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## A Web-Enabled Expert System for Academic Guidance of Students in Federal Polytechnic Bida, Niger State

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### ABSTRACT

Students in tertiary institutions are faced with one academic challenges or the other, such as number of courses credits/units carrying capacity, computation of GPA/CGPA, carry- over/adding and dropping of courses, post-semester of courses, and spill-over of courses. These challenges may be simple or complex, but if not adequately addressed, then the students are likely to be wrongly advised and not properly guided. The students of the Department of Computer Science, Federal Polytechnic Bida are in the categories of students facing such problems. Advising and guiding these students for proper decision making involves many approaches, which are not effective, because of manual processes that involve large population of students meeting the examination officers and course advisers. With this ineffectiveness, this research therefore developed an expert system that will be more effective and accurate in advising and guiding these students for proper decision making. The system would be used independently at anytime, anywhere, and on any devices because of its web-based nature. The development of the system was achieved with the use of Forward-Chaining Algorithm of Rule- Based Expert System, the system was developed with XAMPP as the local server, with web development tools such as PHP scripting language used for the backend, CSS for the frontend, MySQL as the functional database. The implementation of the system is expected to give better data analysis and ease the decision-making process for an effective academic guidance of the students.

**Keywords:** Academic, Advisers, Decision-Making, Expert Systems, Guidance, Web-Based.

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#### Journal Reference Format:

Onuoha, E. C. & Alao, K. A. (2023): A Web-Enabled Expert System For Academic Guidance Of Students In Federal Polytechnic Bida, Niger State. *Journal of Behavioural Informatics, Digital Humanities and Development Research*. Vol. 9. No. 2, Pp 9-26  
Available online at <https://www.isteam.net/behavioralinformaticsjournal>.

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### I. INTRODUCTION

Decision making on challenging issues is a very complex process that needs to be properly addressed. Such decision making in academic challenges is common today in our tertiary institutions. These challenges may be simple or complex, but if not adequately addressed, the students can wrongly be advised, then not properly guided. Students in tertiary institutions are faced with one academic

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challenge or the other, such as credit/unit carrying capacity, computation of GPA/CGPA, carry-over/adding and dropping of courses, post-semester, spill-over of courses, and possible grade accumulation for increased CGPA.

The students of the Department of Computer Science, Federal Polytechnic Bida are in the categories of students facing such problems. Advising and guiding these students for proper decision making involves many approaches, which are currently not effective, because of manual processes of meeting the examination officers and course advisers. A decision support and expert systems are some of the approaches that can be used to address these problems. An electronic approach (Expert System) can help and save time in providing fast expert advice based on the knowledge from its domain knowledge base component (Saraswathi, Hemanth, Udaya, Suraj & Khaja, 2014). 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 as cited in Abisoye, Alabi, Ganiyu, Abisoye & Omokore, 2015).

Many systems have been developed to address these issues, but the systems are found to be ineffective because they are not student-driven. With this ineffectiveness, a decision support expert system is developed to guide students more effectively and accurately for proper decision making. The system is used independently online at anytime, anywhere, and on any device (desktop, laptop, mobile phones, smart phones) because of its web-based nature. The deployment of this student-driven web-based decision support system for students of Computer Science Department for academic guidance, counselling and decision making in their academic challenges gives a better data analysis, ease the decision-making process by effectively and accurately guides these students.

### **1.1 Statement of Problem**

The manual process of meeting the examination officer and the course advisers for academic guidance in the department of Computer Science of the Federal Polytechnic Bida is ineffective and inaccurate as a result of too much workload on the hands of the examination officers which made it not possible to have enough time to advise and guide students in their academic challenges. Also, the large population of students to be attended to by the course advisers makes it impossible to attend to them as adequate as possible. In addition, some students have the fear of having close contact interactions with examination officers and the course advisers.

### **1.2 Research Aim and Objectives**

The aim of the research is to develop a web-enabled decision support system for students' academic guidance and counselling, in the Department of Computer Science, The Federal Polytechnic Bida Niger State, and the objectives are;

1. To get relevant data for academic guidance and counselling.
2. To create database for relevant data and information used for the purpose of students' academic guidance and counselling.
3. To provide a platform and implement a user-friendly interface for students to independently have online academic guidance and counselling at anytime, anywhere, and on any device (desktop, laptop, mobile phones, smart phones).

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## 2. LITERATURE REVIEW

### 2.1 Academic Guidance and Counseling

Guidance according to (Abisoye *et al*, 2015) is described as advising or helping an individual with any kind of educational, vocational or personal problem. The term guidance, is defined in a variety of ways as follows: Welty, Tural, and Weitzel (2009) define guidance as “a systematically organized phase of the educational process that helps a youth grow in his ability to give point and direction to his own life, in order for him to gain richer personal experiences in making his unique contribution to our democratic society.”

According to Egbo (2010), a counseling program should assist students in achieving two seemingly opposing goals: societal adjustment and freedom to operate as distinct individuals. According to Alutu (2007) and Gesinde (2008), guidance is a comprehensive system of services and programs in schools designed to affect students' personal development and psychological competencies. Aremu (2002) and Omoni (2009) describe guidance as an all-encompassing concept that promotes a deeper understanding of an individual or group of individuals with the purpose of offering expert support to a person. From the collection of definitions, it appears that guidance is a professionally structured program intended to assist individuals in making individual adjustments in school, at home, in the workplace, and in society in order to achieve optimal human performance. It's a cognitive educational service (within or outside of the school system) that helps people understand themselves if the client gives correct, dependable, and valid information about himself and his surroundings.

The following are the three main components of guidance and counseling in a school setting: -

- (i) Educational Guidance
- (ii) Vocational Guidance
- (iii) Personal–social guidance

### 2.2 Expert Systems

An expert system is a computer system that holds a huge quantity of data and can make decisions in the same way that a human can. An expert system is a knowledge base with domain knowledge and inference rules based on human expertise (Kumar, Gurram & Srinath 2018). Expert systems are designed to solve a wide range of complex problems that would be impossible for a human to solve. It is mostly represented by if-then rules and solves large difficult issues by reasoning via knowledge. These are the first successful machines created using artificial intelligence (AI) methods.

The knowledge of a human expert is represented in heuristic form by an expert system. The primary idea behind an expert system is to store a human expert's knowledge in a machine and use it whenever it is needed. The knowledge base and the inference engine are the two pieces of this expert system. The first element of the knowledge base is made up of facts and rules. The inference engine, which is the second element, uses these facts to improve new facts based on existing facts. Forward chaining and backward chaining are the two modes of the inference engine. The expert system's overall operation is depicted in the diagram below.

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### 2.3 Review of Related Works

In Gomal University, Pakistan, an expert system was developed to assist new students in choosing a faculty. CLIPS Language was used to create the rule-based Decision Support System. Based on the outcomes of the module examinations, the Decision Support Expert System assesses the student's strengths and proposes the optimal faculty. The fact that it is a stand-alone and customized Decision Support Expert System is a drawback (Muhammad & Nasimullah 2011). Naini, Sadasivam and Tanik (2008) use the Java framework to create a web-based interactive student advising system for course plan selection and registration. Pokraja and Rasamny (2006) describe in VESStA, an expert system that advises students on which courses they should take next. The recommender system also creates a semester timetable based on the semester's courses and students' curricula.

Bansal, Cline, Rangel and Zunke (2003) describe KRAK, a web-based advising system aimed at assisting students in customizing their college study paths, with advisers serving as mentors. It allows students to plan their whole degree, schedule semesters, and access information about courses, professors, and universities. O'Mahony and Smyth (2007) present a collaborative course recommender system that assists students in selecting elective modules based on the core modules they have selected. In circumstances where no spaces are available or scheduling disputes occur, a "More Like This" recommender suggests students take comparable modules to their first choice of electives.

Marques, Ding and Hsu (2001) describe a system that provides advisees with up-to-date online advising and related information, including a recommended list of courses for the following semester in order to fulfill degree requirements. The system contains a web-based main page where system users like students, instructors, and administrative personnel can visit their individual sites. The American University of Beirut (AUB) developed a web-based decision support tool for academic advising (Feghali et al, 2011). The survey between the Student Information System and the Online Adviser was conducted using a questionnaire. The online adviser is more effective and efficient than the student information system at the American University of Beirut. The preceding study has a flaw in that it is not student-driven.

## 3. RESEARCH METHODOLOGY

### 3.1 Data Collection

Data was collected from primary and secondary sources and analyzed to investigate the working of the current system. The review and study of the existing related web-based academic guidance systems. A face-to-face interview was conducted with the Examination officers and the course advisers to obtain relevant data and materials for the academic guidance. The new system was created using the rule-based expert system operating principle, which entails the employment of computer intelligent systems and electronic devices to advise weak student without having to meet with their course advisers/examination officers via client/server (web-based) computer hardware and software. The following major components make up an Expert System: knowledge base, working memory/database, inference engine, and user interface. The standard Expert System Architecture is depicted in Figure 1.

**Knowledge Base:** The domain knowledge which is used to issue solutions is stored in the knowledge base. The knowledge of a rule-based expert system is represented as a set of rules. The rules in the knowledge base are often organized as an IF—THEN construct, also known as a "production rule," with the following format: IF <antecedent> THEN <consequent>.

The antecedent is the requirement that must be met. The rule is triggered/fired when the antecedent is met. The action that is taken whenever the rule fires is known as the consequence.

**Working Memory/Database:** The database contains a set of facts that are matched against the knowledge base's IF (condition) parts of rules.

**Inference Engine:** This is the expert system's main processing component, and it's in charge of gathering data from the user. It looks for relationships in the knowledge base by interpreting, analyzing, and evaluating the rules in order to deliver answers, forecasts, and suggestions based on the knowledge base rules. When the inference engine examines rules, actions are taken if the information provided by the user meets the conditions in the rules.

**User Interface:** The user interface is the way by which a user seeking a solution to a problem communicates with an expert system. The user interface facilitates communication between the user and the system.

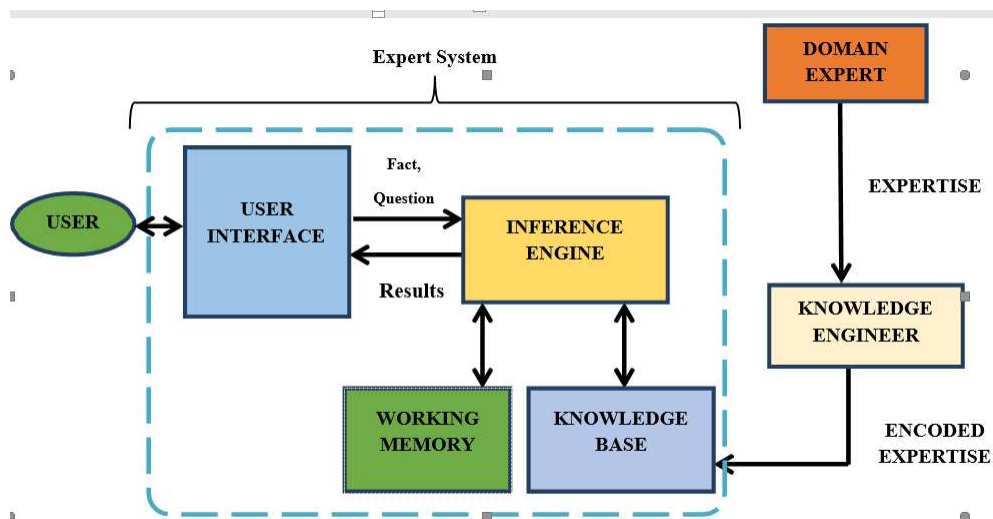


Figure 1: A Typical Expert System (Abhishek and Akansha 2013)

The expert system above operates with the data-driven principle of forward chaining 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.

### General Format/Pseudocode of Forward Chaining Algorithm

According to Griffin (1987) the general format of forward chaining algorithm is:

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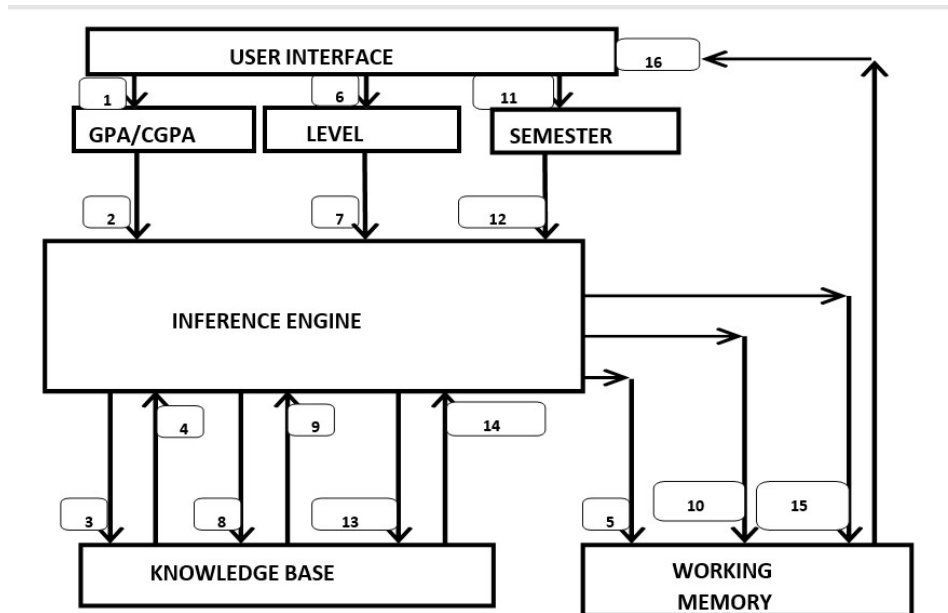
While values for attributes
    remain to be input read
    values and assign to
    attributes evaluate
    conditions
    fire rules whose
    conditions are satisfied
    execute actions
  
```

Step 1	=>	Attributes:	$X_1, X_2, \dots, X_n$
Step 2	=>	Conditions:	$C_1, C_2, \dots, C_n$
Step 3	=>	Rules:	$R_1, R_2, \dots, R_n$
Step 4	=>	Actions:	$A_1, A_2, \dots, A_n$

## THE SYSTEM DESIGN

### The System Architecture

The architecture of the system is as shown in figure 2 below. The architecture shows clearly the various tasks to be performed by the student that is seeking academic guidance.



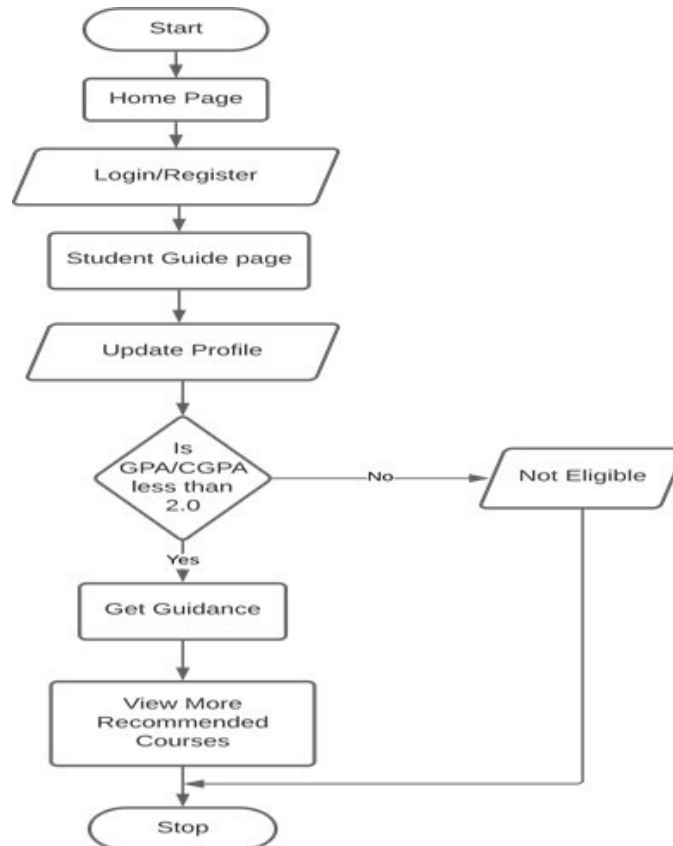
**Figure 2: The System Architecture**

**KEY:** The tasks involved are listed below.

- (1) User which is the student supplies his/her GPA and CGPA through the userinterface.
- (2) The inference engine captures, evaluates and examines the supplied GPA andCGPA.
- (3) The inference engine matches the captured, evaluated and examined GPA andCGPA with the appropriate rule in the knowledge base.
- (4) The inference engine fires/triggers/executes the matched rule in the knowledgebase.
- (5) The fired/triggered rule determine if the student is to drop courses based on the ruleand saved the rule in the working memory.
- (6) User also supplies the current level through the user interface.
- (7) The inference engine captures, evaluates and examines the supplied student level.
- (8) The inference engine matches the captured, evaluated and examined student levelwith the appropriate rule in the knowledge base.
- (9) The inference engine fires/triggers/executes the matched rule in the knowledgebase.
- (10) The fired/triggered rule selects the relevant courses from the stored relevant coursesin (5) above and also stores the selected relevant courses in the working memory.

- (11) The user supplies their current semester through the user interface.
- (12) The inference engine captures, evaluates and examines the semester in (11).
- (13) The inference engine matches the captured, evaluated and examined the courses to be offered in that semester using the appropriate rule in the knowledge base.
- (14) The inference engine fires/triggers/executes the matched rule in the knowledge base.
- (15) The fired/triggered rule selects the relevant courses from the stored relevant semester in (10) above and also stores the selected relevant courses in the working memory.
- (16) The selected and stored relevant courses in (15) above are displayed to the user through the user's interface.

### The System Flowchart



**Figure 3: Flowchart Diagram of the New System.**



The above figure 3 shows how the students will interact with the new system. The students will interact with the system by viewing the Homepage, where the student be prompt to Login or Register (if they do not have an account). The Registration process requires the student to enter a valid matriculation number (2018/124119CS) and a password. After the registration is successful the student will Login into the system using their unique matriculation number and password which will link them to the student guide page, where all the necessary details to guide student are displayed. On the clicking the 'next' button students are prompt to update their profile by inputting their current Grade Point Average (GPA), Cumulative Grade Point Average (CGPA), Level and Semester. After the above steps has been completed, the system test if the student GPA and CGPA is less than 2.0, if more than 2.0 the system will display 'not eligible' to use the system, otherwise it recommends the possible courses to be offered by the student in the current semester. If the recommended courses are not suitable for the student, the student can click on 'View more recommendations' button.

#### The Use-Case Diagram

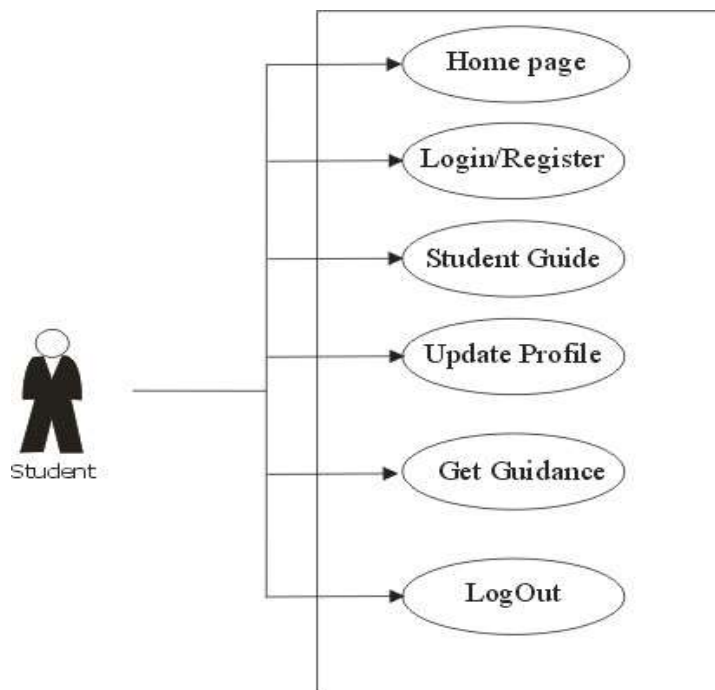


Figure 4\_Use Case Diagram of the New System.

The above figure 4 shows how the students will interact with the new system. The Students will use the system to login, make enquires such as, knowing the minimum and maximum units that can be offered in a semester. The students update profile by entering their GPA, CGPA, Level and current semester. Based on the profile uploaded the student will be guided on what decision to make, which involves dropping of course and possible choices of course(s) they can offer for the semester.

### Input Design

The input to the system from the user (Students) is majorly the user's actions and responses on the web pages of the system website. The actions and responses involve the user's selecting the relevant activities. The steps and replies include the student entering his/her current GPA/CGPA, level and semester appropriately.

Table 1: Student Table

S/NO	NAME	TYPE
1	USERNAME	Varchar(15)
2	STUDENT_PASSWORD	Varchar(15)
3	STUDENT_NAME	Varchar(100)
4	LEVEL	Varchar(5)
5	CURRENT_GPA	Varchar(5)
6	CURRENT_CGPA	Varchar(5)
7	SEMESTER	Int(1)

### 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 in form of interfaces which is interactive with the users, the interface is projected using the Hypertext Transfer Protocol (HTTP).

Table 2: Course Table

S/NO	NAME	TYPE
1	ID	Int(11)
2	COURSE_CODE	Varchar(10)
3	COURSE_NAME	Varchar(50)
4	SEMESTER	Int(3)
5	COURSE_UNIT	Int(3)
6	LEVEL	Varchar(8)

### Storage Design

The system has a fully dynamic and functional database. The database was created using XAMPP and queried using MySQL. As shown in figure 5a and 5b, the web-based academic guidance System consists of databases with the tables shown below:

Table structure Relation view

#	Name	Type	Collation	Attributes	Null	Default	Extra	Action
<input type="checkbox"/>	1 Username	varchar(20)	latin1_swedish_ci		No	None		Change Drop Primary Unique Index Spatial Fulltext More
<input type="checkbox"/>	2 sPassword	varchar(50)	latin1_swedish_ci		No	None		Change Drop Primary Unique Index Spatial Fulltext More
<input type="checkbox"/>	3 sName	varchar(1000)	latin1_swedish_ci		No	None		Change Drop Primary Unique Index Spatial Fulltext More
<input type="checkbox"/>	4 Gender	varchar(10)	latin1_swedish_ci		Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext More
<input type="checkbox"/>	5 Department	varchar(100)	latin1_swedish_ci		Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext More
<input type="checkbox"/>	6 Level	varchar(100)	latin1_swedish_ci		Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext More
<input type="checkbox"/>	7 current_gpa	varchar(10)	latin1_swedish_ci		Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext More
<input type="checkbox"/>	8 current_cgpa	varchar(10)	latin1_swedish_ci		Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext More
<input type="checkbox"/>	9 semester	int(5)			Yes	NULL		Change Drop Primary Unique Index Spatial Fulltext More

Check All With selected Browse Change Drop Primary Unique Index

Figure 5a: Database Showing Different Tables

Server: 127.0.0.1 Database: my\_system Table: tbl\_courses

Browse Structure SQL Search Insert Export Import Privileges Operations Tracking Triggers

Table structure Relation view

#	Name	Type	Collation	Attributes	Null	Default	Extra	Action
<input type="checkbox"/>	1 id	int(11)			No	None	AUTO_INCREMENT	Change Drop Primary Unique Index Spatial More
<input type="checkbox"/>	2 c_code	varchar(10)	utf8mb4_general_ci		No	None		Change Drop Primary Unique Index Spatial More
<input type="checkbox"/>	3 c_name	varchar(50)	utf8mb4_general_ci		No	None		Change Drop Primary Unique Index Spatial More
<input type="checkbox"/>	4 semester	int(3)			No	None		Change Drop Primary Unique Index Spatial More
<input type="checkbox"/>	5 c_unit	int(3)			No	None		Change Drop Primary Unique Index Spatial More
<input type="checkbox"/>	6 level	varchar(6)	utf8mb4_general_ci		No	None		Change Drop Primary Unique Index Spatial More

Check All With selected Browse Change Drop Primary Unique Index

Figure 5b: Database Showing Different Tables

#### 4. SYSTEM IMPLEMENTATION

The implementation 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 implemented using “Bootstrap 3” front-end framework for (cross-platform/responsive-web).

The “Bootstrap 3” contains HTML5 (HyperText 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.

### System Modules

The system is designed in various modules with each having its own set of buttons and links to navigate through the entire system. The major operational modules of the system are explained below.

**The Home Page:** The home page, essentially consists of 'Login/Register' button for students, and it offers brief information about the system.



Figure 6: Home Page

**Registration Page:** Authentication and authorization are required for access to the web-based decision support expert system for student academic guidance and counselling. A user registers by filling out an html form, which is shown below.

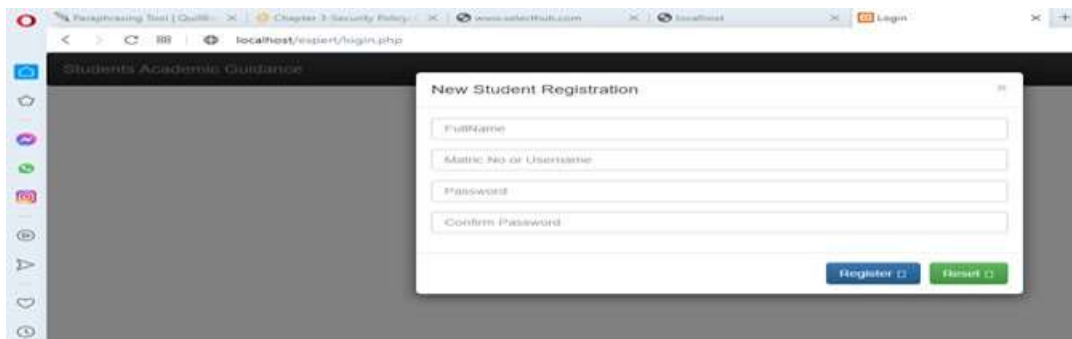
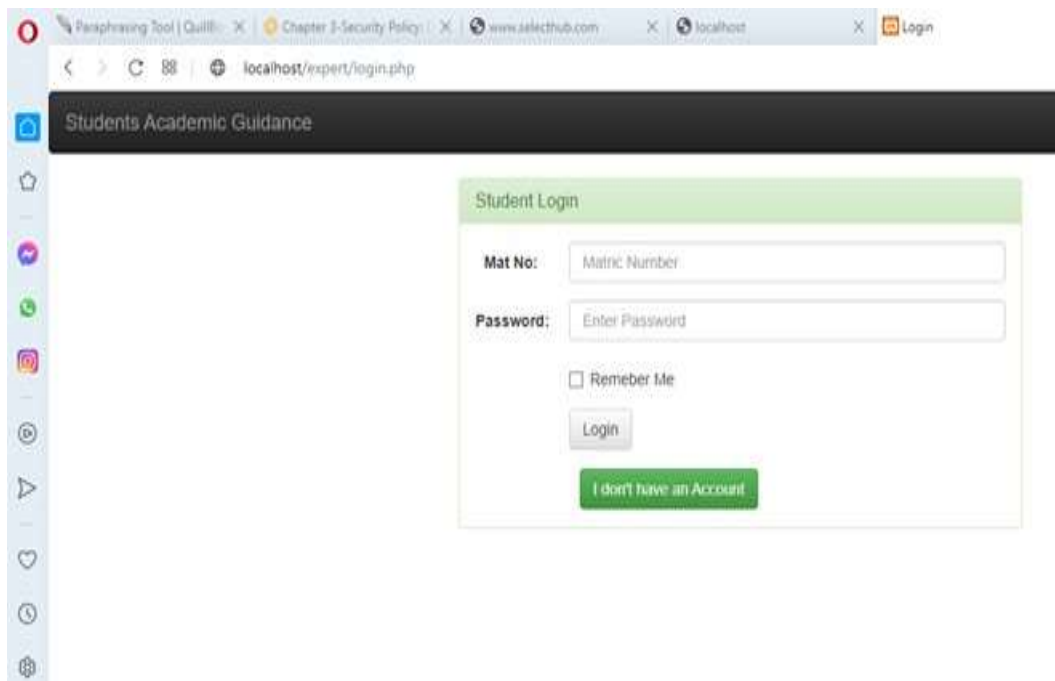


Figure 7: Students' Registration page

**Login Page:** Login is available to any existing or registered user (Students). Students can log in by filling up an html form with their matric number and password and submitting it, as seen in the image below. If the authentication is successful, the user will be logged in.



**Figure 8: Students' Login Page**

**Student Guide Page:** This page contains all of the pertinent regulations that must be adhered to in order to guide the student. Students can inquire about course carrying capacity for each semester, when to add or drop course(s), the amount of course units that can be written in post-semester, course code, course title, and course unit.

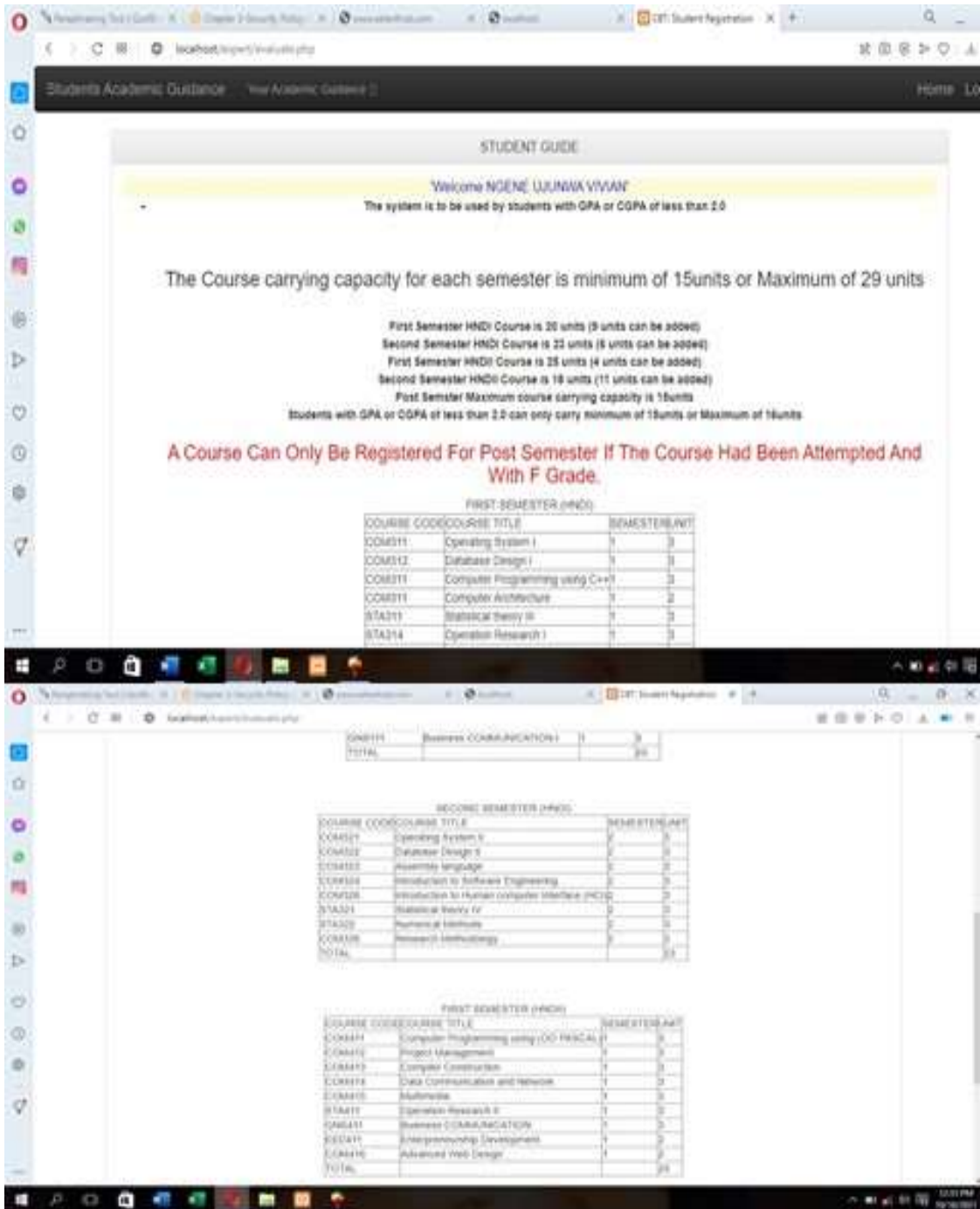


Figure 9a: Welcome Page

FIRST SEMESTER (HNDII)		
COURSE CODE	COURSE TITLE	SEMESTER/UNIT
COM411	Computer Programming using (OO PASCAL)	1 / 3
COM412	Project Management	1 / 3
COM413	Compiler Construction	1 / 3
COM414	Data Communication and Network	1 / 3
COM415	Multimedia	1 / 3
ITA411	Operation Research II	1 / 3
GNS411	Business COMMUNICATION	1 / 3
EED411	Entrepreneurship Development	1 / 2
COM416	Advanced Web Design	1 / 2
TOTAL		25

SECOND SEMESTER (HND11)		
COURSE CODE	COURSE TITLE	SEMESTER/UNIT
COM421	Computer Graphics and Animation	2 / 3
COM422	Introduction to Artificial Intelligent and Expert System	2 / 3
COM423	Professional Practice in IT	2 / 3
COM424	Seminar on Current topics in Computing	2 / 3
COM425	Project	2 / 4
EED421	Small Scale Enterprise	2 / 3
TOTAL		19

Figure 9: Student Guide Page.

**Students' Profile Update Page:** The student(s) update their profile by entering their GPA, CGPA, Level, and current Semester then proceed by clicking the 'update profile' button. The profile update can be done every semester.

A Web Enabled Decision Support Expert System For Students **Academic Guidance** Academic Guidance Your Academic Guidance Home Logout

Student Academic Guidance

Please update your profile to continue

Current GPA

Current CGPA

Select your Level

Select current semester

Update Profile

Get Guidance Reload

Figure 10: Student Profile Update Page.

**Student Guidance Page:** This page shows the student's GPA/CGPA, and recommends some possible courses the affected student can offer based on the course carrying capacity of that student in warning (GPA < 2.0 or CGPA < 2.0) (which should not be more than 16 units and not less than 15 units) for the current semester.

localhost/expert/guide.php

Current GPA

Current CGPA

Select your Level

Select current semester

Update Profile

"Hello ngene ujunwa vivian!, your current GPA is 2.3, CGPA is 0. You are in warning, Therefore it is advised that you drop some courses as the maximum unit you can offer is 16units only'  
'Please find below possible course recommendations!'

Total units : 15

COURSE CODE	COURSE TITLE	UNIT
COM326	Introduction to Human computer Interface (HCI)	3
COM321	Operating System II	3
STA322	Numerical Methods	3
COM322	Database Design II	3
COM324	Introduction to Software Engineering	3

Get Guidance View More Recommendations

4:55 PM  
10/17/2021

**Figure 11: Student Guidance Page.**

## 5. CONCLUSION AND RECOMMENDATIONS

Decision making on challenging issues is a very complex process that needs to be properly addressed. Such decision making in academic challenges is common today in our tertiary institutions. This research has explored the challenges faced with the manual method of guiding or counselling students of the Computer Science Department Federal Polytechnic Bida in their academics such as dropping or adding of courses when they are in warning GPA/CGPA. A web enabled decision support system for student academic guidance and counselling was developed to eliminate the manual process of guiding student.



The web enabled decision support expert system uses a parameter such as a student GPA or CGPA to know if the student is to drop courses and recommend some possible courses the affected student can offer based on the course carrying capacity of that student (which should not be more than 16 units and not less than 15 units) for the current semester. The new system is student-driven, in which students are able to access it at any time and from any location using any internet-enabled device, this will go a long way in guiding large number students without physically meeting the examination officer, and by extension remove the student's fear of face-to-face engagement with the examination officer or course adviser.

The optimal use of the system can be achieved by its integration on the school portal, also future enhancement of this research work could be carried out to accommodate more student-driven parameters that will guide students with GPA > 2.0 and CGPA > 2.0 on possible Grade Point Average (GPA) to obtain in order to achieve higher Cumulative Grade Point Average (CGPA) such as (lower credit, upper credit and distinction).

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