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E-Course Adviser for Students in Tertiary Institutions: An Expert System Design Approach

Emmanuel Etuh[1], **Deborah U Ebem**[2], **Zayyanu Umar**[3]
[1]Department of Mathematics/Statistics/Computer Science, Kwararafa University, Wukari, Taraba State, Nigeria
[2]Department of Computer Science, University of Nigeria Nsukka
[3]Department of Computer Science, Waziri Umaru Federal Polytechnic, Birnin-kebbi, Kebbi State, Nigeria
e-mail: emma.etuh@gmail.com[1], Deborah.ebem@unn.edu.ng[2], zayyanuumar1@yahoo.com[3]
*Corresponding author: E-mail: emma.etuh@gmail.com

Abstract*: Course adviser in tertiary institution guides students on course enrolment which is part of the registration process for students. It is a phase where a student formally enrolls for requisite courses in a particular semester. Students on gaining admission are required to enroll into courses offered in their chosen programme of study every semester progressively with certain credit limits in each semester. The courses are arranged in an ascending order of complexity such that the criterion for registering for a higher course is to have passed the lower prerequisite course(s). Academic advisers are appointed for students to guide them on course enrolment but due to human factor, a lot of students end up registering for inappropriate courses which leads to inefficiency in career. This research work developed a model that classifies students as either "registrable" Or "not registerable". Multi-layered Feedforward Neural Networks was used to develop the model that will classify students. The dataset used consists of 150 records, 4 input layers, one hidden layer, and 1output layer. The train/test split of the dataset was in the ration of 80:20. The Networks was trained for 2000 epochs. The accuracy of the model was 0.97. If a student fails more than 15 credit hours of registered courses, such student will be considered "not registerable" and hence redirected to the expert adviser for proper guidance on the course(s) to register.*

Keywords: *Academic Adviser Model; Feedforward Neural Network; Counseling; Course Registration; Expert Career Guidance*

INTRODUCTION

Course enrolment in tertiary institution is part of the registration process a student goes through every semester to register for courses in a particular semester. It is a phase in the registration process where a student formally enrolls for eligible courses in a particular semester. Each course a student registers for is averagely weighted depending on the lecture hours spent on the course in a week to be either 1, 2, 3 or more credit unit(s) [1].

Candidates admitted into tertiary institutions are required to complete a minimum of 150 units to qualify for graduation. The 60 unit of the credit load must come from the student's core discipline. This requirement is set by a body that governs university education system called the National Universities Commission (NUC) [1].

These units are spread across sessions and semesters depending on the course of study. Students on gaining admission are required to enroll into courses offered in their chosen programme of study every semester with not more than 24 credit units in a particular semester. The programme is structured into sessions and further divided into semesters.

The courses are arranged in an ascending order of complexity such that the criterion for registering a higher course is to have passed the lower prerequisite course(s), hence, enrolment for a higher course is based on the condition that the student has passed the required course(s). Academic advisers are appointed for students who are expected to guide the students on course enrolment. The task of advising though crucial is tasking and complex. Student advising is an important and time-consuming effort in academic life [2].But due to human factors and complexity of advising, a lot of students end up registering for courses they are not qualified to take. Also, a study in [3] observed that improper and untimely advising or computation of results may hinder a student from timely graduation.

The current system of academic advising is manually done where a level adviser is appointed to guide students at each level of their academic progression. Students are expected to interface with the appointed level adviser to receive adequate guidance on course registration.

There are several drawbacks to this manual academic advising approach as each level adviser is also an academic staff saddled with lecturing and other administrative duties as occasion demands. According to a researcher, paper or manual registration also hampers prompt dissension of relevant academic and managerial information [4].The main problem faced by students is how to take the right decision in relation to their academic schedule based on available information [5] as provided by their academic adviser.

The design of an E-Course enrolment system if adopted and implemented will go a long way to helping the students to register appropriately for expected course(s) at each level and semester(s) to ensure smooth and efficient sail through their academic journey. Automated registration system streamlines the application, registration, and monitoring of students in a

school [6]. The design of this system will have a dual positive effect as level academic advisers will be relieved of this tasking activity of student advising thereby helping them to channel their strength to other demanding role in the institution while on the other hand students will be promptly and adequately guided on the right enrolment that will ensure timely graduation.

The design of an expert career guidance model to intelligently advise tertiary institution students on appropriate course(s) to register each semester will therefore assist the students in registering appropriately for requisite course(s) at each level and semester to ensure smooth sail through their academic journey to ensure quality output of graduates that are fit and well equipped for the world-of-work.

Requirement Gathering

To understand the requirements for the conceptualized system, two key activities necessary for requirement gathering are literature review and interview. Literature review of existing related literature was carried out to give the needed background and direction for the analysis and design of the new system. Also, interview with course advisers who are the domain expert for course registration was carried out to guide the design of the proposed conceptual framework.

Review of Existing Literatures

Several Decision Support Systems (DSS) and Expert Systems (ES) have been proposed in literature for automated computer assisted course enrolment. Some of them are stand-alone system, some are web-based without intelligence, and others are rule-based [7]. Some of the related literature reviewed are presented in this section.

Universal Electronic Student Course Registration Model was developed by [4]. This model comprehensively addresses faculty base registration in a unified framework to eliminate organizational resource wastage. Chidinma in [8] designed a course registration and result processing system to facilitate the student's course registration and processing of their examination results. The system automates the processes for result processing and manual course registration. Rajput in [5] proposed an "Intelligent Counselor : An Intelligent Advisory System" to advise students on courses and colleges to register for based on their abilities. The proposed system was developed for Gujarat Online Admission Registration System in India using multi-layer feed forward Neural Network technology. Roushan *et al* in [9].A web-based counseling application was designed to guide students and decision makers in career development and decision making. The application serves as an alternative guidance and individual career development for students [17]. It included career knowledge, planning and alternative options from an expert tool based on knowledge and rule to provide the solutions on student's career decisions

The challenge with some of the rule-base design is that some domain experts find it difficult to communicate what they knew to engineers, while engineers, in turn, find it difficult to know what questions to ask and what to make of the answers [11]. Artificial Neural Network (ANN) has been applied to solving complex systems. ANN uses knowledge of how man's brain systems execute information to solve pattern recognition related problems [12]. Table 1 presents the summary of the reviewed related literatures with their goals, major contributions, and weaknesses.

Table 1. Summary of Literature Review

Author	Title	Goal	Contribution	Weakness/Gap
Roushan*et al* [10]	University Course Advising: Overcoming the challenges using decision support system	Build a support system to assist course adviser	Developed an online course advise support system to assist manual course advising process by academic advisers	Customized system for schools in Bangladesh. Support system that must be used alongside academic adviser
Ejiofor and Uko [4]	Universal Electronic Student Course Registration Model (U-ECRM)	Automate course registration system	The system was automated, eliminate organizational resources wastage (manpower and materials like paper)	Lack intelligence does not ensure adequate guidance to the student on courses to register. Does not enforce pre-requisite registration
Chidinma A M [9]	Course Registration and Result Processing System in Computer Science Department University of Nigeria Nsukka	Automate course registration and result processing system	The system automated both students' result processing and course registration	The design was customized only for the department od Computer Science, University of Nigeria Nsukka. Not generic. Not an expert system.
Chaka and Mungadzi [6]	An Implementation of an Online Based Registration System in Tertiary Institutions in Zimbabwe	Design online registration system for tertiary institutions	The system helps the university authorities in improving their operations in terms of having up to date records where customized reports can be generated	The system handles basic student registration. Does not guide students on detailed course registration intelligently
Estevez *et al* [11]	A model for a web-based course registration system	Design enhanced web-based course registration system	Iterative approach to designing a web-based course registration system	Does not guide students. The system handles basic student registration. Does not guide students on detailed course registration intelligently
Rajput [5]	Intelligent Counselor: An Intelligent Advisory System	Design Intelligent Decision Support Systems (IDSS)	Advises students on courses and colleges to register for based on their abilities	Customized for Gujarat Online Admission Registration System
Daramola *et al* [12]	Implementation of an Intelligent Course Advisory Expert System	Design and implementation of an intelligent Course Advisory Expert System (CAES)	Uses a combination of rule-based reasoning (RBR) and case-based reasoning (CBR) to recommend courses that a student should register in a specific semester	Rule based advising are always limited by the knowledge of the knowledge engineer
Singh [13]	Development of Online Student Course Registration System	Automate registration process for student registration	Eliminate physical human interaction and make the registration process accessible anywhere to the student	The process automation lack intelligence for course advising

Interview with Domain Expert

The domain experts are the level advisers in tertiary institutions. They are saddled with the responsibility of guiding students on course registration to ensure appropriate registration of courses at that level based on the student's progression. To design the expert system, an interview with course adviser who is the domain expert was staged to extract the needed knowledge on the progression of course registration steps. This forms the basis for the design of the E-course adviser expert system as documented in the "as-is" system.

METHODOLOGY

The design of the expert course adviser model was developed with intelligence using machine learning paradigm particularly Feed Forward Neural Network (FFNN). FFNN is a left to right unidirectional ANN that mimics the neuron of human brain in reasoning to make adequate inference based on input signal(s) of the pattern recognition problem. It learn by the training given to it and produce output accordingly [5].

The dataset used for model development was generated from the past results of graduated students of the department of Mathematics, Statistics, and Computer Science, Kwararafa University. The data comprises of 150 sets with 4 attributes. The attributes are the Total Credit Registered (TCR) which is the total credit hour the student registers for the semester, Total Credit Earned (TCE) which are the total number of passed courses, Total Credit Failed (TCF), and the Grade Point Average (GPA). The data was preprocessed and split into a training/testing set.

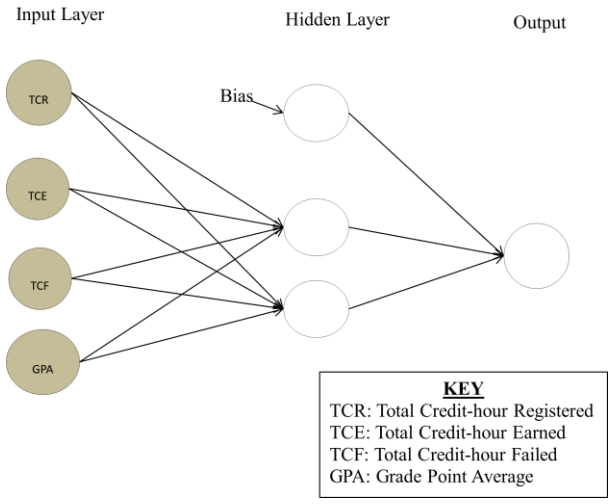

Figure 1: E-Course Adviser Neural Network (EANN)

SYSTEM ANALYSIS AND DESIGN

As-Is System

Most Universities currently use manual course registration system. Depending on the structure of the institution, the students on resumption are expected to pick up their course form in duplicates from their respective faculties and proceed to department for registration.

The following are the procedure for course registration as used by the level adviser to guide students on course enrolment:

1) A new student registers for prescribed courses directly after completing required clearance. Existing students on the other hand checks the results of previous session's semester to know if there are carry-over course(s).
2) If there is no carry-over, the student fills the course registration form with the entire level/semester courses in duplicates for signing. But if the student has a carry-over, the student will be advised appropriately by the academic adviser to register the carry-over courses first before adding the current level course(s).
3) To complete the course registration process, after signing the course form, a copy is submitted to the department, faculty, and exams and record unit respectively or any other unit(s) depending on the structural arrangement of the institution.

To-Be System

Many institutions have web portals that enable students to pay fees and perform registration to some extent electronically. This functionality of the web portal can be extended to include E-Course registration on the portal of the institution to replace the manual course advising and registration system.

The E-Course Registration System will:

1) Check the previous level result of the semester the student is registering for.
2) Check for carry-over courses.
3) If the carry-over courses are more than the carry-able limit AND GPA<1.5, AND the level is > 200, the student is advised to withdraw.
4) If the carry-over courses >= carry-able limit AND GPA<1.5, AND the level is <= 200, the student is placed on probation (can only register the previous level(s) failed courses.
5) If the carry-over courses < carry-able limit AND the GPA<1.5, the student is allowed to register all the carryover courses first, then the current level/semester courses with strong advice to sit-up.
6) If no carry-over, the student can then fill the E-Course registration form with all the level/semester courses; first with the core courses and the preferred elective courses.
7) The student completes the registration process and submits it automatically.
8) The student can then print and keep the registered course-form for record purposes.

Several tools available for the design of a conceptualized system are: process modeling tool[13], a typical example is the Integration Definition for Function Modeling (IDEF0) [14];UML diagram, some of them are Use Case and Data Flow Diagram.

They are used to expose the system specifications used by the programming team during implementation.

Unified Modeling Language (UML): Use Case

UML is a standard tool used to depict Object Oriented Programming system design. Use case explains the user's interaction with the system, they are very helpful tools used to understand user requirements [13]. The four major components of the UML Use Case diagram are: the actors, the system, use cases, and their relationships. Two actors employed in the design are the primary actor, which is the student that initiates activity in the system, and secondary actor which is the E-course expert adviser that responds to the student by advising.

The student actor can login, check result of the previous semester, register courses for the new semester, print course form, and logout. The relationships are represented by the lines and arrows to reflect the primary, included, and extended relationships between the actors and the system.

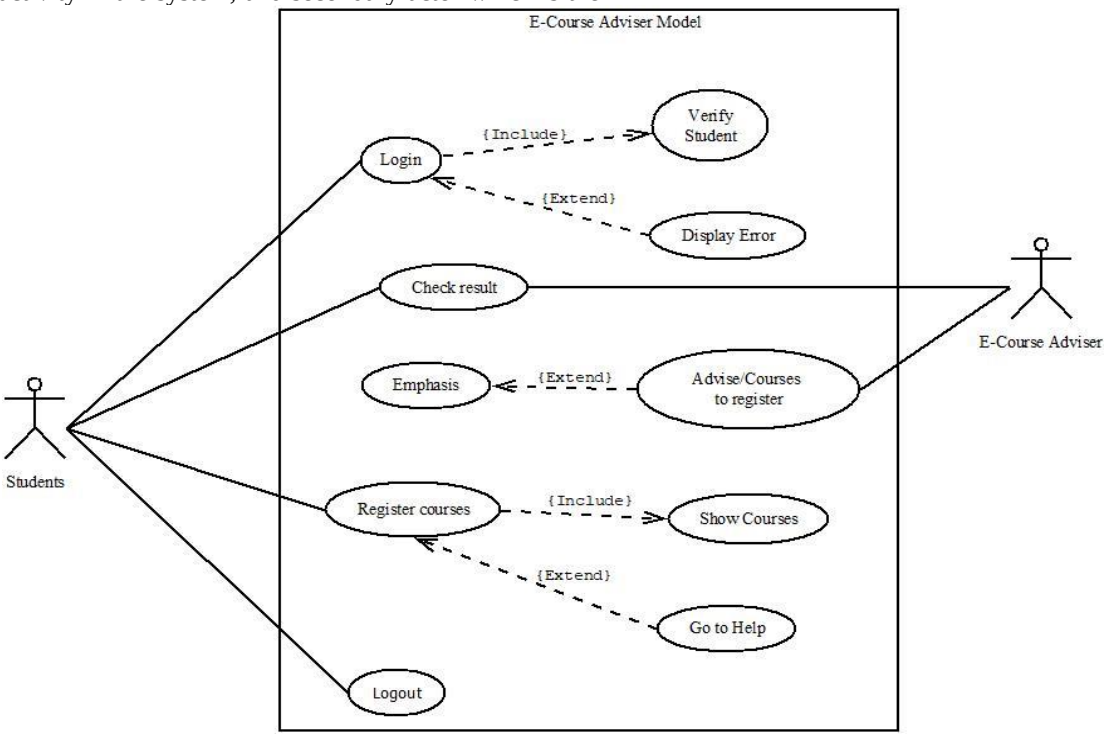

Figure 2. The Use Case Diagram

Data Flow Diagram

The Data Flow Diagram (DFD) of the E-Course Adviser is a diagram that shows contextually the flow of information from the external entities to the system. It is a contextual diagram that depicts the workings of E-Course Adviser System under design. It shows the entire system in context with its environment, the overall business process as just one process with the data flows to and from external entities. External entities are Student, Level Adviser, Departmental Adviser (HoD), and Faculty Adviser. Fig 3 shows the DFD of E-Course Adviser Expert System.

The level 0 diagram or level 0 DFD shows all the processes at the first level of numbering, the data stores, external entities, and data flows among them. The purpose of the level 0 DFD is to show all the major high-level processes of the system and how they are interrelated. All process models have one and only one level 0 DFD. The contextual level diagram when exploded gives detailed view of activities of each external entity. The four external entities that interact with the system are: Students, Level Adviser, Departmental Adviser (HoD), and Faculty Adviser. The processes and data flow for each entity is depicted in the level 0 diagrams labeled.

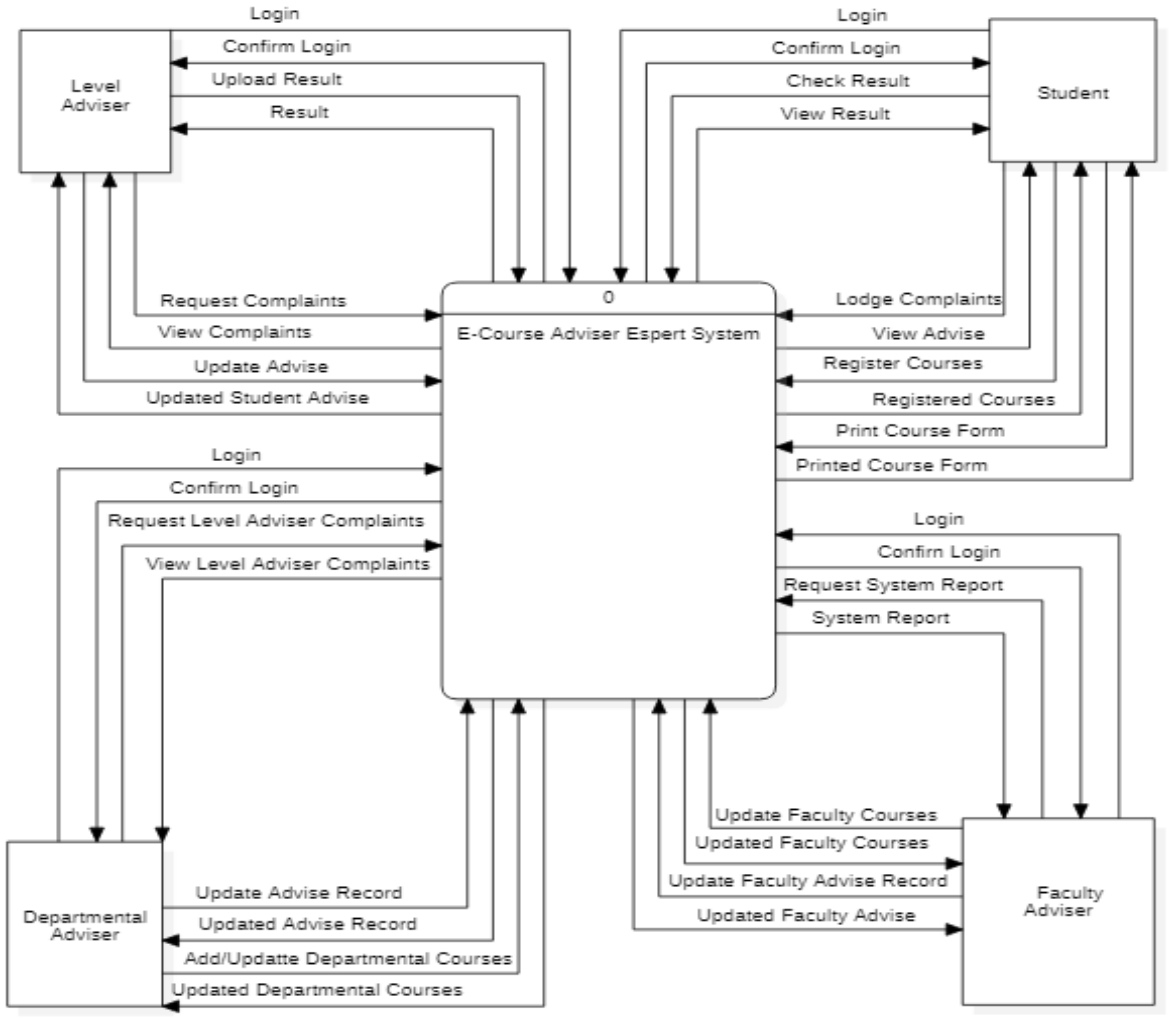

Figure 3. The DFD Contextual Level Diagram

The students are expected to login to the system and check their result for the semester, view the expert advice based on the student's performance before proceeding to register for the new semester. In the case of irregularities with the result, the student is expected to lodge a complaint to the system which will be submitted and attended to by the system admin.

The activities of the level adviser initiate processes and response to the processes as the level adviser engages the system.

The HoD responds directly to any complaints from the level adviser, upload students' results to the system, accesses the knowledge base to update questions asked, upload courses for the department, and updates the knowledge base where necessary.

The data flow diagram shows the activities of the faculty adviser with the expert system. The faculty adviser accesses the knowledge base, requests for system report, respond to complaints, and update the faculty information for academic guidance.

Architectural Framework

The conceptual design of the E-course adviser comprises of three tiers which are the student tier, the solution tier, and the expert tier. The student can interact with the system through a designed student user interface to gain access to the E-course adviser system. The solution tier securely makes the advising unique by implementing student authentication through user login where credentials are supplied. If the login is successful, the student will be redirected to check the result of the previous semester and will be advised accordingly based on the student's performance. The expert tier checks through the student's previous result to intelligently and autonomously guide the student on the courses the student is expected to register for in the new semester.

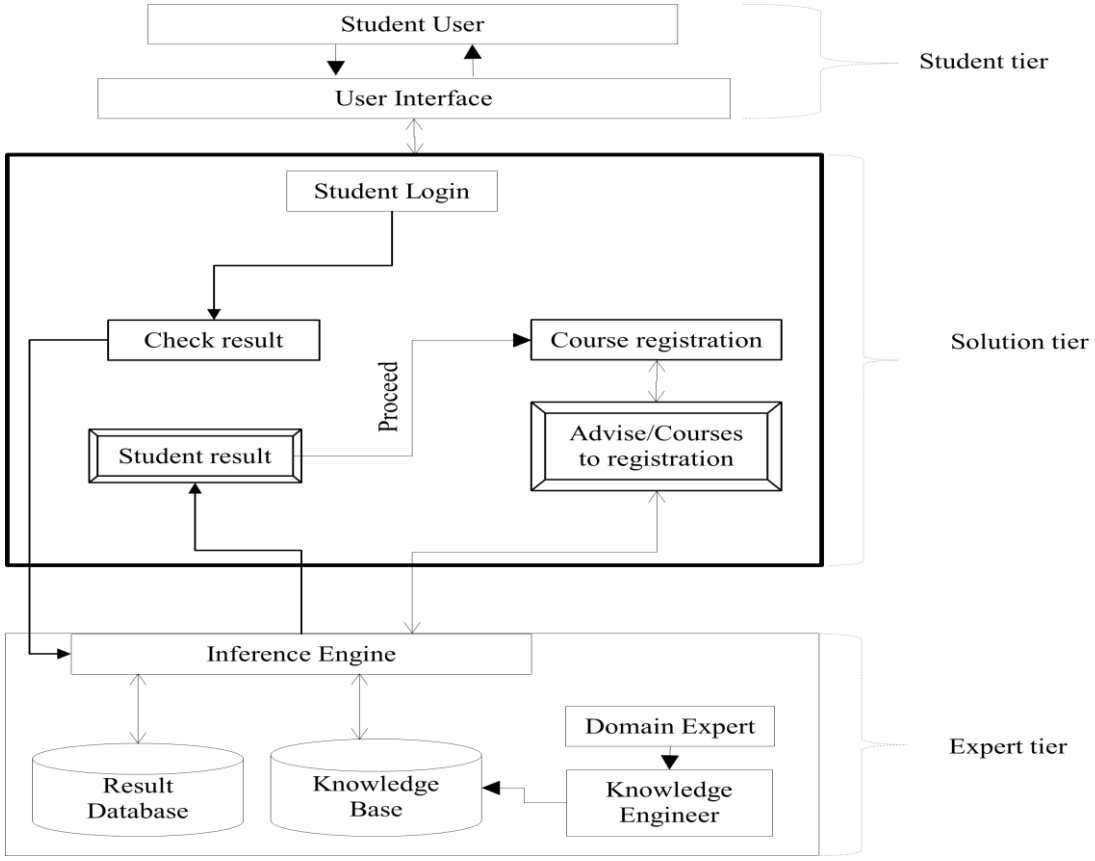

Figure 4: E-Course Adviser Framework

Flow chart

In Figure 5, an admitted student is expected to login to register for semester courses. The student cannot register for a requisite course without meeting the pre-requisite for that course, semester or level. The system checks properly to ensure that the student has cleared the lower courses before taking any higher one using the algorithm presented. After login, the student chooses the level and semester of registration which is confirmed by the system to ensure the student is qualified to register for that level and semester. The student checks the result and lodge complain if necessary and receives automatic response from the expert system before proceeding to register for the semester courses based on the advice of the expert system. Finally, the student can now print the registered course form and keep for record purpose.

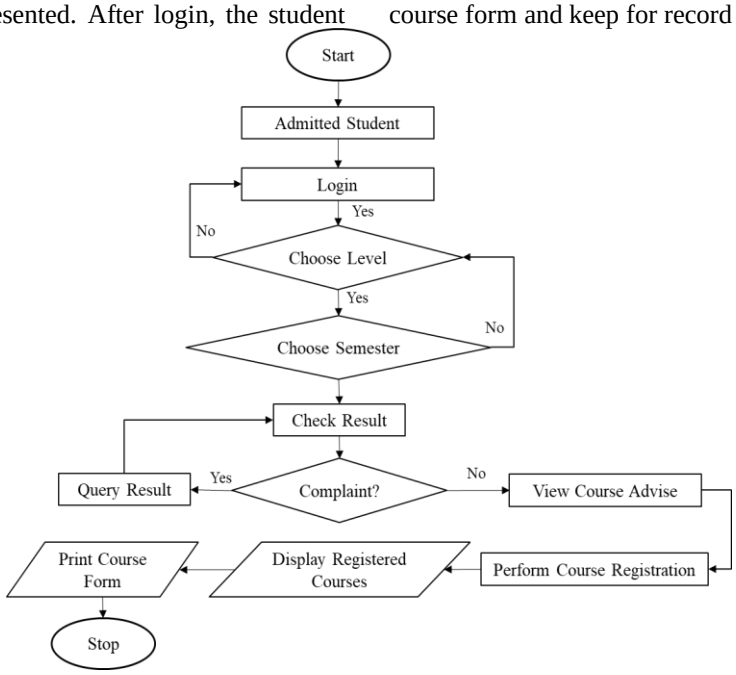

Figure 5: Design flowchart

RESULT AND DISCUSION

This research used Multi-layered Feedforward Neural Networks to classify students as "registerable" and "not registerable". The dataset used consists of 150 records, 4 input layers, one hidden layer, and 1output layer. The train/test split of the dataset was in the ration of 80:20. The Networks was trained for 2000 epochs. The accuracy of the model was 0.97. If a student fails more than 15 credit hours of registered courses, such student will be considered "not registerable" and hence redirected to the expert adviser for proper guidance on the course(s) to register.

Traditionally in the current system, academic advisers are appointed for students who are expected to guide them on course enrolment but due to human factor, a lot of students end up being misguided. The design of E-course enrolment expert system has become indispensable to help the students register appropriately for expected course(s) at each level and semester to ensure smooth and efficient academic pursuit. The student is expected to register and have a login detail as shown in Figure 6. After a successful login, the student will be asked to enter the unique identity to be able to check the registration status as shown in Figure 7. The student's registration link will be enabled once the status changes to "registrable", else, the student will be denied access to registration as shown in Figure 8. It is the predicted output of the user status.

The design, if adopted by tertiary institutions, will drastically reduce the number of academic dropouts and ill-trained graduates with poor performance which emanate from inappropriate registration. The network performed very well at the end of the training and testing.

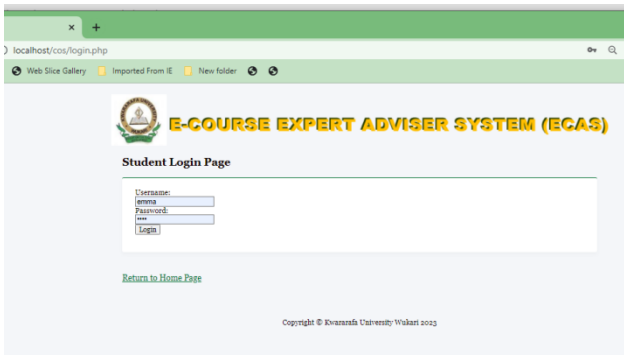

Figure 6: Student Login Page

Figure 7: Student Registration Status

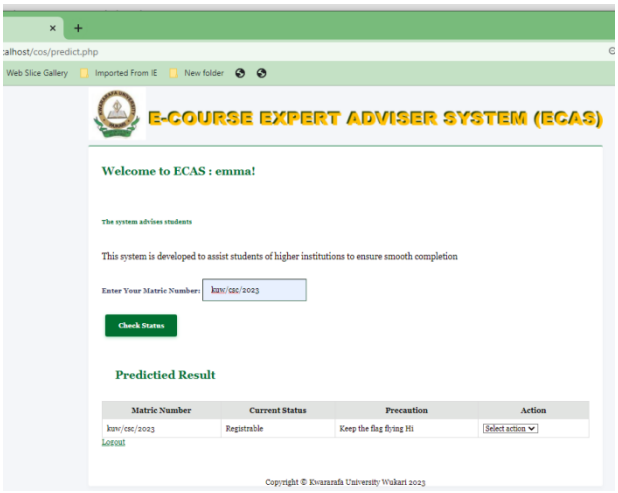

Figure 8: Predicted Result

CONCLUSION AND SUGGESTION

The design of E-Course Adviser System in tertiary institutions is highly necessary to guide students on course enrolment to ensure appropriate registration of the right courses to guarantee effective studentship. It will give directions to the students on the requisite courses to register at appropriate level/semester. The benefits cut across all the stakeholders in higher institutions that will use the system if developed. Firstly, it would save the institution the cost of producing manual registration materials with easy access to student registration data. Secondly, the institution could re-channel the staff for registration and student advising to other demanding sectors of the institution. On the part of the students, it would eliminate the stress of manual registration and it would eliminate errors in registration that lead to student's poor performance and eventual withdrawal. Moreover, it would eliminate data duplication, redundancy, and inconsistency with the manual or semi-manual system. E-course adviser would maximize time, efficiency, consistency, and transparency in guiding the students towards a successful career.

REFERENCES

[1] NUC, *Benchmark Minimum Academic Standards for Undergraduate Programmes in Nigerian Universities*. Abuja, Nigeria: National Universities Commission, 2007.

[2] E. A. Afify and M. M. Nasr, "A Proposed Model for a Web-Based Academic Advising System," *Int. J. Adv. Netw. Appl.*, vol. 9, no. 2, pp. 3345–3361, 2017.

[3] F. M. Innocent, A. Y. Gital, and I. N. Sitlong, "Course Advisory and Results Expert System (CARES): An Implementation of FMI Course Auto-Scheduling," *Int. J. Comput. Appl.*, vol. 179, no. 5, pp. 1–2, 2017.

[4] C. I. Ejiofor and O. E. Uko, "Universal Electronic Student Course Registration Model (U-ESCRM)," *Am. Sci. Res. J. Eng. Technol.*

Sci., vol. 40, no. 1, pp. 1–5, 2018.

[5] A. C. Rajput, "Intelligent Counselor : An Intelligent Advisory System," *Int. J. Sci. Technol. Eng.*, vol. 1, no. 9, pp. 1–6, 2015.

[6] P. Chaka and F. S. Mungadzi, "An Implimentation of an Online Based Registration System in Tertiary Institutions in Zimbabwe," *Int. J. Eng. Res. Technol.*, vol. 2, no. 10, pp. 4011–4040, 2013.

[7] E. Etuh, F. S. Bakpo, Z. Umar, A. E. Omolara, and O. I. Abiodun, "Development of Career Counselling Model for Choice of Courses in Tertiary Institutions using Machine Learning Algorithm," in *The role of science in attaining the sustainable development goals*, 2020.

[8] A. M. Chidimma and M. . Okoronkwo, "Course Registrationa and Result Processing System in Computer Science Department University of Nigeria Nsukka," Nsukka, 2015.

[9] T. Roushan *et al.*, "University Course Advising: Overcoming the challenges using decision support system," in *16th Int'l Conf. Computer and Information Technology*, 2013, no. August 2016, pp. 13–18.

[10] Irwan, Gustientiedina, Sunarti, and Y. Desnelita, "Counseling Model Application : A Student Career Development Guidance for Decision Maker and Consultation," in *IOP Conference Series: Earth and Environmental Science*, 2017, pp. 1–7.

[11] M. Kubat, *An Introduction to Machine Learning*, 2nd ed. USA: Springer, 2017.

[12] O. I. Abiodun *et al.*, "Comprehensive Review of Artificial Neural Network Applications to Pattern Recognition," *IEEE Access*, vol. PP, no. February 2017, p. 1, 2019.

[13] A. Dennis, B. H. Wixom, and R. M. Roth, *System Analysis & Design*, 5th ed. New Jersey: John Wiley & Sons, Inc, 2012.

[14] FIPS 183, *Integration Definition for Function Modeling (IDEF0), Publications, Federal Information Processing Standards*. Washington, DC: U.S Department of Commerce, 1993.