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DEVELOPMENT OF AN EXPERT SYSTEM FOR TEACHING MATHEMATICS IN NIGERIAN JUNIOR SECONDARY SCHOOLS

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ABSTRACT

The traditional chalk-board method of teaching is fast becoming boring and this has led to a decline in the rate at which students develop interest and love for learning. This method lacks enough creativity like the use of visual aids, picture books and hands-on approach that can make learning to be fun and interesting. The use of ICT as a tool for teaching and learning process in Nigeria Educational sector will facilitate the love for teaching and learning especially in subjects like Mathematics that is considered difficult to understand. Hence, this research explored the use of ICT tools to create an expert system that will enhance learning as its advantages are immeasurable over the traditional method. The system is a web-based application developed to teach five different topics in Mathematics in Junior Secondary School using JavaScript Object Notation (JSON), JavaScript, ReactJs, and Cascaded Style Sheet (CSS).

Keywords: Chalk-board, ICT, Mathematics, Web-based

INTRODUCTION

In early times, gaining formal education was demanding. In the inception of education in Nigeria, it took a lot for our fathers as at that time to be educated, as their energy, time, and money will be required. More so, they may have to take a long walk to a particular location or a classroom to develop good cognitive ability, acquire knowledge and have a change in behavior that will deliberately contribute positively to the

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development of the society. The talk-chalk / recitation teaching method were adopted to impart learners with intellectual skill at the early stage of education in Nigeria. The current mode of teaching in most junior secondary schools adopts the use of some materials such as courseware, projector, visual display units, and a marker board.

The introduction of Information and Communication Technology (ICT) in our classrooms will be a welcome development and where it has been introduced, it has not been fully utilized. The use of expert system can improve teaching and learning in the educational sector to enhance knowledge and delivery acquisition.

Expert system integrates human approach of solving problems into computer program to allow this program perform jobs that requires a human expert. An expert system (ES) is a computing system that has the ability of reasoning and representing a knowledge-based domain with a view of solving problems and provide suitable solutions with a computer model of expert human reasoning, reaching the same conclusions the expert would attain if faced with a similar problem (Samudyata, 2020).

An Expert system is a well-known area of Artificial Intelligence designed to enhance the availability of knowledge required in the educational system, in developing countries, expert system has been very useful in teaching courses such as Engineering, Mathematics and distance tutorial lessons. Nigeria cannot afford to be left behind as this will greatly contribute to teaching and learning process due to the advantages it has over the traditional method.

Recent research has shown that expert system is beneficial as a teaching tool because it is equipped with the unique features which allow users to ask questions on how, why and what format.

Also, it has been used in several fields of study including Computer animation (Victor, 2021), Computer Science. Other than that expert system has been used in teaching mathematics related subjects.

In Nigeria, education is supervised by the Federal Ministry of Education. The local authorities take responsibility for implementing state-controlled policy regarding public education and state schools. Junior Secondary School is a component of basic education which came on board with the Universal Basic Education (UBE) program in 1999 (Yusuf and Ajere, 2022).

Six years is the standard duration for Secondary School, which includes 3 years in Junior Secondary School, and 3 years in Senior Secondary School. In the first 3 years students are taught subjects such as Mathematics, Social Studies, English, cultural and creative arts, basic science and technology, pre-vocational studies, business education, Home Economics, French, Computer Studies or Fine arts. For students to be admitted in to

Junior Secondary School (JSS), students must take an examination conducted by the National Common Entrance Examination council (Yusuf and Ajere, 2022).

In developing countries, Expert system has been very useful in teaching courses like Engineering, Mathematics and distance learning tutorial lessons and as such Nigeria cannot afford to be left behind. It is therefore important that the expert system should be used in schools to teach mathematics as this will greatly contribute to teaching and learning process due to the advantages it has over the traditional teaching method.

AIM AND OBJECTIVES

The aim of this research is to design and implement an expert system to teach some topics of mathematics in JSS 1.

The objective includes:

i. To design an interface to enable students interact with the system.
ii. To design a knowledge base containing information from a human expert that would be implemented.
iii. To design an inference engine this uses information from the knowledge base to proffer solution.

REVIEW OF RELATED LITERATURES

Alghamdi, (2018) discussed the evolution of the expert system, its challenges, and applications and he inferred that the application of expert system can significantly reduce teacher's workload and simplify the teaching of subjects that are difficult to understand. He added that an Expert system can benefit both students and teachers in the learning environment

De *et al*., (2019), reviewed expert system as a tool for enhancing and acquiring problem-solving skills of students and increasing students learning motivation in distance universities and he concluded that expert system constitutes a positive and innovative training initiative for learning problems solving skills based on quantitative methods

F. David *et al*., (2019) in an article titled Expert System for solving problems in distance university education affirms that it is considered an expert system because it allows a positive and innovative training initiative for learning problem solving skills. The system was designed using html5, CSS and php.

Lailya *et al.,* (2019) in their research work on Principles of Designing an Expert System in Teaching Mathematics, elaborate that the use of expert systems in education can simplify the process of teaching mathematics. Proper use of the system can significantly reduce

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the workload of a teacher and leave more time for self-development and improving professional mathematical competence.

Modafar *et al.*, (2018) reviewed in the research on Computer Aided Learning for Young Children proposed the use of application to assist young children in learning at their individual speed and also give the parents firsthand knowledge about their ward's improvement and the places where they encounter difficulty in learning.

Eugenio and Roberto (2024) discussed the effect of computer aided instruction (CAI) on students and affirm that CAI has shown statistical improvement and accomplishment in multiplicative skills and as a result of this current research, CAI is more effective than traditional teaching method in terms of teaching mathematics.

Expert System as a Learning Tool

An expert system is a computer system that emulates the decision-making ability of a human expert which aims to solve complex problems using human reasoning knowledge (Kashapova and Pankratov, 2017). The use of the expert system over the years has reduced mental and physical effort, thereby increasing efficiency in various sectors. In order to examine the expert system as a learning tool, this research work reviews some applications of expert system in education generally through Contextual Teaching and Learning Model (CTL).

A contextual learning approach is an approach that connects student learning to the student's daily life experience (Syamsuddin *et al.*, 2022). These authors believe that mathematical ability is one of the most important targets in primary school education and in order to learn it, preceding concepts must be mastered in order to master the next concept and they also believe that CTL can improve mathematical connection ability.

Mathematical Learning Models

The ability to develop a system to facilitate the teaching process and improve learning a subject such as mathematics largely depends on the ability to improve the student's level of understanding and in order to achieve this; this research will examine few learning models as reviewed by some researchers for developing adaptive learning. This paper will be discussing a few: the Concept-Effect Relationship (CER) model and the Contextual Teaching and Learning (CTL) approach.

RESEARCH METHODOLOGY

The methodology used for the new system is a Top-Bottom approach.

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In developing the new system, the user interface was developed using ReactJs and styled using Cascading style sheet (CSS). The inference engine was developed using Javascript to make the required web pages interactive and MySQL was used to create the database for the knowledge base that contains the topics extracted from the JSS curriculum. This is further illustrated using the block chain diagram in Figure 1.

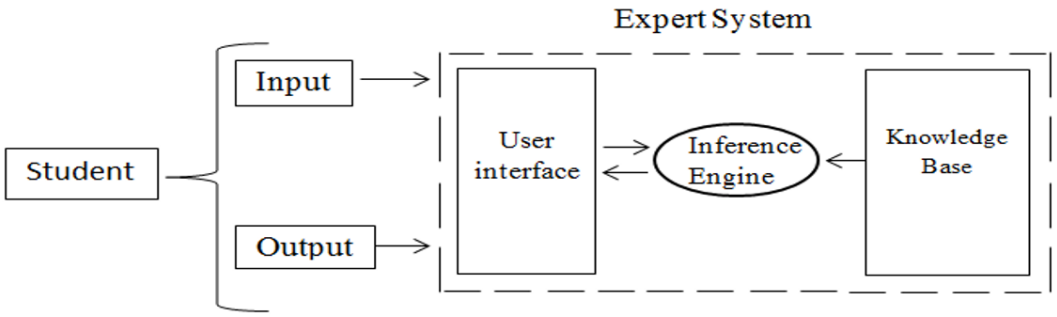


Figure 1**:** Block Design Diagram**.** Source: Steve (2016)

The Expert system consists of a number of components as explained below:

i. **Input:** The students are expected to interact with the expert system by supplying the input that passes through the user interface to the inference engine that queries the search for a match obtained from the Knowledge based.
ii. **Output:** The students upon interacting with the Expert system by learning the topics stored in the knowledge base and attempting the quiz, will obtain the expected output.
iii. **User Interface:** This is the front-end of the application in which the students interact with. The interface was developed using ReactJs and styled using Cascading style sheet (CSS). CSS was used for the styling and beautification of the front-end of the application.
iv. **Inference Engine:** This acts like a search engine, examining the knowledge base for information that matches the query. It was designed using JavaScript which is a scripting language for implementing functionality in web applications.
v. **Knowledge Base:** This is where the knowledge or information, in this case, the topicsextracted from the approved Junior Secondary School Mathematics curriculum (UBE). The knowledge base was implemented and stored as a JSON file.

A Use Case Diagram as represented in Figure 2 illustrates the different modules that explain how the system was developed.

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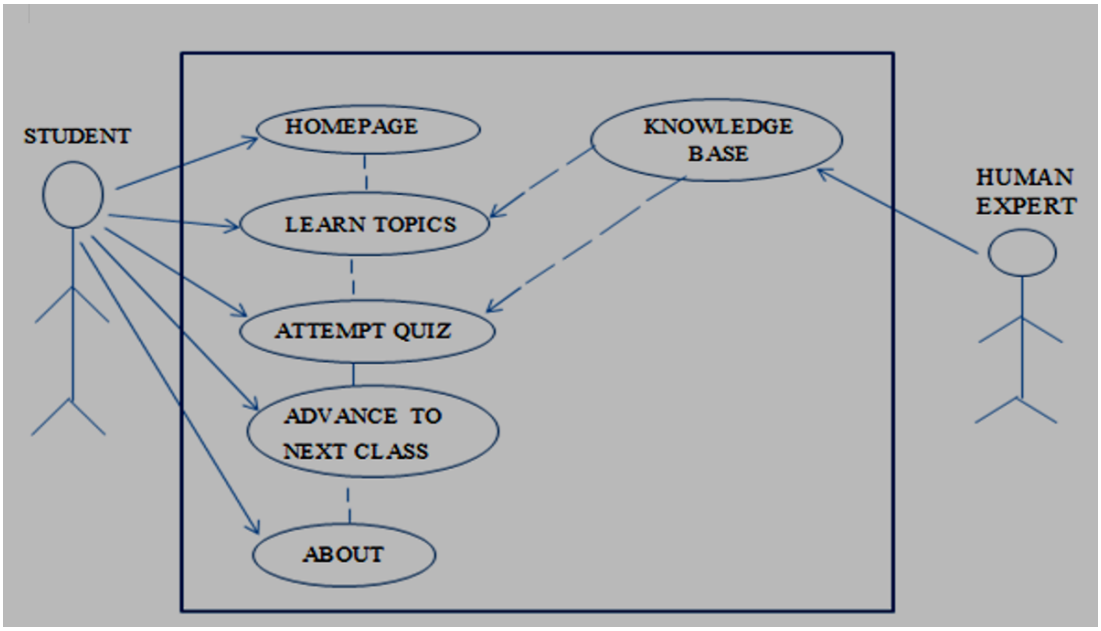


Figure 2: Use Case Diagram

i. **Home Page**: This is the landing page that appears as the student launches the application and contains a welcome note and a "**proceed**" button.

ii. **Learn Topics:** This is the second page that is displayed when the students click the **"Proceed"** button from the home page. This page also contains the "**Submit"** button and the "**Advance to Next Class"** button.

iii. **Attempt Quiz:** This is a section in the learning module containing five (5) questions and three (3) options for the student to read and carefully select the correct answers to the question.

iv. **Advance to Next Class:**This is a button at the end of every learning page that will lead the student to the next topic in the curriculum.

v. **About:**This is a button at the top-right corner of the web page that gives a description of the aim of the software and the names of the minds behind this research work.

SYSTEM DESIGN

In Figure 3, the flowchart involves a number of processes starting with having the students launch the application and then proceed to learn topic where they will be expected to learn the topic and attempt the assessment at the end of every topic. Upon attempting the quiz at the end of a particular topic, they are expected to correctly answer all questions. If all answers are correct, they can proceed to the next topic ELSE they will be prompted to learn the topic and attempt the quiz again. The system confirms at the end of every topic to ascertain if a particular topic is the last topic in the module so they

can proceed to completing the learning module ELSE they will be directed to the next topic in the module. Once the learning module is completed, the learning exercise comes to an end.

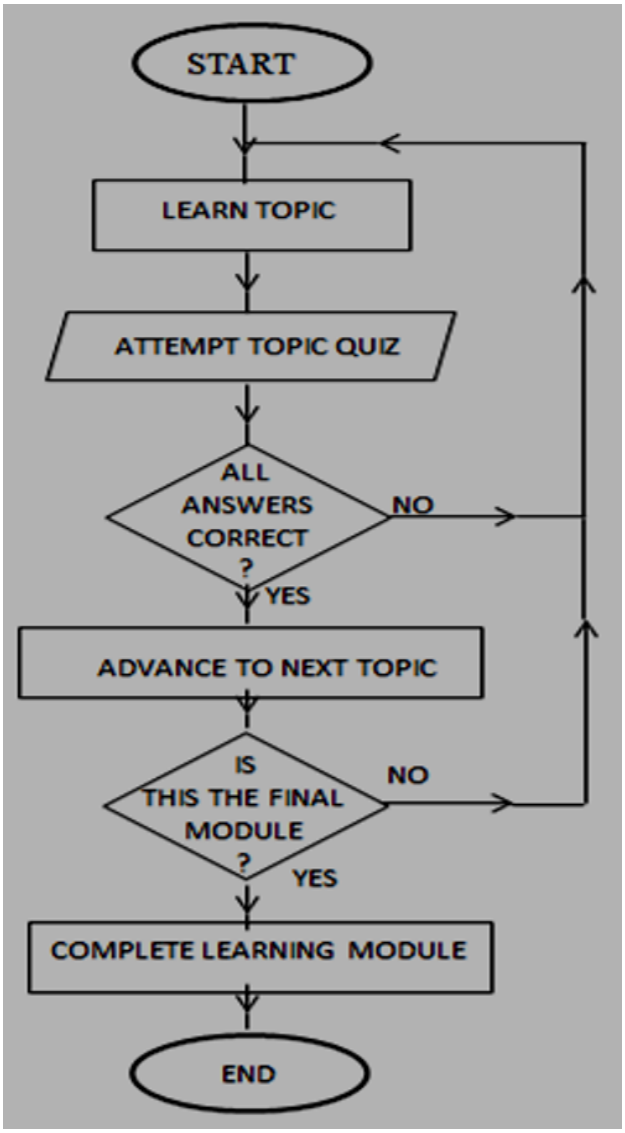


Figure 3: Flowchart for the New System.

HOW TO USE THE SYSTEM

The screen shots shown in Figure 4, briefly illustrates how the already designed Expert System works in teaching mathematics to students.

A. Landing Page

In Figure 4, this page appears when the student opens the application. It consists of a welcome note and the **"proceed button"**.

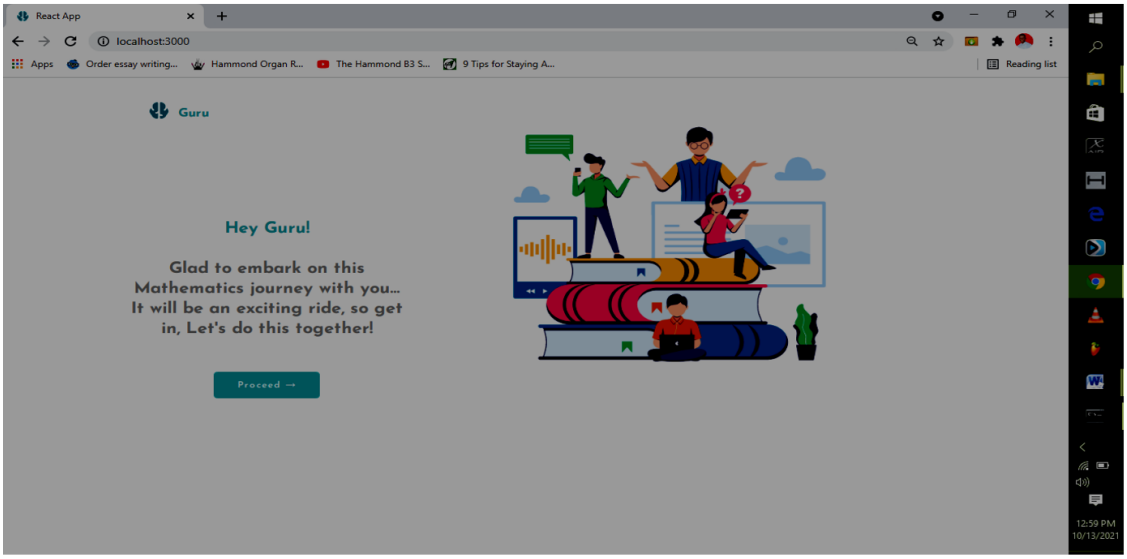


Figure 4: The Landing Page

Learning and Quizzing Module

The Learning module contains lessons on the five different topics to be taught while the Quizzing Module allows student to take assessment at the end of every topic as can be seen in Figure 5. Once the students fail the assessment, the system suggests that they learn the topic and take the quiz again as can be seen in Figure 6. If the student attempts all questions correctly, it gives applause and only then can the student proceed to the next topic as can be seen in Figure 7.

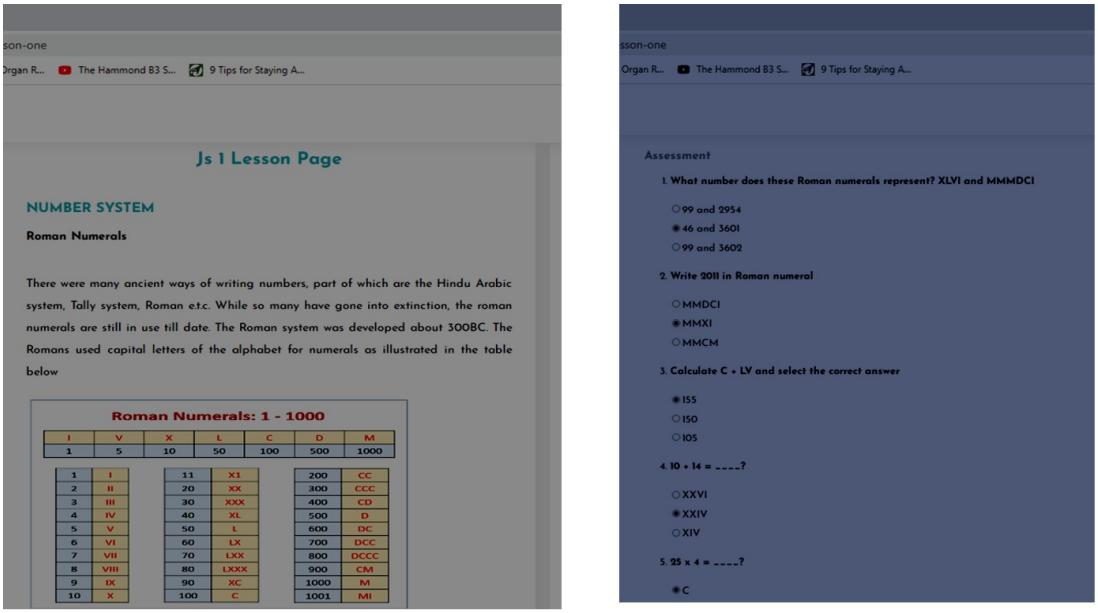


Fig 5: Screenshot of the First Lesson (Number System).

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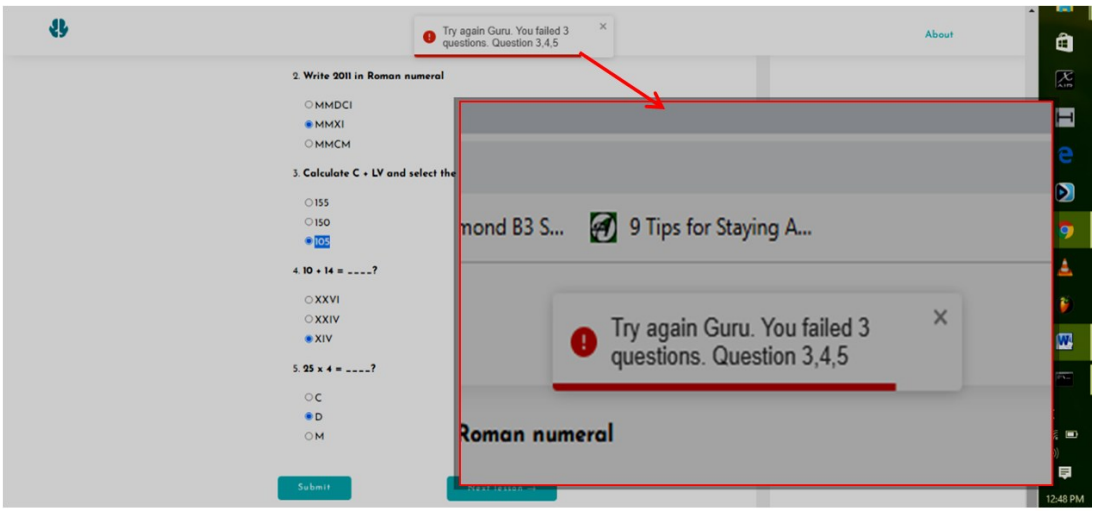


Figure 6: Result showing failure on attempt to question

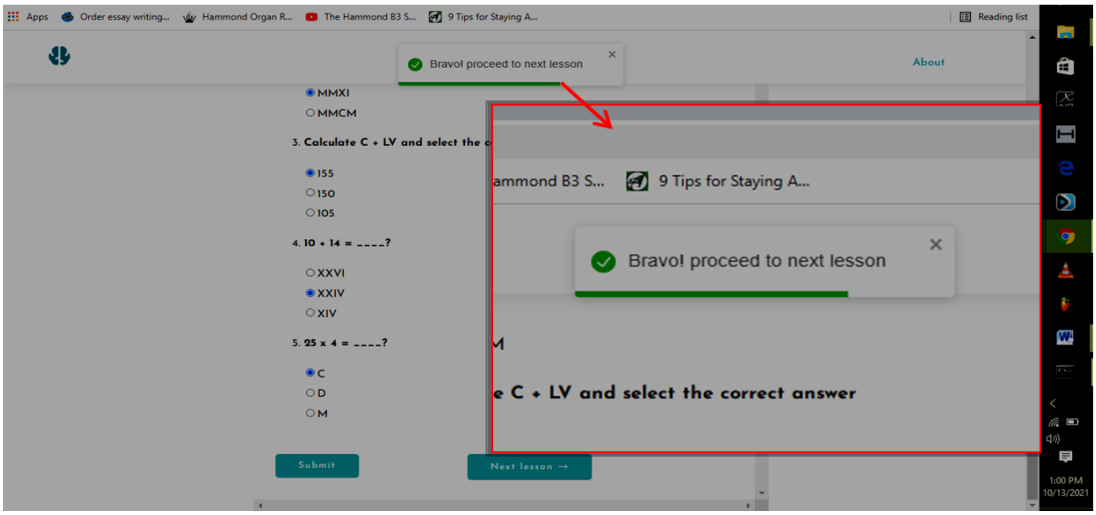


Fig7: Result showing success on attempt to questions.

CONCLUSION AND RECOMMENDATION

An Expert system to teach five topics in mathematics in Junior Secondary School was developed and it is user friendly and fun to work with which makes it interesting for students to engage and in turn improves performance and learning process. Also, the system utilizes ICT tools such as the computers, Expert learning application which is a fast-growing method of learning.

The system can be used as a home learning tool which includes the mathematics curriculum, explanations, and a quizzing section for the students in Junior Secondary School, to improve cognitive development, increase passion and increase the performance of the pupils.

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