

Standardization of Mock Scores in Advanced Level Mathematics and Its Influence on Students Grades in Douala IV Municipality

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Abstract. The study investigated the effect of standardization of mock advanced level mathematics scores on students' grades in Douala IV Municipality in the Littoral Region of Cameroon. Four specific research questions and one hypothesis guided the study. The study used the ex-post facto design since the data collected already existed in the various schools. A sample of 300 students' scores were randomly sampled from three institutions. The instrument used was the raw mock scores of the students who wrote the Littoral Mathematics Teacher Association (LIMTA) mock in the 2022/2023 academic year. Mean scores, standard deviations, Z-scores and T-scores were used to describe the data while the independent T-test was used to test the mean difference between the raw scores and the transformed scores. The results showed that students' academic performance greatly improved when their raw scores were standardized. There was also significant difference between the standardization of mock advanced level mathematics scores and the raw scores implying that students' grades improve when raw scores are standardized. Based on these findings, it was recommended that national examination bodies like the GCE and BAC boards should be standardizing student scores so that the academic performance of the students would improve. Also, seminars should be organized for teachers to improve on their scoring and grading skills.

Key words: Standardization, Mock Scores, Advanced Level Mathematics, Grades of Students, Douala IV Municipality, Raw Scores, Standard Scores

Introduction

Mathematics is a key subject that is valued highly in Cameroon and all over the world. In order to generate competent people who can more readily address and implement problem-solving and decision-making scenarios, mathematics is offered in the primary schools, colleges, higher institutions and universities. Mathematics is a vital instrument for the growth of politics, socio-economics, science and technology since it is regarded by society as the foundation of scientific and technological knowledge. At the advanced level, mathematic is compulsory to some particular series and knowledge acquisition in this domain at the second cycle is crucial in several disciplines including technical, engineering, economics, finance, agriculture, pharmaceuticals, and health sciences. It is for these reasons that mathematics is universally referred to as the Queen and Servant of the sciences, technology, engineering, and all the mathematical and social sciences (Nekang, 2016).

Mock General Certificate of Education (GCE) in ordinary and advanced level mathematics at moment is predominant in the North West, South West and Littoral Regions either as group tests among denominational schools, at the regional level, or at individual school level. In the Littoral Region, there are mock examinations written by various secondary

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schools called the Littoral Mathematics Teachers Association Mock (LIMTA mock). The LIMTA mock is mostly written by the public schools and the lay private secondary school, while most confessional schools in Douala take either the North West or South West regional mock or mock prepared by their school teachers. This is done based on the fact that, mock examinations promote success in further examinations and as such, it is regarded as reasonable and expedient (Che, 2023).

The two types of grading systems commonly used are the criterion-referenced grading and norm-referenced grading. In contrast to the criterion-referenced grading system, which base each student's evaluation on established absolute criteria, the norm-referencing grading system assigns grades to a specified number of students (Lok, McNaught, & Young, 2016). According to Thorndike and Hagen as cited by Mertler (2007), "grading on the curve" is another name for norm-referenced grading. The "normal distribution" has been adapted to the "curve".

Teachers all over the world have used examinations to evaluate student performance for years. According to Romanoski (2002), test results are used to rank students after assessments. Ranking leads to grades, and grades lead to evaluation criteria for admission to institutes of higher education, for employment in particular occupations, and even for judgments of character in the court of law. According to Agborbechem (2015), students' test results are closely scrutinized during class council meetings in secondary and elementary schools, university senate meetings, and grading sessions held by assessment authorities all over the world. Hence, academics and educators alike should pay close attention to the accuracy of test scores, their representativeness of the skills of the test-takers, and the subsequent uses to which test scores are applied. To attain acceptance without prejudice, score standardization is therefore desirable. Generally speaking, standard scores describe or specify the individual's performance in terms of the distance of the raw score from the mean of the reference group in standard deviation units (Joshua, 2005).

Nekang and Anyi (2022) investigated the use of mock Mathematics examination as a predictor of the GCE performance in Ordinary Level Mathematics (Code 0570) in Fako Division, South West Region of Cameroon. They found that there was a significant relationship between students' academic performance in mathematics at the mock and that at the GCE 2019 ($r_{xy} = .503^{**}$, $p < 0.01$ level of significant). The regression analyses showed that students' academic performance in ordinary level mathematics GCE results could be effectively predicted from the mock results. It also revealed that the mock 2019 exam contributed 25.3% ($R^2 = 0.253$) of the students' academic performance in ordinary level mathematics GCE in that year. The analyses further obtained the regression equation of Ordinary level mathematics GCE results (y) on Mock results (x) as $Y = 0.47x + 1.05$. This implies that the regression equation can be used to predict a student's ordinary level mathematics results (y) given that his/her mock results (x) is known. The regression line y on x is a straight line with gradient .47 and the intercept on the y-axis is 1.05.

At advanced level, mathematics mock examination is typically taken as part of preparation to assess how well a student would do on the real examination. Mock examinations are diagnostic evaluations which help students and teachers to identify the topics and subjects they should focus on more, during remediation classes in preparation for the summative evaluation (Effiom, 2004). Students learn about their relative success on the test by comparing the results to those of external examinations like the General Certificate of Education Examination (GCE) in Cameroon. According to Agborbechem (2015), factors such as how hard the test is, how exposed were the students to the skills tested, where the student stands in relation to other people, and the margin of error in the test score can also influence the student test scores. Hence, score standardization gives meaning and allows some kind of interpretation to the scores, allowing direct comparison of two scores. There are many methods of

standardizing raw test scores from assessment, some of which are the Stanine (Standard Nine), Z-scores, T- scores, West African Examination Counsel (WAEC), Nigeria Examination Counsel (NECO), and so on (Stockburger, 2016). This study investigated the effect of standardization of mock advanced level mathematics scores on the grades of students in Douala IV Municipality of the Littoral Region in Cameroon.

Purpose of the Study

The study sought to find out the influence of:

1. Raw scores of mock advanced level mathematics on student performance.
2. Raw scores of mock advanced level mathematics transformed to Z-scores.
3. Z-scores of mock advanced level mathematics to T-scores.
4. Comparing grades of the raw scores of mock advanced level mathematics and grades of the standardized scores (T-scores).

Research Questions

1. What is the effect of raw scores of mock advanced level mathematics on students' performance?
2. What is the influence of converting raw mock advanced level mathematics scores to Z-scores?
3. What is the influence of converting mock advanced level mathematics Z-scores to T-scores?
4. What is the difference in students' performance between the raw scores of advanced level mathematics and the standardized scores (T-scores)?

Statistical Hypothesis

H₀: There is no statistical significance difference between the raw scores of advanced level mathematics and the standardized scores.

H_a: There is a statistical significance difference between the raw scores of advanced level mathematics and the standardized scores.

Scope of the Study

Geographically, the study was delimited to high schools in Douala IV Municipality of the Littoral Region where LIMTA mock examinations are carried out. Content wise, the study was delimited to mock examination results of 2022/2023 academic year, to find the extent and type of relationship that exist between their raw scores and their standardized scores to grades. The research made use of the Classical Test Theory (Spearman, 1904) and the Attribution Theory of Achievement by Bernard Weiner (1979). Methodologically, the research method was a quantitative study since it used data from raw scores. Hence, the ex-post facto design was used.

Methodology

The study used the ex-post facto research design since the data was already existing at the point of collection (secondary data). The population of the study consisted of all the raw mock scores of Advanced Level (A/L) mathematics students who wrote the mock examinations in all the high schools in the Littoral Region of Cameroon. This included all government, Denominational and lay private institutions. The A/L mathematics has two written branches from which students can chose as a specialty which are Pure Mathematics with Mechanics (Code 0765) and Pure Mathematics with Statistics (Code 0770). Mock scores from both sections were used in the study.

The target population of this study comprised of all the raw mock scores of candidates who wrote the LIMTA mock A/L mathematics examination in all the high schools in Douala IV municipality. The accessible population of the study was made up of all the advanced level mathematics students' mock scores in three selected high schools from the LIMTA mock in the year 2022/2023. Simple random sampling technique was used to select 300 raw mock scores from three schools for the study and these schools were selected from each of the categories made up of public, denominational and lay private.

Document analysis was the main tool by which the data were collected. The instrument for data collection were records of student's results published by the management of the various schools selected. The records showed individual raw mock scores in the advanced level mathematics examination. Data collected were analyzed using SPSS according to the objectives of the research. The raw scores from the mock were passed through a standardization process using the T-score. This standardization was used because it ends up with scores on 100 as is the tradition with many examination bodies. Grade boundaries were determined using the number of standard deviations from the mean. The dependent t-test was used to determine if there is any significant difference between the raw mean scores and standard deviations and the standardized mean scores and standard deviations. All data collected were handled with confidentiality and utmost discretion.

Presentation of Results

Research Question One: What is the effect of raw scores of mock advanced level mathematics on students' performance?

The table below presents results for descriptive statistics for students' advanced level mock raw scores for the study.

Table 1. Descriptive Statistics for Students' Mock A/L Mathematics Raw Scores (N=300)

Variable	Mean	Mode	Median	Standard Deviation	Range	50 th Percentile
Mock A/L raw scores	31.22	31.0	28.00	17.37	87.0	28.00

The results from the table revealed that the mean or average score of the advanced level mathematics mock raw scores for 300 students was 31.22%, the middle score (the median) for the exams was 28.0%, meaning that half of the scores (150) fell above the score of 28.0% while the other half of scores (150) fell above 28.0%. The analyses also revealed that the most frequently occurring score (the mode) in the exams was 31.0%. Moreover, the minimum score in the exams was 0% while the highest score was 87%. The range of scores which estimated the difference between the lowest and highest score was 87.0%.

Furthermore, the expected value of the squared variations of the scores from the mean value of the scores 31.22% was estimated to be 301.58, which implied owing from the large value that individual scores were at larger distances away from the mean. The standard deviation for the scores was high (17.37%). The high value for the standard deviation meant that most students' scores in the advanced level mathematics mock were spread out over a wider range. Finally, the results revealed that, one-quarter of the scores were below a mark of 19.0% (25th percentile), half of the scores were below a mark of 28.0% (50th percentile), while three-quarters of the scores were below a score of 40.0% (75th percentile).

When students' raw scores were grouped into 10 classes of scores with a class interval of 10 points per group of scores, results revealed that, closed to a quarter of the students scored

marks within the range of 21-30. In addition, there was an even split between students who scored marks with the ranges, 11-20 and 31-40, given that there were respectively represented by 65 and 63 students.

Table 2. Grouped Frequency Table of Students' Scores

Variable	Frequency	Valid Percentage	Cumulative Percentage
0 – 10	22	07.3	07.3
11 – 20	65	21.7	29.0
21 – 30	80	26.7	55.7
31 – 40	63	21.0	76.7
41 – 50	33	11.0	87.7
51 – 60	11	03.7	91.3
61 – 70	15	05.0	96.3
71 – 80	06	02.0	98.3
81 – 90	05	01.7	100
91 – 100	00	00.0	100
Total	300	100	

The range with the least number of scores was between 81 and 90 marks, given that only five students scored marks within that range. Moreover, more than three-quarters of the class scored marks below 50% as observed from the cumulative frequency column in Table 2 above. The frequency distribution of the data was visualized by the use of a Bar chart.

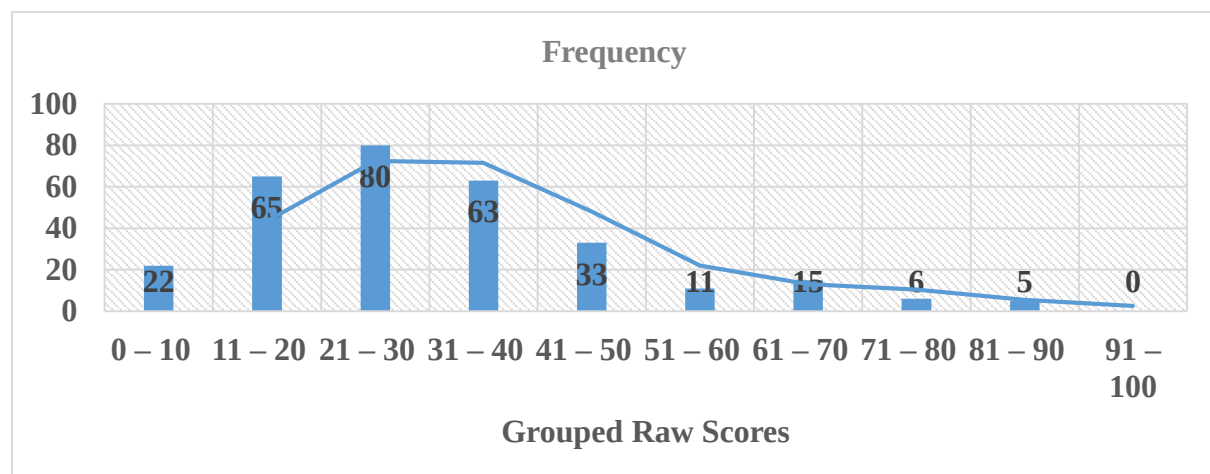


Figure 1. Bar Chart for students' grouped raw scores

When students' raw scores were visualized on a bar chart, it revealed that, the majority of students (80) scored a mark between 21 and 30, followed by students who scored marks between 11 and 20 points (65), 63 students scored marks of 31 and 40 points. The mark scored by the least number of students was between 81 and 90 points (5). In general, only 37 students out of the 300 students who took the exams scored marks 50 points and above. The greater majority of students (263) scored marks below 50% implying a negative skewedness.

Research Question Two: What is the influence of converting raw mock advanced level mathematics scores to Z-scores?

The raw mock advanced level mathematics scores were transformed to Z-scores and its influence on students' performance in Douala IV Municipality is presented below.

Table 3. Descriptive Statistics for Students' Mathematics Z-Scores (N=300)

Variable	Mean	Mode	Median	Standard Deviation	Range	50 th Percentile
Mock A/L Z- scores	00.00	-0.01	-0.19	1.00	5.01	-0.19

The results from the analysis revealed that the mean of the advanced level mathematics mock Z-scores for 300 students was 0.00. This revealed that the average score for the mock A/L mathematics exam on the Z-scale was set at 0%. In addition, the middle score (the median) for the exams was found to lie below the mean with a value of -0.19, meaning that half of the scores in the Z-scale fell below the score of -0.19 while the other half of scores fell above this value.

The analyses also revealed that the most frequently occurring score (the mode) in the exams also laid below the mean and had a value of -0.01. Moreover, the minimum score in the exams was one standard deviation below the mean -1.80 while the highest scores was 3 standard deviations above the mean score in the exams with a value of 3.21. The range of scores which estimated the difference between the lowest and highest score stood at 5 standard deviations above the mean score with a value of 5.01. Furthermore, the expected value of the squared variations of the scores from the mean value of the scores was estimated to be 1.000. Finally, results revealed that, one-quarter of the scores lied at almost one standard deviations below the mean (25th percentile), half of the scores were also laid below the mean (50th percentile), while three-quarters of the scores lied 0.5 standard deviations above the mean by (75th percentile).

Research Question Three: What is the influence of converting raw mock advanced level mathematics scores to T-scores?

The raw mock advanced level mathematics scores were transformed to Z-scores which were further converted to T-scores and its' influence on students' performance in Douala IV Municipality is presented in Table 4 below.

Table 4. Descriptive Statistics for Students' Mathematics T-Scores (N=300)

Variable	Mean	Mode	Median	Standard Deviation	Range	50 th Percentile
Mock A/L T- scores	50.00	49.87	48.15	10.0	50.10	48.15

The results from the analysis revealed that the mean of the advanced level mathematics T-scores for 300 students was 50%. This revealed that the average score for the exams was set at 50 points. In addition, the middle score (the median) for the exams stood at 48%, meaning that half of the scores (150) fell above the core of 48% while the other half (150) of scores fell above 48%.

The analysis also revealed that the most frequently occurring score (the mode) in the exams was 49.87%. Moreover, the minimum score in the exams was 32.02% while the highest score was 87%. The range of scores which estimated the difference between the lowest and highest score was 82.12%. Furthermore, the expected value of the squared variations of the scores from the mean value of the scores 50% was estimated to be 100%. The standard deviation for the scores at-scale was set at 10%. Finally, results revealed that, one-quarter of

the scores were below a mark of 42% (25th percentile), half of the scores were below a mark of 48% (50th percentile), while three-quarters of the scores were below a score of 55% (75th percentile).

Research Question Four: What is the difference in students' performance between the raw scores of advanced level mathematics and the standardized scores?

The statistics for the mean scores and standard deviations for the influence of the standardization of mock advanced level mathematics scores on students' performance in Douala IV Municipality were computed and results displayed in Table 5 below.

Table 5. Mean scores and standard deviations for raw and standardized scores

Variable	Mean	Mode	Median	Standard Deviation	Standard error
Mock A/L raw scores	31.22	31.0	28.00	17.37	1.00
Mock A/L T- scores	50.00	49.87	48.15	10.0	0.58

The table shows that the mean of the raw scores was 31.22% while that for standardized scores was 50.0% (a mean score difference of 18.78); the mode of the raw scores was 31.0% while that for standardized scores was 49.87; the median of the raw scores was 28.0% while that for standardized scores was 48.15%; the standard deviation of the raw scores was 17.37% while that for standardized scores was 10.0%; and the standard error of the raw scores was 1.0% while that for standardized scores was 0.58%. Since the mode, median and mean of the standardized scores are approximately equal, it means that the scores were normally distributed as prescribed by measures of central tendency. Also, the variation from the mean for both set of scores was almost the same. Conclusively, the standardization of mock advanced level mathematics scores has an influence on students' performance in Douala IV Municipality.

The statistics for the performance in terms of grades for the standardization of mock advanced level mathematics scores of students in Douala IV Municipality were computed and results displayed in Table 6 below.

Table 6. Grades for raw and standardized scores

Variable	Mock A/L exam raw scores		Mock A/L T-scores		
Grades	Frequency	Percent	Frequency	Percent	Results
A	05	01.7	02	0.7	Raw scores
B	01	00.3	03	1.0	T-scores
C	09	03.0	16	5.3	T-scores
D	15	05.0	30	10.0	T-scores
E	13	04.3	69	23.0	T-scores
O	40	13.3	145	48.3	T-scores
F	217	72.3	35	11.7	T-scores
Total	300	100	300	100	

The analyses show that the transformation of mock A/L mathematics raw scores through Z-scores to T-scores reduced the A grades from 05 (01.7%) to 02 (0.7%) and the number of F grades from 217 (72.3%) to 35 (11.7%). The number of B, C, D, E, and O grades increased.

Cumulative analyses show that since the pass grades are A, B, C, D, and E; only 43 (14.3%) of the students passed the mock A/L mathematics examination. Given that the raw scores were transformed through Z-scores to T-scores, 120 (40.0%) of the students would have passed the mock A/L mathematics examination. This implies that scores transformation has a great positive influence on students' performance.

Verification of Hypothesis

H₀₁: There is no statistical significance difference between the raw scores of advanced level mathematics and the standardized scores.

The t-test statistics for the standardization of mock advanced level mathematics scores on students' performance in Douala IV Municipality were computed. The scores were tested for any differences in means at the 95% confidence interval of the difference and results displayed in the table below.

Table 7. T-Test for Equality of Means for the Effect of Converting R-Scores of Mock Advanced Level Mathematics to T-scores

	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference	t _{cal.}	df	Sig. (2tailed)	t _{crit.}	Decision
R-scores	300	31.22	17.37							
T-scores	300	50.0	10.0	.44	18.61	42.272	299	.000	1.960	Reject Ho1

Note: N= Sample size, t_{cal.} = t_{calculated}, t_{crit.} = t_{critical}, df = Degree of Freedom

From the table above, the difference in the mean advanced level mock scores between the two groups of scores was 18.78 points. The difference in mean scores was a large difference indicating that the advanced level mathematics students would have benefited from the transformation. Since the calculated value ($t_{cal} = 42.272$) is greater than the critical value ($t_{crit.} = 1.960$) with $df = 299$ at $p \leq 0.05$ level of significance, we reject the null hypothesis (H_{01}) and conclude that there is a statistical significance difference between the raw scores of advanced level mathematics and the standardized scores in Secondary Schools in the Douala IV Municipality of the Littoral Region of Cameroon. Therefore, the standardization of scores in all mathematics tests and examinations has significant positive effects on the grades and general performance of students.

Conclusion

The study investigated the effect of standardization of mock advanced level mathematics scores on students' grades in Douala IV Municipality in the Littoral Region of Cameroon. The raw mock advanced level mathematics scores (R-scores) were transformed to Z-scores which were further converted to T-scores. The results from the analysis revealed that the mean of the advanced level mathematics mock T-scores for 300 students was 50%, the middle score (the median) for the exams was 48%, meaning that half of the scores (150) fell above the core of 48% while the other half (150) of scores fell below 48%. Since the mode, median and mean of the standardized scores are approximately equal, it means that the T-scores were normally distributed as prescribed by measures of central tendency. Also, the variation from the mean for both R-scores and T-scores was almost the same. Conclusively, the standardization of mock advanced level mathematics scores has an influence on students' performance in Douala IV Municipality.

Given that the raw scores were transformed through Z-scores to T-scores, 120 (40.0%) of the students would have passed the mock A/L mathematics examination. This implies that scores transformation has a great positive influence on students' performance. There is a statistical significance difference between the raw scores (R-scores) of advanced level mathematics and the standardized scores (T-scores) in Secondary Schools in the Douala IV Municipality of the Littoral Region of Cameroon ($t_{cal} = 42.272$, $df = 299$, $p \leq 0.05$). Therefore, the standardization of scores in all mathematics tests and examinations has significant positive effects on the grades and general performance of students.

Recommendations

Based on the findings of the study, it is recommended that national examination bodies like the GCE and BAC boards in Cameroon should be standardizing student scores so that the performance in terms of grades and number of the successful candidates should improve. Also, seminars should be organized for teachers to improve on their scoring and grading skills. The ministries of education should adopt test standardization for all summative public examinations like the Government Common Entrance Examination and the First School Leaving Certificate Examination. Finally, test experts and psychometrics should be involved in all processes and levels of test standardization from test construction, moderation, trial testing, final selection, proofreading, administration, marking, scoring, grading and publication.

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