in the result of the hypothesis tested: $t(15) = 1.04$, $p = 0.316 > 0.05$. Thus, the hypothesis was not rejected. This means that the hypothesis which stated that "there was no significant difference between male and female students' self-assessment of their learning with C-S-Unplugged method" was not rejected.

Discussion

The findings of the study revealed that the students were able to comprehend the binary concept using the C-S-Unplugged method. It was revealed from the findings that the nature of the C-S-Unplugged method which involved students' engagement and exposure of the students to different concepts in entertaining ways assisted the students to have high comprehension level of the binary concept. Students were able to comprehend the binary concept through

Table 3: T-test Analysis of Significant Difference between Male and Female Students' Self-Assessment of their Learning with C-S-Unplugged Method

Gender	No	X	SD	df	T	Sig. (2-tailed)	Remarks
Male	7	3.74	0.14	13	1.042	0.316	Not rejected
Female	8	3.59	0.35				
Total	15						

the use of the C-S-Unplugged method because the method involved students' engagement and encouraged students' collaboration. This finding is in line with that of Wing (2006) who observed that one of the approaches to introduce students to a concept in computer science and computational thinking is the use of games and computational thinking concepts in an entertaining way. The belief is that games and entertaining ways of teaching will motivate the students to broaden participation and comprehension in computer science courses and careers. It simultaneously instilled an understanding of the targeted concepts and promote students' interest in computing.

The findings of the study revealed that the students' self-assessment of their learning with the C-S-Unplugged method were positive based on the grand mean value of the result. It was gathered that majority of the students enjoyed learning with the C-S-Unplugged method. It was reported that the learners learned better with the innovation of the C-S-Unplugged. It was observed from the students' assessment that the students enjoyed learning with the method of C-S-Unplugged. Students have found the C-S-Unplugged method to be a more attractive tool for learning computer science. The students felt more comfortable learning with the innovation of C-S-Unplugged approach, irrespective of their gender affiliation.

Conclusions and Implications

This research examined the students' comprehension of binary concept using the C-S-Unplugged method in the selected secondary school in Ilorin, Kwara State. The C-S-Unplugged is a method of teaching Computer Science in an interesting, students' engaging and entertaining way without using a computer. The results obtained from the data collected and analyzed in this study indicated that C-S-Unplugged method assisted the

students to comprehend the binary concept in computer studies curriculum better. The study showed that majority of the students performed excellently in the C-S-Unplugged method performance test. All the students enjoyed learning with the C-S-Unplugged method. The conclusion therefore is that, both male and female students had positive self-assessment of their learning with C-S-Unplugged method.

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