Investigating the Score Grading System of Kassala University

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Abstract

Since 1993, the University of Kassala has utilized a score grading system with four grades: A, B, C, and D. In 2007, this system expanded to include six grades: A, B+, B, C+, C and D. This extension was intended to better align with the properties of the standard normal curve, this paper will outline the original four-grade system, detail the transition to the six-grade system, and evaluate whether the new system satisfies the Standard Normal cure rules.

Keywords: Grading System, Score Normalization, Standard Normal Curve, Normal Distribution, Gaussian Distribution, Academic Assessment, Raw Scores, Educational Measurement, Fairness in Grading, Statistical Evaluation, University of Kassala, Grade Inflation, Percentile-Based Grading, Z-score Conversion, Standard Deviation, Mean-based Grading, Academic Performance, Evaluation Methodology, Grade Alignment, Bell Curve.

المستخلص

منذ عام 1993، اعتمدت جامعة كسلا نظام تقديرات يتضمن أربع درجات: A، B، C، و D. وفي عام 2007، تم توسيع هذا النظام ليشمل ست درجات: A، +B، B، +C، C، و D. وقد كان الهدف من هذا التوسيع هو تحقيق مواءمة أفضل مع خصائص المنحنى الطبيعي المعياري. تستعرض هذه الورقة نظام الدرجات الأصلي ذي الأربع درجات، وتفصّل الانتقال إلى نظام الدرجات الست، كما تقوم بتقييم ما إذا كان النظام الجديد يفي بقواعد المنحنى الطبيعي المعياري.

الكلمات المفتاحية : نظام التقييم / نظام الدرجات، تطبيع الدرجات، المنحنى الطبيعي المعياري، التوزيع الطبيعي، التوزيع الغاوسي، التقييم الأكاديمي، الدرجات الخام، القياس التربوي، العدالة في التقييم، التقييم الإحصائي، جامعة كسلا، تضخم الدرجات، التقييم المعتمد على النسب المئوية، تحويل درجة Z (الدرجة المعيارية)، الانحراف المعياري، التقييم المعتمد على المتوسط، الأداء الأكاديمي، منهجية التقييم، مواءمة الدرجات / ضبط الدرجات، منحنى الجرس (المنحنى الجرسي)

1. Introduction

Universities aim to accurately assess student performance, a goal that cannot be achieved through raw scores alone. Transforming raw scores is necessary for several reasons:

1- Raw scores do not accurately reflect a student performance relative to their peers.
2- Consistency across different courses is needed to compute a general average raw scores of various courses should be consistent in order to compute the general average, as scores from difficult exams will differ from those of easier exams.
3- Comparing student's performance across different years for the same semester would be incorrect.
4- Raw scores lack the statistical metrics required to analyze exam quality and student's performance.
5- Sometimes, raw scores do not accurately the actual level of the students.

Grading systems are generally composes of three stages, preparing, normalizing and grading of scores. The raw scores my not reflect the real performance of the students because of some reasons like:

1- Tiredness.
2- Emotional distress.
3- Unfamiliarity with test environment or format.
4- Test language not being the student's first language.
5- A shortages expert professors.
6- Examiners come from diverse academic backgrounds accustomed to different grading standards.

If any of these factors are present, the class may perform significantly lower or higher than expected based on historical course patterns. In such cases, raw scores should be normalized.

Benefits of Normalized Scores

Normalization involves distributing student's raw scores according to the Gaussian Probability Distribution, the objective is to achieve a fair distribution of scores along the percentile domain, for example (30..99). Applying the concept of fairness to raw scores, known as score normalization, reforms the score distribution to correct any distortions.

Normalizing scores serves two main purposes:

Interpretation: It gives a meaningful context to the scores, allowing for better interpretation.

Comparison: It enables direct comparison of scores from different exams. For instance, a score of 50 on a System analysis exam may not equate to a score of 50 on a Simulation exam.

2. Literature Review

Effective assessment of student performance remains a central concern in higher education. Grading systems, when improperly structured or implemented, can lead to inconsistencies, misclassifications, and a lack of fairness across different academic contexts. A number of researchers have investigated grading practices and the statistical foundations required to ensure meaningful evaluations.

Brookhart (1993) explored teachers' grading practices and emphasized that many of them lack a clear statistical basis, which can lead to discrepancies between student scores and their actual academic performance. The study also highlighted how subjective interpretations of raw scores may compromise the validity of assessments.

McMillan (2001) examined grading methods in secondary education and found that grades are often assigned without proper normalization. This creates challenges in comparing results across exams of varying difficulty levels, which compromises fairness and comparability — a concern also applicable in higher education systems.

Sadler (2005) focused on criterion-based grading in universities and warned against introducing intermediate grades, such as B+ or C+, without appropriate statistical adjustments to cutoff points. He argued that such practices could result in overlapping grade intervals and distort the intended distribution, weakening the system's integrity.

Allen (2005) analyzed the validity of grades as accurate indicators of academic achievement and pointed out that unless grading aligns with statistical principles such as the normal distribution, the scores might fail to reflect true performance levels. His findings support the need for a structured normalization process to correct distortions caused by contextual or subjective factors.

Together, these studies provide a strong foundation for evaluating the grading system at Kassala University, particularly in light of its transition from a four-grade to a six-grade model. The literature clearly indicates the importance of aligning grading with statistical models—specifically the standard normal curve—to enhance fairness, interpretability, and consistency in academic evaluation.

3. Problem Statement

The need to investigate the grading system at Kassla University arose after extension from a four-grade system(A,B,C,D) to a six grade(A,B+,B,C+,C,D), many expert teachers suspect flaws in the development process, yet no formal review has been conducted. This research aimed to evaluate the current score grading system to determine it aligns with normal curve rules. If it does, it will dispel experts' doubts; if not, we will detail how to address the identified issues.

4. Normal Distribution

The normal distribution is a continuous probability distribution for random variable (x). Its graph, known as normal curve (or Bell Curve), Hass the following properties:

1. The mean, median, and mode are equal.

2. The normal curve is bell shaped and is symmetric about the mean.

3. The total area under the normal curve is equal to one.

4. The normal curve approaches but never touches the x-axis as it extends further from the mean.

5. Between μ-δ and μ+δ (in the center of the curve) the graph curves downward.

4. Standard Normal Curve Rules

The standard normal curve is specific bell curve with a mean of 0 and standard deviation of 1 (see Figure 1). Transforming each data value of a normally distributed random variable into a score results in the standard normal distribution. This transformed into a score, the result will be the standard normal distribution. When this transformation ensures that the area under the nonstandard normal curve within any interval is equivalent to the area under the standard normal curve within the corresponding boundaries.

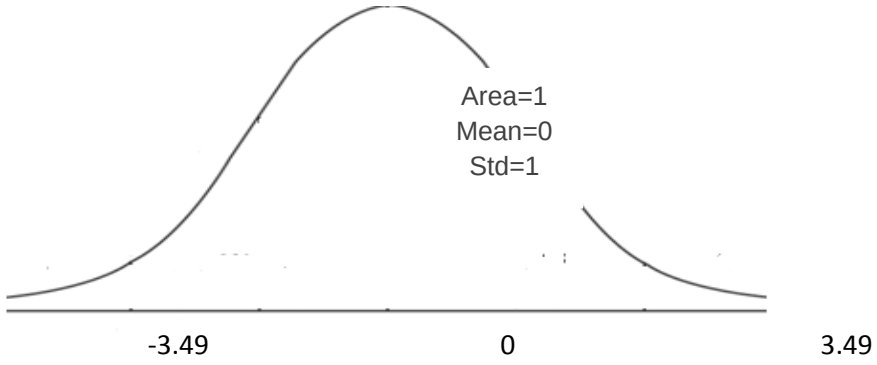


Figure 1: Standard Normal Curve

5. Properties of the Standard Normal Curve

1. The cumulative area is close to 0 for scores close to z-scores = -3.49.

2. The cumulative area increases as z-scores increase.

3. The cumulative area for z = 0 is 0.5000.

4. The cumulative area appreaches1 for z-scores near 3.49.

6. Normalization Methodology

The normalization methodology involves transforming raw scores into normalized scores (NormSc) based on the mean(μ) and the standard deviation (δ) of the raw score distribution. This process ensures that the ranking of scores remains the same, but the actual score values adjust according to cutoff values to align with standard normal curve.The following steps outline the process of this methodology:

1- Define the grades ranges: (F<50, 50<= D <60, 60<= C <70, 70<= B <80, A>=80).

2- Define the cutoff values: Determine CutoffA, CutoffB, CutoffC and CutoffD, using percentile to Z conversion table, according to the desired percentages of A's, B's, C's and D's.

3- Calculate the average (μ) and the standard deviation (δ): Obtain these values from the raw scores.

4- Find the corresponding standard grade for each cutoff value: Use the formula $G = \mu + cutoff_{*}\delta$ to calculate GA, GB, GC, GD.

5- Calculate the Normal Score: Transform the scores into normalized scores.

6- Classify Normal Scores into grades: Assign grades based on the normalized scores.

7- End.

7. Score Grading Algorithm

Grading involves classifying student performance as A, B ,C, D or F based on predefined grade ranges.. Narrow grade ranges are considered fairer than wide ranges, which is why many universities use different grading systems. The following table illustrates various grading systems in different countries:

Table 1: Different grading systems

Saudi Arabia		**Kazakhstan**		**Japan**		**Tanzania**		**Sudan**	
Imam Un.		**General**		**Kurume Un.**		**Tanzania Un.**		**Kassala Un.**	
Range	Grade	Range	Grade	Range	Grade	Range	Grade	Range	Grade
A+	95–100	100-95	A	90-100	AA	80-100	A	80-100	A
A	90-94	90-94	A-	80-89	A	70-79	B	75-79	B+
B+	85–89	85-89	B+	70-79	B	60-79	C	65-74	B
B	80–84	80-84	B	60-69	C	50-59	D	60-64	C+
C+	75–79	75-79	B-	0 - 59	F	40-49	E	55-59	C
C	70–74	70-74	C+			35-39	S	0 - 49	F
D+	65–69	65-69	C			0 - 34	F		
D	60–64	60-64	C-						
F	0–59	55-59	D+						
		50-54	D						
		0 - 49	F						

The general systems can vary significantly, but the principle remains to fairy assess student performance in a manner consistent with the institution's academic standards.

The following steps give a general idea about how the grading algorithm works; four Grades are used as an example.

1- Input NormSc

2- If NormSc >=GA add NormSc to grade A

3- If GB <= NormSc < GA add NormSc to grade B

4- If GC <= NormSc < GB add NormSc to grade C

5- If GD <= NormSc < GC add NormSc to grade D

6- If NormSc < GD add NormSc to grade F

7- End

8. Analyzing Kassala University Grading System

The grading system of Kassala university initiated in 1992 with five grades A, B, C, D and F, developed to seven-grade system (A, B+, B, C+, C, D and F) in 2005 to make it fairer. Adding more grades requires significant

modifications; otherwise the system may lose some characteristics of the normal distribution. Developing grading systems requires three steps:

1- Modifying z-scores using a z to Percentile table

2- Calculate Cutoff values.

3- Ensuring that the number of grades and cutoff values are consistent.

4- Modifying normalizing equations

8.1- Cutoff Equations:

The system uses four z-scores (ZA= 1.28), (ZB= 0.52), (ZC= -0.5), (ZD= -1.28), to calculate four cutoff values as follows:

$GA = \mu + 1.28 * \delta$

$GB = \mu + 0.52 * \delta$

$GC = \mu - 0.52 * \delta$

$GD = \mu - 1.28 * \delta$

8.2 Grades Range

The seven grades correspond to following ranges:

Table 2: Seven Grade Scheme

Grade	Range
A	80-100
B+	75-79
B	70-74
C+	65-69
C	60-64
D	50-59
F	0-49

8.3- Score Normalizing Equations

Grade A:

IF Raw Score>=GA Then NormSC = Round(100 + 20 / (100 - GA) * (Score – 100),0)

Grade B+:

IF GA<= Raw Score>=GB Then NormSc = Round(79 + 9 / (0.76 * δ) * (score - GA), 0)

Grade B:

IF GA<= Raw Score>=GB Then NormSc = Round(74 + 9 / (0.76 * δ) * (score - GA), 0)

Grade C+:

IF GB<= Raw Score>=GC Then NormSc = Round(69 + 9 / (1.04 * δ) * (score - GB), 0)
Grade C:
IF GB<= Raw Score>=GC Then NormSc = Round(64 + 9 / (1.04 * δ) * (score - GB), 0)
Grade D:
IF GC<= Raw Score>=GD Then NormSc = Round(59 + 9 / (0.76 * δ) * (score - GC), 0)
Grade F:
IF Raw Score<GD Then NormSc = Round(49 + 50 / (GD-1) *(score+1 - GD), 0)

Comparing the four and seven grade systems, (see table 3), we find that modifications were made only to grades and ranges, the cutoff's values remain the same. are still the same, The shaded area, which belongs to B+, B, C+ and C grades indicates that B+ and B share the same Cutoff value (0.52) and cover 20% of the standard normal curve area. Similarly, C and C+ share the same Cutoff value (-0.52) and cover 40%. However these grades map to different ranges: while these grades mapping to different ranges, B+ (75-79), B (70-74), C+ (65-69), and C (60-64). This means, B and B+ occupy the same domain (1.28 - 0.52) on the Normal Standard Curve, as do C and C+ (0.52-0), as illustrated in table 3.

Table(3):Four and Seven Grade Schemes

A	1.28	10%	80 - 100	A	1.28	10%	80 - 100
B	0.52	20%	70 - 79	B+	0.52	20%	75 - 79
C	-0.52	40%	60 - 69	B	0.52		70 - 74
D	-1.28	20%	50 - 59	C+	-0.52	40%	65 - 69
F	< -1.28	10%	00 - 49	C	-0.52		60 - 64
				D	-1.28	20%	50 - 59
				F	< -1.28	10%	00 - 49

From Figure 3 and 4, we can see that the modification of cutoff values has been ignored, this defect could cause problems in classifying normalized scores for grades B, B+ and C, C+. Repairing this defect requires separating the shared domains by adding new Cutoff values to create distinct domains: one for B and the other for B+, and similarly for C and C+.

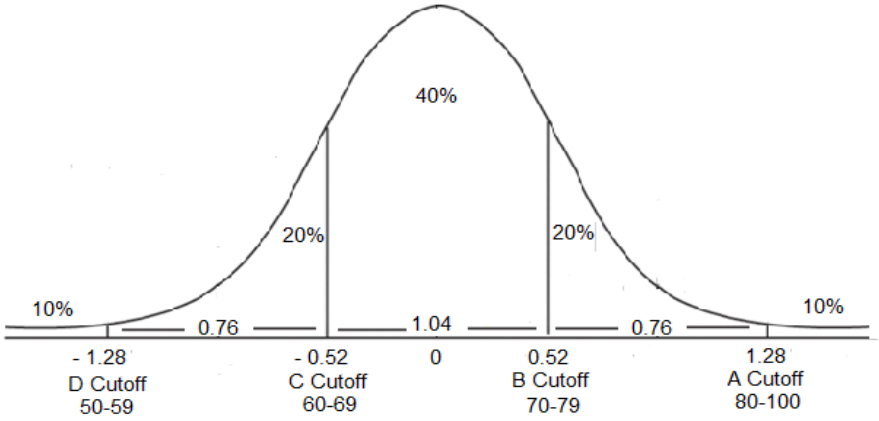


Figure 3: The old seven Grade System

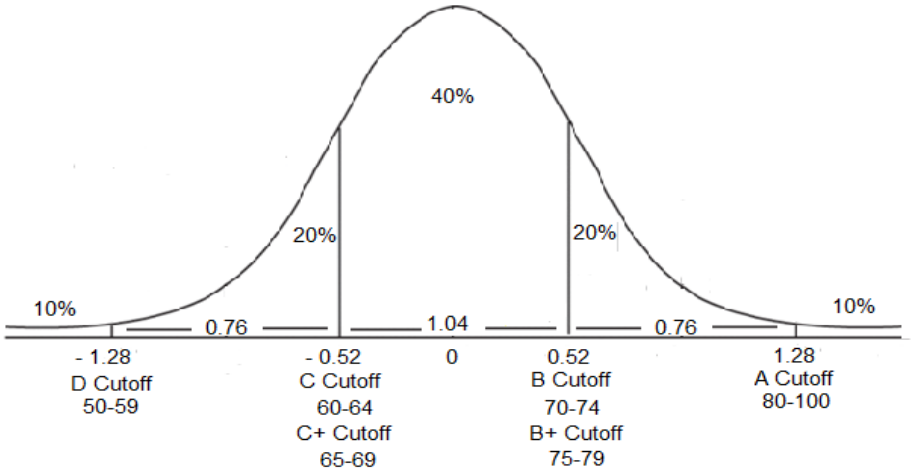


Figure 4: The current seven Grade System

8.4 Developing the Current System

As mentioned in section 8.3, two Cutoff values are needed: one for C+ and one for B+, the following steps outline how to define these cutoff values:

1- Define grade range size:

The B grade size is 9, which will be divided into 4 for B+ and 5 for B, similarly, the C grade size is 9, divided into 4 for C+ and 5 for C.

2- Find z-score for B+ and C+: The z-scores for B+ and C+ are 0.84 and 0, respectively.

3- Find Cutoff Equations (see Figure 5):

$GB+ = \mu+0.84*\delta$

$GC+= \mu$

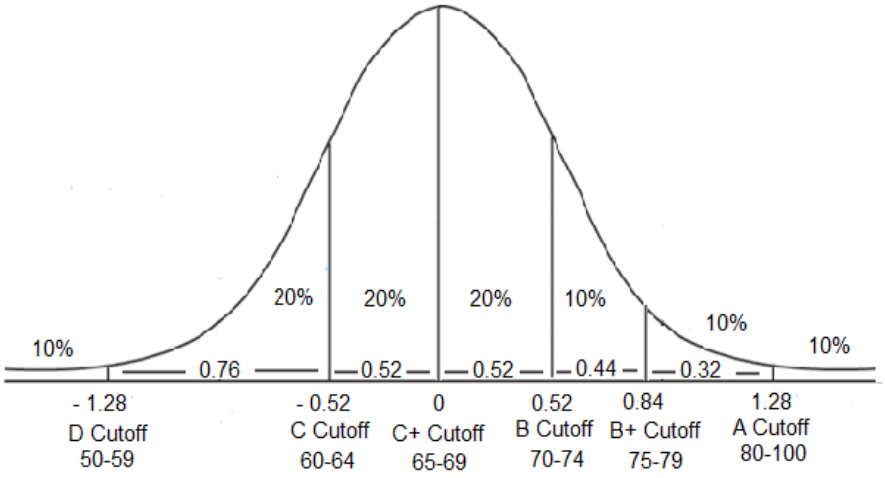


Figure 5: The proposed seven Grade System

4- Apply score Normalization Equations (see Figure 6)

Grade A:

IF Raw Score>=GA Then NormSC = Round(100 + 20 / (100 - GA) * (Score – 100),0)

Grade B+:

IF GA<= Raw Score>=GB Then NormSc = Round(79 + 4 / (0.44 * δ) * (score - GA), 0)

Grade B:

IF GA<= Raw Score>=GB Then NormSc = Round(74 + 5 / (0.32 * δ) * (score - GA), 0)

Grade C+:

IF GB<= Raw Score>=GC Then NormSc = Round(69 + 4 / (0.52 * δ) * (score - GB), 0)

Grade C:

IF GB<= Raw Score>=GC Then NormSc = Round(64 + 5 / (0.52 * δ) * (score - GB), 0)

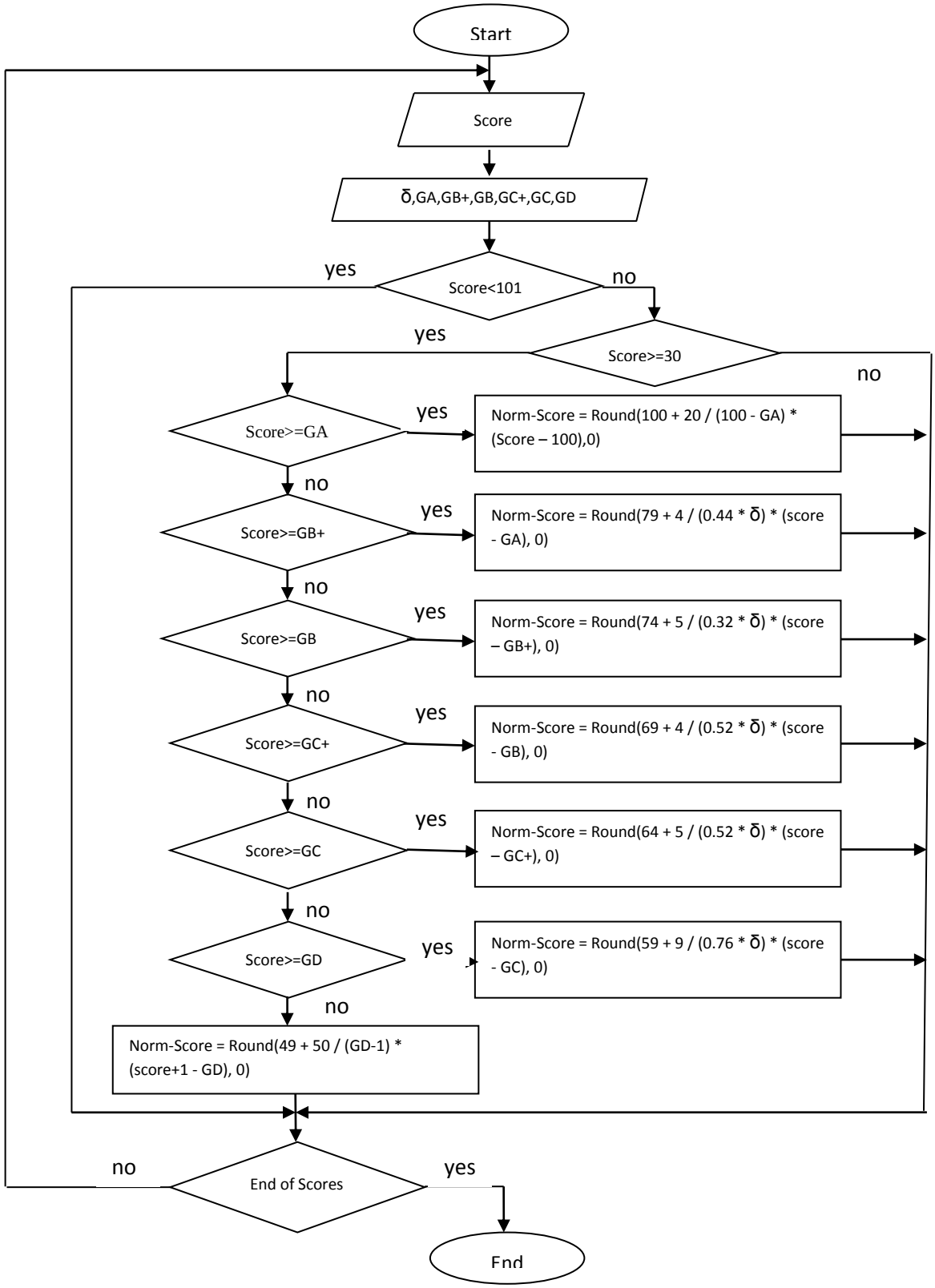
Grade D:

IF GC<= Raw Score>=GD Then NormSc = Round(59 + 9 / (0.76 * δ) * (score - GC), 0)

Grade F:

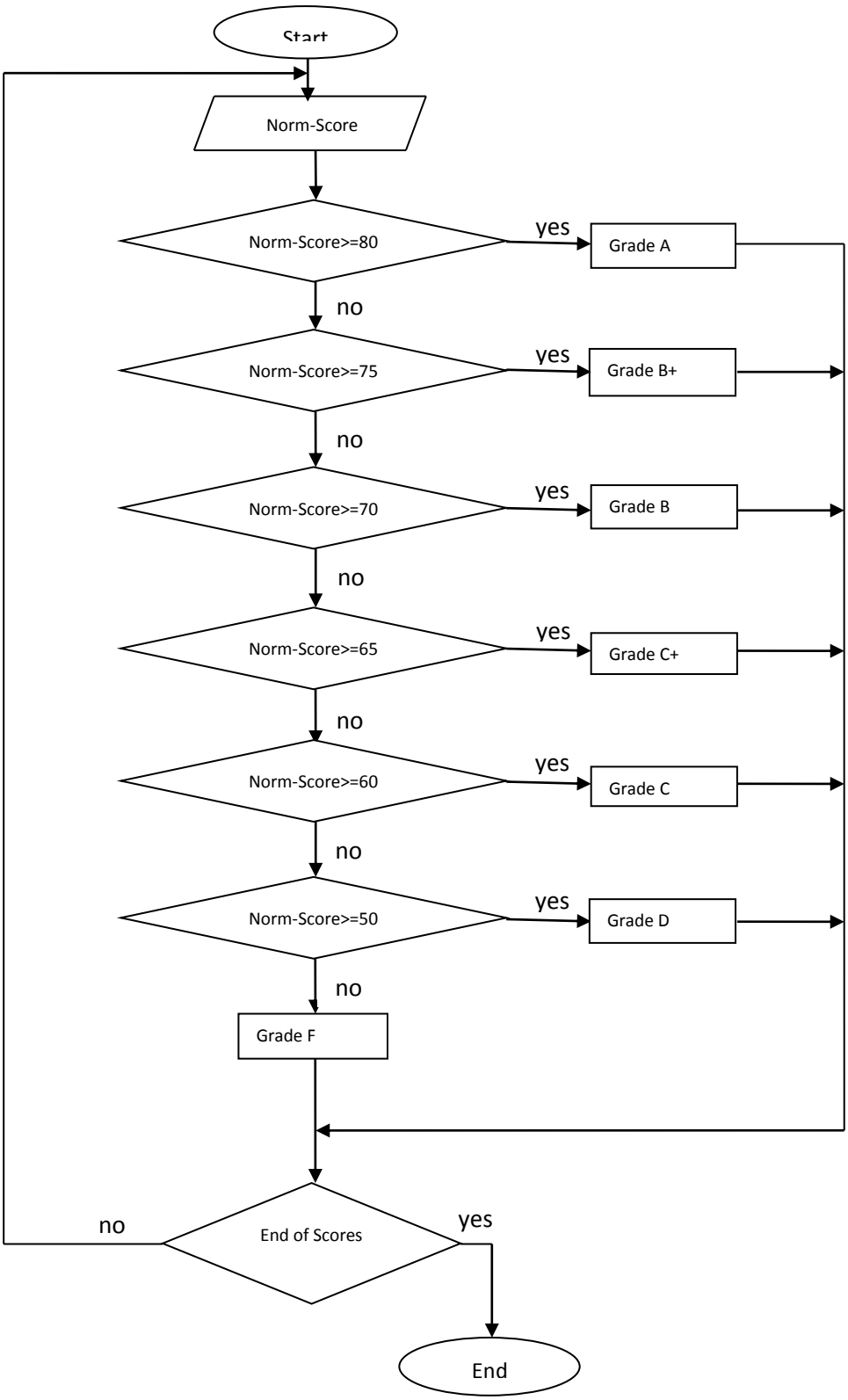
IF Raw Score<GD Then NormSc = Round(49 + 50 / (GD-1) *(score+1 - GD), 0)

Figure 6: Normalization equations flowchart



Now, the grading algorithm will be modified according to the new normalization equations, as shown in Figure 7.

Figure 7: Grading algorithm flowchart



9. Results and Discussion

The analysis revealed a critical flaw in the current six-grade system used at the University of Kassala. Although the number of grades increased from four to six, the cutoff points were not redefined, leading to overlapping grade ranges. Specifically, grades such as B+ and B were both assigned within the same numerical range used for grade B in the older system. This caused:

Ambiguity in assigning grades.

Inflation or deflation in academic standing.

A breakdown in consistency across departments and years.

Upon applying the standard normal curve as a reference, the corrected grading model demonstrated the following:

Clear boundaries between each grade based on Z-score intervals.

Improved fairness in score interpretation and student ranking.

Enhanced statistical soundness, making the system more reliable for longitudinal comparison.

The proposed model introduces well-defined, percentile-based grade ranges, correcting the existing overlap. This approach ensures that each grade represents a distinct performance level, aligned with normal distribution principles.

Some course results have been taken from the collage of Computer Science and Information technology over different years, tow kind of errors were found:

1- **Insignificant Errors**

In this case, the normalized score (NormSc) may be more or less than expected, but does not affect on the classification process, as the NormSc still falls within the expected range, as shown in table(4).

Table 4: Insignificant Errors

μ = 49.69767			δ = 13.3747		
No	Score	CS	DS	CSG	DSG
1	44	**61**	**60**	C	C
2	48	63	63	C	C
3	65	**77**	**78**	B+	B+
4	52	66	66	C+	C+
5	48	63	63	C	C
6	50	65	65	C+	C+
7	55	68	68	C+	C+
8	56	69	69	C+	C+
9	33	50	50	D	D
10	70	82	82	A	A
11	33	50	50	D	D
12	54	67	67	C+	C+
13	37	54	54	D	D
14	43	**60**	**59**	C	C
15	68	81	81	A	A
16	30	47	47	F	F
17	33	50	50	D	D
18	43	**60**	**59**	C	C
19	31	48	48	F	F
20	65	**77**	**78**	B+	B+
21	50	65	65	C+	C+
22	67	80	80	A	A
23	58	71	71	B	B
24	37	54	54	D	D
25	56	69	69	C+	C+
26	46	**62**	**61**	C	C
27	49	**64**	**63**	C	C
28	51	**65**	**66**	C+	C+
29	37	54	54	D	D
30	36	53	53	D	D
31	73	84	84	A	A
32	51	**65**	**66**	C+	C+
33	45	61	61	C	C
34	65	**77**	**78**	B+	B+
35	32	50	50	D	D
36	52	66	66	C+	C+
37	62	**75**	**76**	B+	B+
38	46	**62**	**61**	C	C
39	48	63	63	C	C
40	36	53	53	D	D
41	85	91	91	A	A
42	67	80	80	A	A
43	30	47	47		F

2- **Significant Errors**

In this case, the errors are crucial because the NormSc advanced or retreated by one grade more than expected, as shown in table 5 and table 6.

Table 5: Significant Errors

μ = 60			δ = 7.887603		
No	Score	CS	DS	CSG	DSG
1	58	62	62	C	C
2	54	56	56	D	D
3	51	52	52	D	D
4	51	52	52	D	D
5	63	68	68	C+	C+
6	57	61	60	C	C
7	59	63	63	C	C
8	66	73	73	B	B
9	75	83	83	A	A
10	67	**74**	**75**	**B**	**B+**
11	68	76	77	B+	B+
12	68	76	77	B+	B+
13	70	79	79	B+	B+
14	57	61	60	C	C
15	68	76	77	B+	B+
16	65	71	71	B	B
17	53	55	55	D	D
18	50	50	50	D	D
19	45	45	45	F	F
20	59	63	63	C	C
21	69	77	78	B+	B+
22	60	**65**	**64**	**C+**	**C**
23	67	**74**	**75**	**B**	**B+**
24	66	73	73	B	B
25	47	47	47	F	F
26	61	66	65	C+	C+
27	58	62	62	C	C
28	47	47	47	F	F
29	61	66	65	C+	C+

Table 6: Significant Errors

μ = 46.67816			δ = 10.09316		
No	Score	CNorm	MN	CG	MG
1	43	61	60	C	C
2	45	63	62	C	C
3	34	50	50	D	D
4	58	77	78	B+	B+
5	41	58	58	D	D
6	36	53	53	D	D
7	36	53	53	D	D
8	50	67	67	C+	C+
9	37	54	54	D	D
10	35	51	51	D	D
11	48	66	65	C+	C+
12	36	53	53	D	D
13	**47**	**65**	**64**	**C+**	**C**
14	38	55	55	D	D
15	**47**	**65**	**64**	**C+**	**C**
16	44	62	61	C	C
17	49	66	66	C+	C+
18	60	80	80	A	A
19	**47**	**65**	**64**	**C+**	**C**
20	42	60	60	C	C
21	50	67	67	C+	C+
22	**52**	**70**	**69**	**B**	**C+**
23	56	75	76	B+	B+
24	37	54	54	D	D
25	54	72	72	B	B
26	35	51	51	D	D
27	49	66	66	C+	C+
28	38	55	55	D	D
29	45	63	62	C	C
30	39	56	56	D	D
31	55	74	74	B	B
32	**47**	**65**	**64**	**C+**	**C**
33	31	46	46	F	F
34	69	85	85	A	A
35	37	54	54	D	D
36	38	55	55	D	D
37	46	64	63	C	C
38	54	72	72	B	B
39	56	75	76	B+	B+
40	50	67	67	C+	C+
41	60	80	80	A	A
42	63	82	82	A	A
43	54	72	72	B	B
44	50	67	67	C+	C+
45	44	62	61	C	C
46	36	53	53	D	D
47	62	81	81	A	A
48	78	89	89	A	A
49	40	57	57	D	D
50	40	57	57	D	D
51	43	61	60	C	C
52	**52**	**70**	**69**	**B**	**C+**
53	**52**	**70**	**69**	**B**	**C+**
54	75	88	88	A	A
55	43	61	60	C	C
56	34	50	50	D	D
57	55	74	74	B	B
58	63	82	82	A	A
59	43	61	60	C	C
60	40	57	57	D	D
61	43	61	60	C	C
62	65	83	83	A	A
63	49	66	66	C+	C+
64	49	66	66	C+	C+
65	55	74	74	B	B
66	40	57	57	D	D
67	40	57	57	D	D
68	**47**	**65**	**64**	**C+**	**C**
69	48	66	65	C+	C+
70	47	65	64	C+	C
71	46	64	63	C	C
72	33	49	49	F	F
73	42	60	60	C	C
74	45	63	62	C	C
75	48	66	65	C+	C+
76	36	53	53	D	D
77	44	62	61	C	C
78	54	72	72	B	B
79	40	57	57	D	D
80	38	55	55	D	D
81	44	62	61	C	C
82	73	87	87	A	A
83	34	50	50	D	D
84	34	50	50	D	D
85	41	58	58	D	D
86	58	77	78	B+	B+
87	30	45	45	F	F
88	32	48	48	F	F

10. Scientific and Practical Results

10.1- Scientific Results: The simulation results confirmed that the original six-grade system at the University of Kassala lacked alignment with the principles of the standard normal distribution. Statistically, the B+ and B grades shared the same range from the previous four-grade model, leading to significant overlap in the Z-score domain. By recalculating cutoff points based on Z-score thresholds, the proposed model ensures that each grade interval corresponds to a unique statistical range, thereby restoring the integrity of the distribution.

This alignment with the Gaussian model improves the theoretical soundness of the grading process, allowing for meaningful comparisons across cohorts and exam difficulties.

10.2- Practical Results: From a practical standpoint, the revised grading model provides a clearer and fairer evaluation framework for academic institutions. With the new cutoff points in place, grade inflation and misclassification are minimized. Administrators can now apply a standardized, objective criterion to assign grades, making internal reviews and external benchmarking more transparent.

Moreover, the model can be adapted to other faculties or institutions using similar numeric scoring systems, thus serving as a scalable solution to grading inconsistencies across higher education systems.

11. Recomondations

1- We suggest adding C+ and B+ Cutoff's to get rid of significant and insignificant errors.

2- Dividing D grade into tow ranges, D and D+, and also dividing grade A into, A and A+, according to what happened to C and B grades in order to have fierier Grading system.

3- The system should give the ability of tuning the average and the standard deviation according to the historical patterns of the courses in some cases.

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