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Career Guide Expert System for Nigerian Secondary Schools Based on Howard Gardner Categorisation of Intelligence

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ABSTRACT

Career Guide Expert System for Nigerian secondary schools is an applied research targeted at developing a web-based career guidance system for students transitioning from the Universal Basic Education (UBE) Scheme to Senior secondary school (SSS). The transitioning process requires students to choose among groups of subjects (Science, Art, or Commercial) to study in SSS which ideally requires the services of counsellors. However, there is a shortage of counsellors in schools. This research will significantly address the problem of shortage of professional counsellors and inefficient associated manual career guidance, which can negatively affect the career trajectory of students. Three parameters (Howard Gardner Intelligence Categorization, Academic performance and student aspirations) were used in determining which of the three alternatives (Science, Art, and Commercial) suits a student the best. The inference engine of the Expert System was implemented using a weighted sum multiple decision criteria model to determine which alternative suits a student the most based on the data generated from the quiz attempted by a student. The system was validated by a professional counsellor who subjected the system to a test with twenty samples of student data and certified that the system was accurate. Thus, if this system is incorporated into the Nigerian educational system, it will revolutionize the career guidance process, leading to better performance of students and future career satisfaction.

1. Introduction

Education plays a crucial role in an individual's life, serving as a fundamental building block for future success and unlocking countless opportunities. It encompasses many advantages, such as fostering intellectual enlightenment and cognitive growth and equipping students with the skills to plan their career trajectories or pursue higher education. Acquiring knowledge within a specific field shapes thoughts, emotions, and behaviours, leading to personal accomplishment and positively impacting the wider community (Smith & Brown, 2019). However, pursuing a field of education conflicts with one's inherent ability and personality may end in disaster, leading to frustration, low productivity, and impact (Rounds & Su, 2014).

In Nigeria, formal education is divided into three levels: basic education, senior secondary school, and tertiary education. Transitioning between these levels requires students to select from various options to determine their career paths. Decision-making necessitates knowledge and understanding of the available options and their implications. Students transitioning from Universal Basic Education (UBE) to senior secondary school are often young and lack the experience necessary to make informed decisions regarding their subject combinations. This is where guidance and counselling units can be immensely helpful. However, Nigerian secondary schools suffer from a shortage of available counsellors, leaving students to make these decisions on their own.

Guidance, as defined by Gysbers and Henderson (2014), involves personal help from a competent person to assist individuals in deciding their goals, actions, and the best ways to achieve them. It focuses on helping individuals effectively deal with their problems rather than solving problems on their behalf. In schools, guidance services aid

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students in making informed decisions and adjustments, fostering personal growth and societal contribution (American School Counsellor Association, 2019). These activities typically involve educational professionals, parents, teachers, administrators, other experts, and sometimes spiritual leaders (Jayakumar & Duvvuru, 2022; Abisoye *et al.*, 2015).

A career spans a large portion of a human lifetime, starting from early academic pursuits and continuing through the working years until retirement. The career path one chooses significantly impacts potential income, work type, personality, and outlook (Rounds & Su, 2014). Hence, making the right career decision is crucial, as a wrong choice can drastically alter an individual's future (Kazi & Akhlaq, 2017). In Nigeria, career decisions begin during the transition from UBE to senior secondary school, where students choose between Science, Art, or Commercial subjects. This decision lays the foundation for their future career aspirations, making it essential for students to make the right choices to ensure a promising future for themselves and the nation.

Research by Nweze and Okolie (2014) in Ebonyi State, Nigeria, using a sample of 270 questionnaires, found that 77.22% of respondents indicated a lack of counselling services to assist in career decision-making. This posed a great concern, as young students cannot often make informed career decisions. This could impact national growth because the nation's progress is the sum of all individual contributions from its citizens. Aziken *et al.* (2021), found that 49% of university graduates would have chosen different courses if given the chance. This suggests that incorrect course allocation in tertiary institutions may stem from poor subject choices in senior secondary school.

The lack of effective guidance and counselling services in Nigerian secondary schools, as pointed out by Nweze (2014), can be partly attributed to the insufficient attention and priority given to it by the government department responsible for enacting policies in the education system. Few secondary schools in urban areas have counselling units, and where counsellors are present, the ratio of counsellors to students is too low for effective guidance. This shortage of counsellors and limited understanding of the unit's significance is more pronounced in rural schools, making it unattractive for school heads to establish such a unit.

Career guidance in secondary school is crucial as it forms the foundation for one's career trajectory. However, achieving optimal career guidance for all students requires a different approach. This research proposes an automated system to guide Nigerian students under the UBE scheme to select suitable subject classifications—be it Science, Art, or Commercial—at the senior secondary school level.

2. Literature review

With the rapid advancement in technology, humans are increasingly harnessing its power to improve their lives. The demand for maximum efficiency, reliability, high-level understandability, and unbeatable performance drives the adoption of machine solutions for expert requirements (Brynjolfsson & McAfee, 2014; Davenport & Kirby, 2016; Manyika *et al.*, 2017). Human experts use cognitive abilities to infer solutions, but these processes can be affected by factors like fatigue, distractions and so on (Wang & Zhang, 2021). Additionally, the scarcity of professionals in some fields has led to the development of expert systems, which incorporate human problem-solving instincts into machines via software.

2.1 Expert system

An Expert System (ES) is a branch of Artificial Intelligence (AI) (Sadiku, *et al.*, 2018) that uses an interactive computer-based decision-making process to address various problems. It combines factual data and heuristics to solve complex decision-making issues in specific domains. ES originated at Stanford University, USA, and is a specialized computer program that derives its knowledge and proficiency from experts in a particular field (Brock, 2018). Essentially, it mimics the decision-making process of human experts, making it an automatic data processing system that emulates the expertise of knowledgeable individuals in specific areas. Unlike human experts, expert systems are

unaffected by fatigue or other external factors, often making them a preferred alternative due to their speed and accuracy.

The applications of expert systems have become popular and useful in simplifying the work of professionals across various fields. Its wide range of applications has motivated many researchers to explore its potential to make life easier. Notable application areas include the health sector (for medical diagnosis), the agricultural sector (for crop management and pest control), the educational sector (for student career guidance) and so on. A study by Supriyanto *et al.* (2019) on the use of expert systems in student guidance services found that these systems significantly benefit students by enhancing learning outcomes, specialization in education and training, improving performance, achieving goals, and facilitating self-evaluation.

2.2 Howard Gardner's categorisation of intelligence

Sternberg (1985) in Cherry (2022) define intelligence as a “mental quality encompassing the ability to learn from experience, adapt to new situations, understand and handle abstract concepts, and use knowledge to influence one's environment”. This definition highlights the mind's capacity to acquire and apply skills, adjust to various circumstances, and deal with complex ideas. Contrary to the traditional view of intelligence as a single entity, Gardner's multiple intelligence theory, as discussed in Meydan and Goksu (2015), suggests that individuals possess different types of intelligence, each reflecting distinct ways of processing information and solving problems. Gardner identifies eight types of intelligence: Verbal-Linguistic, Logical-Mathematical, Spatial, Bodily-Kinesthetic, Musical, Interpersonal, Intrapersonal, and Naturalistic, indicating that people can excel in some areas while having varying levels of skill in others.

According to research on Howard Gardner's theory of multiple intelligences, the level of excellence a student achieves is closely tied to the type of intelligence that is most dominant or developed within the individual (Shearer, 2018). The relative strength of these intelligences can vary significantly from person to person, and this variation can have a significant impact on a student's academic performance and overall achievement (Shearer, 2018).

2.3 Review of related works

In 2017, Hajgude *et al.* introduced Careerchase, a Career Guidance System that utilizes Case-Based Reasoning (CBR) and Rule-Based Reasoning (RBR). This system was specifically developed to assist students in Maharashtra, India, who are enrolled in the 10+2 education structure, in selecting appropriate courses for tertiary or post-secondary education. The researchers took into consideration six criteria to aid the students in their decision-making process. This web-based expert system makes inferences based on academic marks, overall percentage, and elective subjects using CBR by comparing new cases with existing ones. The remaining three criteria, which include income level, Intelligence Quotient (IQ), and interest, are inferred using RBR. Students engage with a user-friendly graphical interface (GUI) on the web application, entering the necessary information to determine a suitable career path.

Ezenkwu *et al.* (2017) developed an Automated Career Guidance Expert System using the Case-Based Reasoning (CBR) technique to help students choose tertiary courses that align with their academic abilities, addressing issues like poor course selection, academic struggles, and delayed graduation. The system used 1000 cases, divided into 20% for testing and 80% for training. The researchers determined the similarity metric and neighbourhood parameter (k) experimentally, using Euclidean distance and setting k to 10. The CBR algorithm achieved a 0% classification error on test cases. The system was prototyped as a MATLAB GUI application.

Kabari and Agaba (2019) developed an Intelligent Career Advisor Expert System to address the lack of adequate career guidance for secondary school students in Nigeria. They noted that many students were making decisions about their tertiary education without professional counselling due to the high number of students and the complex nature of the counselling process. To alleviate this issue, they created an expert system to ensure every student

received proper guidance. The system used SSCE and JAMB exam results to recommend suitable courses for students and was implemented as a desktop application in C#. It featured a user-friendly interface, a robust database for storing information, and an expert system component to handle the intelligent aspects of counselling. This innovative solution aimed to streamline the counselling process, helping students make informed decisions and reducing the workload on human counsellors.

Myla *et al.* (2019) researched to develop a web-based expert system to assist higher secondary school students in selecting their major after graduation. The system considered students' interests and their academic performance in higher secondary school. It interacted with students by asking questions about their interests and performance and then provided course recommendations. Implemented using rule-based expert system technology, the system's accuracy was validated by comparing its results with those from human counsellors, showing that the system was more accurate. Supriyanto *et al.* (2019) developed an online expert system to provide career guidance for vocational high school students, helping them make informed decisions about their future, such as pursuing jobs, further education, or entrepreneurship. They used the waterfall software development approach and implemented an inference engine with forward chaining rules. Professional counsellors validated the system's effectiveness and confirmed its accuracy, endorsing it as an independent tool to assist students in making crucial life decisions.

Aimufua *et al.* (2022) researched to develop a career guidance and counselling portal for senior secondary school students, addressing the shortcomings of manual career counselling. The portal contains a list of courses being studied in the tertiary institution in which if a student selects a course, the system will provide the student with the necessary guidance regarding the course selected. The web portal was designed to reduce the overwhelming workload on counsellors and the issues related to manual record-keeping. Using a top-down software development approach, the researchers emphasized thorough understanding and planning before coding. The system features two interfaces: a user interface for students to interact with the system and an administrative interface for tasks such as system updates and maintenance.

3. Materials and Methods

This section details the procedures and materials utilized in the study, ensuring that the research can be replicated by others. It describes the workings of the current system and its constraints, outlines the design of the new system, and explores the various methodologies and models employed to implement the conceived solution. Additionally, it encompasses the research findings, featuring system interfaces that demonstrate the functional requirements implemented in the system.

3.1 Existing system

Each Student transitioning from Nigerian UBE to senior secondary schools deserves career guidance and counselling because it is the first career-related decision a student will make and it serves as a foundation upon which other career-related decisions will be made. Unfortunately, the current manual career guidance system in Nigerian schools is inadequate, with a significant percentage of schools lacking such a unit. Thus, to solve the problems associated with the manual career guidance process, an in-depth study of the manual process was conducted. Necessary information was collected through interviews and observation and was analysed to ascertain the workings of the manual system and the functionalities necessary to be incorporated into the conceived system. During the investigative process, the following weaknesses were identified:

- i. The average ratio of counsellors to students is too low, making it difficult for the counsellor to be able to meet the guidance needs of the students.
- ii. Some counsellors lack dedication and work ethic, making them difficult to approach.
- iii. Less efficient method of managing data due to the use of paper-based data storage.

- iv. In certain cases, counsellors may only be available during regular working hours, restricting the number of students they can attend to.
- v. There is a generation gap problem whereby students perceive counsellors to be middle-aged and not older individuals leading to a belief that they can only provide outdated guidance.
- vi. It's important to remember that counsellors are humans too, with their own emotions, personal responsibilities, and pressures. As a result, they may experience emotional outbursts or be unavailable when needed, which can discourage students from reaching out to them.

3.2 Proposed system

The proposed system is a web-based expert system platform designed to provide students with 24/7 access to career guidance, addressing issues of accessibility and availability of human counsellors. It aims to help students in rural and urban areas have access to career guidance and provides a tool to support overwhelmed human counsellors. The proposed system incorporates a database to efficiently organize and manage data and the result of guidance and counselling processes, automating the processes that currently contribute to inefficiency. Thus, the proposed system will reduce the workload for counsellors, improving their efficiency in guiding students.

The proposed system is a rule-based expert system that is made up of three modules:

1. **Knowledge base:** This module stores facts and rules derived from interviews and consultations with counsellors. The facts and rules obtained from domain experts are encoded into a formal language that can be inferred by the inference engine before they are stored in the knowledge base to be used inference engine for decision-making.
2. **Inference engine:** Responsible for applying rules from the knowledge base on the data supplied by a student during quiz sessions. The inference engine was implemented by adopting a weighted sum multiple criteria models with three alternatives (Science, Art and commercial) subject classification of the senior secondary school and three parameters (Howard Gardner's categorisation of intelligence, student Basic Educational certificate Examination result and students' career aspiration) to recommend a suitable alternative for a student.
3. **User interface:** This is the contact point between the system and the students. It is a friend interface implemented using web technology through which students can perform quizzes in which the result will be used by the system to recommend a suitable alternative for a student. It also allows students to view results and the rationale behind the system's recommendation

3.2.1 Software development model used

This research, which involves developing an expert system, adopts the agile software development model for several reasons:

1. **Adaptability to Evolving Knowledge:** Expert systems often require frequent updates to reflect changes in rules or knowledge. Agile's flexibility enables continuous adaptation to evolving requirements.
2. **Iterative Development:** Agile's iterative approach supports incremental development and refinement of the knowledge base. This aligns with the dynamic nature of expert systems that may need frequent adjustments based on feedback.

3. **Continuous Stakeholder Collaboration:** Agile promotes regular collaboration with stakeholders, including domain experts. This collaboration is crucial in expert systems to ensure the accuracy and relevance of the knowledge base.
4. **Frequent Testing and Validation:** Agile emphasizes continuous testing, which is advantageous for expert systems. Regular testing ensures that the system effectively applies rules and knowledge to make accurate decisions.
5. **Quick Adaptation to Feedback:** Agile's iterative cycles allow for swift adaptation to feedback. This capability is valuable in expert systems where adjustments based on user feedback or changes in the career landscape may be necessary.

3.2.2 Design of the proposed system

In every software development process, after all the functional requirements of a system are identified and documented, the requirements are converted into various forms of designs, each having a certain level of abstraction for effective communication with different stakeholders who may not be familiar with the technical aspect of the system. Figure 3.1 is an architectural design of the new system showcasing the main components of the new system and how the components interact with one another.

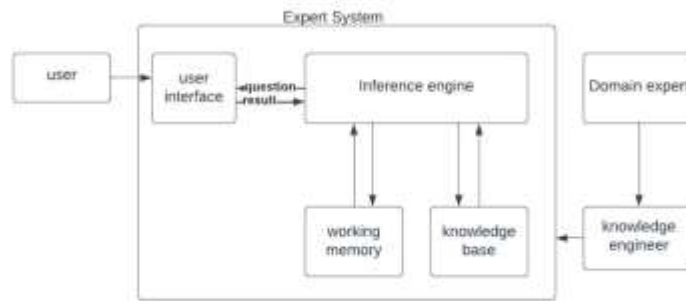


Figure 3.1 Architectural system design

The details provided in Figure 3.1 do not capture a detailed flow of control as students interact with the proposed system. Therefore, Figure 3.2 presents a flowchart diagram depicting the flow of control as users interact with the system. Figure 3.2 consists of shapes connected with directed arrows which illustrate the control flow as users navigate through the system. In the diagram, the kite symbol signifies a process that entails a decision, the parallelogram symbol represents a process involving user input or system output, the rectangle symbol denotes the operation to be performed by the system, and the oval shape marks the starting and ending point of the entire process.

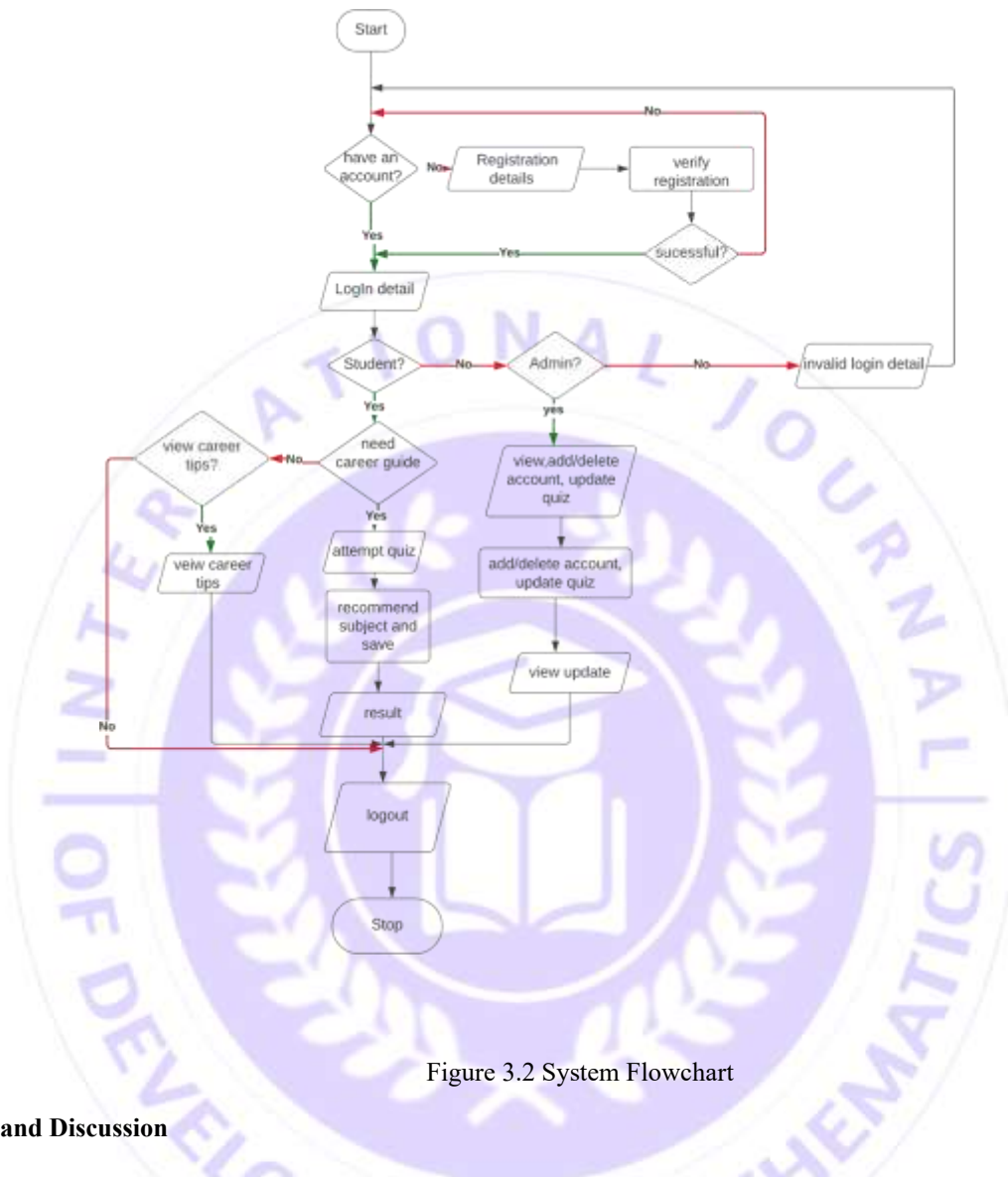


Figure 3.2 System Flowchart

4. Result and Discussion

The proposed system was designed using Bootstrap, a framework for building the front end of web applications. Bootstrap integrates HTML, CSS, and JavaScript to facilitate the rapid development of user interfaces. For the backend, the XAMPP server was used as a local host. XAMPP is a popular cross-platform web server that incorporates Apache, MySQL, PHP, and Perl, allowing programmers to write and test their code on a local web server. The result of this research work is showcased through the screenshot taken in real-time during the system operation to enable effective discussion of the functional requirement incorporated into the new system

4.1 Registration and login

The login page is the first page a student will encounter when they try to use the system for career guidance. The login page is connected to two different pages (registration and admin page) via buttons as shown in Figure 4.1. The login page allows only users who had registered previously to input their details into the appropriate space

provided. If the user is not registered, clicking on the registration button will direct him/her to the registration page as shown in Figure 4.2.



Figure 4.1 Login page



Figure 4.2 Registration page

4.2 Home page

After successful registration and login, the system directs the user to the home page where the user can either perform a quiz to get recommendations from the system or read through the career tips by clicking on quiz and tips respectively. Figure 4.3 is the screenshot of the home page.



Figure 4.3 Home page

4.3 Recommendation page

After a student has undergone the quiz which consists of three sections, that is, the academic performance section, the intelligence test section and the student aspiration section, the system recommends for the student the best alternative among science, art or commercial classes based on the result of the quiz. Figure 4.4 is a screen capture of the recommendation page.



Figure 4.4 Recommendation page

From the recommendation page, a student can decide to view the reason why the system is recommending a particular alternative for him/her by clicking on the view analysis button. The button directs the student to the analysis page as shown in Figure 4.5, where a student can see the system ranking on each alternative and parameter, and why the system recommends a particular alternative.



Figure 4.5 Analysis page

5. Conclusion

In this era of rapid technological advancement, it is wisdom to harness the power of technology in every area of human endeavour to make life easy. Having identified the problem associated with manual career guidance in Nigerian secondary schools, which is predominately motivated by the shortage in the number of counsellors, adopting this research into Nigerian schools will be a game change as it will revolutionize the career counselling process and ensure that most students transitioning from UBE scheme have access to career counselling service.

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