
Development of a Web-Enabled Expert System for Career Path Guidance of the Unbundled Computer Science Programme in the Nigerian Polytechnics

Alao Kazeem Akinbola & Iyanda Waleola Samsondeen

Department of Networking and Cloud Computing

The Federal Polytechnic

P.M.B. 55, Bida, Niger State

E-mail: alao.akinbola@fedpolybida.edu.ng; andzeem14@gmail.com

Phone: +234-8038318009

ABSTRACT

The National Board for Technical Education (NBTE) recently unbundled the Computer Science programme in the Nigerian Polytechnics into four options at the Higher National Diploma (HND) Level. These options are Software and Web Development, Cyber Security, Artificial Intelligence, Networking and Cloud Computing. The prospective students of HND for the options are at crossroad with the challenges of selecting the best or suitable option amongst the four available options. This challenges is caused as a result of inadequate knowledge about the prospects and professional skills/requirements that are abound in each of the options. It is in view of this that this research modelled an expert system that guides the prospective students of HND in decision making of selecting a suitable career option, with the adoption of expert system architecture and components, where the prospects and professional skills/requirements are domiciled for prospective students for adequate knowledge and guidance for right decision of career choice/option of the unbundled Computer Science programme. The development was carried out on a system running Microsoft Windows 7 Ultimate platform/Microsoft Windows 8 platform. Being a responsive web application, the client-side/user/web interface pages were encoded and developed using “Bootstrap 3” front-end framework for (cross-platform/responsive-web). The “Bootstrap 3” contains HTML5 (Hyper Text Markup Language), CSS3 (Cascade Style Sheet), and JavaScript. For the back-end, XAMPP was used as web server with support for PHP as a scripting language and MySQL for working memory functional database.

Keywords: Domiciled, Expert System, Prospective, Unbundling, XAMPP

Journal Reference Format:

Alao Kazeem Akinbola & Iyanda Waleola Samsondeen (2026): Development of a Web-Enabled Expert System for Career Path Guidance of the Unbundled Computer Science Programme in the Nigerian Polytechnics. Journal of Behavioural Informatics, Digital Humanities and Development Research. Vol. 12 No. 1. Pp. 7-32. <https://www.isteams.net/behavioralinformaticsjournal>
[dx.doi.org/10.22624/AIMS/BHI/V12N1P2x](https://doi.org/10.22624/AIMS/BHI/V12N1P2x)

I. INTRODUCTION

Choosing a field of study among many can prove daunting. As a result of this, many students have fallen into the pitfall of choosing wrong careers. The right or wrong choice of career determines the level of performance or non-performance of a student while in the school, and also the level of an individual productive or non-productive when the career has become a job.

This performance/productive or non-performance/non-productive therefore determines the overall rate of growth and development of a nation. According to Mopelola and Benjamin (2013) there are two issues involved in choosing a career; the first is “the career” while the other is “self” or the person choosing the career. As observed by (Marilyn, 2015), choosing a career is one of those momentous decisions that can change the course of one’s life. However, this change can be positive or negative. The positive change could be attributed to choosing a right career, while the negative change could arise from a wrong choice of career. The unbundling of Computer Science at HND level into four areas/options of specialization of Software and Web Development, Cyber Security, Artificial Intelligence Technology, Networking and Cloud Computing has thrown into confusion many of the students seeking admission into any of the options, the uncertainty of the option to choose as a result of inadequate knowledge about the prospects and professional skills/requirements that are abound in each of the options. This state of confusion and uncertainty poised high risk of taking wrong choice or decision with respect to the available four options.

Approaches to career path guidance and recommendation can be manual, which is known as human guidance and counseling, and electronic which is known as computer-based guidance and counseling. An Expert System is an interactive computer based decision tool that uses both facts and heuristics in solving difficult decision making problems, based on knowledge acquired from an expert (Alhassan, 2013; Abisoye, Alabi, Ganiyu, Abisoye and Omokore, 2015) Also, Saraswathi et al (2014) said the programs that attempt to emulate the behavior of human experts are known as Expert System.

Therefore, this research deploys a web-driven expert system model where the prospects and professional skills/requirements are domiciled that guides the prospective students of HND in decision making of selecting a suitable career option in the various options of the unbundled Computer Science programme by interacting electronically for guidance and recommendations at anytime, anywhere and on any device (desktop, laptop, mobile/smart phones) with the exploration of the expert system features such as questioning ability, reasoning power, providing explanations, providing alternative solutions, by using the If--Then rules in a rule-based knowledge base.

1.1 Objectives of the Research

The specific objectives of the research into the Development of a Web-Enabled Expert System for Career Path Guidance of the Unbundled Computer Science Programme in the Nigerian Polytechnics, are to:

- (i) gather and create a database that would store all the relevant data for all the prospects and professional skills/requirements that are abound in each of the options of the unbundled computer science programme.
- (ii) design an expert system model with expert system architecture for the career path guidance system.
- (iii) use web development tools for the development and implementation of the career path guidance system.

2. REVIEW OF RELATED WORKS

Alao, Bolarinwa, Kuboye, and Ibam (2017) development of a web-based Intelligent Career Guidance System for Pre-Tertiary Science Students in Nigeria. The system was developed to solve the problem of non adequacy of career counselors in Nigerian secondary schools. The system adopted expert system features to recommend suitable career path by using the combination of best science subjects, intelligent quotient value, and personality interest. Muhammad and Nasimullah (2011) developed a stand-alone, customized and rule-based decision support/expert system for guiding fresh students in selecting a faculty in Gomal University, Pakistan. Their system was developed to solve the problems of lost of time, money, and failure of university students in their studies because they did not choose the right university/faculty/major that was compatible with their capabilities and abilities. The system has two module tests which are the capability module test and the intelligence module test. The sources of knowledge used for the system came from human academic experts, admission criteria of Gomal University, past record and future result of students. The knowledge were converted into facts and rules in CLIPS Language syntax.

With today's increasing number of colleges and courses, the details provided by human experts may not be fully sufficient to judge whether a college/course will suit for a particular student (Saraswathi, Hemanth, Udaya, Suraj and Khaja, 2014). They designed a customized, online Expert System for career guidance for higher secondary school students in India, for the selection of their undergraduate courses in various Colleges at the Pondicherry Engineering College, India. The system used jSoup parsing technique to acquire web pages information about Colleges/Courses at the Pondicherry Engineering College, India. The web pages information was used to develop a knowledge base, constructed using IF---THEN rules, the knowledge base is classified into two categories: the University admission requirements and the student's preferences. Colleges/courses were recommended on the basis of the details provided by the students.

According to Abisoye, Alabi, Ganiyu, Abisoye and Omokore (2015) the existing manual career guidance system is faced with the problems of few number of human counsellors, unavailability of a counsellor in some schools. Abisoye *et al* (2015) developed a web-based career guidance information system for pre-tertiary institution students in Nigeria to solve the afore-mentioned problems. In their system, a career quiz on interest/hobbies/skills was formulated and put in the database that was created using WAMP (Windows Apache MySQL PHP) server and queried using SQL, the user interface was developed using HTML and CSS, Java Script was used to create the career quiz, and PHP was used to implement the primary working component. Their web-based career guidance system improved on the existing manual system, helped pre-tertiary students in Nigeria get a good understanding of themselves, and base on the quiz results, best career path was recommended.

There is a need to enhance the quality of service of the guidance and counselling unit in Nigeria with the development of a Decision Support System for counsellors to assist secondary school “leaving students” who are likely to have problem in selecting the right discipline as they intend to study in tertiary institutions of their choice (Balogun and Thompson, 2009). Career Master: a stand-alone, human counsellor-driven Decision Support System (DSS) for guidance and counselling of secondary school “leaving students” in Nigeria was designed and implemented by (Balogun *et al*, 2009). Their system was developed under three subsystems (data management subsystem, model management subsystem, knowledge management subsystem) using Visual Basic 6.0 programming language., where the data management subsystem is composed of a database that contains students personal information, the study test questions and answers used for the intelligent quotient assessment of the students, the model management subsystem is composed of model base that contains special mathematical counselling model that provides the capabilities analysis, and the knowledge management subsystem contains the production rule of the form IF—THEN to solve complex problems of the parameters intelligent quotient test results, counsellors advice, parent advice and friends advice that were used for career path recommendation. Their system also used correlation formular to check the degree of correlation of both the DSS and human counsellors recommendations.

Shortage of human and time resources has led to the choice of unsuitable careers resulting in widespread poor performance at the work place (Ojenge and Muchemi, 2008). A stand-alone, customised career guidance using expert system approach was used by Ojenge *et al* (2008) to dispense career guidance to the youth in a cheap and quick process. They designed a model that was developed and implemented with Visual Studio and MS-ACCESS, the model consists of (personality analysis module and college entrance criteria module), the modules host the knowledge and rules that are based on Myers-Briggs Typology Indicator (MBTI) model. Rabiatal (2006) developed a web-based career guidance system for secondary school students in Malaysia, to provide alternative and an improvement in the capacity of traditional method of conducting career guidance to students. Her system was developed with the information obtained from career guidance experts and guidance teachers; the information gathered was integrated and evaluated to create a knowledge base. A database of students’ profile and career test on student’s interest and personalities was created; the system was constructed and implemented using PHP, JavaScript and MySQL.

Taiwo and Joshua (2015) said students must be provided with rich guidance and counselling services, so that they can discover relevant courses where they stand better chance, not just to graduate as at when due, but to come out with better performance. A human counsellor-driven, stand-alone system for career guidance through admission procedures in Nigerian universities using artificial neural networks was developed by Taiwo *et al* (2015), to be used by human counsellor for career path recommendation to students. Their system used data from two federal universities in Nigeria through questionnaire that was served the final year students of these institutions, the system explored the O level, UTME and Post-UTME performances of the respondents, Multilayer Perceptron Topology was used for data arrangement, the system was implemented with Visual Basic.

In today's education environment, where it is very hard to choose career option in a right way, machine learning practices can provide significant contribution to users for opting the right education domain to shape their career (Ankit, Ashutosh, Sunil, Pardeep and Durg, 2014). A stand-alone decision support system for determining right education career choice was developed by Ankit *et al* (2015) to support decision making process of students that want to shape their career in a right way. Their system has Career Advice Model (CAM) that was implemented with Java programming language. The CAM is based on machine learning techniques and rule based Decisions Support System, the CAM has the major components of an expert system (User Interface, Inference Engine, Knowledge Base). Myers Briggs Type Indicator (MBTI) model was employed to capture and analyse the academic ability test and personality test. FUZZY LOGIC was used to generate the personality type of the student.

3. DATA COLLECTION

The system operational data used for this research was obtained by interviewing human experts in the four programmes of the unbundled computer science, and adaptation of structured multiple questions relevant to the four programmes of the unbundled computer science.

(i) Collection of National Diploma Relevant Courses in Computer Science

The collection of all the National Diploma Courses in Computer Science was obtained from NBTE Curriculum as listed below.

S/NO	COURSE CODE	COURSE TITLE
1	COM 111	Introduction to computing
2	COM 112	Introduction to Digital Electronics
3	COM 113	Introduction to Programming
4	COM 115	Computer application packages I
5	COM 121	Programming using C Language
6	COM 122	Introduction to Internet
7	COM 123	Programming Language using Java I
8	COM 124	Data structure and Algorithms
9	COM 125	Introduction to Systems Analysis & Design
10	COM 126	PC Upgrade & Maintenance
11	COM 211	Programming Language using Java II
12	COM 212	Introduction to systems Programming
13	COM 213	Unified Modelling Language (UML)
14	COM 214	Computer Systems Troubleshooting
15	COM 215	Computer Application Packages II
16	COM 221	Basic Computer Networking
17	COM 223	Basic Hardware Maintenance
18	COM 224	Management Information system
19	COM 225	Web Technology
20	COM 226	File Organisation and Management

(ii) Preparation of Structured Multiple Objective Questions

The preparation and setting of structured multiple objective questions that are relevant and related to the four unbundled programmes was carried out, with two hundred (200) objective questions in the question bank, with each of the unbundled programme having fifty (50) questions. The structured multiple objective questions is to assess the knowledge and understanding of each of the unbundled programme to aid the relevant programmes recommendations. Some few sample questions are shown below for each of the unbundled programme.

4. DATA ANALYSIS

- (i) **Analysis of National Diploma Relevant Courses in Computer Science:** The National Diploma courses in Computer Science were categorized two, tagged as CATEGORY A Courses and CATEGORY B Courses with each category recommending the most two relevant programmes of the unbundled HND Computer Science as shown in tables 1 and 2 below:

Table 1: Category A Courses and Relevant Programmes Recommendations

CATEGORY A		
S/NO	COURSE CODE	COURSE TITLE
1	COM 112	Introduction to Digital Electronics
2	COM 122	Introduction to Internet
3	COM 126	PC Upgrade & Maintenance
4	COM 214	Computer Systems Troubleshooting
5	COM 221	Basic Computer Networking
6	COM 223	Basic Hardware Maintenance
RELEVANT PROGRAMMES RECOMMENDATIONS		
NETWORKING AND CLOUD COMPUTING/CYBER SECURITY AND DATA PROTECTION		

Table 2: Category B Courses and Relevant Programmes Recommendations

CATEGORY B		
S/NO	COURSE CODE	COURSE TITLE
1	COM 113	Introduction to Programming
2	COM 121	Programming using C Language
3	COM 123	Programming Language using Java I
4	COM 124	Data structure and Algorithms
5	COM 125	Introduction to Systems Analysis and Design
6	COM 211	Programming Language using Java II
7	COM 212	Introduction to systems Programming
8	COM 213	Unified Modelling Language (UML)
9	COM 224	Management Information system
10	COM 225	Web Technology
11	COM 226	File Organization and Management
RELEVANT PROGRAMMES RECOMMENDATIONS		
SOFTWARE AND WEB DEVELOPMENT/ARTIFICIAL INTELLIGENCE		

- (ii) **Analysis of Structured Multiple Objective Questions:** The overall performance (the highest value/score) in each of the structured multiple objective questions that are relevant and related to the four unbundled programmes provides and determines further specific and relevant programme(s) for recommendations.

MATHEMATICAL MODEL FOR DATA ANALYSIS AND DATA MINING

The above collected and analyzed data (Course Categories and test performance) recommend relevant unbundled programmes with the adoption of data mining operation by applying the principle of “elements satisfying a condition” in set theory, using a mathematical model below:

A student T just finished National Diploma in Computer Science and needs to choose a programme of study from the unbundled HND Computer Science. However, a career recommendation system considers: (three favourite courses from the National Diploma programme in Computer Science and performance in the structured multiple objective questions test) to recommend a suitable programme for student T. With the application of set theory, we have domain Sets:

Unbundled Computer Science Programmes, $J = \{j_1, j_2, j_3, \dots, j_k\}$
 Favourite ND Courses, $S = \{s_1, s_2, s_3\}$
 Structured Test Result, $Q = \{q : q = (M \times 100)/C\}$

By applying the principle of “elements satisfying a condition” in set theory, each parameter in the domain sets gives:

Case 1: Recommended Unbundled Programmes from $j \in J$ by $s \in S$

$\Rightarrow X = S(x) = \{x_1, x_2, x_3, \dots, x_i ; i < k\}$
 \Rightarrow (List of Unbundled Computer Science Programmes filtered out from $J = \{j_1, j_2, j_3, \dots, j_k\}$ by $S = \{s_1, s_2, s_3\}$)
 $\Rightarrow X \subseteq J \quad \Rightarrow S(x) \subseteq J$

Let $J = \{j_1, j_2, j_3, \dots, j_k\} =$ (List of all Unbundled Computer Science Programmes) = {Networking and Cloud Computing, Software and Web Development, Cyber Security and Data Protection, Artificial Intelligence}

Let $S = \{s_1, s_2, s_3\} = \{COM 123, COM 214, COM 221\} =$ {Three favourite courses selected by student T}

\Rightarrow Category A courses are more than Category B courses, That is: Category A > Category B

Therefore, Recommended relevant unbundled programmes from $j \in J$ by $s \in S$

$\Rightarrow X = S(x) = \{x_1, x_2, x_3, \dots, x_i ; i < k\}$
 \Rightarrow {Networking and Cloud Computing, Cyber Security and Data Protection}

Working Memory/Database: The database includes a set of facts used to match against the IF (condition) parts of rules stored in the knowledge base (Michael, 2005).

Inference Engine: This is the main processing component of the expert system that is responsible for gathering information from the user. It seeks relationships from the knowledge base by interpreting, examining and evaluating the rules in the knowledge base to provide answers, predictions, suggestions from the rules in the knowledge base. When rules are examined by the inference engine, actions are executed if the information supplied by the user satisfies the conditions in the rules.

User interface: The user interface is the means of communication between a user seeking a solution to the problem and an expert system. The communication should be as meaningful and friendly as possible (Michael, 2005). This is the platform by which the user interacts with the expert system. A dialogue is conducted by the user interface between the user and the system.

(ii) System Design Architecture

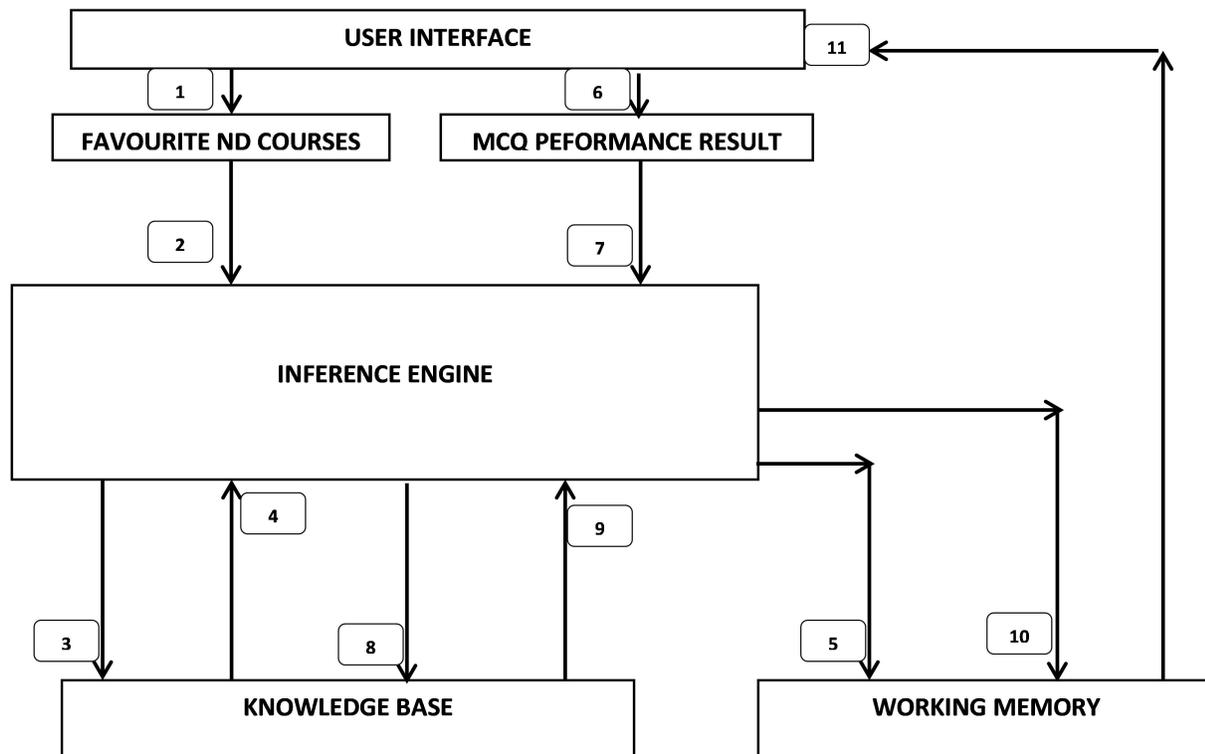


Figure 2: Architecture of the Web-Enabled Career Path Guidance System

KEY:

1. User supplies three favourite ND Computer Science Courses through the user interface.
2. The inference engine captures, evaluates and examines the supplied favourite Courses.
3. The inference engine matches the captured, evaluated and examined favourite Courses with the appropriate rule in the knowledge base.
4. The inference engine fires/triggers/executes the matched rule in the knowledge base.
5. The fired/triggered rule selects the relevant unbundle programme(s) from all the four unbundled
 - i. programmes in the working memory and also stores the selected relevant unbundled
 - ii. programme(s) in the working memory.
6. User supplies answers to structured multiple questions through the user interface, and result of the performance is obtained.
7. The inference engine captures, evaluates and examines the result of the performance.
8. The inference engine matches the captured, evaluated and examined result of the performance with the appropriate rule in the knowledge base.
9. The inference engine fires/triggers/executes the matched rule in the knowledge base.
10. The fired/triggered rule selects the most relevant unbundled programme(s) from the stored
 - i. relevant unbundled programme(s) in (5) above and also stores the selected most relevant
 - ii. unbundled programme(s) in the working memory.
11. The selected and stored most relevant unbundled programme(s) in (10) above is/are displayed as recommendation to the user through the user's interface.

(iii) System Design Algorithm: Forward Chaining Algorithm

Forward chaining algorithm is a pattern matching algorithm that provides a generalized logical description of an implementation of functionality (inference engine) responsible for matching data or facts against productions (rules) in a production rule system. It is primarily used to determine which of the system's rules should fire based on its data store. This involves assigning values to attributes, evaluating conditions, and checking to see if all the conditions in a rule are satisfied.

(iii) System Design Flowchart
(iv)

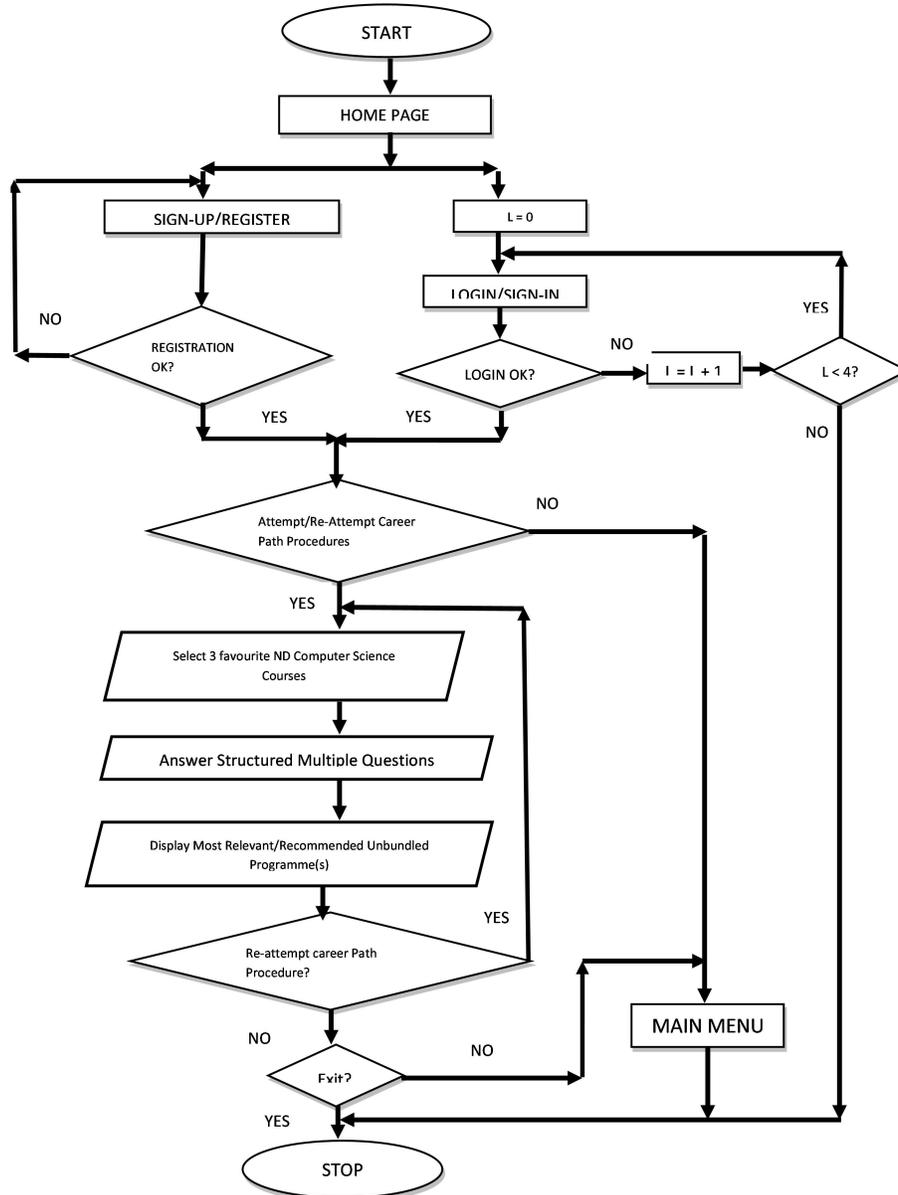


Figure 3: Flowchart of the Web-Enabled Career Path Guidance System

(v) Input Design

This describes various inputs to the system that are needed for the output to the user. The input to the system from the client/user side is majorly the user’s actions and responses on the web pages of the system website. The actions and responses involve the user’s interaction with the system by clicking on menus and hyperlinks, as well as selecting the relevant and appropriate answers to questions in the career path procedure. The user’s web page response to questions on selection of three favourite ND courses in computer science was designed using list box, and out of all ND courses in computer science, only three favourite courses can be selected. Also, the user’s web page response/answers to structured multiple questions was designed using radio buttons whereby for each question only one correct answer option out of the three answer options can be picked.

(vi) Output Design

The output is what the user will see on the screen, it contains the outcome of the processed data/input. The output design is projected inform of interface which is interactive with the users, the interface is projected using the Hypertext Transfer Protocol (HTTP).

(vii) Storage Design

The system was designed to have a fully dynamic and functional database created using XAMPP and queried using MySQL. The Career Path Guidance System has a database named *student_career_guide* which has eleven tables named: *admins*, *students*, *departments*, *categories*, *nd_courses*, *student_course_selection*, *evaluation_questions*, *department_scores*, *evaluation_tests*, *students_courses*, *recommendations*. The ***admins*** table consists of the registration/login information about the system administrator that has the access to the database backend for the purpose of management of the entire database structure. The table 3 below shows the various field names, data types, and field sizes in the ***admins*** table.

Table 3: The *admins* table.

FIELD NAME	DATA TYPE	DATA SIZE
id	INT	11
fullname	VARCHAR	100
email	VARCHAR	100
password	VARCHAR	50
role	enum	

The ***students*** table consists of the registration/login information about the users (students). The table 4 below shows the various field names, data types, and field sizes in the ***students*** table.

Table 4: The *students* Table

FIELD NAME	DATA TYPE	DATA SIZE
Id	INT	11
full_name	VARCHAR	100
email	VARCHAR	100
password	VARCHAR	50
role	enum	20
profile_image	VARCHAR	255
nd_result	VARCHAR	255

The *departments* table consists of the unbundled programmes in computer science in the NBTE curriculum. The table 5 below shows the various field names, data types, and field sizes in the *departments* table.

Table 5: The *departments* Table

FIELD NAME	DATA TYPE	DATA SIZE
id	INT	11
department_name	VARCHAR	255
category_id	INT	11

The *categories* table consists of grouping of the unbundled programmes in relation and accordance to all the courses relevant to ND computer science in the NBTE curriculum. The table 6 below shows the various field names, data types, and field sizes in the *categories* table.

Table 6: The *categories* Table

FIELD NAME	DATA TYPE	DATA SIZE
id	INT	11
category_name	VARCHAR	255

The *nd_courses* Table consists of all the courses relevant to computer science in the NBTE curriculum. The table 7 below shows the various field names, data types, and field sizes in the *nd_courses* table.

Table 7: The *nd_courses* Table

FIELD NAME	DATA TYPE	DATA SIZE
id	INT	11
course_name	VARCHAR	255
category_id	INT	11
category	enum	

The *student_course_selection* table consists of the three most favourite courses selected by the student from the list of all the courses relevant to computer science in the NBTE curriculum. The table 8 below shows the various field names, data types, and field sizes in the *student_course_selection* table.

Table 8: The *student_course_selection* table.

FIELD NAME	DATA TYPE	DATA SIZE
id	INT	11
student_id	INT	11
course1_id	INT	11
course2_id	INT	11
course3_id	INT	11
recommended_category_id	INT	11

The *evaluation_questions* table consists of all the structured multiple objective questions that are relevant and related to the four unbundled programmes, with two hundred (200) objective questions in the question bank, with each of the unbundled programme having fifty (50) questions. The table 9 below shows the various field names, data types, and field sizes in the *evaluation_questions* table.

Table 9: The *evaluation_questions* table.

FIELD NAME	DATA TYPE	DATA SIZE
id	INT	11
category_id	INT	11
department_id	INT	11
question	text	
option_a	VARCHAR	11
option_b	VARCHAR	11
option_c	VARCHAR	11
option_d	VARCHAR	11
correct_option	enum	

The *department_scores* table consists of the score obtained in each of structured multiple objective questions attempted by the student. The table 10 below shows the various field names, data types, and field sizes in the *department_scores* table.

Table 10: The *department_scores* table.

FIELD NAME	DATA TYPE	DATA SIZE
id	INT	11
test_id	INT	11
department	Enum	
score	INT	11

The **evaluation_tests** table consists of the total score obtained in the relevant category of the structured multiple objective questions attempted by the student. The table 11 below shows the various field names, data types, and field sizes in the **evaluation_tests** table.

Table 11: The evaluation_tests table.

FIELD NAME	DATA TYPE	DATA SIZE
id	INT	11
student_id	INT	11
Category	Enum	
Attempt	INT	11
total_score	INT	11

The **students_courses** table consists of the recommendations of the category of unbundled programme obtained from the three most favourite courses selected by the student from the list of all the courses relevant to computer science in the NBTE curriculum. The table 12 below shows the various field names, data types, and field sizes in the **students_courses** table.

Table 12: The students_courses table.

FIELD NAME	DATA TYPE	DATA SIZE
id	INT	11
student_id	INT	11
recommended_category_id	INT	11
recommended_department_id	INT	11
course_name	VARCHAR	200

The **recommendations** table consists of the final recommended most relevant unbundled programme after the students had selected the three most favourite courses from the list of all the courses relevant to computer science in the NBTE curriculum, in conjunction with the department score obtained in each of the relevant category of the structured multiple objective questions attempted by the student. The table 13 below shows the various field names, data types, and field sizes in the **recommendations** table.

Table 13: The recommendations table.

FIELD NAME	DATA TYPE	DATA SIZE
id	INT	11
student_id	INT	11
category	enum	
Department	VARCHAR	200
final_score	INT	11
decision_note	text	

(viii) System Development Platform

The development is being carried out on a system running Microsoft Windows 7 Ultimate platform / Microsoft Windows 8 platform. Being a responsive web application, the client-side/user/web interface pages were encoded and developed using “Bootstrap 3” front-end framework for (cross-platform/responsive-web). The “Bootstrap 3” contains HTML5 (Hyper Text Markup Language), CSS3 (Cascade Style Sheet), and JavaScript. For the back-end, XAMPP was used as web server with support for PHP as a scripting language and MySQL for working memory functional database.

6. SYSTEM IMPLEMENTATION AND DISCUSSION OF RESULTS

In order to evaluate the performance of the Development of a Web-Enabled Expert System for Career Path Guidance of the Unbundled Computer Science Programme in the Nigerian Polytechnics, the system was implemented with pilot test involving the targeted users (prospective HND students), which are the applicants. The motive of the implementation/evaluation was to check the accuracy and reliability of the system. In the implementation, the software was hosted on the internet with the web link <https://career.afd.ng>, and all modules of the system were tested and executed as explained below.

Home Page: The Home page is the first page that a user (prospective HND student) sees when the application is launched with the web link <https://career.afd.ng> as shown in the figures 4a and 4b below. The home page details the general information about the system, and also the perspective of the prospects of each of the programme of the unbundled HND Computer Science. Also, the buttons to create user’s account and login to the system is located at the home page. Any new user (prospective HND student) creates account, while an existing user (prospective HND student) has to login.

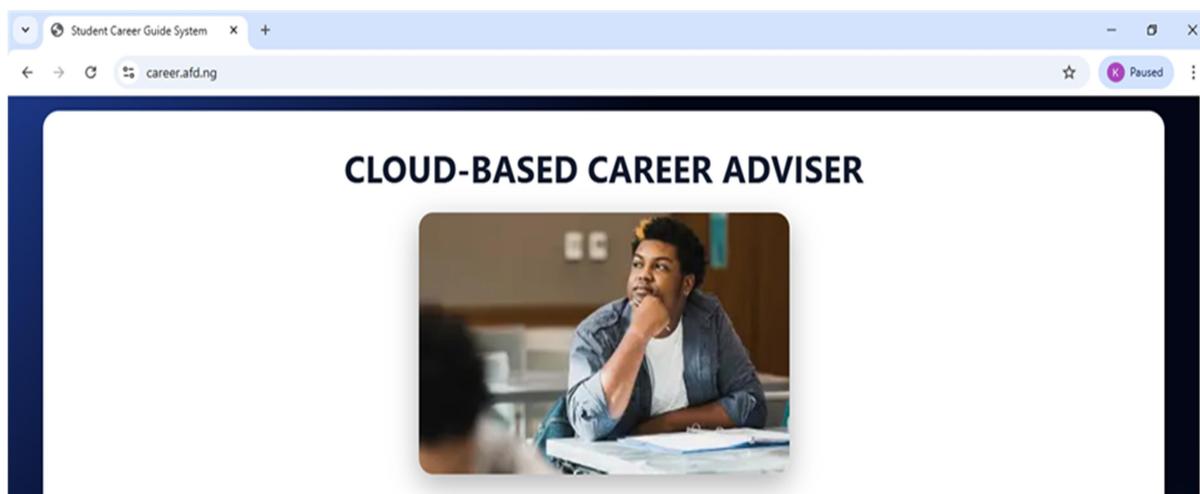


Figure 4a: The Application Home Page



Figure 4b: The Application Home Page

Registration/Login Page: The registration page has shown in figures 5a and 5b below allows any new user (prospective HND student) to create an account, while an existing user (prospective HND student) has to login.

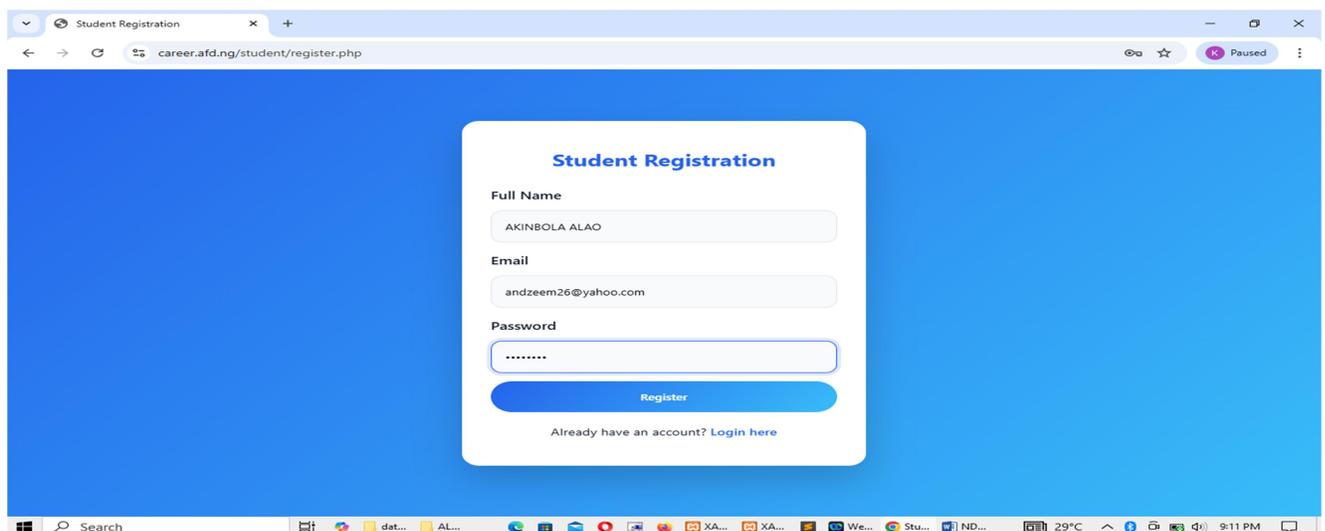


Figure 5a: Applicant Registration Page

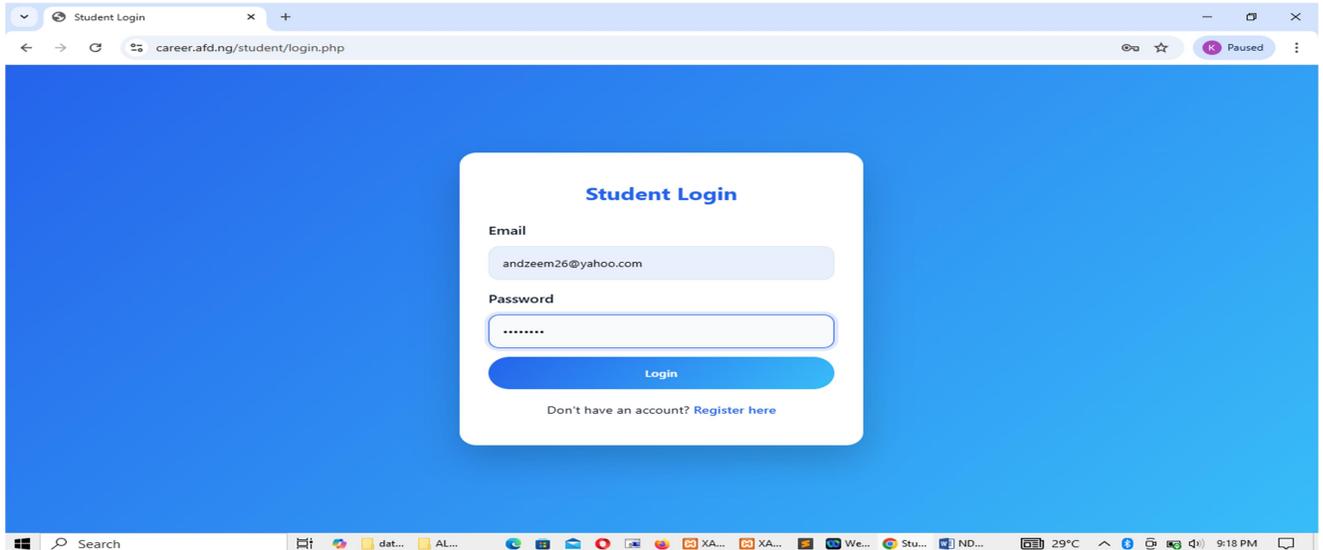


Figure 5b: Applicant Login Page

User Dashboard Menu Page: The user's dashboard menu page shown below in figure 6a serves as the functionality interface where a user can manage and update record, and also undergo the career evaluation procedure. The interfaces for various functions are the dashboard menu are displayed below in figures 6b, 6c and 6d.

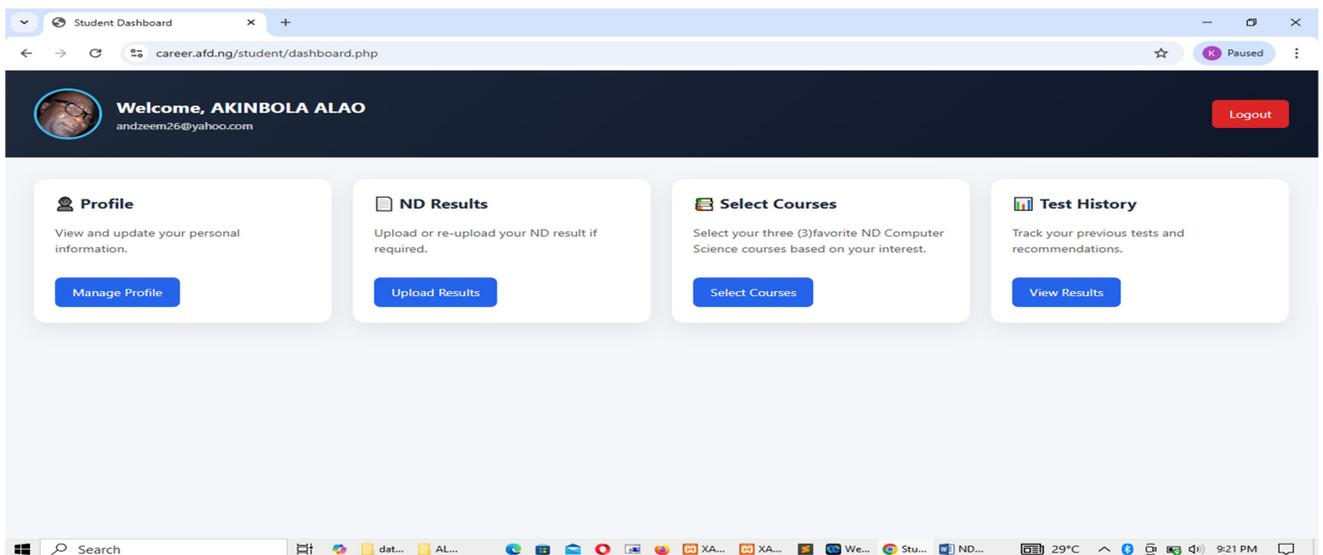


Figure 6a: User Dashboard Menu

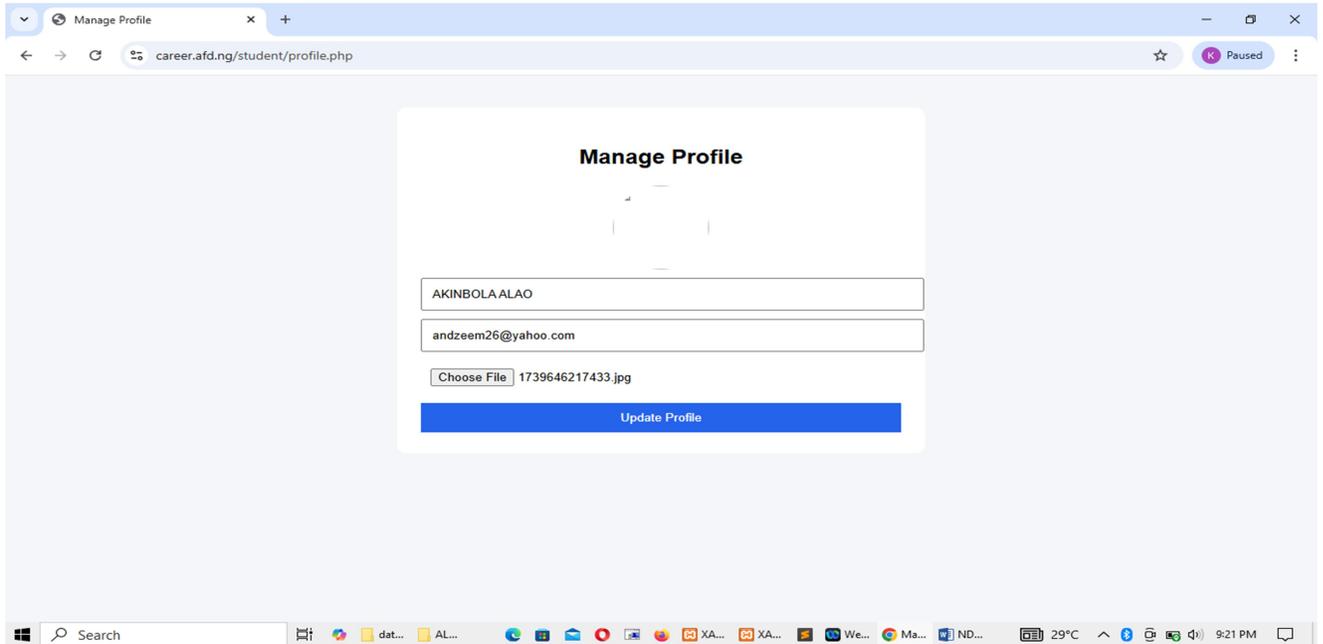


Figure 6b: Profile Management Page

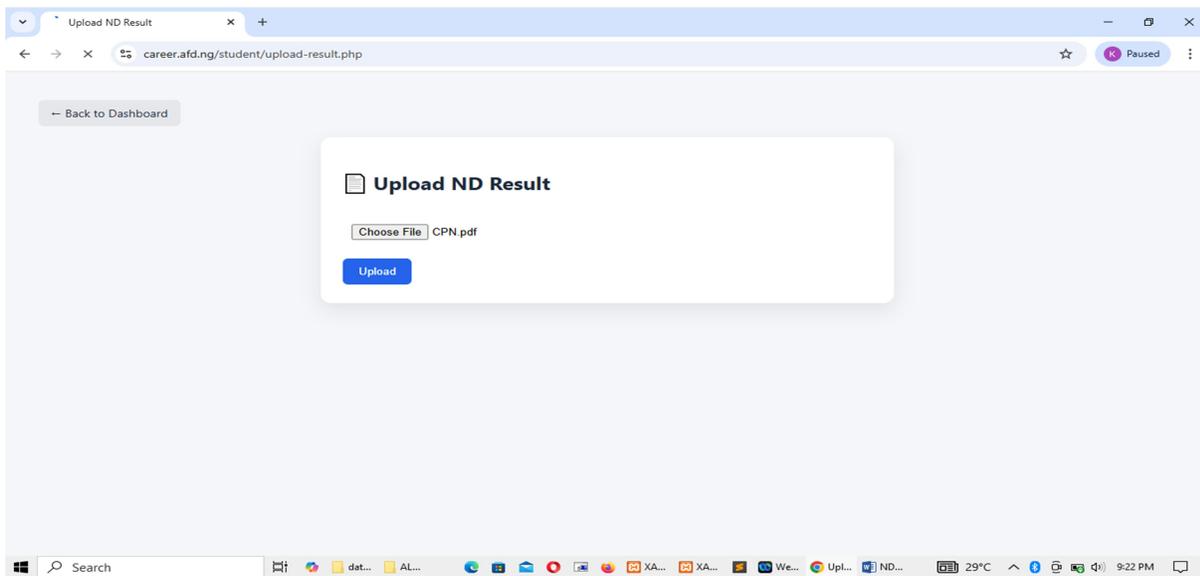


Figure 6c: Result Upload Page

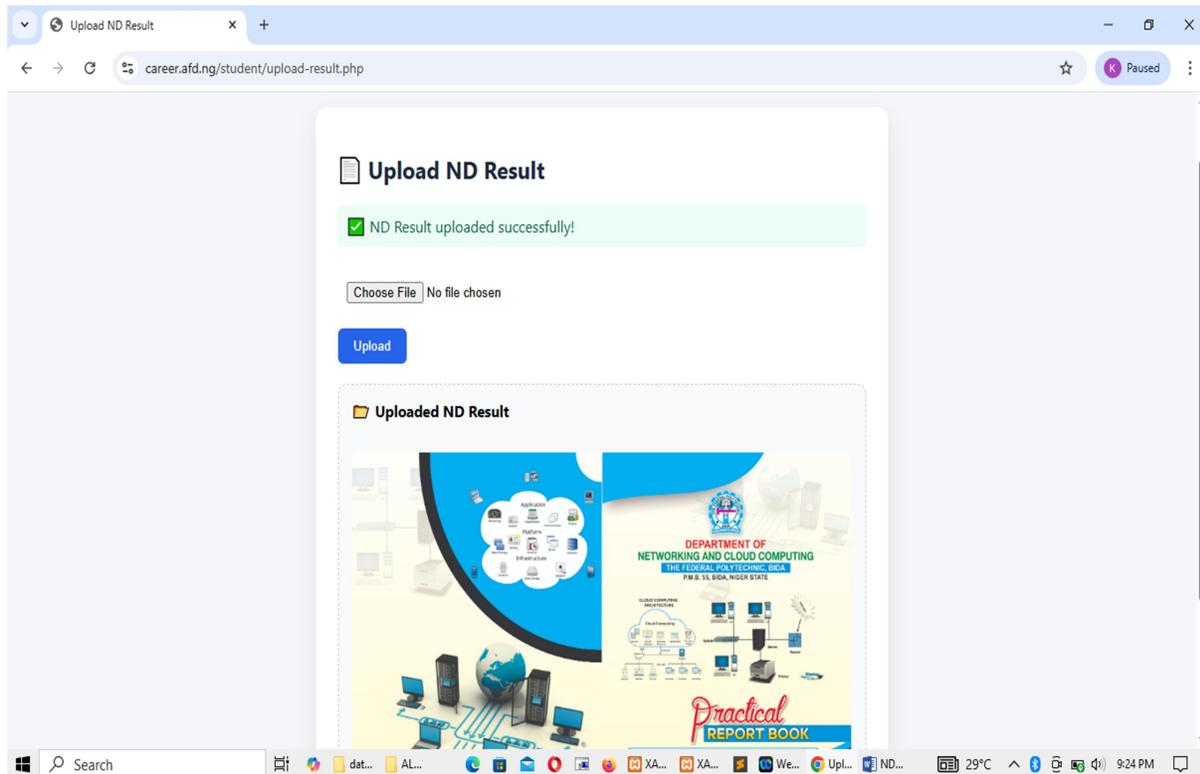


Figure 6d: Successful Upload of Result Page

Career Path Evaluation Pages:

(a) Selection of Most Favourite Courses in National Diploma Computer Science

This is the first stage of the career path evaluation procedure, and the pages shown below in figures 7a and 7b allow the user to select three most favourite courses out of all the offered courses at the National Diploma Computer Science. This three most favourite courses combination is used to filter out most two relevant programmes out of the unbundled HND programmes.

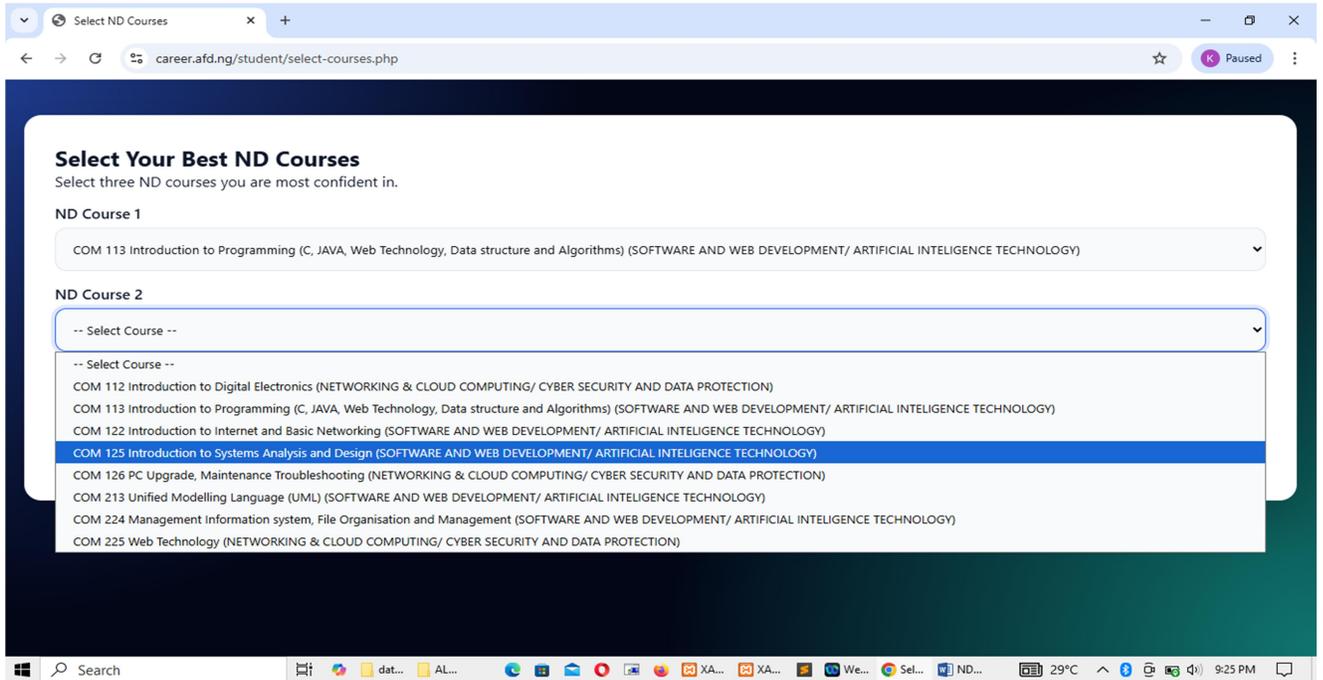


Figure 7a: Selection of Favourite Courses

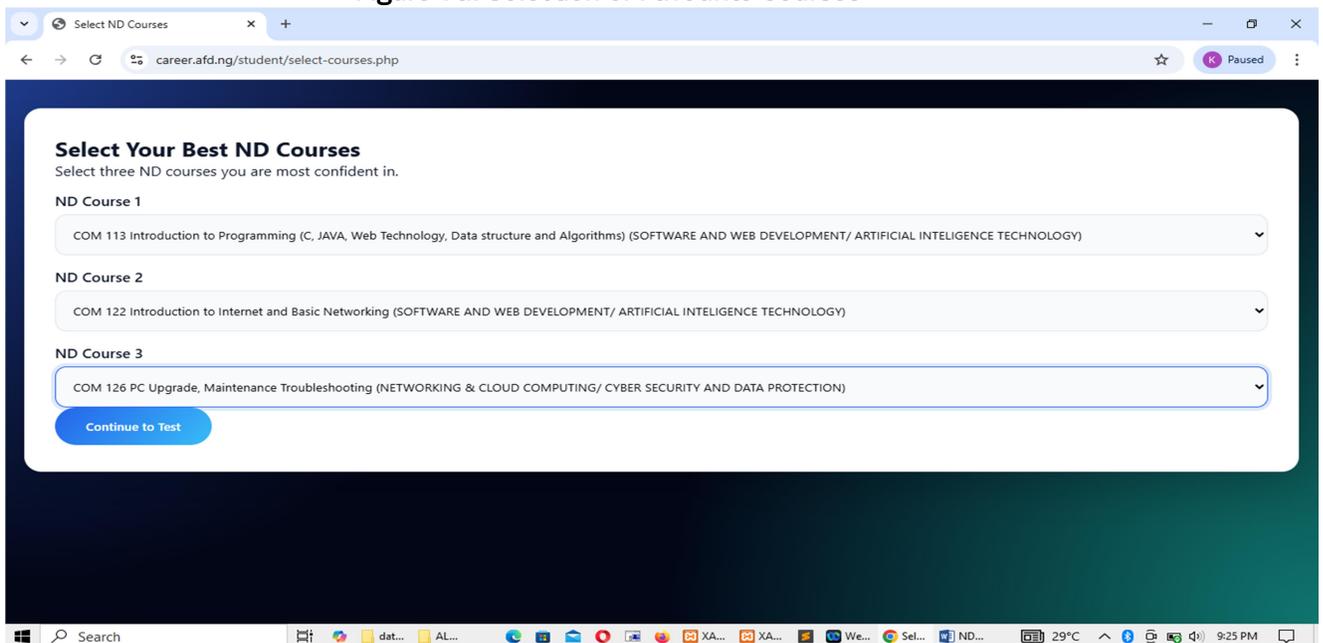
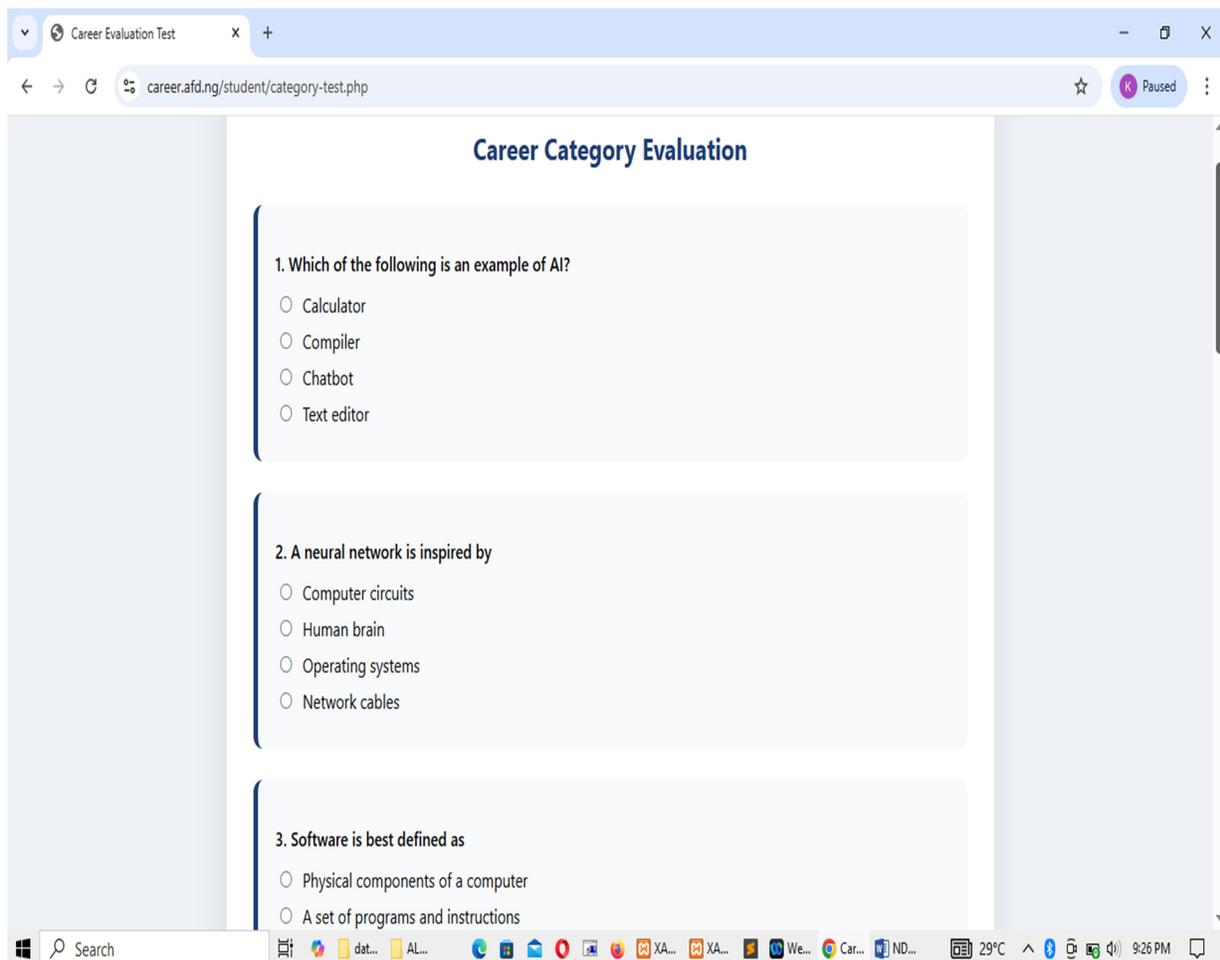


Figure 7b: Selected Favourite Courses

(b) Structured Multiple Objective Questions Page

This is the second stage, where the user attempt at least ten (10) randomly selected structured multiple objective questions to assess the knowledge and understanding of each of the unbundled programme to aid the relevant programmes recommendations.

The pages displayed below in figures 8a, 8b, 8c are the samples structured multiple objective questions. The overall performance (the highest value/score) in each of the structured multiple objective questions that are relevant and related to the four unbundled programmes provides and determines further, the specific and relevant programme(s) for recommendations.



The screenshot shows a web browser window with the address bar displaying 'career.afd.ng/student/category-test.php'. The page title is 'Career Category Evaluation'. The content consists of three multiple-choice questions, each with four options:

1. Which of the following is an example of AI?
 - Calculator
 - Compiler
 - Chatbot
 - Text editor
2. A neural network is inspired by
 - Computer circuits
 - Human brain
 - Operating systems
 - Network cables
3. Software is best defined as
 - Physical components of a computer
 - A set of programs and instructions

Figure 8a: Sample of randomly selected structured multiple objective questions

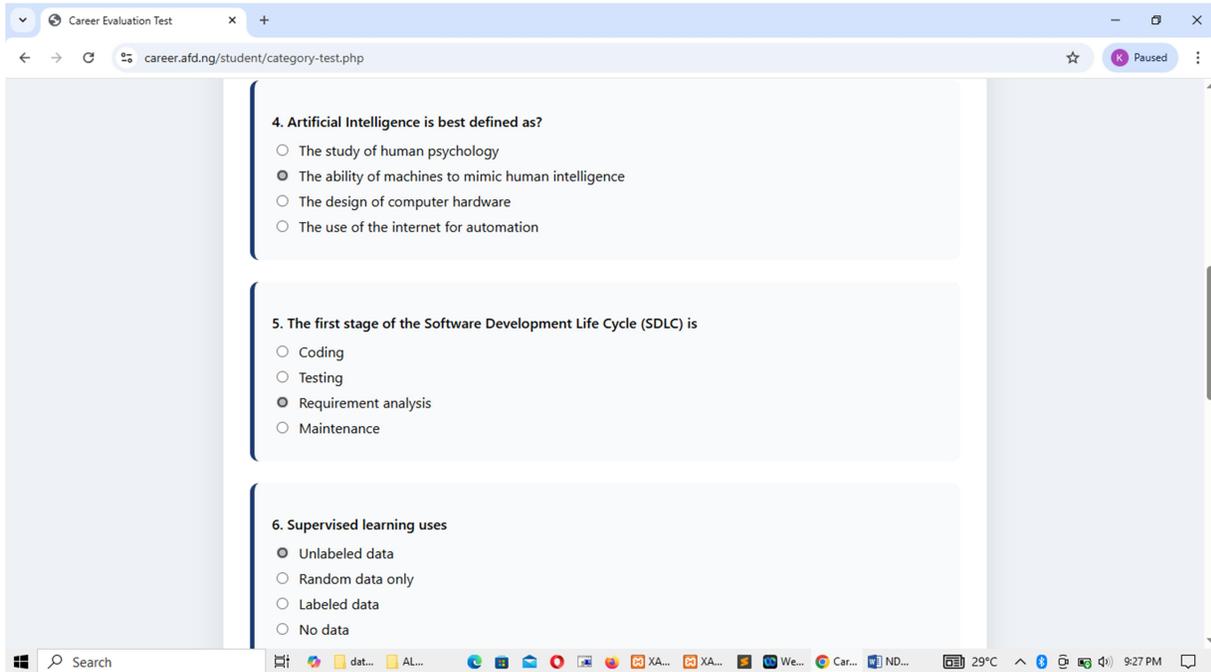


Figure 8b: Sample of randomly selected structured multiple objective questions

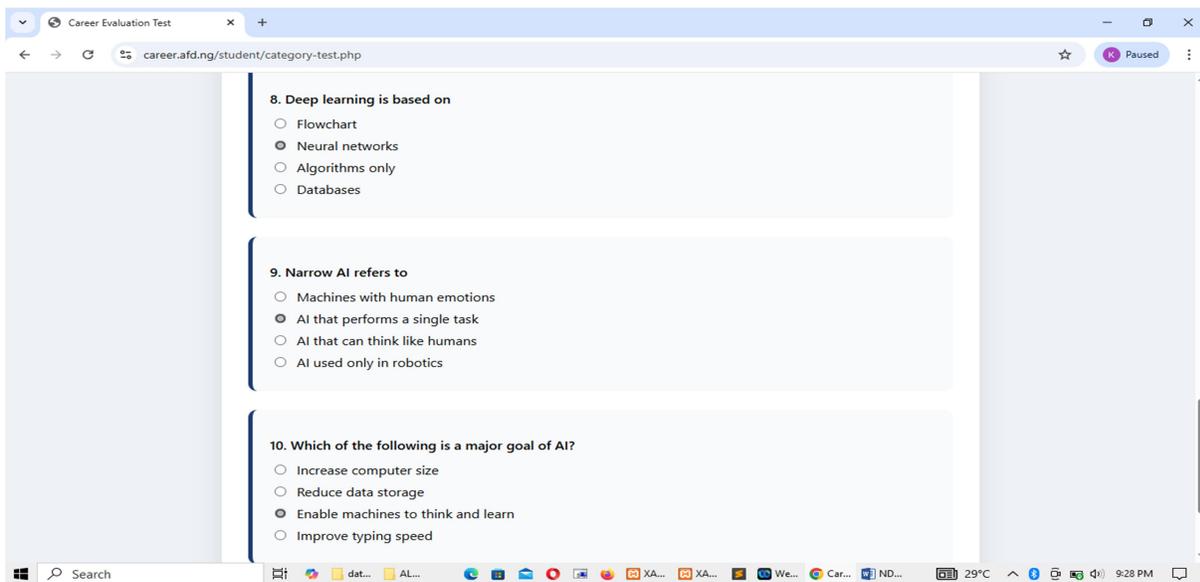


Figure 8c: Sample of randomly selected structured multiple objective questions

(v) Recommended Programme(s) Page

These pages as shown in figure 9 is the final result of the recommended most relevant unbundled programme(s) obtained after the user had undergone the career path evaluation tests (i.e **Selection of Most Favourite Courses in National Diploma Computer Science and attempt of Structured Multiple Objective Questions**). A click on any of the recommended programme(s) displays information on brief description about the programme(s) and the relevant career prospects.

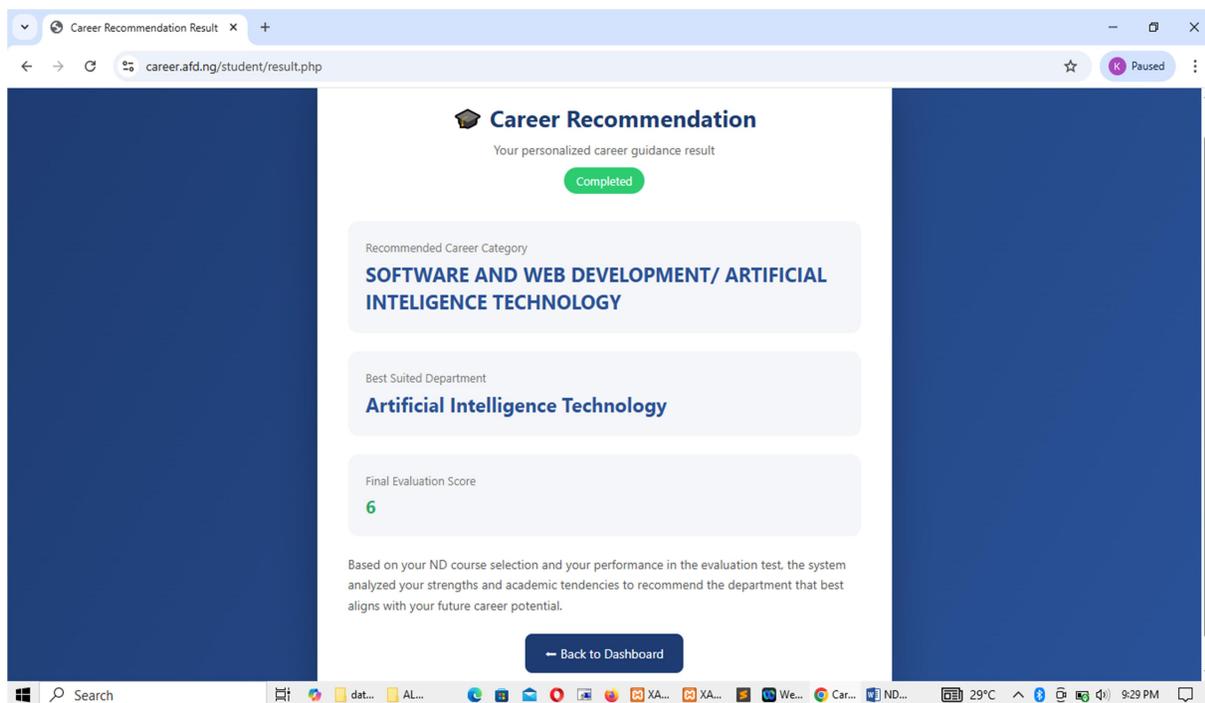


Figure 9: Sample of Recommended Programme(s) Page

7. CONCLUSION AND RECOMMENDATIONS

This research into the **Development of a Web-Enabled Expert System for Career Path Guidance of the Unbundled Computer Science Programme in the Nigerian Polytechnics** has achieved the deployment of a web-driven expert system model where the prospects and professional skills/requirements of the unbundled HND Computer Science programmes are domiciled and guides the prospective students of HND in decision making of selecting a suitable career option in the various options (Software and Web Development, Cyber Security, Artificial Intelligence Technology, Networking and Cloud Computing) of the unbundled Computer Science programme by interacting electronically for guidance and recommendations at anytime, anywhere and on any device (desktop, laptop, mobile/smart phones).

It is thereby recommended that the prospective HND students of the unbundled computer science explore and maximize the usage of the system for proper guidance as they make decision in the choice of programme in the unbundled computer science, this total exploration and maxima usage of the system can be readily achieved by the integration of the system into the registration portal of all polytechnics, where the prospective students can easier accessibility to the application.

Acknowledgement

Appreciation goes to the Tertiary Education TrustFund (TETFUND), Management of The Federal Polytechnic, Bida, Niger State Nigeria, the Directorate of Research and Publication of The Federal Polytechnic, Bida, Niger State, Nigeria for the financial support received to carry out the execution of this research under the Institution Based Research (IBR).

REFERENCES

1. Abhishek, P., & Akansha, A. (2013). Inference Engine: Brief Introduction on Inference Engine in Expert System. <http://www.slideshare.net/AbhishekPachisia/inference-engine>.
2. Abisoye, O. A., Alabi, I., Ganiyu, S. O., Abisoye, B. O., & Omokore, J. (2015). A Web- Based Career Guidance Information System for Pre-Tertiary Institutions Students in Nigeria. *The International Journal of Scientific Research in Science, Engineering and Technology*, Vol. 1, Issue 3.
3. Alao, K. A., Bolarinwa, I. A., Kuboye, B. M. & Ibam, O. E. (2017). Development of a Web-Based Intelligent
4. Career Guidance System for Pre-Tertiary Science Students in Nigeria”. An Article Published online by the
5. Circulation in Computer Science (CCS Journal), Computer Science Laboratory (CSL) Press, New York, NY 10282, USA. Vol. 2, No 8, pp (4-17).
6. Ankit, M., Ashutosh, S., Sunil, K. S., Pardeep, K., & Durg, S. C. (2014). Decision Support System for Determining: Right Education Career Choice. *Elsevier*, Vol. 4, No.1, pp. 8 – 174.
7. Balogun, V. F., & Thompson, A. F. (2009) Career Master: A Decision Support System (DSS) for Guidance and Counselling in Nigeria. *The Pacific Journal of Science and Technology*, Vol. 1, No. 2.
8. Chathra, H., Maheshika, D., Savinndhi, S., Narmada, W., Anusha, R., & Asoka, S. K. (2006). Artificial Intelligence Approach to Effective Career Guidance. *Sri Lanka Association for Artificial Intelligence (SLAAI), Proceedings of the third Annual Sessions*.
9. Marilyn, L. (2015). Ten Tips for Choosing a Career, *Demand Media, Demand Media, Hearst Newspapers, LLC*. Houston Chronicle, P. O. Box 4260 Houston, Texas 77210-4260. <http://work.chron.com/ten-tips-choosing-career-2065.html>
10. Mopelola, O., & Benjamin, B. (2013). Career Guidance for Nigerian Students: Why Career is Becoming more difficult https://cdnetng.org/?q=welcome_secondary_school
11. Muhammad, Z. A., & Nasimullah, A. R. K. (2011). A Proposed Decision Support/Expert System for Guiding Fresh Students in Selecting a Faculty in Gomal University, Pakistan. *Industrial Engineering Letters*, Vol. 1, No. 4.

12. Ojenge, W., & Muchemi, L. (2008). Career Guidance Using Expert System Approach. *Strengthening the Role of ICT in Development*. Available on www.academia.edu/2643353/Career_Guidance_Using_Expert_System_Approach.
13. Rabiatal, A. B. I. (2006). Career Guidance System for Secondary School Students in Malaysia. *Faculty of Information Technology and Quantitative Science, Universiti Teknologi, MARA, Malaysia*.
14. Saraswathi, S., Hemanth, M. K. R., Udaya, S. K., Suraj, M., & Khaja, S. K., (2014). Design of an Online Expert System for Career Guidance. *The International Journal of Research in Engineering and Technology*, Vol. 03, Special Issue 07.
15. Taiwo, K., & Joshua, K. (2015). Career Guidance Through Admission Procedures in Nigerian Universities Using Artificial Neural Networks. *International Journal of Advanced Research in Computer Science and Software Engineering*, Vol. 5, Issue 9, pp. 427-433.