Proposed Method of Evaluating the Eligibility Criteria for Supplementary Assessments

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***Abstract* – During assessments, the results of an examination or test are assigned into a category of pass or fail. In engineering studies and most other disciplines, the pass/fail category is determined from grading of assessments, typically requiring allocation of a quantitative mark achieved by a candidate, in a given module or course program. Institutions have well-defined policies on mark criteria used to determine the pass/fail category. However, quite a challenging issue arises from the category of students whose performance falls within the pass/fail borderline, typically 40 to 51% mark category.**

The marks of students in this borderline category are usually influenced not only by cognitive abilities of the candidate but also by marking errors, and unpredictable factors arising during the period of assessment or examination. Accordingly, there is a group of candidates that are awarded a pass category, that "truly" belong to the fail category, and the converse is also true. As such, there is an in-built error in almost all assessment practices. For example, once a student obtains exactly or just above 50%, they do not often receive a re-test consideration, yet it is possible that the student's "true" score could be in the fail category. So examiners have to embark on a process to separate out those who achieved a fail but could have passed. This is normally conducted by offering a re-test in form of supplementary assessment or examination.

In this paper, it is attempted to review the common sources of errors affecting marking, and to discuss issues particularly leading to re-tests. The *overlapping distribution method* is proposed for use to evaluate the selection of a specific mark cut-off as a required criteria that students must meet to qualify for re-tests. Such an evaluation method can be applied to inform policy on re-tests and supplementary examinations.

***Keywords* – Eligibility criteria, supplementary assessments, marking error, academic performance, reliability, scores**

I. INTRODUCTION

Owing to the high costs of studies at higher education institutions (HEIs), the performance of students enrolled often draws high financial stakes. In most cases in Africa, students finance their studies through the meager incomes of families and through bank loans. In countries such as South Africa, some engineering students can be fortunate to find sponsorships from the private sector industry, usually offered by companies, firms or government corporates. Students who complete their engineering studies, are required to pay back their loans in cash or in kind by working for the sponsor for a period of time. During the period of their engineering studies, stakes are high regarding the performance of students during examinations. Those who fail summative assessment of a module, face the high risk of losing their sponsorship and/or, dropping out of the HEI altogether.

This article focusses on grading of summative assessments with particular interest in deciding the pass/fail categories through re-tests. For this purpose, the overlapping distribution method (ODM) is explored as a potential technique for deciding on the appropriate cut-off mark criteria that students must meet in order to qualify for supplementary examinations.

II. FACTORS AFFECTING STUDENTS' ACADEMIC PERFORMANCE

The issue of academic performance of students at HEIs is a foremost priority matter for all stakeholders of higher education from students and parents, lecturers and professors, to executive management of education institutions. Problems in academic performance of students, relate to a wide array of factors that may impact their results. It is therefore befitting that this area has attracted a great deal of research interest at various institutions globally, as exemplified by the intensity of research publications on the subject [1]-[10]. In Africa, studies in this subject have been done in various countries including South Africa [10], Uganda [5], Nigeria [2]-[3], amongst others.

The academic performance of students not only have financial implications as discussed earlier, but it also affects their graduation. An extensive study by the Engineering Council of South Africa [11], found that for the four-year engineering undergraduate programs offered by HEIs in South Africa, only 30% of first year enrolments graduate after five years, 14% remain within the system usually repeating various program modules while 56% drop out of university without completing their engineering studies. This high dropout rate is an issue that resonates with the high interest among stakeholders, in an attempt to understand its causes, with a view of improving the current dropout rate. In the broader picture of issues in Sub-Saharan which has the lowest enrolment worldwide, improving academic performance would contribute to increasing the very low number of engineers in the sub-continent. Studies [11]-[13] show that the number of qualified engineers per thousands of the population is very low in Africa, being one engineer for 3166 thousands of the population for South Africa, 5930 thousands for Tanzania and 6373 thousands for Zimbabwe. This number of engineers in Africa is very low compared to other developing countries, such as 227 thousands for Brazil, 681 thousands for Chile.

In a quest to improve academic performance, studies have identified a group of six factors [4,11] comprising:- Student selection for admissions to a HEI, student study habits and interests, institutional support systems, student family and home environment during studies, program structure and curriculum, academic lecturers and instructors. All these factors are experienced by a student at different stages of space and time spent at the university study environment. More importantly, these factors eventually influence the outcomes of the student's academic performance. An attempt to represent the interactions and influences of these factors is shown in Fig. 1 [14]. Some of the factors such as the learning environment are not within the students control but rather under the universities support system. However, these challenges test the student's personal abilities such as persistence etc., to adapt and exploit existing university resources towards his/her performance.

Attempts have also been made to develop conceptual models that explain the pathway leading to student retention or drop out. An example of such a model was suggested by Tinto [15-16] giving a time-based longitudinal framework, leading to the eventual success or failure of the student in the study program, as shown in Fig. 2. Three of these factors that appear to bear defining success are the student's attributes of skills and abilities, prior schooling and the academic program during study. Applying Tinto's model, Bitzer and Trokie de Bruin [17] found that prior schooling does influence a student's persistence and retention rates once at university, with low and average performing students at high school showing over-confidence after joining varsity, a factor which may lead to under-estimation of out-of-class requirements and potentially causing adverse academic performance. Martha's [5] study in Uganda identified performance at matric or higher certificate of education (A-level), socio-economic condition of the family, and quality of the high school studied, to majorly influence academic performance of students once they joined university.

As mentioned earlier, academic lecturers and instructors have a significant role in delivering the academic program and deciding on the pass/fail categories of students. In a study by Alos et al. [4], the factor that was reported to be of highest influence on academic performance among final year students was academic lecturing followed by the student's study habits and institutional support systems. In interpreting these results, it should be kept in mind that cultural factors associated with different demographics and locations of institutions can be of important influence too.

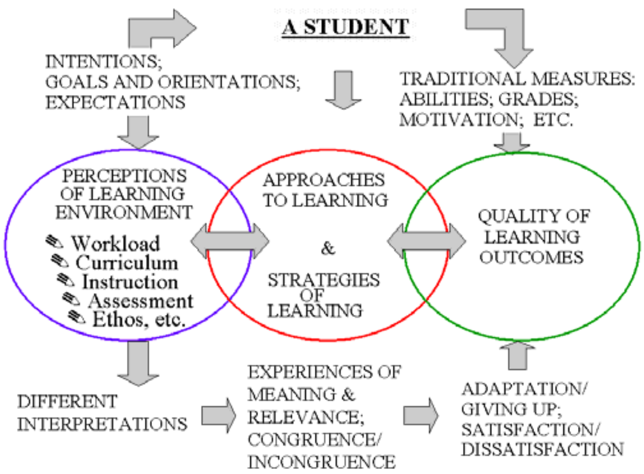

Fig. 1 Student experiences at university [14]

Even within Africa, the student demographics can vary amongst different countries. A case in point is South Africa, which following the end of apartheid in 1994, has embarked on *massification* of education generally, and accelerating growth in higher education, leading to its 16% enrolment at HEIs, the highest among African countries. However, demographic changes in enrolments at HEIs imply that socio-economic factors play a crucial role in the retention of students from previously disadvantaged backgrounds, with factors such as long-distance travel, poor feeding due to poverty, exposure to crimes and violence, all contributing to their academic performance [11].

III. MARKING RELIABILITY

All tests and examinations contain some errors. In the context of this paper, *reliability* is defined as the absence of random error from the administration of an assessment. Theoretically, it is a measure by which the score awarded differs from the true score. But in every assessment, the true score is unknown. Reliability measurement therefore aims at minimizing non-systematic or random errors. The three common sources of errors are discussed in the following [18-19]:

A. Errors in the assessment process

During delivery of an academic course or module, students are taught a given skills set, embedded within the different topics of the module. However, when it comes to assessment, the selection of test items is typically random.

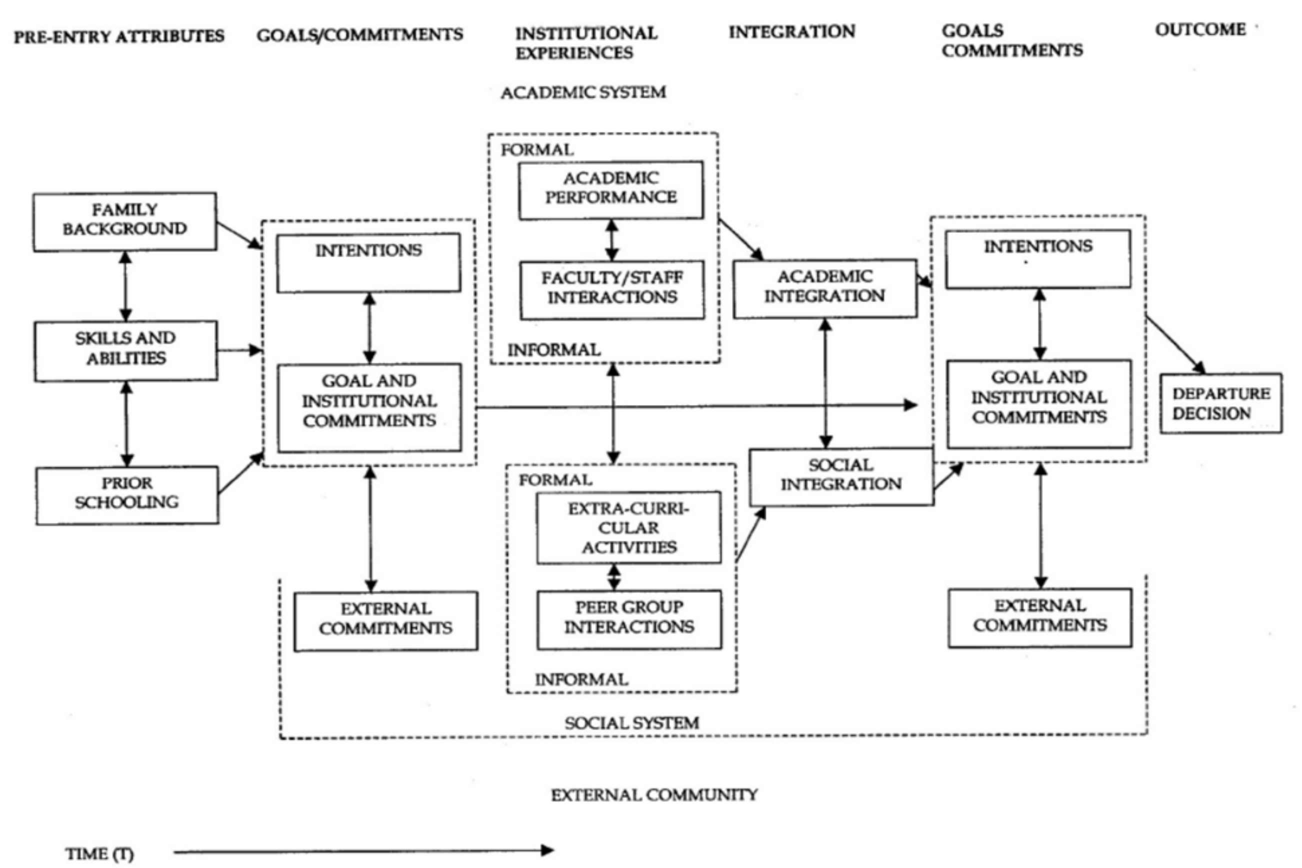

Fig. 2 Tinto's longitudinal integration model of institutional departure [15]-[17]

B. *Errors in the assessment process*

During delivery of an academic course or module, students are taught a given skills set, embedded within the different topics of the module. However, when it comes to assessment, the selection of test items is typically random. The assumption is that a student is expected to be well prepared in all the skills and knowledge lectured. In selecting the test items, sampling errors are introduced when particular skills are tested while others are not examined at the same level or not given at all. Accordingly, the assessment depends on the limited number of those selected items or topics. This method of conducting tests and exams may tilt the student's performance during a given test event, if for example, a student is better prepared in a particular skills set or topics than in others.

C. *Errors in student's consistency*

Students are not always consistent to the same level, a trait shared by all human beings. Sometimes, a student may be fresh and upbeat while in other times, he/she can be tired, bored, feeling lazy and sleepy, all arising from an array of various socio-economic factors, environment, and personal habits that also tend to vary on daily basis. Some of these factors could be beyond the students control. Receiving bad news, say on loss of a relative for example, prior to an examination would potentially adversely impact the psychology and mindset of a student, eventually depreciating his/her effort and productivity in the assessment. These factors can also lead to errors such as haste, panic, nervousness, loss of concentration, amongst others.

D. *Errors in scoring*

Scoring is the domain of academic instructors. Like students, examiners are not perfectly consistent. Errors in grading can be influenced by the type of examination i.e. essay or multiple type questions, and abroad array of factors including candidates writing, fatigue, experience, mood etc., of the examiner.

IV. MEASURING SCORES

The commonly applied approach to score determination, the *classical reliability theory*, expresses the score received by a student statistically as [19,20]:

$$X_{it} = T_i + E_{it}$$

Where X_{it} is the score that a student, i receives during a given test or exam event at time, t. T_i is the student's theoretical "true" score, and E_{it} is an error or noise responsible for the difference between X_{it} and T_i. The error value is determined statistically. Minimising, E_{it} ensures that the assessment is accurate as X_{it} converges towards, T_i.

V. OVERLAPPING DISTRIBUTION METHOD

Following the scoring of scripts, some marks will fall between the borderline of a pass and a fail, such as marks between 40 and 51%. Usually it becomes quite subjective to decide which of the students would be given a pass and which would be awarded a fail at the first assessment opportunity. The common practice at HEIs is to give supplementary examinations, as a means of acknowledging the underlying system and random errors, and attempting to eliminate their effect on the student's academic performance.

Different HEIs exercise different policies on deciding the candidates that would be considered eligible for re-test or supplementary examinations. In South Africa, the minimum cut-off mark required of students to qualify for supplementary exams tends to differ from one institution to another; it is usually 45, 40, or 35% depending on the institution. In most institutions, the rationale used to decide on the minimum cut-off mark does not seem to be clear but it appears to involve factors such as large class sizes, increased work load for academic instructors, ability of the students to pass given a second chance, amongst others.

A. Research problem

As mentioned above, two groups of students emerge after conducting script marking or summative assessment. These groups may be named the “Fail” (F) Group and the “Pass” (P) Group. Among the F-group, there are students who should belong to the P-group and vice versa. These are usually students whose marks are borderline, in the range of say, 40 to 51% and may be referred to as “Supplementary” (S) group. Fig. 3 is a statistical representation of overlapping distributions, giving relations between the three groups. By deciding on the cut-off mark for students who may qualify for supplementary examination, the real issue is an attempt to identify the S-group, correctly. The question then arises, what should be the correct cut-off mark to use: 45, 40, 35% or none?. In this investigation, the ODM is proposed for use to evaluate the cut-off mark criteria.

B. Theoretical success rates

A statistical procedure was conducted, by fixing the reference mark to the typical pass value of 50%. The fail group distribution was then adjusted to different cut-off mark levels of 45%, 40%, 35% to represent the S-group. The probability that an S-group of students based on each cut-off mark level, will achieve a pass grade during supplementary exams, is then determined.

For purposes of theoretical evaluation, the error value used was taken from the recommendations of SABS 0100-1 [21] which assigns the standard deviations of 5, 6 and 7 to good, average, and poor degree of control, respectively. Using E_{it} = 5, the relations based on normal distributions were plotted for 30, 35, 40, 45% mark cut-off and probabilities of passing were determined relative to the 50% mark. Figs. 4 and 5 give the probabilities that the S-group of students who obtained 30, 40% and 35, 45% overall assessment mark respectively, will pass supplementary examination.

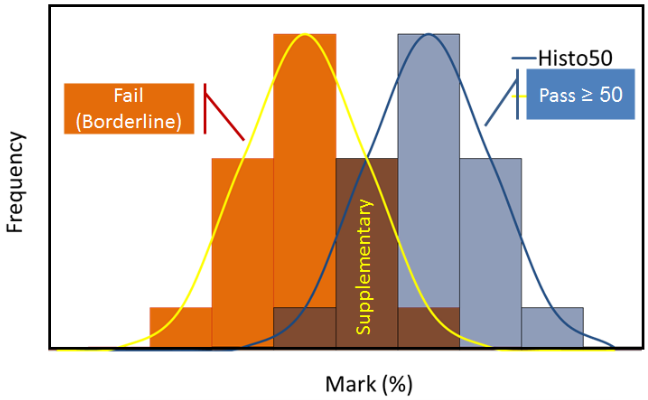

Fig. 3 Relations between the fail, pass and supplementary groups

The ODM shows that for students having a mark of 45%, six (6) of 10 students who sit supplementary exams would be expected to pass. Similarly, three (3) of 10 students who obtain 40% overall mark, may pass supplementary exams. For students with a mark of 35% , only one (1) of 10 students may be expected to pass supplementary exams, while no pass at all can be expected of students with ≤ 30% mark. The analysis implies that students with the cognitive ability to pass supplementary exams should attain an overall mark of at least 35% from formative and summative assessments. But since the proportion of this S-group that pass supplementary exams is low (10%), the criterion may only be worth considering for large class sizes, such as over 300 students. Rather, 40% criterion appears to be suited for small and medium size classes.

VI. CONCLUSION

Academic performance of students, leading to their success or dropping out of the university study programs depends on a broad array of factors. In Sub-Saharan Africa, the accelerated expansion of education to accommodate students of different backgrounds implies that a varied range of socio-economic factors play a major role. Within academic institutions, factors also exist, that would impact students' performance in a highly varied manner. These issues all account for the mark received by the student in a given module or study program during (an) assessment event(s). Within the mark is an in-built systematic and random errors.

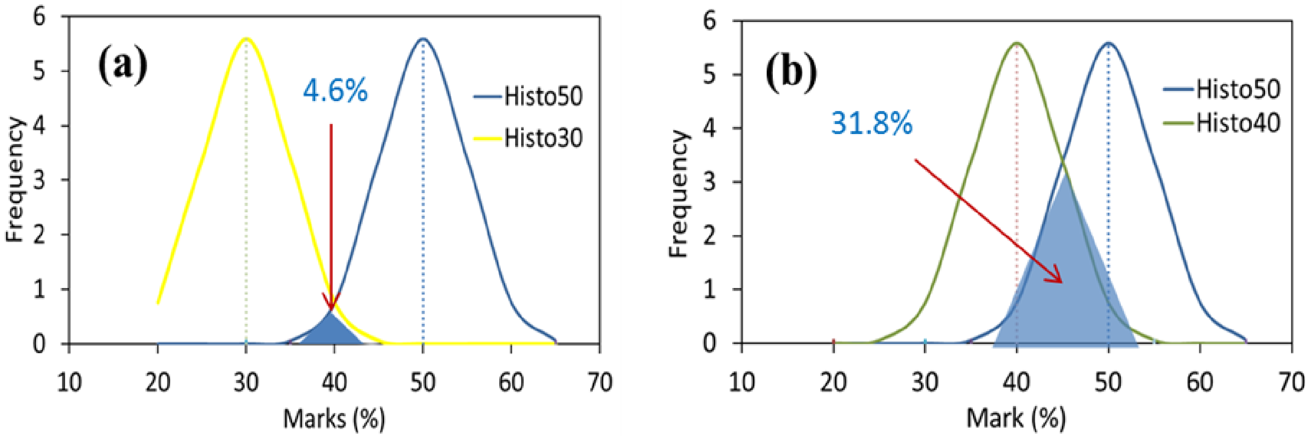

Fig. 4 Probability of students passing under (a) 30% limit and (b) 40% limit criteria for S-group

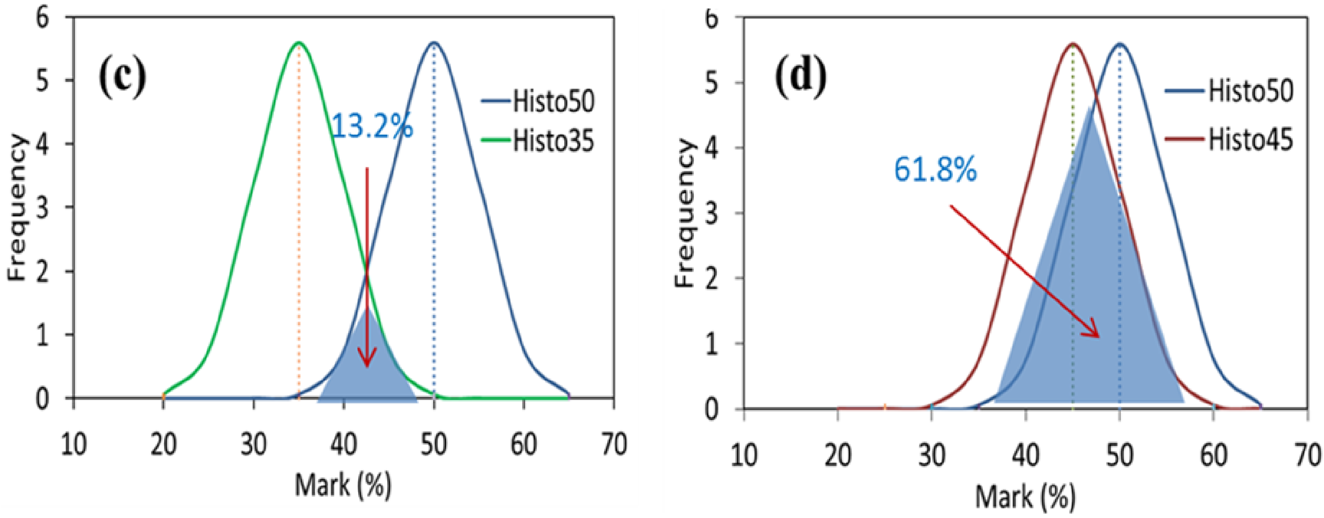

Fig. 5 Probability of students passing under (c) 35% limit and (b) 45% limit criteria for S-group

Offering supplementary exams, serves as a means by which the influence of these errors on a student's success or failure, is resolved. However, there is no clear method of appropriately deciding which students deserve to undergo the supplementary exam. Accordingly, the policy of most HEIs on eligibility criteria for supplementary exams is often subjectively determined.

In this study, a statistical concept is explored, referred to as the *overlapping distribution method*. It is demonstrated that the method can be used to shape policy on the minimum cut-off mark requirement that students must meet in order to qualify for supplementary exams, based on their potential to achieve a pass.

It is found that students obtaining as low as 40% exam mark would have a potential to pass with 30% of them being able to pass. For an exam mark of 35%, only 10% of students would be expected to succeed in supplementary exams while no pass would be expected for students who obtain 30% exam mark or lower.

The analysis indicates a minimum exam mark of 35% and 40% as suitable cut-off criteria for large and small classes respectively. Although the analysis is theoretical, it underscores the approach as a potential statistical method, which may be used to guide HEI policy on the minimum requirements needed to qualify for supplementary exams.

VII. FURTHER RESEARCH

The ODM statistical concept, which is introduced in this article, has the potential to be developed further as a prediction method for determining success rates in supplementary exams, which in turn may be valuable in shaping policy guidelines of HEIs. Further research is needed to examine the method using historical data from courses or program modules. One of the important aspects requiring research is determination of error, calculated as root mean square (RMS) value, along with validation of the proposed ODM using the *classical reliability* *theory* to compare predictions and actual recorded historical data.

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