



Career Guidance through Admission Procedures in Nigerian Universities Using Artificial Neural Networks

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Abstract— *The study describes the application of Artificial Neural Network model in guiding students for suitable career through admission procedures in Nigerian universities. Before a candidate can be admitted to any of the Nigerian universities, he/she must be appraised based on some factors. The researchers looked into and identified various factors that may likely influence the performance of a student. These factors include ordinary level subjects' scores and subjects' combination, universal tertiary matriculation examination scores, post-universal tertiary matriculation examination scores, age on admission, parental background, types and location of secondary school attended, gender, number of sitting for Senior Secondary Certificate Examination, among others. These factors then served as input variables for the Artificial Neural Network model. A model based on the Multilayer Perceptron Topology was deployed and trained using final year students' data from faculty of Sciences, Bayero University Kano and University of Ilorin, both in Nigeria. The output from the neural network was leveraged with Visual Basic to obtain the final result. The final result so generated can offer a genuine solution to admission problems confronting Nigerian Universities.*

Keywords— *Data Mining, Artificial Neural Network, Multilayer Perceptron, Education, Admission.*

I. INTRODUCTION

University education is highly esteemed as far as Nigeria is concerned due to the fact that the number of candidates seeking for admission outweighs the capacity that the available universities can accommodate. The ambition of graduates of secondary school is to get admission into university in order to pursue a degree [1]. They further stressed that one major problem facing university system in Nigeria is associated with selection and placement of students. This is not a new problem; the practice has always been to sort out candidates that are qualified for admission. However despite the sorting, not all the qualified candidates that are admitted are rightly placed because the sorting criteria are not adequate.

The question is “What is the main idea behind admission system?” The answer is not far-fetched; the main idea of the admission system is to determine eligibility of candidates to be admitted into the university. This goes a long way to affect the level of research and training within the institution, and by extension, has an overall effect on the development of the country itself, as these candidates turn out to be the Strategic Thespian in the affairs of the country in all sectors of the economy. As a result of the fact that the ratio of number of students seeking admission when compared to total available space in various university is on the high side, there is increased pressure on the admission process. This pressure is not unconnected to rambling cases of admission scam and related problems [2].

Admission requirement is of three stages; the first requirement is that a candidate must have five credits in relevant subjects including English Language and Mathematics in Senior Secondary Certificate Examination (SSCE) and or National Examination Council (NECO) [3]. The second admission requirement is that candidate must attempt and pass up to the cut-off point (although the cut-off mark varies across various universities), Universities Tertiary Matriculation Examination (UTME), which is conducted by the Joint Admissions and Matriculation Board (JAMB). The third admission requirement is Post UTME which is being conducted by the university that candidate has chosen. However, from observation, desperate candidates are able to manipulate the system. It is a well-known fact that the present process of selecting candidates is not adequate. As a result, there is need to rescue this situation so as to retain the integrity for which Nigerian Education System was known for in seventies and eighties [2].

For many centuries, act of inventing new things has been one of the goals of human kind. We envisioned these inventions as relieving us of cumbrous and dreary tasks so that we can enjoy a more fruitful life. One of the examples of such machines is artificial neural networks which have enormously improved the quality of lives. A neural network has ability to replicate human brains through artificial means [4].

This research work employed artificial neural network in guiding students for suitable career through admission procedures in Nigerian universities using Bayero University Kano, Kano State and University of Ilorin, Kwara State as case studies.

II. MATERIAL AND METHOD

A. Literature Review

[5] conducted an inquiry on factors affecting students' performance. He used introductory undergraduate physics course as a case study and found out that general attitude of students toward science courses has a significant effect on

student's academic performance. In addition, he also discovered that age also plays a significant role when it comes to students' academic performance.

However, [6] found that academic environment and the type of service received have a significant effect on students' academic performance. He also found that staff development such as in-service training and professional development has a significant effect on high school performance but there was no correlation between family income level and academic performance.

[7] investigated factors affecting students' academic performance in the first accounting course and found out that internal classroom factors positively influenced students' academic performance in the first accounting course. However, students' academic performance did not appreciate when the external factors was combined with the internal factors.

In addition to the findings of [5], [8] worked on contributing factors to students' performance. In their research they found out those factors such as access to internet, admission status and gender also play a significant role in determining the performance of students academically.

[9] looked into various factors that can influence the academic performance of undergraduate students of Uganda University. They found out that there is a strong correlation between admission points, parents' social economic status, former school background and academic performance of under graduate students in the university. They went further to emphasize that students with A' Level admission points perform better than those with Diploma admission point, but they could not fathom any relationship between students' age and academic performance.

[10] described a student evaluation approach based upon neural networks; they used this approach to determine placement of university students into basic mathematics courses. The existing approach used the results of a mathematics placement exam given to incoming freshmen to determine course placing, but the study suggested neural networks to be suitable alternatives to such exams. In addition, [11] presented a student management application of data mining, where data mining algorithms were used to predict whether or not students would enroll in the next term. The data for the predictions was from a community college and included features such as student demographics, courses taken and total units earned. The author also investigated the use of a clustering technique to form homogeneous groups of data.

[12] also applied data mining techniques to the problem of targeting financial support at suitable prospective students; the described university is reported to be exploring the use of data mining in the identification of potential students who will attend only if they receive financial support; such students may be contrasted with those for whom financial support will not affect their attendance. The aim of such a project is to target offers of financial support towards students whose attendance is dependent upon such assistance and thus to improve their recruitment results.

The application of mining contrast sets to university admission policy review, with the aim of improving student diversity, quantity and quality, is presented in [13]; such sets describe the differences between groups of data, and the authors present the STUCCO algorithm for their discovery. STUCCO reflects the differences between undergraduate applicants to a university who chose to enroll and those that did not. The student data used includes SAT score, GPA, a composite formed from SAT and GPA, home location and ethnicity.

Some of the researchers even tried to explain the link between students' achievements, economic circumstances and the risk of becoming a drop-out that proved to be positive. [14] explained the effects of age, qualification, and distance from learning place, etc. on students' performance. The performance of students on the module is not affected by such factors as age, sex and place of residence but is associated with qualification in quantitative subjects. They also found out that those who live near the university perform better than other students.

Artificial Neural Network (ANN) has been used to predict the students' success. [15] concurred that the best model in predicting the final Cumulative Grade Point Average (CGPA) of the students upon graduation is ANN. [15] sought to find out a correlation between Students University tertiary matriculation exam (UTME) scores and their academic performance in Nigerian universities, using the Faculty of Technology, University of Ibadan, Nigeria as a test case. He investigated the relationship between students' UME scores, first, second, and final year Grade Points (GP) with the use of a simple correlation and regression analysis. He concluded in his research that there exists a positive relationship between students' admission scores and their undergraduate performance. However, a recent trend after Adedeji's study indicates the unreliability of the UTME scores. Thus it becomes necessary to identify other suitable factors, in addition to UTME scores, that can predict the suitability of a candidate for admission.

B. Methodology

This study was carried out using data from two federal universities in Nigeria viz University of Ilorin, Kwara State and Bayero University, Kano, Kano State. The researchers drew the sample from these two federal universities. Of the one hundred and fifty four (154) questionnaires served the final year students of these institutions, the returned useable questionnaires were one hundred and twelve giving a return rate of 72.7%. Data collection was effected through a questionnaire titled questionnaire for science final year students.

The survey questionnaire was used as the main data-gathering instrument for this thesis. By means of employing this Questionnaire for data gathering, the researchers were able to obtain the advantages of both quantitative and qualitative data gathering methods.

The researchers opted to integrate the qualitative approach in this study due to its significant advantages. The use of qualitative data gathering method is advantageous as they are more open to changes and refinement of research ideas as the study progresses; this implies that qualitative data gathering tools are highly flexible. Moreover, no manipulation of the research setting is necessary with this method; rather than employ various research controls such as in experimental approaches.

The researchers divided the questionnaire into two main sections: a profile and the survey proper. The profile contains socio-demographic characteristics of the respondents such as Student Matric No., Sex, Ethnicity, Religion, Marital Status, Family Background, Origin, Age of Student at Admission, Parents' Educational status, Parents' Occupation, Parents' income per annum, etc.

The survey proper explored the O level, UTME and Post-UTME performances of the respondent, particularly on its usability as an admission selection and appraisal tool. The researchers used Likert format in structuring the questions.

C. The Input Variables

The input variables selected are:

1. Matriculation number
2. Department
3. Course
4. Sex
5. Marital status
6. State of origin
7. Level at university
8. UTME score
9. POST-UTME score
10. Age of student at admission
11. O/level results in Mathematics, English Language, Physics, Biology and Chemistry,
12. Time that has elapsed between graduating from secondary school and gaining university admission,
13. Parents educational status,
14. Zonal location of student's secondary school,
15. Type of secondary school attended (privately owned, State or federal government owned),
16. No. of sitting for SSCE Exam
17. Location of university and place of residence, an
18. Student's Gender and
19. Present CGPA

The researchers transformed the above listed factors into a format suitable for neural network analysis in Table 1.

Table 1 Input Data Transformation

S/N	INPUT VARIABLES	DOMAIN		
1.	UTME SCORE*	SCORE	NORMALIZED SCORE	
2.	POST-UTME SCORE*	SCORE	NORMALIZED SCORE	
3.	O LEVEL SCORE	ENGLISH	A1	1
			B2 – B3	2
			C4 – C6	3
		MATHEMATICS	A1	1
			B2 – B3	2
			C4 – C6	3
		PHYSICS	A1	1
			B2 – B3	2
			C4 – C6	3
		CHEMISTRY	A1	1
			B2 – B3	2
			C4 – C6	3
		BIOLOGY	A1	1
			B2 – B3	2
			C4 – C6	3
4.	AGE AT ENTRY	BELOW 23	1	
		23 YEARS AND ABOVE	2	
5.	TIME ELAPSE BEFORE ADMISSION	1 YEAR	1	
		2 YEARS	2	
		3 YEARS AND ABOVE	3	
6.	EDUCATED PARENT(S)	YES	1	
		NO	2	
7.	TYPE OF SECONDARY SCHOOL ATTENDED	PRIVATE	1	
		FEDERAL	2	
		STATE	3	
8.	GENDER	MALE	1	
		FEMALE	2	

9.	PARENT INCOME PER ANNUM	>1 MILLION	1
		>500,000 BUT <1 MILLION	2
		<500,000	3
10.	STAYING WITH	BOTH PARENTS	1
		SINGLE PARENT/GUARDIAN	2
		ALONE	3
11.	PASSED SSCE AT	ONE SITTING	1
		2 SITTINGS	2
12.	MARITAL STATUS	SINGLE	1
		MARRIED	2
13.	LOCATION OF SCHOOL	CITY	1
		TOWN	2
		VILLAGE	3
14.	FAMILY BACKGROUND	MONOGAMY	1
		POLYGAMY	2

* Since the general University Tertiary Matriculation Examination performance may vary yearly normalizing is necessary. The normalized score = (candidate score)/ (average score for the class).

D. Design and Building of the Neural Network

After the data has been transformed and the method of training has been chosen, it is necessary to then determine the topology of the neural network. The network topology describes the arrangement of the neural network. Choosing the topology of the neural network is a difficult decision [17] and [18]. The network topologies available are numerous; each with its inherent advantages and disadvantages. For example, some networks trade off speed for accuracy, while some are capable of handling static variables and not continuous ones. Hence, in order to arrive at an appropriate network topology, various topologies such as Multilayer Perceptron, recurrent network, and time-lagged recurrent network were considered. Due to the nature of our case study data, which is static and not sufficiently large to enable the use of complex topologies, the Multilayer Perceptron was selected.

E. Network Training and Validation Process

The network was trained with the number of runs set to three and the Epoch set to terminate at 1000. The training performance is then evaluated using the following performance measures:

$$MSE = \frac{\sum_{j=0}^p (d_{ij} - y_{ij})^2}{NP} \tag{1}$$

The Mean Square Error (MSE):

where:

p = number of output of processing element.

N= no of exemplars in the data set.

Yij=network output for exemplars i at processing element j,

dij=desired output for exemplars i at processing element j.

F. The Output Variable

The output variable represents the performance of a student on graduation. The output variable is based on the current grading system used by the university. However, for the scope of this research work, the domain of the output variables represents some range of Cumulative Grade Point Averages (CGPA). The classification of output variable domain chosen, that is 1st class and 2nd class upper as ‘GOOD’, 2nd class lower as ‘AVERAGE’, and 3rd class and pass as ‘POOR’, follows the practice of classifying candidates into these domains by most employing companies and postgraduate institutions as indicated in table 2.

Table 2 Output Data Transformation

S/N	OUTPUT VARIABLE	DOMAIN	
		CLASS	CGPA
1	GOOD	1ST CLASS	4.50 – 5.00
		2ND CLASS	3.50 – 4.49
		UPPER	
2	AVERAGE	2ND CLASS	2.40 – 3.49
		LOWER	
3	POOR	3RD CLASS	1.50 – 2.39
		PASS	>=1.00

III. RESULTS

After the training and cross Validation, the network was tested with the data. This involves given the input variable data to the network without the output variable results. The output from the network is then compared with the actual variable data. The result from the neural network was leveraged with Visual Basic to obtain the final result. Table 3 shows the input and output data of candidate with Number KOL001.

Table 3 Admission Prospects For Candidate With Jamb No: Koll001

O LEVEL RESULT	
MATHEMATICS	C5
ENGLISH	C6
PHYSICS	C6
BIOLOGY	C5
CHEMISTRY	C4
UTME SCORE	223
POST-UTME SCORE	57
AGE	BELOW 23
GENDER	MALE
GREW UP IN	CITY
LOCALITY	URBAN
YEAR ELAPSED	
BEFORE ADMISSION	1 YEAR
SPONSOR INCOME	>1 MILLION
MARITAL STATUS	SINGLE
STAYING WITH	BOTH
PARENTS	
FAMILY BACKGROUND	MONOGAMY
TYPE OF SCHOOL ATTENDED	PRIVATE
THIS CANDIDATE, IF ADMITTED TO ANY OF THE FOLLOWING PROGRAM, THE ATTACHED FIGURES ARE THE Expected Cumulative Grade Point Average (ECGPA)	
INDUSTRIAL CHEMISTRY	3.31
ELECTRONICS	2.85
MATHEMATICS	2.83
BIOLOGY	2.82
PHYSICS	2.50
MICRO-BIOLOGY	2.26
CHEMISTRY	2.40

From the study it was discovered that many non-examination factors positively or negatively affect students' performance. Some students have the same O' Level Result, same Jamb Result but went ahead to perform better in the University owing to non-examination factors. These include home background, parents' financial and social status, student's age at admission, student locality.

IV. CONCLUSIONS

A. Conclusion

Today, the importance of guidance and counseling with respect to career choices is often overlooked and undervalued. This is responsible for many dropouts in our tertiary institutions. To make their school and future lives healthy, comfortable and productive, students must be provided with rich guidance and counseling 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.

B. Further Research direction

The extension of this research to non-sciences departments is recommended. The current admissions system should be reviewed in order to improve the standard of candidates being admitted into the institution.

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APPENDIX A

SAMPLE OF QUESTIONNAIRE

QUESTIONNAIRE FOR SCIENCE FINAL YEAR STUDENTS

This is a special set of questions. It is not a test of achievement because there is no right or wrong answer. Nor is it a process to uncover something about your personality. We are concerned about means of enhancing admission process and placement for science students in Nigeria universities. That is why it is important that you carefully consider your answer to every test question, without staying with it long. Work calmly with concentration, and try to be honest. You are not to write your name on the form to guarantee the confidentiality attached to the expected response.

Thank you for your consideration.

1. Student Matric No.: _____
2. Department: _____
3. Course: _____
4. Sex: (a) Male (b) Female
5. Ethnicity: (a) Hausa (b) Ibo (c) Yoruba (d) Others
6. Religion: (a) Christianity (b) Islam (c) Traditional (d) Others
7. Marital Status: (a) Single (b) Married (c) Widow (d) Separated (e) Divorce
8. Family Background: (a) Monogamous (b) Polygamous
9. Level at University: (a) 400 (b) 500
10. You schooled in a (a) Village (b) Town (c) City

11. Will you consider the locality where you grow up as: (a) Rural (b) Semi-urban (c) Urban
12. State of Origin: _____
13. Age of Student at Admission: (a) Below 23 (b) 23 and Above
14. UTME Score: _____
15. POST-UTME Score: _____
16. O'Level Result in:

Mathematics:	(a) A1	(b) B2 – B3	(c) C4 -- C6
English:	(a) A1	(b) B2 – B3	(c) C4 -- C6
Physics:	(a) A1	(b) B2 – B3	(c) C4 -- C6
Chemistry:	(a) A1	(b) B2 – B3	(c) C4 -- C6
Biology:	(a) A1	(b) B2 – B3	(c) C4 -- C6
17. Time that has elapse between graduation from secondary school and gaining admission to university:
(a) 1 year (b) 2 years (c) 3 years and above
18. Parents Educational status: (a) Educated (b) Not Educated
19. Type of Secondary school attended: (a) Private (b) State (c) Federal
20. Parents Occupation: (a) Public Sector (b) Private Sector (c) Self Employed
21. Parents income per annum: (a) Above ₦1M (b) Above ₦500,000 but less than 1M (c) Below ₦500,000
22. Staying with: (a) Both Parents (b) Single Parent (c) Guardian (d) Alone
23. Passed SSCE Exams at: (a) 1 Sitting (b) 2 Sitting
24. Present CGPA: (a) ≥ 4.5 (b) < 4.5 but ≥ 3.5 (c) < 3.5 but ≥ 2.5 (d) ≤ 2.5