STUDENT'S PERCEPTION TOWARDS THE DESIGN OF CUSTOM COMPUTER AIDED INSTRUCTION SOLUTION FOR TEACHING AND LEARNING OF UNDERGRADUATE PHYSICS

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ABSTRACT

Undergraduate students in Science and Engineering programmes in Nigerian universities offer Physics as a course at one level or the other as contained in Nigeria University Commission (NUC) Basic Minimum Academic Standard (BMAS). In line with this, Al-Hikmah University offers some general Physics courses at the 100 level of some of its science-based programmes. This work carried out a preliminary investigation to get the opinions of selected 100 level students in the university regarding how Computer-Assisted Instruction (CAI) can promote the teaching and learning of Physics as a course. One hundred and fifty students in the first year that offer Physics were selected using random sampling technique. Out of this, a larger percentage of them were of the opinions that computer-based application will promote teaching and learning of the subject. The findings further revealed that a good number of the sampled undergraduates believe that the phobia they have for Physics will disappear if CAI can be used in combination with the traditional classroom teaching approach. Based on the responses gathered from the survey, a good architectural design for achieving custom Physics learning solution was discussed. The design process is aimed at being useful for the development of an effective custom-based Physics CAI software. The paper concluded that having this kind of software design process will promote the development of Physics CAI learning solution using a suitable programming language.

Keywords: *Computer-Based Learning, Software Design, Effective Teaching, Effective Learning*

1. INTRODUCTION

Computer Aided Instruction (CAI) involves the use of the computer as a tool to facilitate and improve instruction. CAI programs use tutorials, drill and practice, simulation, and problem solving approaches to present topics, and they test the student's understanding (Collet-Klingenberg, 2008). It is an interactive instructional technique whereby a computer is used to present the instructional material and monitor the learning. Arnold (2000) also identified that CAI is a diverse and rapidly expanding spectrum of computer technologies that assist the teaching and learning process. The proposed framework for Computer Aided Instruction in Physics is targeted at making learning to be student-centered.

CAI is a popular e-learning approach in educational sector that has been well explored for more than three decades (Kristof et al., 2014). This study aimed at investigating the readiness of selected students on the need to have CAI solution developed for Physics at undergraduate level, Physics is one of the undergraduate courses offered in the Science and Engineering programmess in many Nigerian universities as contained NUC BMAS. Several CAI-based solutions have been developed for some subject areas such as Mathematics, Physics, Statistics, Art courses and so on. However, there is paucity of works in investigating the needs for designing such CAI solution for Physics as a subject that will be customized to the curriculum and needs of the target student group.

Furthermore, Jensen (1967) was of the opinion that several educators have been showing interest in the using computers for teaching. As reported in literature, a software framework provides a standard approach for building and deploying applications. The architecture being proposed in this work details out the software solution will be structured and use in order to achieve effective teaching and learning of Physics. According to Jacobsen, Eggen and Kauchak (2009), effective classroom teaching requires professional commitment. The authors equally pointed out that learning to teach is a complex and multifaceted in that it requires many different kinds of knowledge. Among this include: Content Knowledge, Pedagogical knowledge and Teaching skills.

The main aim of this study is to design an effective and learner-centered Physics learning solution. An undergraduate Physics course called General Physics I is taken as the case study. In order to identify how to go about designing a solution that will meet the expectation of the learners, a descriptive approach was first adopted.

This study first of all sought the opinions of sampled one hundred and fifty 100level students that offer Physics in the Faculty of Natural and Applied Sciences, Al-Hikmah University, Ilorin. Then, the responses of the students will guide in designing architectural description of the proposed software-driven learning platform that can complement the traditional teaching technique.

2. BASIC FEATURES IN COMPUTER AIDED INSTRUCTION SOLUTION

A Computer Aided Instruction Application is expected to have some basic features. Some of these features are targeted at making sure that learning is user-centered. For instance, a Computer Assisted Instruction solution of this nature must be user-friendly, instructive and provide good avenue for the learners to self-assess themselves at the end of each module (Collet-Klingenberg, 2008). As reported in literature, there are several examples of CAI applications. For instance the learning solutions in this category do include guided drill and practice exercises, computer visualization of complex objects, computer-facilitated communication between students and teachers and more (Arnold, 2000). Forsythe and Freed (1978) pointed out that Computer Aided Instruction has some absolute advantages over other modes of teaching. Forsythe et al (1978) equally argued that another advantage of CAI is that it can allow students to proceed at their own rates of speed, rather than one which is either convenient for the administration or designed for the "average" student.

3. REVIEW OF RELATED STUDIES

Banik (2017) carried out an experimental work to investigate the effect of Computer Assisted Instruction and Traditional Method in teaching Physics at Higher Secondary school level. A developed Computer Aided Instruction was used in the experiment on the students of class XI who offer Physics as a subject in higher secondary school. The author argued that the experiment showed that CAI is effective in terms of the achievement of learner in teaching Physics. Similarly, Banik and Biswas (2017) in their study identified the importance of using Computer Aided Instruction to teach current electricity as a topic in Physics. The authors used Pretest-Posttest equivalent group. They claimed that the results of the experiment showed that CAI is effective in terms of the cognitive achievement of learner in teaching current electricity at Post test stage.

Agboh (2015) investigated the effect of CAI technique on Students' Achievement in Financial Accounting in Colleges of Education in South East Nigeria. The study found out that CAI

is useful for students learning. It recommended colleges of education lecturers should adopt the use of CAI technique for effective teaching and learning of their students. Jhumu (2015) carried out a study that explored the impacts of Computer Aided Learning (CAL) on English language teaching in secondary schools in rural areas of Bangladesh. The focus of the study is in class 9 to 10 of schools in the rural areas of the country.

Mappalotteng (2014) proposed a CAI model that is targeted at teaching in vocational high school. The CAI program was developed in the form of Interactive CD for teaching the targeted subject. The author argued that the users' responses on the usefulness of the developed CAI product were very good and promising. Kristof, Carla and Nicky (2014) provided literature review which pays special attention to the existing causal evidence of computer-assisted programs on learning outcomes. The authors concluded that the use of CAI-programs in learning environment enables learners to catch-up on learning outcomes. The authors further pointed out that Computer-assisted instruction (CAI) programs are considered as a way to improve learning outcomes of students. Ramani and Patadia (2013) designed and developed Computer Assisted Instruction for teaching Mathematics and tested its effectiveness through survey technique.

Moreover, Ramani and Patadia (2012) investigated the teaching of Mathematics as a subject as well as the importance of CAI for teaching the subject. Collet-Klingenberg (2008) discussed general guidelines for implementing computer-aided instruction. He has argued that CAI can be an extremely beneficial supplement for education generally. The author was of the opinion that the steps for implementation of computer-aided instruction are actually guidelines for the general use of computer software for instructional purposes. Computer-aided instruction can be selected as an evidence-based instructional strategy because the learner already has an interest in computers or because of the availability of software to teach the targeted skill or behaviour (Ramani et al., 2012).

Jensen (1967) identified three levels in which a student and computer may interact for the purpose of teaching and learning. The author emphasized the following: individualized drill and practice system, Tutorial system and Dialogue System. Hendrickson (n.d.) reviewed recent developments in CAI applications in the area of Civil Engineering. The work concluded that CAI can now be widely adopted for teaching civil engineering as a discipline. Dowdle (n.d.) discussed the benefits that can be accrued from Computer Assisted Instruction or Computer Aided Instruction do include independent learning, self motivation in students ass

well as the ability to receive frequent feedback from learning environment.

None of the studies reviewed involve designing a custom CAI solution targeted at achieving improved learning of the subject among the learners. The approach used in this work is believed to promote effective adoption of learning based together with traditional classroom teaching in the university used as case study.

4. MATERIALS AND METHODS

The target population is 100level students that offer Physics at undergraduate level of Faculty of Natural and Applied Sciences. Random sampling was then used to select one hundred and fifty students for the study. The study used a combination of survey technique and proposal of software architectural design. The survey is used for gathering useful information about the opinions of students for the need of electronic learning solution as well as what the architectural description of the proposed application. The survey gathered perception of sampled undergraduate students who offer Physics as a course in 100level. Two research questions were raised and they were used to establish the need to have instructive and efficient Computer Aided Instruction for the teaching and learning of Physics as an undergraduate course. Then, a software design flow which can be used to achieve effective development of Physics learning solution is provided. The choice of Physics is partly due to the need to promote the interest of students in the subject as well as reducing the phobia for the subject among the students by supplementing what they learn in the conventional classroom settings.

5. RESULTS AND DISCUSSION OF RESULTS

5.1 Results

This section contains the responses of students on what their expectations if a Computer Aided Instruction Application is used in conjunction with the face-to-face classroom teaching and learning of Physics.

Table 1: Gender Distribution of the Respondents

Gender	Frequency	Percentage (%)
Male	83	55.33
Female	67	44.67
Total	150	100.0

Table 1 shows the gender distribution of the respondents. The table showed that male respondents in the study are in majority.

Table 2: Responses of Students on the University readiness to adopt Physics CAI solution

S/N	Statement	YES (%)	No (%)
i	Do you have idea or understanding of how a typical Computer Aided Instruction Application work?	131 (87.3%)	19 (12.7%)
ii	Do you think the combination of Computer Aided Instruction with classroom teaching can boost the learning rate of Physics among undergratuaates?	146 (97.3%)	4 (2.7%)
iii	Does your university have adequate ICT-literate lecturers and facilities to support this initiative?	148 (98.7%)	2 (1.3%)
iv	Do you expect the CAI solution to include lecture notes, drills and practices in order to aid self evaluation of learners?	137 (91.3)	13 (8.7)

Table 3: Perception of students on the Need for CAI solution in teaching and learning Physics

S/N	STATEMENT	SA	A	SD	D	Mean
1.	A combination of traditional teaching and learning environment with computer based software may be better for my Physics learning at undergraduate level?	137	9	2	2	3.87
2.	The use of Computer Aided Instruction for learning Physics will bring an improvement in my understanding of the subject	139	7	2	2	3.89
3.	Learning Physics with Computer-based Instruction removes phobia for Physics as an undergraduate course	129	16	4	1	3.82
4.	The use of CAI application will allow me to learn at my own pace compared to the traditional learning environment alone	142	4	2	2	3.91
5.	Using a combination of traditional classroom learning and tailored made CAI application for physics will promote my academic performance in the course	136	11	1	2	3.87
6.	Level of Computer literacy can influence the student learning processes in a Computer-based learning system	139	8	2	1	3.88

Grand Mean: 3.87

Table 3 provided the summary of perception of the selected students on the need for the use of CAI solution to support traditional Physics learning environment in the university. The individual mean of the responses of the students were used to measure their opinions on each statement in the questionnaire. In other to get the total views of the students and grand mean was computed as shown under the table. On the view of students regarding the need for having Computer Aided Instruction to teach and learn the course provided a grand mean of 3.87 was obtained. For the individual statement in Table 3, the mean obtained in five of the statements out of six items are equal to or higher than the Grand Mean. The interpretation is that a greater percentage of the students believe that Computer Aided Instruction solution is needed for the teaching and learning of Physics in the institution. This belief was arrived at, having considered how some of the basic concepts in a 100l general physics can better be understood when computer based learning solution is adopted to support traditional classroom teaching of the stubject.

5.2 The Flow Diagram of Proposed CAI for teaching Physics

The flow diagram is as shown in figure 2. It consists of two main modules that can be incorporated into the final CAI software solution that can be used for teaching and learning Physics.

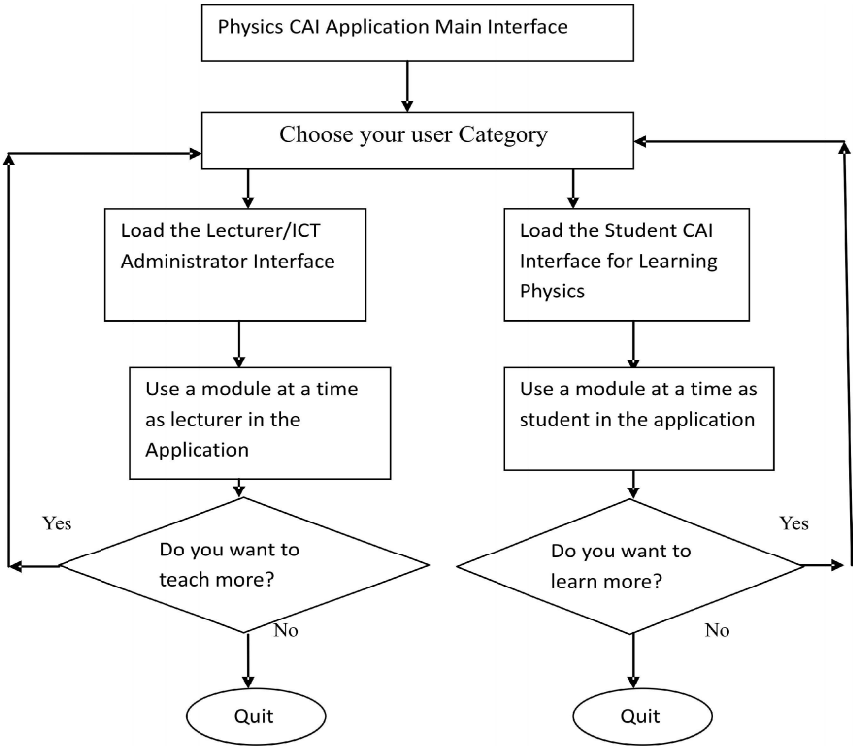

Figure 2: Main CAI Program Flowchart

The program flowchart in figure 2 is used to represent the flow of activities in the use of the two main modules proposed learning application. The flowchart shows how the lecturer or student module can be effectively be put to use severally across the different features in the proposed application.

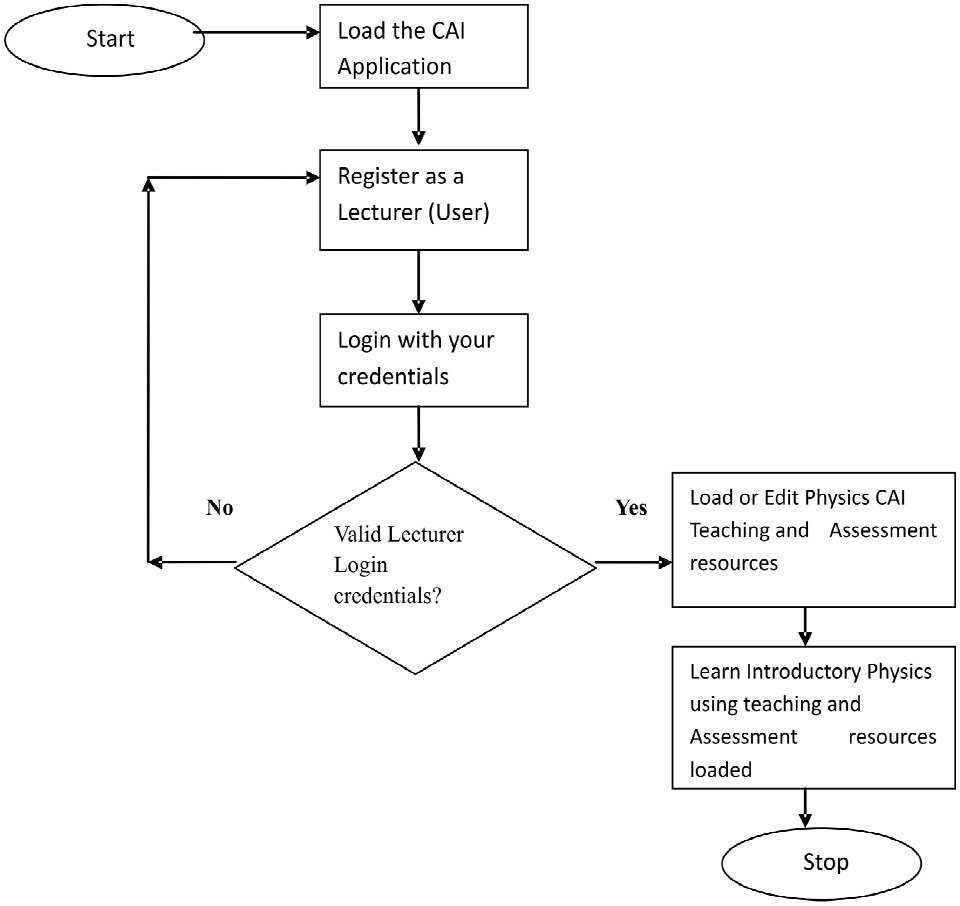

Figure 3: Flowchart showing Lecturer's Usage Procedure in CAI Application

Figure 3 provided diagrammatical representation of the procedures that the user, herein refer to as the lecturer follow in making use of the learning application. The figure specifies that the lecturer must have registered on the application. Then, for every usage he/she must login with the valid credentials. When invalid login credentials are provided each time, the user is redirected to try again.

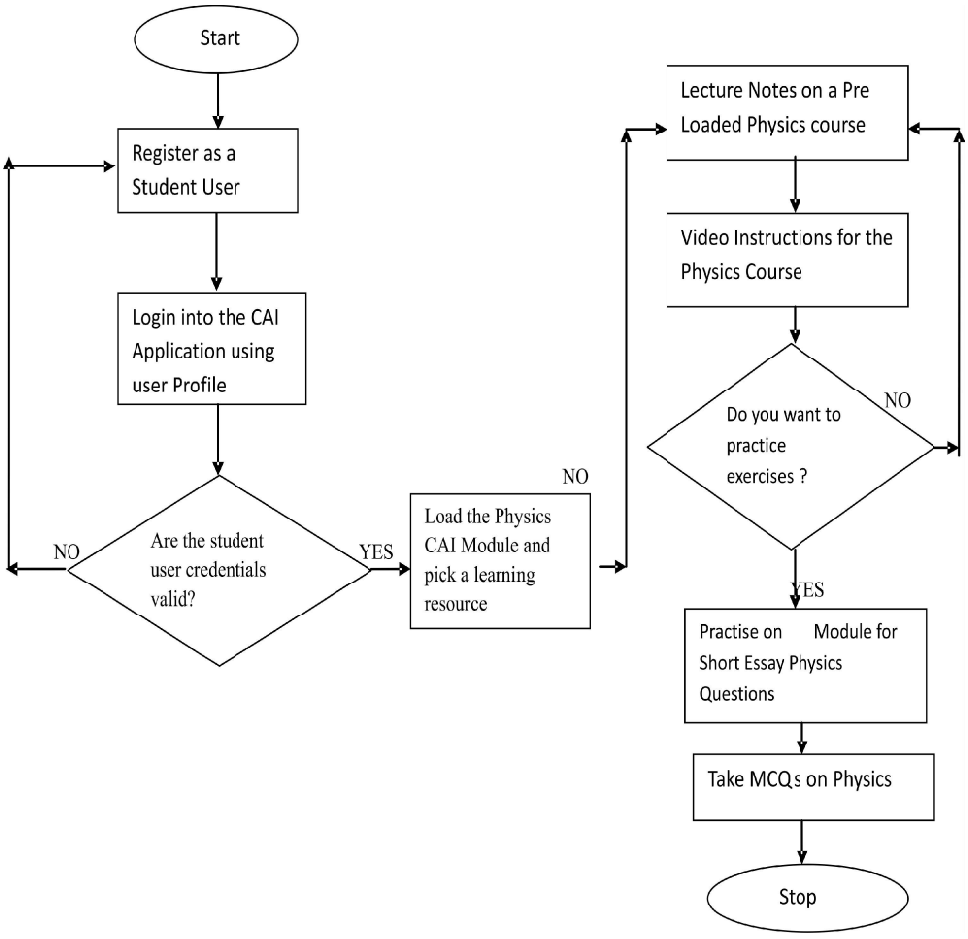

Figure 4: Flowchart showing the Overall Student's Application Usage Process

Figure 4 provided the flow of activities in the use of the proposed application by the user herein referred to as the student. The modules in the application are clearly indicated. It is evident that the student must have been a registered student for the course before he/she can use the application.

5.3 Use-Case Diagram

Use Case Diagram is shown in figure 5.is used for modeling the various activities expected of the main users (actors) of the proposed custom CAI software. The key actors (users) identified in the use case diagram are the student, the lecturer and the application administrator who may be designated as IT admin.

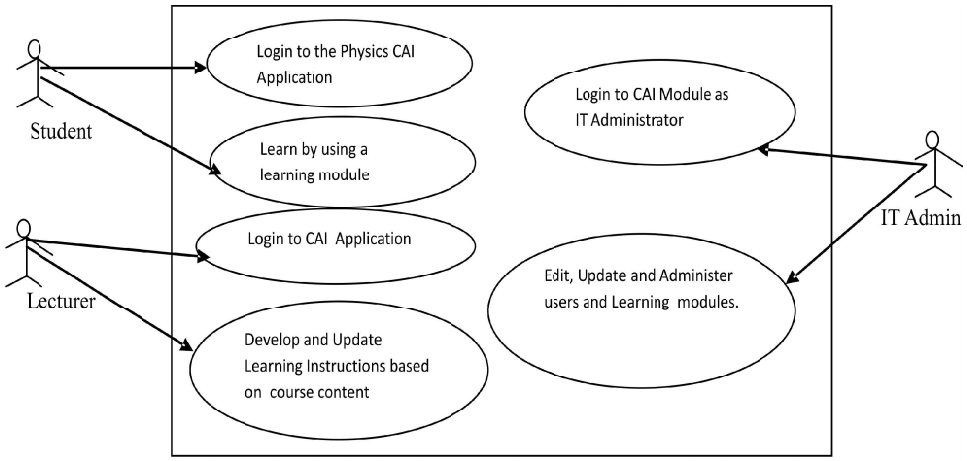

Figure 5: Use Case Diagram of the Proposed Solution

6. DISCUSSIONS

In the first stage of the study which involves information gathering from respondents who are first year undergraduate students in the university that offer Physics as a course, it was gathered that 83 of them were males while 67 were females. The findings further revealed that majority of the students showed interest in using CAI solution for learning undergraduate Physics as a way to supplement the traditional classroom learning environment. Their responses also showed that the use of CAI in conjunction with the traditional lecture mode can aid the mastery of the subject. Based on the questionnaire, the majority of the students revealed that the inclusion of Drills and Exercises in the proposed application will enable them to learn and practice in their own pace.

On the perception of students on the University readiness to adopt Physics CAI solution, 98.7% of the students responded that the university is fully compliant technology-wise while deploying a CAI solution for learning. Similarly, on the perception of students on the need for CAI solution in teaching and learning undergraduate Physics, a grand mean of 3.87 was obtained. For the individual statement in Table 3, the mean obtained in five of the items/ statements out of six items are equal to or higher than the Grand Mean. The interpretation of this is that a greater percentage of the students believe that CAI solution is needed for the teaching and learning of Physics in the institution.

In the second stage of this work, a general design structure of the proposed software was captured using Flowcharts and Use Case Diagram. The first module of the software is expected to have login interfaces for the, Physics

lecturer and the students. The proposed design followed the technique argued in the literature that a Computer Aided Instruction solution support variety of modules so as to achieve effective CAI solution. The software framework can be used for developing the final CAI software solution that can be used to support traditional teaching and learning of Physics in a university environment. The software structure incorporates structural description that can be followed while building the CAI application that has relevant features that can aid learning among undergraduate Physics students.

7. CONCLUSION AND FUTURE RESEARCH DIRECTION

The research focuses how a functional customized CAI application can be used for the teaching and learning of Physics using Al-Hikmah University, Ilorin as a case study. The study first used a survey approach to seek the opinions of targeted 100l students on the proposed CAI software for teaching Physics. Then, a software design approach that can be used for building such Computer Aided Instruction Application for a first year undergraduate Physics course at Al-Hikmah University, Ilorin, Nigeria was proposed. The proposed software design is based on the preliminary responses of the sampled students. It was argued that having a CAI solution in place will add value to the traditional teaching of the subject in the university. It is believed that, a much more effective learning platform that will meet the desired needs of both the lecturers and the students of Physics can be achieved if the architectural design is taken into consideration while building the application.

REFERENCES

[1] Agboh Callistus I. (2015). Effects of Computer Assisted Instructional Technique on Students' Achievement in Financial Accounting in Colleges of Education in Southwest Nigeria, *Research Journal of Finance and Accounting, 6(20)*

[2] Arnold D.N. (2000) Computer-Aided Instruction, Microsoft Encarta, Online Encyclopedia

[3] Banik, S. (2017). Effectiveness of teaching physics through computer assisted instruction and traditional method at higher secondary level. *2* (5), *retrieved from https://pdfs. semantic scholar.org/7411/aba579 a865b 0cc7291f2693f353df05f74b0.pdf*

[4] Banik, S., & Biswas, N. B. (2017). Effects of Computer Assisted Instruction (CAI) on the Teaching of Current Electricity at Higher Secondary Level, International Journal of Advanced Scientific Research & Development (IJASRD), 04(09/ I), pp. 13–23.https://doi.org/ 10.26836/ijasrd/2017/v4/i9/4902.

[5] Collet-Klingenberg, L. (2008). Computer-aided instruction: Steps for implementation, Madison, WI: The National Professional Development Center on ASD, Waisman Center, University of Wisconsin, retrieved from https://csesa.fpg.unc.edu/sites/csesa.fpg.unc.edu/files/ebpbriefs/CAI_Steps_0.pdf

[6] Dowdle Nancy (n.d.). Computer Assisted Instruction, A guided Tour, Project "A" HRD 860, retrieved from https://www.google.com/url?sa= t&rct=j&q=&esrc=s&source=we b&cd=1&ved=2ahUKEwjdqLi4sbLmAhUO-YUKHQPfD_gQFjAAegQIAhAI&url=http%3A%2F2Fwoulibrary.wou.edu.my%2Fweko%2Feed502%2FCAI_TOUR. ppt&usg=AOvVaw0YpEbgsE5OQD-8ISyAkEC7

[7] Finkelstein, N. D. (2000). Teaching and learning physics/ : An alternative model for physics instruction, outreach and research, 1–23.https://pdfs.semantics cholar.org/7411aba579a865b0cc7291f2693f353df05f74b0.pdf

[8] Hendrickson C. (n.d.). Applications of Computer Aided Instruction, retrieved from https://pdfs.semanticscholar.org/6ab6/0de6dfcfeacd73665a41b166c382aba109bb.pdf

[9] Holmes G. and Marilyn, E. (1981). Computer-Assisted Learning/ : Design and Implementation. Paper presented at the Concordia Colloquiumon Language Laboratories (Montreal, Quebec, July 6-8,1981)

[10] Jacobsen David A., Eggen Paul & Kauchak Donald (2009) .Methods for teaching, Promoting Student Learning in K-12 Classrooms,*8th Edition, Pearson Education, Inc.*

[11] Jensen, Dennis C. (1967). An Investigation of Computer Assisted Instruction. All Graduate Plan B and other Reports. Paper 566, retrieved from http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1587&context=gradreports

[12] Jhumu, R. J. (2015). Exploring impacts of Computer Aided Learning (CAL) on English language teaching in secondary schools in class ix-x in rural areas in Bangladesh, *JHU, (November).*

[13] Kristof De Witte, Carla Haelermans and Nicky Rogge (2014). The Effectiveness of a Computer Assisted Math Learning Program

[14] Madison, WI: The National Professional Development Center on ASD, *Waisman Center, University of Wisconsin.*

[15] Mappalotteng, A. M. (2014). Developing a Computer-Assisted Instruction Model for Vocational High Schools. *International Journal Of Engineering And Science*, *4*(10), 31–42.

[16] Pal, J., Pawar, U. S., Brewer, E. A., & Toyama, K. (2006). The case for multi-user design for computer aided learning in developing regions, (197), 781. https://doi.org/10.1145/1135777.1135896

[17] Ramani Ramila and Patadia Harsha (2012). Computer Assisted Instruction in Teaching of Mathematics, *IOSR Journal of Humanities and Social Science, 2(1): 39-42, www.iosrjournals.org*

[18] Ramani Ramila and Patadia Haesha (2013). Reaction of Students on Developed Computer Assisted Instruction for Teaching Arithmetic*, Education 3(1):37-42*