A Multi-Factor Student Assessment Methodology.

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ABSTRACT

Evaluating the true capability of students' IQ capacity and determining the true success and failure rates which serves as a means of promotion into the next level, have been a great concern to management of various tertiary institutions. This research study formalizes strategies and that objectively assess students' academic performance. The study establishes the facts that though present assessment methods via continuous assessments and examination reveals a measure of students' academic abilities, it limits the capability of students, results in a high failure rate and supports the idea that "examination is not a true test of knowledge". An assessment format is proposed and implemented that assures that the true ability of a student is exploited.

(Keywords: examination, learning, student tests, department, course, faculty, pass, tertiary education)

INTRODUCTION

Student learning assessment according to Angelo (1995) is the ongoing process of establishing clear, measurable expected outcomes of student learning, ensuring that students have sufficient opportunities to achieve those outcomes, systematically gathering, analyzing, and interpreting evidence to determine how well student learning matches faculty's expectations, and using the resulting information to understand and improve student learning.

Assessment is an integral part of the teaching-learning process that consists of all of the procedures and strategies that are used to obtain information about student learning (Linn and Baker, 1995). The result of an assessment is a value judgment which could be: pass, fail, excellent, very good, good, fairly good, poor, and so on. There is a distinction between an assessment and a test. A test, which is also an examination, is one form of an assessment that frequently consists of a set of questions that are administered during a fixed period of time under supervised conditions. The examination is the most powerful tool the teacher has to promote a good teaching process (Nulden, 1998) and it can be administered verbally or in written form.

Examinations results aid students' selection, certification and progress reporting to parents and policy makers. Examinations have also been used to monitor, measure, and judge the performance of the educational system in country (Fagbamiye, 1998). In Nigerian institutions, it is the key method of assessment for determining the best students in a class, department or faculty.

The first assessment examination was a written one that took place in a classroom in China and since then, several examinations have been conducted. In 2357 BC the Chinese examination for military officers was conducted. In 1115 BC civil service examinations for candidates into the Chinese Imperial Service was conducted. Between 1122BC and 255 BC admission and semiannual examinations were conducted. From 400 BC a combination of oral and written examinations started with the Han Dynasty between 206 BC and 220 AD who conducted written examination for civil servants, and then by the Jesuits. University examinations started in the middle ages were candidates' admissions and assessments included both oral and written examinations (Fajana 1978).

In Nigeria, over the years, entrance and in-school examinations for modern schools, primary schools, secondary schools and universities as it applies in each era have undergone some curriculum changes and reforms (Fafunwa, 1971;

Eseh, 2005; Fajana, 1978; Revised, 1985; Ugwu, 2005). Also several assessment techniques have evolved to evaluate students' academic performance, they include: diagnostic assessment, formative assessment, portfolio assessment, summative assessment (Black and William, 1998; Rust et al., 2003).

Diagnostic assessment helps in identifying and establishing a students' previous knowledge-base, clarify misconceptions in order to aid the teachers' knowledge dissemination direction. This assessment method includes: pre-tests on course contents and abilities, self-assessments in identifying skills and competencies, discussion board responses on content-specific prompts and interviews which could be brief and private.

Formative assessment focuses on the process toward completing the product and provides the students feedbacks on their learning and the teacher feedbacks on his/her teaching. This assessment technique includes: in-class activities, homework exercises, final year examinations. However, after the completion of a course or project, there is no provision for further revisions.

Portfolio assessment provides continuous feedbacks on students' ongoing performance during learning. A major advantage of this assessments approach is that examinations occur continuously throughout the session on all courses. Summative assessment occurs at the end of the learning process and provides information and feedback on the teaching and learning process. An advantage of this technique is that this final assessment provides feedbacks that the students can take advantage of in order to improve. A disadvantage of this technique is that students who are good at memorizing class notes will perform better (Ajibola, 2008). Also students do not get course learning feedbacks (Baud and Falchikova, 2006).

Of all the aforementioned methods, in the University environment, the use of tests and examinations are the most prevalent. Test (i.e. continuous assessment) usually is graded 20% or 30% while examinations are graded 80% or 70% respectively of the overall course score. Using only examination narrows the innate potentials of students because some students just read and cram for examinations without a deep knowledge of its application to the real world and sometimes it deprive worthy students of merit. The credibility of some examinations have been eroded through unethical behaviors involving manipulations, malpractices and favoritism which spurs the need for a more fair approach for the selection of exceptional students.

This paper formalizes the assessment strategies, proposed and implemented a model that objectively assesses students' academic performance and chooses the best students in class considering other assessment factors such as; group work, class attendance, assignment, test, creativity/laboratory work, classroom assessment and oral presentation. The study establishes the facts that though present assessment methods via continuous assessments and examination reveals a measure of students' academic abilities, it limits the capability of students, results in a high failure rate and supports the idea that "examination is not a true test of knowledge".

This paper also presents a review of related works and a detailed description of the generic assessment methodology prevalent in most departments in the University of Benin. The methodology was also represented as a computer algorithm. A proposed assessment methodology and its equivalent computer algorithms representation as well as the experimentation and conclusions of the work are also presented.

RELATED WORKS

Research on techniques and methods towards predicting students' performance using algorithms have been undertaken by some researchers.

Oyelade et al. (2013) designed a model for analyzing students results based on cluster analysis. Standard statistical algorithms were used to arrange students' scores data according to their level of performance. According to them, many factors could act as barriers to students attaining and maintaining a high Grade Point Average that reflects their overall academic performance during their tenure in University.

These factors could be targeted by the faculty members in developing strategies to improve student learning and improve their academic performance by way of monitoring the progression of their performance. K-mean clustering algorithm was implemented for

analyzing students' result data of a private Institution in Nigeria which was used as benchmark to monitor the progression of academic performance of students in higher Institution.

Chanranjit et al. (2014) analyzed the potential use of one of the data mining technique called association rule mining in enhancing the quality of students performances. The extracted rules help to predict the performance of the students and it identifies poor, good and excellent students, and also helped to improve the result of the student. In their work, the Apriori algorithm was used, which extracts the set of rules, specific to each class and analyzes the given data to classify the student based on their performance in academics. Students were classified based on their involvement in doing assignment, internal assessment tests, attendance etc., which helps to analyze the performance of the student based on the pattern extracted from the educational database.

Ramjeet and Ahmed (2012) designed and evaluated a fast-learning algorithm using Ada Boost ensemble with a simple genetic algorithm called "Ada-GA" where the genetic algorithm is demonstrated to successfully improve the accuracy of the combined classifier performance. The Ada-GA algorithm proved to be of considerable usefulness in identifying the students at risk early, especially in very large classes. This early prediction allows the instructor to provide appropriate advising to those students. The Ada/GA algorithm is implemented and tested on ASSISTments dataset, the results showed that the algorithm has successfully improved the detection accuracy as well as it reduces the complexity of computation. Their work built a prediction model by analyzing the factors that affect the performance of the students using the "ASSISTments Platform dataset". Their study was able to solve the difficulty of monitoring students' performance, especially in very large classes.

Kuyoro et al. (2013) designed an optimal algorithm suitable for predicting first year tertiary students' academic performance based on their family background factors and previous academic achievement. The study focused on comparing the performance of machine learning algorithms on data relating to students family background factors and previous academic achievement with the aim of identifying the optimal model for predicting students' performance. Here, the students' first year academic performance was measured by Cumulative Grade Point Average (CGPA) at the end of the first session and the previous academic achievement was measured by the Senior Secondary Certificate Examination grade score and UME score. In the design of the experiment, data relating to students' academic performance was collected from the students' record; data relating to students' family background and previous academic achievement was extracted from the enrolment form in the students' files; and data repositories that interface with Waikato Environment for Knowledge Analysis WEKA (a collection of machine learning algorithms tools for data pre-processing, classification, regression, clustering, association rules and visualization) computing environment was created.

Sixty-six percent of the data was used to train the models, while the remaining was used to test. WEKA computing tools was used to generate 10 classifiers and multilayer perception (artificial neural networks) machine learning algorithms. The machine learning algorithms generated from the students' data was compared using 10-fold cross-validation and hold-out methods. Accuracy level and confusion matrices benchmarks were used to determine the optimal predictive model.

Julianti et al. (2012) designed an algorithm to help the academic advisors with a more practical way of predicting the final passing results of a student-based on their performance in several subjects in early semesters of their study period. In their research, a data mining task called classification was employed. Classification is performed through a technique called Classification and Regression Trees, which diagrammatically is presented in the form of decision trees. In their research, a more practical method is introduced and applied, based upon the classification of functions of data mining. The classification was performed using software based upon the Classification and Regression Trees algorithm.

Ramjeet and Ahmed (2012) explore the applicability of K-means and Fuzzy C-Means clustering algorithms to student allocation problem that allocates new students to homogenous groups of specified maximum capacity, and analyze effects of such allocations on the academic performance of students. The paper also presented a Fuzzy set and Regression analysis based Dynamic Fuzzy

Expert System model which is capable of dealing with imprecision and missing data that is commonly inherited in the student academic performance evaluation. The model automatically converts crisp sets into fuzzy sets by using C-Means clustering algorithm method. The comparative performance analysis indicates that the student group formed by Fuzzy C-Means clustering algorithm performed better than groups formed by K-Means and Hard C-Means clustering algorithms. In their research paper, the proposed dynamic Fuzzy Expert System automatically converts the crisp data into fuzzy set and also calculates the total mark of a student.

Nguyen et al. (2010) proposed a novel approach which uses recommender system techniques for educational data mining, especially for predicting student performance. To validate this approach, they compared the recommender system techniques with traditional regression methods such as logistic/linear regression by using educational data for intelligent tutoring systems.

Although numerous papers have been published using the recommender systems but their work made contributions such as; applying recommender system techniques such as matrix factorization in the educational context, especially for predicting student performance; researching the mapping of educational data (student performance data in this case) to user-item-rating triples used in recommender systems; comparing recommender systems with traditional techniques such as linear regression or logistic regression.

Kalpesh et al. (2013) developed a system that predicts the performance of students from their previous performances using concepts of data mining techniques under Classification. This helped higher institutions to have an approximate prior knowledge of enrolled students to predict their performance in future academics. Their work tends to identify promising students and also provides them an opportunity to pay attention to and improve those who would probably get lower grades. In their paper, they analyzed a data set containing information about students, such as gender, marks scored in the board examinations of classes, marks and rank in entrance examinations and results in first year of the previous batch of students. By applying the ID3 (Iterative Dichotomiser 3) and C4.5 classification algorithms on this data, they predicted the general and individual performance of freshly admitted students in future examinations.

THE GENERIC ASSESSMENT PROCEDURES

In the existing system, students' academic performance is being assessed using majorly two criteria; they include examinations and continuous assessment (tests). Before the end of the semester, the continuous assessment is administered to students which are scored over 20 marks based on their knowledge of the course. The continuous assessment is usually in written form and could either be open-ended questions requiring short written answers either a word or a phrase. Most times open-ended questions are administered to test more complex reasoning of students such as logical thinking, interpretation or analysis. The tests could also be open-ended in form of essays where students are required to give a more lengthy written response. Students could also be tested in form of multiple choices where alternatives are given to choose from or true-false tests.

At the end of the semester, examinations are conducted for the students which are scored over 80 marks. These examinations could also be administered in any of the aforementioned forms. The addition of the tests results and examination results sum to a total of 100 marks for each course and are graded accordingly based on the student's performances. With this background information, we are now better positioned to represent the existing system as the computer algorithm 3.1:

Let Examination be represented as E;
Let continuous assessment be represented as T;

INPUT: E, T is integer;
OUTPUT: score;
    Score: = 0; // initialize score to zero
    Score: = E + T; // sum scores of examination and test
End.

Algorithm 3.1: Generic Assessment Algorithm

THE PROPOSED ASSESSMENT PROCEDURES

The proposed system is a model to assess students' academic performance. In this model, a number of assessment factors are put into place to better test students' knowledge (practically or in writing) on the course. The total mark obtainable in a course is 100 marks which are

split among each of the factors to be considered for assessing the students. Below are the factors for assessment and their respective allocated marks: assignments are scored 10 marks, examination 30 marks, continuous assessment (10 marks), oral presentation (10 marks), group work (10 marks), classroom assessment (10 marks), class attendance (10 marks) and creativity/lab work (10 marks). The above factors are further split into dependent and independent factors.

The dependent factors are so called because the students' total score for dependent factors (T_D) depends on the students' class attendance i.e., the students score for class attendance determines his/her total score. In this case a student who does not attend classes regularly may not actively participate in the other forms of assessment resulting in poor grades. The dependent factors include the following: oral presentation (Or), classroom assessment (Cl), group work (Gr) and creativity/lab work (Cr). The dependent factors (T_D) is denoted as Equation (1):

$$T_D = \alpha \sum (F_d/8) \quad \textbf{(1)}$$

Where the sum of dependent factors (T_D) is 50 marks, α represents class attendance and F_d denotes each of the dependent factors. From equation (1), if α (class attendance) equals zero then the students' total score for dependent factors (T_D) automatically becomes zero; which means such a student has lost 50 marks.

The independent factors (T_I) do not depend on the students' attendance. Students can partake in them without necessarily attending classes. These factors include: assignments (A), examination (E) and continuous assessment (CA). The sum of these factors gives a total of 50 marks. The independent factors (T_I) is denoted as Equation (2):

$$T_I = \sum F_i \quad \textbf{(2)}$$

where F_i represents each of the independent factors. In general, the total assessment score denoted as T_A is represented as Equation (3):

$$T_A = \alpha \sum (F_d/8) + \sum F_i \quad \textbf{(3)}$$

Equation (3) is a sum total of the dependent factors (T_D) and the independent factors (T_I) which gives a total of 100 marks as the total assessment score (T_A). With Equation (3) given, the proposed framework can be analyze in a computer algorithm. Let class attendance, oral presentation, classroom assessment, creativity/lab work, assignment, examination and continuous assessment be represented as α, Or, Ca, Gr, Cl, A, E, T, respectively:

```
INPUT: α, Or,Ca, Gr, Cl, A, E, T, are all integers;
OUTPUT: score
METHOD: Fd = Or + Ca + Gr + Cl;
{
    If α! = 0;
    {
        Score: = α; // assign score to α
        Score: = Score* (Fd/8) // compute score
                 using the formula
}
    else
    {
        Score: = 0 // output zero
    }
 Fi: = A + E + T; // sum of assignment,
       examination and test
 Score: = score + Fi; // compute total score using
          the formula
Output score
}
```

Algorithm 4.1: The proposed Assessment Algorithm

EXPERIMENTATION

The generic assessment algorithm and the proposed assessment algorithm were implemented in C# programming language (Nørmark, 2010) using the data sets of the same set of 20 students in a particular course titled CSC 428 (Graph Theory). Table 1 and Figure 1 summarize the performance of the students using the existing generic methodology while Table 2 and Figure 2 show the results obtained from the proposed methodology.

Figure 3 shows the comparison of the students' performance using both assessment methods. It is evident that the academic performance of students' improved drastically using the proposed method. In this case, the system discourages limitation of students' capability and encourages hard work. The attendance rate of students will increase drastically since it is a high determining factor of their grades.

Table 1: Assessment Scores using the Generic Methodology.

MATRIC NO	TEST(20MKS)	EXAM(80MKS)	TOTAL(100MKS)	GRADE
PSC1004378	20	45	65	B
PSC1004497	15	25	40	E
PSC1004459	10	25	35	F
PSC1004403	5	17	22	F
PSC1004366	19	58	77	A
PSC1004454	15	48	63	B
PSC1004172	10	41	51	C
PSC1004461	10	30	40	E
PSC1004445	9	41	50	C
PSC1004458	12	27	39	F
PSC1004371	14	16	30	F
PSC1004489	8	25	33	F
PSC1004375	20	26	46	D
PSC1004437	20	58	78	A
PSC1004509	18	40	58	C
PSC1004398	16	32	48	D
PSC1005599	15	22	37	F
PSC1004404	14	49	63	B
PSC1004392	17	30	47	E
PSC1004450	20	31	51	C

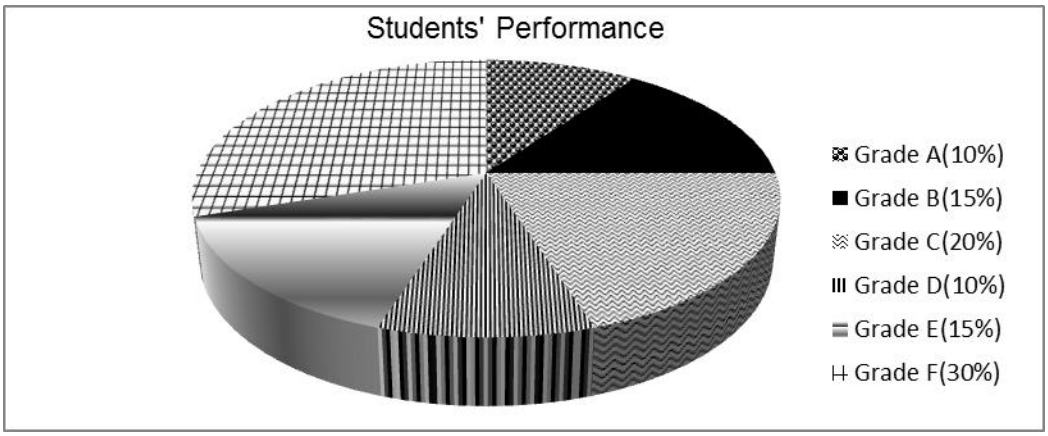

Figure 1: Grade Summary of the Generic Assessment Methodology.

Table 2: Assessment Scores using the Proposed Assessment Methodology.

Mat no	Test (10mk)	Exam (30mk)	Assign. (10mk)	Oral P. (10mk)	Cr/lab. (10mk)	Gr work (10mk)	Cl. Ass. (10mk)	Cl.attd (10mk)	Total (100)	Grade
PSC1004378	10	25	8	10	10	8	8	9	83.5	A
PSC1004497	10	30	7	10	8	10	7	7	77.6	A
PSC1004459	5	25	10	8	9	8	7	7	68	B
PSC1004403	2	15	8	5	8	8	6	8	52	C
PSC1004366	8	25	8	9	10	10	5	10	83.5	A
PSC1004454	10	25	8	10	8	8	8	9	82.3	A
PSC1004172	10	30	10	10	8	8	8	9	89.3	A
PSC1004461	6	20	8	6	9	8	5	9	65.5	B
PSC1004445	6	15	10	8	4	8	4	3	40	E
PSC1004458	10	15	8	7	10	10	6	7	61.1	B
PSC1004371	9	5	8	8	8	10	5	9	58	C
PSC1004489	4	10	8	7	6	8	4	8	47	D
PSC1004375	10	15	7	4	9	10	5	8	60	B
PSC1004437	6	15	7	8	6	6	4	2	34	F
PSC1004509	10	25	8	9	6	10	6	4	58.5	C
PSC1004398	8	10	10	9	8	8	5	4	44.5	D
PSC1005599	10	10	10	10	9	10	5	6	55.5	C
PSC1004404	9	30	7	10	8	8	6	10	86	A
PSC1004392	9	20	9	8	10	10	6	7	67.7	B
PSC1004450	10	15	6	10	8	10	5	10	72.2	A

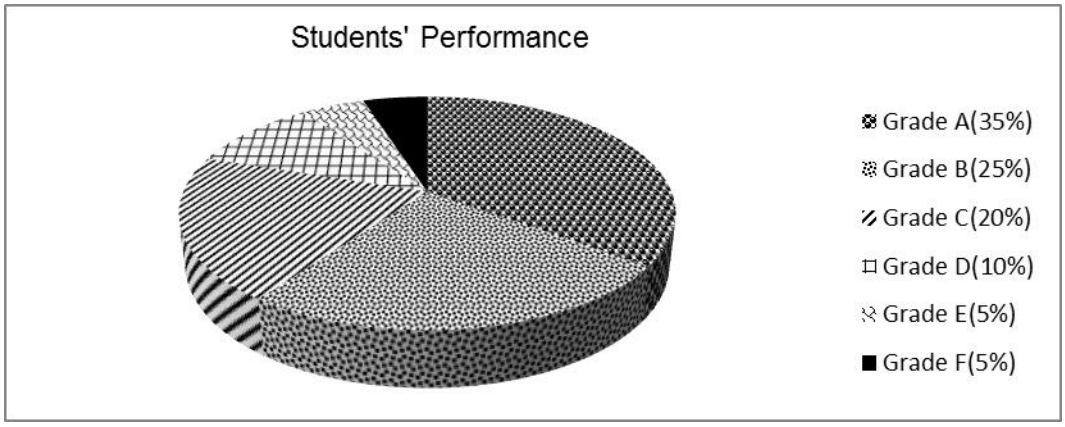

Figure 2: Grade Summary of the Proposed Assessment Methodology.

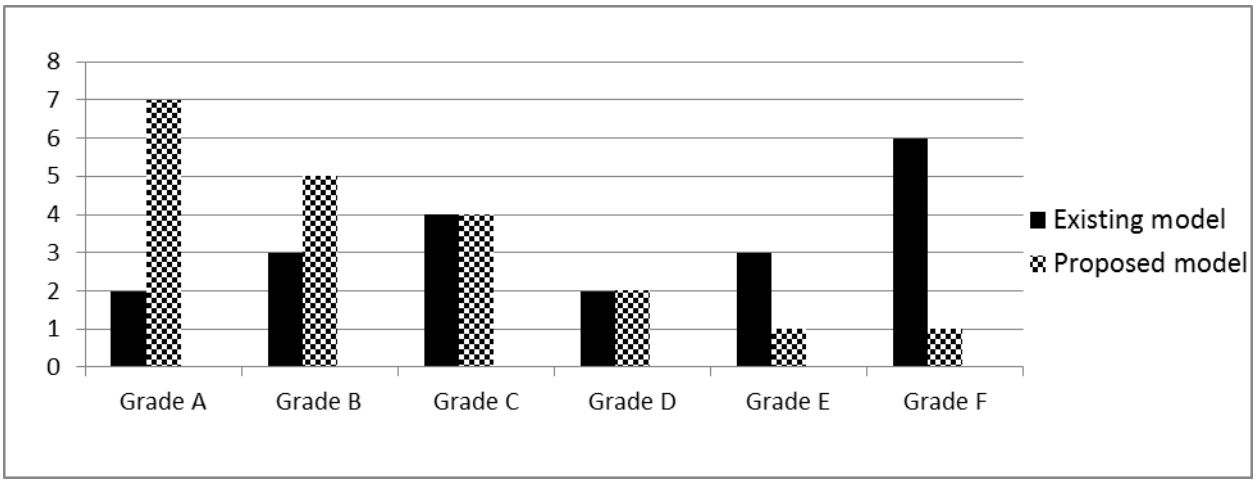

Figure 3: Comparison of Results.

The problem of students' nonchalant attitude during lectures will be curbed because students will also be graded in the classroom. Flexibility in the learning process is encouraged which further improve students I.Q level because students are tested based on various factors. Therefore, determining the best students in a class is fair and impartial since a lot of factors are considered to make up a student's grade.

CONCLUSION

The assessment of students in any institution is an integral part of the educational sect. In assessing of students' academic performance, proper measures must be taken to ensure students are properly assessed. The backbone and future of a society greatly depends on the in-built potentials, capability, level of I.Q. and knowledge capacity of the students being brought forth (graduates) by any institution. Since the advent of formal education, one of the most important factors considered is the assessment methods for evaluating the knowledge area of students. Unfortunately, it is sometimes not enough to evaluate students' performance using just tests and examination. Most times, students' are not mentally and practically tasked enough. Also, students' can easily cheat to pass their tests and examination, therefore fairly rating students' based on their effort becomes difficult; for a system that cannot guarantee that the most deserving students are so rewarded is not fair.

Thus, the proposed model provides various means of testing students' academic performance. With this, students can be properly scrutinized and evaluated based on their knowledge area in each course.

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