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ABSTRACT

This study analyzes examination questions and papers in 12 academic departments and seven faculties at a Kenyan (Africa) state university between the 1989-1990 and the 1994-1995 academic years, charging that the findings reveal impoverished university training. The paper argues that the emphasis in most examinations is on the lower mental skills, as defined by Bloom's taxonomy, and is evidence that university training is little more than a four-year rote learning program. It charges that the university examination system groups students into classifications and measures performance level within a narrow criteria that does not recognize improvement of student thinking skills as the primary goal of education. The research design coded examination questions and papers using one independent variable (the academic faculty or department) and six dependent variables that corresponded to Bloom's taxonomy (knowledge, comprehension, application, analysis, synthesis, evaluation). Analyses of the data were conducted separately for each of the seven departments. The results indicated that most examination questions in this representative state university dwell on lower-order mental processes, although examinations in applied fields had higher-order questions. The paper offers the suggestion that university instruction be redesigned to focus on the quality of graduates rather than on the quality of entering students. (Contains 31 references.) (CH)

THE DISTRIBUTION OF UNDERGRADUATE EXAMINATION QUESTIONS AMONG THE SPECIFIED COGNITIVE LEVELS: A CASE OF AN AFRICAN UNIVERSITY

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ABSTRACT: This study examining a total of 9,484 questions from 675 examination papers offered by 12 academic Departments in six Faculties in an African state university (Kenya, East Africa), between the 1989/90 and the 1994/95 academic years has revealed that much emphasis is placed on the lower mental skills of the Bloom's Taxonomy -- B. S. Bloom et al., (1956).

Most undertakings summoned by the examination questions require a student's ability to reproduce course contents at a lower cognitive level at the very best. From the findings of this study a dismal prediction of an impoverished university product is likely. Such an observation provides enough evidence to reason that university training is a mere four-year rote learning program. A secure conclusion can, therefore, be made that the university examination system attempts to merely group its students into classifications symbolizing a level of performance within a narrow criteria.

Whereas Taba (1966) developed a model of teaching from a specific kind of thinking which underlies inquiry, formal education has attentively concerned itself with the acquisition of information and the development of literal comprehension. There is, however, no doubt that such lower mental processes are of value. It is, nevertheless, likely that throughout the world problem solving, inferential thinking, and various higher order mental processes will be required if the student is to use what is learned at the university level. It is only at that point that one could be acknowledged as indubitably educated.

Assisting students to improve their thinking skills is increasingly recognized as a primary goal of education (Privateer, 1999). According to Tucker (1988), we must create organizations capable of vastly increasing the faculties for higher order thinking. A similar viewpoint has been maintained by Jones and Idol (1990), when they affirm: "We must improve students' capacities to acquire, analyze, and apply complex information, to locate, communicate, and produce information effectively, to solve problems quickly and efficiently, to be committed to life long learning" (p. 3).

Professional literature (see for example, Rau & Heyl, 1990; Smith & Malec, 1995; Smith, 1996, Thompson, 1996), in most post-secondary education themes show a growing interest in higher order cognitive processes --problem solving and critical thinking. Such literature has been reviewed by Johnston (1995). To attain such an ideal, a subscription to policies of instructional interventions and measurements engendering in educators, researchers and policy makers a vision of university education based on a thorough understanding of the various dimensions of thinking, cognitive instruction, and their full implications.

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Grant and Marsden (1987) have argued that the difference between an expert and a novice problem solver:

> Resides in the content of thought and not just the what but also the how of what they know. If this view is correct then we can conclude that the difference in the structure and content of thought are more important than the simple amount of knowledge contained in one's memory (p..25).

Kissock and Iyortsum (1984) in reviewing the work of Agboola have observed that institutions of learning have fallen short of developing "citizens who can make reflective decisions on their own about things that concern them and the society at large." They further observe that:

> (T)oo many teachers pay more attention to recall learning which requires pupils simply to repeat information and facts memorized earlier. They neglect the higher level of thinking that direct the higher levels of thinking that direct students to find relationships between ideas, draw inferences, explain facts, make judgements for generalizations, interpret, apply skills and understanding to new situations, analyze, and create new ideas, all of which are necessary for the development of critical thinking" (p. 3).

Studies in the last few decades indicate that most teachers prepare classroom questions that foster thinking at the lower taxonomic levels (Pfeiffer and Davis, 1965; Billeh, 1974, and Trachtenberg, 1974). These studies have only probed individual subject content or courses. Little has been evidenced in the literature that analyzes questions across subject areas on a longitudinal approach. Our study, as reported here, embarks on this subject from a longitudinal approach and examines this query as it is reflected by different course contents.

The central purpose of examinations is to assess what has been learned and not merely check the extend to which an individual can (or cannot), reproduce the information previously transmitted. Miller (1990), remarks that examiners have a tendency to measure those elements of content that are easy to measure. This proclivity has been challenged by Tolley (1989: 254), who, rightly, state: ". . . bringing in assessment means that one is concerned with what is learned and how it is learned, content, process, and outcomes . . ."

Bloom (n.d.), has observed that:

> . . . students perform best on the lower mental processes involving knowledge and perform less well on items involving some interpretation and comprehension, and perform least well on test problems requiring application, higher order, mental processes and complex inferences (p.45).

Research findings (Brophy and Evertson 1976; Redfield and Rousseau 1981; Berliner 1984), indicate that students' overall achievement score rises when teachers ask questions that require students to apply, analyze, synthesis and evaluate information acquired through instructional intervention in addition to simply recalling facts. Similar results have also been reported earlier by Andre (1979) and Watts and Anderson (1971). Their results found increased performance after higher order questioning was applied. Andre (1979), for example, concluded that higher order questions facilitate learning compared with lower order questions.

The effectiveness of any university's instructional interventions should be measured not only by the students' performance as observed by way of academic achievements through examinations, but also by content and structure of the measuring instruments themselves. The construction and scoring of these instruments might, probably, obscure meaningful information on what students know and can do. This is summarized well by Archbald and Newmann (1988) who have explained that dominant approaches to assessment fail to tap authentic forms of academic achievement.

University training serves to produce a finished product that will have sufficiently acquired the requisite skills and dispositions underwritten by the main stance of the teaching profession. And more specifically, a university training has that obligation to prepare professionals who can translate knowledge expressed in general theoretical terms to well designed strategies and practices. For a university to launch and succeeds in such a crusade, it must incorporate into its intervention phases procedures encouraging the employment of higher order thinking.

Kenya's state university education is currently the object of nationwide discontent, a source of malice tinged with frustrations from university lecturers who silently complain of the ill-equipped products of the 8-4-4 system; parents who dutifully pay a premium towards tuition and maintenance of their college going children without a stipulated guarantee of employment; employers who are dismayed by graduate job-seekers who are unable to write a coherent letter of application; university administrators over undergraduate lecturers who spend less time devoted to productive research and instruction while they search additional resources to supplement their merger university wages; and more serious is the pervasive uncertainty about just how university training is suppose to work.

The context in which this study of the distribution of examination questions among the established educational cognitive levels is hinged on is one of continuing public debates about the declining standards of education. Too often, an unswerving blame is pointed at the introduction of the 8-4-4 system in Kenya.

The following null hypotheses are of interest to this study:

- There will be no significant differences between faculties in the manner in which examination questions are distributed among the specified cognitive levels.
- There will be no significant differences between departments in the manner in which examination questions are distributed among the specified cognitive levels.
- There will be no significant differences between departments within a faculty in the manner in which examination questions are distributed among the specified cognitive levels.
- There will be no significant differences between degree programs in the manner in which examination questions are distributed among the specified cognitive levels.
- There will be no significant differences between the Main examination and the Supplementary examination across all disciplines in the university in the manner in which examination questions are distributed among the specified cognitive levels.
- There will be no relationship between academic programs in the form of mental tasks required by examination questions.

METHODOLOGY

Sampling Design

A research design composed of one independent variable, six dependent variables, and four intervening variables (three predictors and one criterion), were utilized. Selected Departments within seven academic Faculties at Moi University were considered as the independent variable.

The six dependent variables corresponded to Bloom's taxonomy: percent Knowledge questions; percent Comprehension questions, percent Application questions; percent Analysis questions; percent Synthesis question; and percent Evaluation questions. Each of these six dependent variables were defined as the percent of questions or sub-questions from the total number of a given course examination. Because each dependent variable was computed as a percentage, these variables are ipsative.

The three intervening predictor variables isolated were categorized thus because they may differ or be associated with one or more of the six dependent measures were: academic discipline (faculty/department), academic program (degree), and intention of examination, namely: Main or Supplementary (type). Besides the six dependent variables, an additional intervening criteria variable was included. This was labelled as tasks of simple and complex mental processes. This variables is intervening because it is associated with two or more of the six dependent variables. Specifically, simple mental processes were a collapsing of the first two levels of the taxonomy (Knowledge and Comprehension). The complex mental processes included the fourth through the sixth level of the taxonomy (Application, Analysis, Synthesis, and Evaluation).

Procedures

Three basic steps comprised the procedures for this study. First, a list of examination papers among the offerings of courses (covering academic years 1989/1990-1994/1995), at Moi University was compiled (these are retrievable from the National Collection section of the M. Thatcher Memorial Library). These documents were listed to provide a sample frame of 2,503 examination papers. From these, 675 (27%) examination papers (consisting of 9,484 questions and sub-questions) were further classified according to their self-reported descriptions to provided the intervening predictor variable: Type.

Second, a list of University Faculties and academic Departments was secured from which six Faculties were pre-meditatively selected and 12 Departments were randomly obtained to provide the independent variables: Faculty and Department. From the Faculties selected information concerning the degree offerings was determined thereby providing the intervening predictor variable: Degree.

Third, two independent coders were trained in the methods and criteria of classifying examination questions according to the Bloom's taxonomy. Further an instrument, which is a modified version of constructs formulated by Kemp (1985) and Gibbs & Trevor (1989), was developed and utilized by the coders as a guide in determining the categorization of examination questions.

RESULTS

The hypotheses formulated for this study have been analyzed through a series of analysis of variance procedures. Each hypothesis has been assessed in light of the results and findings then subsequently reviewed as a whole.

The descriptive statistics provided in Table 1 and 2 outfit a preliminary perspective on the trends of the measure employed in this study. For example, Table 1 is a summary of the distribution of descriptive data which includes the mean, and the standard deviation representing each of the 12 departments. A visual observation of this data, clearly indicates a noticeable non-equitable distribution of the mean percentages distribution among the six levels.

This trend points out that most examination questions have a tendency to remain on the simple mental processes on virtually all independent variables. However, even though there is such an unmistakable distribution centered around the lower fields of cognitive processes it is necessary, therefore, to examine if it is statistically significance before providing any declarative that these are or may not be mere occurrences of chance.

Descriptive statistics, however, cannot by themselves determine the relative importance or significance of the data as they apply to any one of the objective measures. For that reason, both priori and posterior inferential statistical analyses were employed. This was accompanied by an execution of several univariate (ANOVA) and multi-variate (MANOVA) analysis of variance.

Table 1
Summary of Characteristics of Examination Questions
by Department as Selected for Analysis

		LEVELS OF COGNITION					
DEPARTMENT		I	II	III	IV	V	VI
	M	6.83	45.18	11.21	3.41	0.85	32.49
Literature [1]	SD	9.81	17.52	14.29	14.29	7.71	3.42
N=113 (16.74%)	SE	0.92	1.64	1.34	0.72	0.32	1.75
Info. and	M	39.56	33.85	9.50	7.24	2.91	3.82
Media Techn.[2]	SD	24.98	20.22	10.69	8.54	5.79	8.48
N=34 (5.04%)	SE	4.28	3.46	1.83	1.46	0.99	1.45
Info. and	M	29.00	33.85	12.28	12.89	8.11	3.28
Book Trade[2]	SD	21.00	16.34	14.90	11.88	10.67	7.65
N=17 (2.52%)	SE	5.09	3.85	3.51	2.80	2.51	1.80
	M	37.44	31.30	16.84	7.44	2.89	3.47
Forestry[3]	SD	18.97	13.02	15.04	11.13	6.81	7.11
N = 63 (9.33%)	SE	2.39	1.64	1.89	1.04	0.86	0.89
Wildlife	M	48. 18	31.05	9. 96	4.52	1.45	3.61
Management[3]	SD	21.55	18.51	13.34	6.79	6.72	8.09
N = 67 (9.93%)	SE	2.63	2.26	1.63	0. 82	0.81	0.99
Educ. Admin.	M	32.47	42.80	11.93	2.07	0.00	10.93
and Curr. Dev.[4]	SD	20.12	17.95	17.01	4.54	0.00	12.00
N = 15 (2.25%)	SE	5.20	4.64	4.39	1.73	0.00	3.10
Educ. Comm.	M	25.78	53.85	8.85	0.29	0.22	10.89
and Technology[4]	SD	17.14	22.01	9.08	1.54	1.16	14.02

N = 27 (4.00%)	SE	3.29	4.24	1.75	0.29	0.22	2.70
	M	4.15	53.89	14.07	2.30	0.24	26.85
Philosophy[1]	SD	6.76	20.61	14.74	7.79	1.62	17.57
N = 46 (6.81%)	SE	0.99	3.04	2.17	1.14	0.29	2.60
	M	53.97	32.32	6.58	4.71	1.44	0.90
Botany[5]	SD	24.81	24.91	8.50	7.78	3.65	2.81
N = 38 (5.63%)	SE	4.02	4.04	1.38	1.26	0.65	0.46
Production	M	17.06	16.88	49.95	5.52	7.31	2.97
Technology[6]	SD	16.22	18.51	29.58	9.11	9.33	6.72
N = 129 (19.11%)	SE	1.43	1.63	2.61	0.80	0. 82	0.59
Electrical	M	13.41	28.76	47.61	0.91	5.15	4.32
Communication[6]	SD	10.12	15.92	16.63	2.29	6.41	5.72
N = 74 (10.96%)	SE	1.18	1.85	1. 93	0.27	0.75	0.67
Physics[5]	M	13.90	22.19	49.18	4.28	7. 67	2.88
	SD	9.91	14.28	17.26	9.54	9.10	4.62
N = 51 (7.60%)	SE	1.39	2.00	2.41	1.34	1.28	0.65

Note: Means (M) and Percentages (%) may not add up to 100% due to rounding error.

[1]School of Social and Cultural Development Studies, [2]Faculty of Information Sciences, [3]Faculty of Forestry, [4]Faculty of Education, [5]Faculty of Science, [6]Faculty of Technology

Table 2
Summary of Characteristics of Examination Questions
by Faculty as Selected for Analysis

				LEVELS OF COGNITION			
FACULTY		I	II	III	IV	V	VI
Sch. of Cult. &	M	6.06	47.70	12.04	3.09	0.67	30.79
Social Studies	SD	9.09	18.83	14.43	7.72	3.02	18.47
N = 159 (23.1%)	SE	0.72	1.49	1. 15	0.61	0.24	1.46
Faculty of Info	M	35.94	34.17	10.50	9.21	4.71	3.64
Sciences	SD	24.17	18.80	12.26	10.09	8.12	8.13
N = 52 (7.7%)	SE	3.35	2.61	1.70	1.40	1.13	1.13
Faculty of	M	43.00	32.17	13.29	5.94	2.15	3.55
Forestry	SD	20.97	16.02	14.55	9.23	6.73	7.60
N = 130 (19.3%)	SE	1.84	1.41	1.28	0.81	0.59	0.67
Faculty of	M	28.17	49.91	9.95	0.93	0.41	10.91
Education	SD	18.31	21.12	12.38	3.05	0.93	13.19
N = 42 (6.2%)	SE	2.83	3.26	1.91	0.47	0.14	2.04
Faculty of	M	31.01	26.52	30.99	4.46	5.01	2.03
Science	SD	26.68	20.05	25.47	8.79	7.89	4.05
N = 89 (13.2%)	SE	2.83	2.13	2.70	0.93	0.83	0.43
Faculty of	M	15.73	21.21	49.10	3.84	6.52	3.46
Technology	SD	14.39	18. 48	25.61	7.71	8.43	6.39
N = 203 (30.1%)	SE	1.01	1.30	1.80	0.54	5.92	0.45

Note: Percentage Means may not add to 100% due to rounding error.

Null Hypothesis One

It was hypothesized that there will be no significant differences between faculties in the manner in which examination questions are distributed among the specified cognitive levels. To determine whether the measures differentiated between the faculties, a battery of univariate analyses of variance were conducted.

The results of each of these one-way ANOVA exhibited highly significant differences [$F(5\ 669)$, = 76.06 (Knowledge), 45.89 (Comprehension), 94.23 (Application), 7.02 (Analysis), 18.06 (Synthesis),148.57 (Evaluation), $p < .001$], between all the representative faculties on the six dependent measures.

Even though the univariate F tests provided results proved beyond doubt the nonexistences similarities between the faculties in their construction of examination questions, a further procedure which included a Hotelling-Lawley trace was estimated to satisfy curiosity. The results confirmed our original ANOVAs (Hotelling-Lawley Trace = 2.594, $F = 57.279$, $df = 30$, $p < 0.001$). Based on this battery of analysis of variance, the null hypothesis predicting similarities was not confirmed.

Null Hypothesis Two

It was hypothesized that there will be no significant differences between departments in the manner in which examination questions are distributed among the specified cognitive levels. This hypothesis was tested in a series of ANOVA procedures to determine the presence of any similarities or differences in this regard between the departments. The data summarized in Table 1 was used in this procedure. A summary of the ANOVA product comparing the twelve departments is shown in Table 3. The results indicate significant differences ($p < .001$), on all the dependent measures of the taxonomy. Based on this analysis, the null hypothesis could not be confirmed.

Table 3
Summary of Six Analysis of Variance For Departments on Dependent Variables Called: Levels of the Taxonomy

SOURCE	SS	df	MS	F-Ratio	P value
Knowledge	165107.12	11	15009.74	56.39	<0.001
Error	176473.55	663	266.34		
Comprehension	91348.72	11	8304.43	25.34	<0.001
Error	217289.76	663	337.74		
Application	227517.81	11	20683.44	61.78	<0.001
Error	221980.14	663	334.81		
Analysis	4089.79	11	371.80	5.72	<0.001
Error	43067.60	663	64.96		
Synthesis	5580.84	11	507.35	11.56	<0.001
Error	29042.84	663	43.81		
Evaluation	91899.84	11	8354.53	69.01	<0.001
Error	80269.95	663	121.07		

Null Hypothesis Three

The third hypothesis predicted that there will be no significant differences between departments within a Faculty in the manner in which examination questions are distributed among the specified cognitive levels. Each Faculty was examined separately.

School of Social, Cultural, and Development Studies

A multi-variate test statistic was ran to test this hypothesis. The results revealed a statistical significance which provided a basis for a rejection of the predicted hypothesis of no differences [$F(6, 152) = 3.886$, $p < 0.001$].

A further investigation seeking to identify where the differences laid prompted an execution of a univariate *F* statistic procedure. Although differences remained between the way the Department of Literature and the Department of Philosophy constructs their examination questions, they were only slight in all the levels except the Comprehension level (Level II), where significant differences were determined [$F(1, 157) = 7.268$, $p < 0.01$].

The departments in the School of Social, Cultural, and Development Studies have consistently examined their students heavily on the lower cognitive levels. However, it is clear from the data provided in Table 1 that the Literature Department which had a mean percentage score of 45.18% dedicated to Comprehension level questions was, indeed, significantly lower than that of the Department of Philosophy (53.89%) on the same level during those five years.

Faculty of Information Sciences

A multi-variate procedures was executed on the data presented in Table 2. This MANOVA test statistic indicated that there exists significant differences in the manner in which the two departments in the Faculty of Information Sciences construct their examination questions [$F(6, 45) = 2.539$, $p < 0.05$]. A subsequent one-way analysis of variance procedure intended to discover if this status of significant differences was valid in all levels of the measure was rendered.

While the multi-variate estimation had exhibited highly significant results, the ANOVAs indicated that the effect of the predictor variable laid squarely on a single level (Synthesis), [$F(1, 50) = 5.232, p = 0.026$]. A measure that approached the level of significance (but never made it), was the Analysis (IV), whereby the Department of Information and Media Technology was out-distanced by the Department of Publishing and Book Trade by a greater margin ($M = 7.24$, $Sd = 8.54$ and $M = 12.89$, $Sd = 11.88$, respectively). The other levels of the measure did not reveal any differences that were significantly different at $p < .05$. Therefore, the null hypothesis could not fully be confirmed, insofar as the fourth level of the cognitive skills is concerned.

Faculty of Forestry and Wildlife Management

The tests performed to compare the departments in the Faculty of Forestry and Wildlife Management failed to fully confirm the predicted null hypothesis of differences on all predictors. Both the univariate and the multi-variate F tests revealed contrasting relationships between the Department of Forestry and the Department of Wildlife Management. These differences (Table 4) were found on the main effect in two (Levels I and III), of the six dependent measures ($p < 0.001$).

While the construction of the test items concentrated more on the two lower levels of cognitive skills (with over 60% of question items contained in the first and second levels for each of the two departments), they still differed remarkably on the first level where the Department of Wildlife Management exceeded the Department of Forestry by giving 22.00% more recall type questions. No significant difference were found in their offering of questions on Levels II (Comprehension), IV (Analysis), V (Synthesis), and VI (Evaluation) of the Taxonomy [$F(1, 128) = 0.008, p > .05$; $F(1, 128) = 3.31, p > .05$; $F(1, 128) = 1.49, p > 0.05$; and $F(1, 128) = 0.01, p > 0.05$ (respectively)].

Table 4
Summary of Analysis of Variance for Faculty of Forestry and Wildlife Management for Dependent Variables Called: Levels of the Taxonomy

SOURCE	SS	df	MS	F -Ratio	P value
Knowledge	3741.52	1	3741.52	9.04	< 0.001
Error	52969.41	128	413.82		
Comprehension	2.41	1	2.14	0.01	0.93
Error	33116.14	128	258.72		
Application	1539.61	1	1539.61	7.65	0.01
Error	25779.28	128	201.40		
Analysis	277.24	1	277.24	3.31	0.7
Error	10720.27	128	83.75		
Synthesis	67.43	1	67.43	1.5	0.22
Error	5766.79	128	45.05		
Evaluation	0.60	1	0.60	0.01	0.92
Error	7453.63	128	58.23		

Faculty of Education

The ANOVA products were obtained to compare the mean percentage scores for the Department of Educational Policy, Administration and Curriculum Development with those from the Department of Educational Communication and Technology. The results (Table 5) obtained in these executions clearly indicates that even the very lowest *p*-value was still greater than an *alpha* of .05. Even though the mean percentages and their standard deviations were observably different (as depicted in Tables 2), they do not, however, exhibit differences that are statistically significant. It has been revealed, therefore, that the null hypothesis of differences between the two departments in the manner in which their examination questions are distributed among the specified cognitive levels can not be rejected.

Table 5
Summary of Six Analysis of Variance For the Faculty of Education for Dependent Variables Called: Levels of the Taxonomy

SOURCE	SS	df	MS	F -Ratio	P value
Knowledge	431.43	1	431.43	1.297	0.262
Error	13306.40	40	33.66		
Comprehension	1177.81	1	1177.81	2.754	0.105
Error	17105.81	40	427.64		
Application	91.55	1	91.65	0.591	0.446
Error	6194.34	40	154.86		
Analysis	30.22	1	30.22	3.448	0.071
Error	350.56	40	8.76		
Synthesis	0.48	1	0.48	0.549	0.463
Error	34.67	40	0.87		
Evaluation	0.02	1	0.02	0	0.992
Error	7129.60	40	178.24		

Faculty of Science

To examine the third null hypothesis, similar procedures were followed in the treatment of data presented in Table 2. Both multivariate for all levels combined and univariate for executions for individual levels were performed. The multivariate test statistic revealed differences containing margins of significance [F (6, 82) = 46.558, p < 0.001]. Since this magnitude of differences was noticeably high, a battery of univariate F tests was ran to identify its locations.

Presented in Table 6 are the results of the six univariate F tests. These results, clearly, reject the predicted hypothesis of no differences in five of the six measures. The difference between the mean percentages for the Department of Botany and the Department of Physics on only one dependent measure (Analysis) was very slight (0.43%), and did not place the F value of the ANOVA within the critical region of below α = .05. The correlation coefficient for the two departments on that particular measure was above r = .80.

Table 6
Summary of Analysis of Variance For the Faculty of Science for Dependent Variables Called: Levels of the Taxonomy

SOURCE	SS	df	MS	F-Ratio	P value
Knowledge	34965.51	1	34965.51	109.89	<0.001
Error	27681.48	87	318.18		
Comprehension	2229.76	1	2229.96	5.85	0.02
Error	33170.25	87	381.28		
Application	39512.31	1	39512.31	195.58	<0.001
Error	17576.68	87	202.03		
Analysis	4.14	1	4.14	0.05	0.82
Error	6795.97	87	78.12		
Synthesis	842.26	1	842.26	15.8	<0.001
Error	4636.73	87	53.29		
Evaluation	86.03	1	86.03	5.52	0.02
Error	1356.87	87	15.60		

Faculty of Technology

The sixth and final independent variable included in the battery of analyses ran to test the null hypothesis of no differences between departments within the same faculty in the manner in which examination questions are distributed among the specified cognitive levels are the Departments of Production Technology and Electrical and Communication Technology. A Hotelling-Lawley trace obtained an F statistic value with a significance level of [$F(6, 196) = 9.568, p < 0.001$]. However, when six ANOVA tests were carried out (one for each of the six criterion measures), statistically significant differences were, indeed, found only in Levels II (Comprehension) and IV (Analysis). The Department of Electrical and Communication Technology exceeds the Department of Production Technology by nearly 12% in its demand of an exercise of comprehension skills on course content materials and places 61% less demand on the Analysis level on a mere 5.52% evidenced by the Department of Production Technology. Where these significant differences occurred on any of the six levels, they reach magnitudes of $p < 0.001$.

Null Hypothesis Four

It was predicted that there will be no significant differences between the degree programs in the manner in which examination questions are distributed among the specified cognitive levels. For all statistical analyses treating similarities in degree programs, the mean percentages of each degree program constituted the dependent observation while the four types of degrees, namely Bachelor of Arts, Bachelor of Education, Bachelor of Science, and Bachelor of Technology constituted the predictor variables.

Table 7 presents data on descriptive statistics depicting a summary of the mean percentages, their standard deviations, and their standard error on the four treatment groups on the six dependent measures called Levels of the Taxonomy. The results of the ANOVAs executions on this data revealed statistically significant difference on each of the four categories for the main effect called degree program on all six criterion variables [$F(3, 671) = 103.99$, (Knowledge), 72.61 (Comprehension), 131.17 (Application), 8.54 (Analysis), 25.07 (Synthesis), 204.38 (Evaluation), $p < 0.01$].

Table 7
Summary of Characteristics of Examination Questions
for Degree Programs Selected for Analysis

		LEVELS OF THE TAXONOMY					
DEGREE		I	II	III	IV	V	VI
Bachelor	M	6.06	47.70	12.04	3.09	0.67	30.79
Arts	SD	9.09	18.83	14.43	7.72	3.02	18.47
N = 109 (16.1%)	SE	0.72	1.49	1.15	0.61	0.24	1.46
Bachelor	M	28.17	49.91	9.95	0.93	0.41	10.91
Education	SD	18.31	21.12	12.38	3.05	0.93	13.19
N = 93 (13.8%)	SE	2.83	3.26	1.91	0.47	0.14	2.04
Bachelor	M	38.00	30.15	18.60	6.13	3.70	2.95
Science	SD	24.13	18.12	20.47	9.38	7.54	6.57
N = 272 (40.3%)	SE	1.46	1.10	1.24	0.57	0.46	0.40
Bachelor	M	15.73	21.21	49.10	3.84	6.52	3.46
Technology	SD	14.39	18.48	25.61	7.71	8.43	6.39
N = 201 (29.8%)	SE	1.01	1.30	1.80	0.54	0.92	0.45

Note: Means (M) and Percentages (%) may not add up to 100% due to rounding error.

Null Hypothesis Five

It was surmised that there will be no significant differences between the Main and the Supplementary examination across all disciplines in the university in the manner in which examination questions are distributed among the specified cognitive levels. For examination type, we used department's reported information classify the Examinations as Main or Supplementary. Table 8 characterizes the obtained means, standard deviation and standard error for all the dependent variable on the predictor variable called: Examination Type. Also specified in the Table is the proportion within which the variable engrossed in the randomly selected sample of 675 examination papers. This is indicated with letter (N).

Table 8
Summary of Type of Examination for All Academic Programs on the Dependent Variable called: Levels of the Taxonomy

		LEVELS OF THE TAXONOMY					
TYPE OF EXAMINATION		I	II	III	IV	V	IV
MAIN	M	23.26	32.81	25.90	4.53	3.77	9.79
EXAMINATION	SD	22.35	20.84	25.22	8.60	7.34	15.41
N = 583 (87%)	SE	0.93	0.87	1.08	0.36	0.31	0.64
SUPPLEMENTARY	M	22.82	33.04	25.13	3.86	2.64	11.69
EXAMINATIONS	SD	23.73	24.74	29.49	7.17	6.42	18.15
N = 92 (13%)	SE	2.47	2.58	3.07	0.75	0.67	1.89

Table 9
Summary of Analysis of Variance for all Academic Programs for Dependent Variables Called: Levels of the Taxonomy

SOURCE	SS	df	MS	F-Ratio	P value
Knowledge	9.36	1	9.36	0.02	89
Error	340241.27	670	507.82		
Comprehension	4.32	1	4.32	0.01	0.92
Error	307192.96	670	458.50		
Application	46.40	1	46.40	0.07	0.79
Error	447465.02	670	667.86		
Analysis	35.89	1	35.89	0.51	0.48
Error	474676.60	670	70.85		
Synthesis	102.21	1	102.21	1.96	0.16
Error	34928.03	670	52.13		
Evaluation	284.15	1	284.15	1.14	0.29
Error	167487.03	670	249.98		

To address the fifth hypothesis, a battery of ANOVAs was executed on the predictor (examination type) against the six criterion measures (levels of the taxonomy). The data exhibited in Table 8 was used in this procedure. Following a visual evaluation of the data, the mean percentages and their standard deviations were observed to contain differences. Table 9 illustrates the results of the one-way analysis of variance on the data summarized in Table 8.

Whereas the Main examination had, relatively, higher percentage means on all the six criterion levels (Table 8), these scores were found not to be statistically different from those obtained on Supplementary examinations at alpha .05 level of significance. Because this observation was drawn from a broad spectrum, more specificity was extracted by subjecting each of the six Faculties (separately and individually), to a similar statistical procedure. The data displayed in Table 10 was used. This data summarizes the mean percentages, standard deviation and standard error of the mean for individual Faculties of the university that were included in this study on the examination type.

Individual ANOVAs were carried out to ascertain if these means were statistically different. Table 11 portrays the results of the one-way analyses of variance performed on the data related to the type (Main or Supplementary), of examinations paper obtained for the School of Social and Cultural Development Studies. It is apparent from these results that the p values corresponding to the obtained F ratios did not reach levels of significance at $\alpha = 0.05$ in any but one case. The only instance that the effects were associated with the predictor was on the sixth level ($p < 0.05$). In this case, Supplementary Examination solicited 9.00% more Level VI questions than did the Main examinations. The null hypothesis of no significant differences could not be rejected in all other instances.

Table 12 depicts the results of one-way analyses of variance for the Faculty of Information Sciences. An examination of these results indicates that the differences were not reliably different in any of the six levels. The null hypothesis of no significant differences could not be rejected at $\alpha = 0.05$ level. A confident conclusion could, therefore, be drawn that throughout the five years included in this inquest, the Faculty of Information Sciences has provided both the Main examination and the Supplementary examinations that were uniformly equivalent.

Table 10
Summary of Characteristics of Examination Types According to Faculties

FACULTY	TYPE OF EXAMINATION		LEVELS OF THE TAXONOMY I	II	III	IV	V	VI
School of	MAIN	M	6.16	48.08	12.46	3.33	0.70	29.60
Social	(N = 138)	SD	9.41	18.65	15.01	8.13	3.11	18.32
Cultural Develop.	SUPP	M	4.76	45.24	9.24	1.57	0.52	38.62
N = 159	(N = 21)	SD	6.73	20.24	9.63	3.99	2.40	17.97
	MAIN	M	36.13	34.19	10.71	9.90	2.23	3.94
Information	(N = 48)	SD	24.35	18.65	12.39	10.00	8.59	8.39
Science	SUPP	M	40.00	40.25	8.00	7.25	4.72	0.00
N = 52	(N = 4)	SD	15.30	12.12	11.80	14.50	9.50	0.00
Forestry	MAIN	M	42.29	30.93	14.10	5.69	2.47	3.82
and	(N = 108)	SD	20.50	15.06	15.06	9.04	7.29	7.96
Wildlife	SUPP	M	46.36	32.36	9.36	7.20	0.59	2.20
N = 130	(N = 22)	SD	23.34	20.48	11.20	10.25	1.91	5.45
Education	MAIN	M	28.30	51.92	7.96	0.80	0.24	10.80
N = 42	(N = 24)	SD	17.89	19.24	7.96	3.00	1.20	14.98
	SUPP	M	28.44	46.72	12.16	1.06	0.00	11.61
	(N = 18)	SD	18.97	23.21	16.58	3.12	0.00	10.39
Science	MAIN	M	32.54	26.15	30.14	4.41	4. 62	2.21
N = 89	(N = 78)	SD	26.69	18.98	25.79	9.11	7.57	4.19
	SUPP	M	20.18	29.09	37.00	4.82	7.82	0.82
	(N = 11)	SD	25.16	27.51	23.28	6.32	9.85	2.71
Technology	MAIN	M	16.52	22.62	48.84	3.85	6.51	3.68
N = 203	(N = 186)	SD	14.62	18.37	24.73	7.91	8.36	6.60
	SUPP	M	7.12	5.82	73.77	3.71	6.71	1.12
	(N = 17)	SD	7.28	11.62	22.39	5.16	9.41	2.50

Note: Mean percentages may not add up to 100% due to rounding error.

M = Mean Percentages SD = Standard Deviation

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Table 11
Summary of a Battery of Six Analysis of Variance For Types of Examinations in School of Social, Cultural, and Development Studies for Dependent Variables Called: Levels of the Taxonomy

SOURCE	SS	df	MS	F-Ratio	P value
Knowledge	40.28	1	40.28	0.48	0.49
Error	12957.31	155	83.60		
Comprehension	153.16	1	153.16	0.43	0.52
Error	55742.16	155	359.63		
Application	211.40	1	211.40	1.01	0.32
Error	32428.87	155	209.22		
Analysis	59.17	1	59.17	0.98	0.32
Error	9353.02	155	60.34		
Synthesis	0.60	1	0.60	0.07	0.8
Error	1441.47	155	9.30		
Evaluation	1609.35	1	1609.35	4.9	0.03
Error	50953.77	155	328.73		

Note: Degrees of freedom for Error are less as a result of deletion due to missing data.

Table 12
Summary of a battery of Six Analysis of Variance For Types of Examinations in the Faculty of Information Sciences for Dependent Variables Called: Levels of the Taxonomy

SOURCE	SS	df	MS	F-Ratio	P value
Knowledge	55.44	1	55.44	0.1	0.76
Error	28563.25	50	571.27		
Comprehension	135.71	1	135.71	0.4	0.53
Error	16780.06	50	335.60		
Application	27.08	1	27.83	0.18	0.68
Error	7631.92	50	152.64		
Analysis	25.85	1	25.85	0.24	0.62
Error	5321.23	50	106.43		
Synthesis	0.85	1	0.85	0.01	0.92
Error	3735.23	50	74.71		
Evaluation	57.25	1	57.25	0.86	0.36
Error	3314.81	50	66.30		

Table 13
Summary of a Battery of Six Analysis of Variance For Types of Examinations in the Faculty of Forestry and Wildlife Management for Dependent Variables Called: Levels of the Taxonomy

SOURCE	SS	df	MS	F-Ratio	P value
Knowledge	303.74	1	303.74	0.69	0.41
Error	56407.19	128	440.68		
Comprehension	37.78	1	37.78	0.15	0.7
Error	33080.50	128	258.44		
Application	408.73	1	408.73	1.94	0.17
Error	26910.17	128	210.24		
Analysis	40.94	1	40.94	0.48	0.49
Error	10956.57	128	85.60		
Synthesis	64.05	1	64.05	1.42	0.24
Error	5770.17	128	45.08		
Evaluation	49.29	1	49.29	0.85	0.36
Error	7404.93	128	57.85		

Table 13 depicts the result of one-way analyses of variance performed on the descriptive data contained in Table 10 for the Faculty of Forestry and Wildlife Management. It is apparent from the yields that the obtained *F* ratios, uniformly, did not reach the levels of significance.

The descriptive data in Table 10 related to the Faculty of Education were analyzed in one-way analyses of variance and their results are shown in Table 14. The differences between the Main examination and the Supplementary examinations are not evident. These results do not provide *F* ratios confined to the critical region. The predicted hypothesis, therefore, of no differences could not be rejected.

The data in Table 10 related to the Faculty of Science were estimated using one-way analyses of variance and the results are summarized in Table 15. An examination of the results indicates that there exists no statistically significant differences between the two types of examinations papers offered by the Faculty of Science. The predicted hypothesis of no significant differences could not rejected at the .05 level of significance on any of the six measures.

A sixth and last ANOVA was estimated on data in Table 10 related to the Faculty of Technology. The results are summarized in Table 16. Significant *F* values were obtained on the first three levels of the taxonomy ($p < 0.01$). The fourth through the sixth levels did not portray significant differences. It was, therefore, determined that the predicted null hypothesis of no significant differences between the two types of examinations could be rejected in so far as the Knowledge, Comprehension, and Applications levels were concerned.

Table 14
Summary of a Battery of Six Analysis of Variance For Types of Examinations in the Faculty of Education for Dependent Variables Called: Levels of the Taxonomy

SOURCE	SS	df	MS	F-Ratio	P value
Knowledge	0.02	1	0.02	0	0.99
Error	13674.96	39	350.64		
Comprehension	284.88	1	284.88	6.62	0.44
Error	17949.90	39	460.25		
Application	209.72	1	209.72	1.37	0.25
Error	5974.73	39	153.20		
Analysis	0.80	1	0.80	0.08	0.78
Error	379.98	39	9.72		
Synthesis	0.62	1	0.62	0.7	0.41
Error	34.50	39	0.89		
Evaluation	4.65	1	4.65	0.03	0.87
Error	7070.57	39	180.02		

Table 15
Summary of a Battery of Six Analysis of Variance For Types of Examinations in Faculty of Science for Dependent Variables Called: Levels of the Taxonomy

SOURCE	SS	df	MS	F-Ratio	P value
Knowledge	1471.97	1	1471.97	2.09	0.15
Error	61175.02	87	703.16		
Comprehension	83.16	1	83.16	0.21	0.65
Error	35317.06	87	405.94		
Application	453.54	1	453.54	0.7	0.41
Error	56635.45	87	650.98		
Analysis	1.60	1	1.60	0.02	0.89
Error	6798.51	87	78.14		
Synthesis	98.89	1	98.89	1.6	0.21
Error	5380.10	87	61.84		
Evaluation	18.55	1	18.55	1.33	0.29
Error	1424.34	87	16.37		

Table 16
Summary of a Battery of Six Analysis of Variance For Types of Examinations in Faculty of Technology for Dependent Variables Called: Levels of the Taxonomy

SOURCE	SS	df	MS	F-Ratio	P value
Knowledge	1375.88	1	1375.88	6.84	0
Error	40424.22	201	201.12		
Comprehension	4393.52	1	4393.52	13.67	0
Error	64612.37	201	321.50		
Application	11288.49	1	11288.49	18.73	0
Error	121171.54	201	602.84		
Analysis	0.32	1	0.32	0.01	0.94
Error	11999.31	201	59.70		
Synthesis	0.59	1	0.59	1.01	0.93
Error	14354.01	201	71.41		
Evaluation	102.06	1	102.06	2.52	0.11
Error	8156.41	201	40.58		

Null Hypothesis Six

The sixth and final null hypothesis predicted that there will be no significant relationship between academic programs in the form of mental tasks required by examination questions. To provide data used to test this null hypothesis the six levels of the taxonomy were reclassified. The first two levels of the taxonomy represented the simple mental process operation while the third to the sixth levels represented the operation of complex mental processes. Thus this breakdown produces two distinct categories designated as Simple and Complex. These two categories provided elements of a sufficient size to make reasonable comparisons possible.

We expected that the mean percentages and standard deviations for the difference of the two mental process categories would be similar. The data subjected to this analysis of variance is the difference between the mean percentage scores for simple mental processes and the mean percentage scores for complex mental processes after the data obtained from examination was correctly placed into the two categories: Simple and Complex mental operations. We first subjected the obtained differences into a step-wise regression. Three predictors (Faculties, Departments, and Degree programs), were examined since they all related directly to the academic programs. In rendering this regression a standard value of alpha-to-enter and alpha-to-remove was set at .150 based on the Monte Carlo studies of step-wise regression (Bendel and Afifi, 1977), to obtained: R= .326 (Faculties); R = .290 (Departments); and R = .321 (Degree Program). These coefficients were then included in a multiple correlation regression to estimate the probability level of significance (Table 17).

Table 17
Summary of Analysis of Variance On Academic Programs for Dependent Variable Called: Simple and Complex Mental Process

SOURCE	SS	df	MS	F-Ratio	P value
Regression	2.95	1	0.98	26.6	<0.00
Residual	24.81	671	0.03		

As shown in Table 17, significant differences exists between the distribution mean percentage scores for simple mental process questions and the mean percentage scores for complex mental process questions. This regression analysis does, clearly, favor simple mental processes over the complex. Because these results were a product of a multiple correlational matrix, *posterior* evidence was necessary on single predictors. The same data was examined further on *post hoc* procedures that subjected each of the three predictors (independently), to separate single factor contrasts. The pattern of results did not support the predicted hypothesis of no significant differences between the academic programs in their requirements of form mental tasks called for by examination questions. The F values associated with the two categories extracted from the six levels of Bloom's taxonomy were observed to display a statistical significance level of < 0.001. An interaction, therefore, exists that is directly associated to the construction of examination papers and the predictor insofar as the levels of mental processes is concerned.

DISCUSSION

The statistical analysis and the empirical findings reported in this study, clearly, illustrate the value of conducting this type of study from a position informed by rich theories of learning. Following critical analyses of the data obtained the results indicated that such equitable distribution as reflected by a representative university assessment instrument is non-existent. Furthermore, the general model provided by Bloom has been shown here to be adequate in providing a level of analysis at which a study of the quality of education in Kenya as it pertains to the development of cognition abilities and its theories can be fruitfully explored.

The subjection of various characteristics of the selected data to sound inferential examinations provides uncontestable basis for making valid conclusions on the trends displayed by the assessment systems of at an African state university. These subjections were undertaken based on three assumptions: one, that higher-level learning is potentially transferable to new situations and problems (Henry Ellis, 1965); two, intellectual skills learned in the process of solving a particular problem can be applied, or transferred to the solution of new or related problems; and three (this being in contrast), rote learning has very limited transferability (Ehman, et. al. 1974).

The results of our study are straight-forward -- examination questions in a representative African state university, uniformly, dwell on lower order mental processes. However, as was expected, the applied field courses probably attract questions in the higher order due to the fact that they call for a more practical outlook. The exception to this is evident in the Department of Wildlife Management and Botany where at least 79 percent and 86 percent (respectfully) lower order mental process questions were found. This situation was remarkably surprising. With the exception of the Department of Forestry, none of the other sciences exceeded a cumulative mark of 50 percent in the two lower order categories.

Research needs to be done to find out if different subject matters are predisposed to present test items on a lower level scale. However, there is no substantial evidence in this study to allow us to extend the speculation and argue that examination papers opting for the higher level of thinking exhibit greater syllabus freedom i.e. independence and autonomy of content matter.

There is no empirically defined data in the literature suggesting that students in non-applied courses cannot realize their intellectual potentials or that they operate on lower cognitive levels even though there exists strong propensities suggesting that "the more difficult the subject . . . the more the student had to exercise the mind" (Ornstein and Levine, 1985: 454).

Our study neither endeavored to provide nor discovered any evidence to suggest that colleges and universities should restructure their pedagogical exertions for the purpose of encouraging a particular course or program that would provide higher order test item. However, there are grounds for suggesting that lecturers responsible in non-applied courses should be cautioned to provide a greater amount of test items calling for higher order thinking. For example, the Department of Educational Administration, Planning and Curriculum Development does not, whatsoever, engage its students in synthesizing materials obtained in the lecture theaters. Whereas, with all manners of seriousness, that department derives its very name from the fifth level of the taxonomy. The departments of Philosophy and Literature portrayed a minimal degree in its efforts to incorporate that same level (Synthesis) even though 32 and 27 percent, respectfully (see Table 1), of their examination questions have consistently been superior (Evaluation Level).

On the overall, the science oriented courses use more categories than the arts in their testing. Reduced to a round mean, the typical non-science examination instrument used 3 categories compared to 5 used by the science courses. Hence, there was slight evidence to indicate that a typical science oriented course used a marginally greater number of categories in settings examination. The applied sciences offer an advantage for higher order cognitive processes: first, they are allied with a tradition of inquiry that lends credibility to education. This, on its own, justifies the stratification of their test setting. The historic roots of non-science courses are concerned with the expansion of the mind, reflection, contemplation and so on. Such traditional epistemological perspectives should, however, not provide university lecturers (and especially those in non-applied programs) an excuse to dwell on test items which call for simple mental processes and merely depend on instructional interventions to furnish that. Rather, efforts must be made in exploring possibilities that include the adoption of experiential basis capable of arranging content and assessment items which demonstrate modes of inquiry that cover all six realms of cognitive skills.

Given the sobering results of this study, two aspects ought not to be side-lined in the restructuring effort. First, effectiveness in any instructional scheme purporting to foster learning should examine the fit of the intervention modes. Such an audit should consider the characteristics of the teaching staff and students as variables. On the one hand, instructional interventions employed including lectures, seminars, field activities, laboratory experiences, team-teaching and others must be assumed to be the best and most suitable in the delivery and assessment of a particular content area rather than just the most accessible and economical mode.

On the other hand, varying student interests and abilities will also mediate effectiveness. It is at this dimension that the university as a leading academic institution must come in with its plea to reform the first twelve years of Kenya' 8-4-4 system. There is a need to systematically establish the students' entrance abilities and interests without assuming the satisfaction of those traits by the national standardized examinations. In isolating the levels of these two variables instructional modes can, selectively, be appropriated or be redesigned so that learning paradigms would focus on the quality of graduates rather than the quality of entering students (see Boggs, 1998).

In sum, university assessement constructs have been found to be increasingly oriented to an emphasis on the lower levels of mental engagements. A serious investigation might as well be undertaken on these constructs building on our study and contemplating to find out how problem solving tasks are treated in those cases where a demand is placed on critical thinking.

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