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

Kehinde Muritala Nuhu, Nafisat A. Adedokun-Shittu, Caleb Asiyanbola, Adedeji Hammed Ajani*

Department of Educational Technology, Faculty of Education, University of Ilorin, Nigeria
Correspondence: E-mail: nuhu.km@unilorin.edu.ng

ABSTRACTS

Computer Science (CS) Unplugged is a method of teaching for introducing non-specialists to concepts of CS through hands-on activities that do not require the use of a computer. Often the deeper concepts of CS have been considered as being too difficult for secondary school students in Nigeria. CS Unplugged methods have been used successfully with students of a wide range of ages in foreign countries. In this regard, it is germane to investigate if students can apply the activities of CS Unplugged to a real-life situation in Nigeria using the binary concept. Thus, we need to investigate students' application level of binary concepts using CS Unplugged in secondary schools. The study adopted a one-short case pre-experimental design with an intact class of 15 Senior Secondary School One (SS I) students. The result revealed that students were able to apply the binary concept in a real-life situation with no gender difference established. The findings thus implied that if CS concepts are taught using the CS-Unplugged approach, students would be able to apply computer science concepts to real-life situations thereby imbibing their problem-solving skills. It was thus recommended among others that secondary school teachers should make use of the CS Unplugged method since it exposes students to activity-based learning and it makes them relate the activities to a real-life situation.

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1. INTRODUCTION

The term "Computer Science" (CS) has become widely used in recent years as the skills associated with the subject have become crucial to developing innovative digital technology, and qualifications in this area are highly sought after. The CS Unplugged activities are intended to allow learners to learn by doing. CS Unplugged is an unusual approach that targets exposing students to the great ideas of learning computer science without using computers. The primary goal of the Unplugged project is to promote Computer Science (and computing in general) to young people as an interesting, engaging, and intellectually stimulating discipline.

The facilitators of CS Unplugged are interested in capturing learners' imagination and addressing varying misconceptions about computer science. This concept helps to develop the computational thinking skills in primary school pupils, secondary school students to tertiary institution learners. It also bridges the technological gap between the tech-privileged and non-privileged; the information-rich and information-poor; industrialized countries and the developing world. CS Unplugged has varieties of formats which are video demonstrations, pictorial representations, and flipped classroom style. Many concepts in computer science have been taught through the CS Unplugged activities which include deadlock and routing, network sorting, binary representation, logic gates, error detection, and a host of others that have made learning real.

Learners can learn through personal actions and experience and start developing their ideas about the world on their own. They interpret things according to their thoughts and familiarities. Activity-based teaching method helps students construct their knowledge. "A child best learns to swim by getting into water; likewise, a child best learns science by doing science". Doing science is not only limited to reading or hearing but it holds students in laboratory work to test ideas and develop an understanding. Hence, a science-teaching plan is incomplete without science experiences and hands-on activities.

Dianne stated that "gone are the days when students learn the ways or approach, they have been taught but rather they should be taught the way they learn". This statement supports the activities of the CS Unplugged platform which was designed to expose students to computer science concepts through engaging games and puzzles that use cards, string, crayons, and lots of running around. More so, it involves activities-based learning which makes students learn by doing to have hands-on activities. The hands-on activities are a kind of learning that makes learning to be real and not learning in abstraction. It provides a mechanism for educators to exchange ideas, including teaching methods and ways to integrate problem-solving activities into the curriculum. Principles of CS Unplugged involve students' engagement in a fun and captivating activities, using 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.

Shah and Rahat (2014) opined that the Activity-based learning method generates an ideal situation for science students, especially at the secondary school level. In a situation whereby teachers' activity-based teaching methods, learners are involved actively in hands-on minds-on experiences and acquire an opportunity to relate intangible concepts and theories with actual observations. Activity-based teaching method helps learners to understand the scientific concepts. Students' active involvement in the teaching-learning process and activities help them in the application of scientific knowledge in various real-life situations. If a learner is provided the opportunity to think and solve the problems on their own then the learning becomes long-lasting. The important features of activity-based teaching are that it is

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learner-centered and it encourages self-learning. It also allows the learner to study according to his / her ability and skills. This invariably supports students' centered learning.

Student-Centered Learning refers to a wide variety of educational programs, learning experiences, instructional approaches, and academic support strategies that are intended to address the distinct learning needs, interests, aspirations, or cultural backgrounds of individual students and groups of students (Reeve, 2013). Some researchers reported on their study on middle- and high-school students who studied the CS Unplugged activities in Japan. They concluded that CS Unplugged enhanced students' motivation, thinking abilities, applicability, and imagination.

The program was introduced into a middle school, to increase the interest students show in CS, some activities taught how to program with Alice, and some were the CS Unplugged activities. The researchers concluded that there was an improvement in the students' interest in CS because it was based on student-centered learning. CS 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, binary representation, logic gates, error detection, and a host of others.

CS 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 CS Unplugged activities demonstrate the above topics using games, magic tricks, and other entertaining methods that require only the simplest equipment, primarily worksheets. The CS Unplugged activities have become more and more popular among teachers. In addition, several CS Unplugged activities are recommended in the curriculum for elementary schools.

CS Unplugged pupils do not usually experience anxiety or boredom since they perceived the activities as educational, which in turn improves their academic achievement. Moreover, this skill is important for academic achievement in basic programming. These results suggest that students can improve their academic achievement and maintain the level of skills acquisition across Unplugged activities (Polat & Yilmaz, 2022). Initially, CS Unplugged was intended for outreach to the general public, but in some countries, it is starting to be introduced into schools. CS Unplugged is used worldwide and has been translated into many languages. Recent reports paint a bleak picture of K-12 computer science education. States have few standards focused on the conceptual facets that underpin computer science (e.g., an understanding of algorithms), but instead emphasize lower-level skill-based concepts (e.g., using technology in other learning activities).

Moreover, what sets computational thinking apart is its applicability across all disciplines. It is a unifying principle with ties not only to computer science but also to all disciplines from the sciences to the humanities. Computational thinking goes beyond computer literacy, which is the efficient use of technology, and also beyond fluency, which is focused on skills that enable to use of technology. Computational thinking includes analytical skills that enhance how one approaches a problem and an appreciation for how computing can augment a person's abilities and enhance efficiency. Although computational thinking was quick to catch on in the computer science education community, most current definitions of computational thinking are vague and lacking in detail and examples.

One approach to introducing students to concepts in computer science and computational thinking is the use of games and robots to introduce computer science and computational thinking concepts. The belief is that games and robots will motivate students to broaden

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participation in computer science courses and careers, for they simultaneously instil an understanding of the targeted concepts and promote student interest in computing.

Computer Science Unplugged is a compilation of free activities to introduce students of all ages to the central concepts in computer science without the use of a computer. One of the primary aims is to demonstrate to students that computer science is more than programming. A curriculum kit of Computer Science Unplugged materials is offered through The National Center for Women and Information Technology (NCWIT). Since one of the barriers to computer science and computational thinking is technology, it is reasonable to think that the technology-free options would appeal to many classroom teachers. This approach may have additional appeal to those who are not technologically savvy themselves or who lack the proper training. It might also be attractive to those who do not have easy access to computers for all students.

Stoilescu (2010) taught 10 CS Unplugged activities over two semesters in a local high school. He checked the effect of the activities on students' interest in CS as well as on their understanding of what CS is and its application, in general, and of specific concepts taught in the activities. The researcher reported that, following the participation in the CS Unplugged activities, students generally understood what CS is 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 center 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). In addition, he checked the role of mathematics in CS. Views about women in CS, Views about the work in CS, focusing on the need for cooperation in CS. Two additional categories were believed should have been covered in the activities to achieve the objectives of CS Unplugged.

2. METHOD

The study adopted a mixed-method research design which comprised of a one-short case pre-experimental design and qualitative method with a set of self-designed instruments to elicit responses from the participants on their application-level binary concept to a real-life situation and the influence of gender on their application level. The students were exposed to the activities of CS Unplugged by teaching them binary concepts and the interview was used to gather information on students' application level of binary concepts using CS Unplugged and later transcript into figures to determine the applicability level. Purposive sampling techniques were used to select a sample school and 15 participants were used. Most 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 activities of the CS Unplugged method. Among these secondary schools is a secondary school purposively selected for the study.

The samples were drawn from students offering computer studies and students from the senior secondary school class one since the topic chosen for the CS Unplugged (Binary Concept) is for the upper basic curriculum. Data gathered from the instruments were transcript and coded on an Excel spreadsheet; the analysis and interpretation of data

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obtained were subjected to descriptive and inferential statistics through the use of IBM Statistical Product and Service Solution (SPSS) version 20.0 software. Percentages values were used to answer the research question raised. Descriptive statistics of frequency counts and Percentages were used to analyze the demographic information of the respondents while percentages were used to answer the research question raised.

3. RESULTS AND DISCUSSION

3.1. The Results of Data Obtained in Respect of the Research Question and Hypothesis are Presented: What is the Students' Application Level of Binary Concept using the CS Unplugged Method in a Real-Life Situation?

To determine students' application level of binary concepts using the CS Unplugged method in a real-life situation, data were collected from the respondents based on interviews related to the treatment they have been exposed to. The results are shown in **Table 1**. **Figure 1** show bar char representing application level.

Table 1 showed students' application level of binary concept using CS Unplugged method to real-life situation, item 1,2,4,6,8,9,10,11,12, 13,14 and 15 revealed that the student's application level of binary concept using CS Unplugged method to real-life situation was high with percentage score of 100, 100, 80, 100, 80, 100, 100, 100, 80, 100, 100 and 100% respectively. Item 3 and 5 also indicated that the student's application level of binary concepts using the CS Unplugged method to the real-life situation was average with a percentage score of 60.

Therefore, the result showed that the student's application level of binary concepts using the CS Unplugged method in the real-life situation was high since the percentage scores of the majority of the students were within 71% and above which is the benchmark and overall percentage score was 88%.

Table 1. Respondents' application level of binary concept using cs unplugged method to real life situation.

S/NO	Students' ID	Gender	Scores	Percentage	Level
1	A001	F	5	100	High
2	A002	M	5	100	High
3	A003		3	60	Average
4	A004		4	80	High
5	A005		3	60	Average
6	A006		5	100	High
7	A007		3	60	Average
8	A008		4	80	High
9	A009		5	100	High
10	A010		5	100	High
11	A011		5	100	High
12	A012		4	80	High
13	A013		5	100	High
14	A014		5	100	High
15	A015		5	100	High

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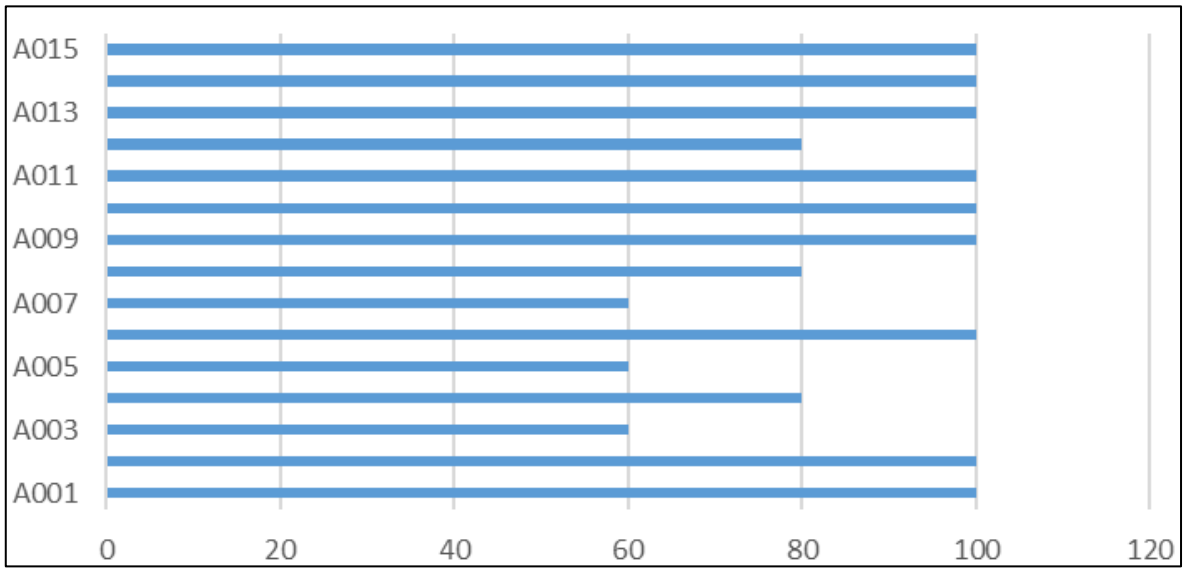

Figure 1. Bar chart representing students' application level.

3.2. Hypothesis

H_{o1}: There was no significant difference between male and female students' application level of binary concepts using the CS Unplugged method in a real-life situation.

To test whether there was no significant difference between male and female students' application level of binary concepts using the CS Unplugged method in a real-life situation, Data collected from male and female students' application levels were analyzed using a *t*-test, and a 2-tailed significant was used to determine the significance of the hypothesis at 0.05 significant level. The results of the analysis were represented in **Table 2**.

Table 2. ***t-test*** analysis of significant difference between male and female students' application level of binary concept using cs unplugged method to real-life situation.

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**						

From **Table 2**, it can be deduced that there was no significant difference between male and female students' application level of binary concepts using the CS Unplugged method in a real-life situation. 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' application level of binary concept using CS Unplugged method to the real-life situation" is not rejected. The conclusion, therefore, is that both male and female students were able to apply the CS Unplugged method.

3.3. Discussion

The findings of the study revealed that students were able to apply the binary concept to a real-life situation and students' application level was high. Students were able to relate the binary number to a real-life situation. Students' applicability level was high as a result of students' engagement in algorithmic thinking, thinking in abstraction, and the computational thinking nature of the method. In CS Unplugged, students from elementary school ages

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upwards work without computers with hands-on activities that help them to understand a broad range of CS topics in an engaging and motivating way. The activities tend to be kinaesthetic, often on a large scale, and involve teamwork. For example, the Sorting Network activity has teams of six running through a network drawn on the ground. The activities tend to allow students to discover answers for themselves, rather than just being given solutions or algorithms to follow.

A constructivist approach is encouraged (where the teacher uses the scaffolding provided by Unplugged to ask questions that lead them to discover the knowledge themselves), as we want students to realize that they are capable of finding solutions to problems on their own, rather than being given a solution to apply to the problem. This is in line with Adomi and Kpangban (2010) who observed that there are developments in the Nigerian education sector that indicate some level of innovation application in Nigerian secondary schools.

There was no significant difference between male and female students' application of binary concepts using the CS Unplugged method to a real-life situation. Both males and females were able to successfully apply the binary concepts to a real-life situation.

4. CONCLUSION

This research examined students' application level of binary concepts using the CS Unplugged method in a real-life situation in the selected secondary school in Ilorin, Kwara State. CS Unplugged is a method of teaching Computer Science in an interesting, students' engaging, and entertaining way without using the computer. The results obtained from the data collected and analyzed in this study indicated that the constructive nature of the CS Unplugged method helped students to apply the binary concepts in the computer science curriculum to a real-life situation. The study showed that the majority of the students responded appropriately to the interview. Moreover, gender does not influence students' application of binary concepts to a real-life situation.

5. ACKNOWLEDGMENT

All cited works are highly acknowledged.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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