STATISTICAL STUDY OF THE PATTERNS OF STUDENTS' ACHIEVEMENT IN SCIENCE COURSES: AN INDUCTIVE APPROACH

BY

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ABSTRACT

Federal College of Education (Technical), Umunze started in 1989/90 with the goals of producing skilled and well motivated teachers for the basic level of education. The College has since then been accumulating data on student-teachers' achievement. Nothing however, has been done in terms of studying the pattern of these data for the purpose of deciding how good these goals have been achieved and injecting creativity to the educational process. But the understanding of pattern of students' achievement will provide information about the relationship of the means to the goals. Data from six hundred and forty-five students in four departments of the School of Sciences were used to study the pattern of students' Cumulative Grade Point Average (CGPA). The results show that the mean CGPA for the 645 students is 2.74; while the CGPA for males and females are 2.72 and 2.74 respectively. The result further showed that gender and choice of accommodation have no effect on achievement. It also revealed that for the five years studied, the CGPA for the different courses differed significantly in their variability within the courses and also, that Mathematics and Biology differed significantly in their mean CGPA. The study further showed that Biology had the least mean CGPA. A one sample t-test showed that this overall mean CGPA differed significantly from the criterion CGPA of 3.00. Although, one-sample the CGPA achievement pattern showed a negatively skewed curve; however, it equally showed a negative kurtosis indicating Platykurtic curve: The results indicated that the pattern of the CGPA differed significantly from normality, and presented problem of individual differences within students' CGPA. It is suggested that an experimental and survey research be conducted in the school for possible causes outside gender and accommodation differences.

INTRODUCTION

Federal College of Education (Technical) [FCE(T)], Umunze, started the School of Sciences in 1999/2000 with the Biology, Chemistry, Mathematics and Physics departments. The College admits both male and female students for programmes in

NCE(T) certificate and has students who live in or out-campus. Since the inception of the College, nothing has been done to investigate the effect of the various independent variables affecting achievement. It is thought by the researcher that discovering the pattern of students' achievement will help show with zero as the lowest grade and 5 as the highest grade.

Table 1: Grading System in FCE(T), Umunze

Raw Score	Letter Grade	Scale	CGPA Interval	Level of Pass
70 - 100	A	5	4.5 – 5.0	Distinction
60 - 69	B	4	3.5 – 4.49	Credit
50 - 59	C	3	2.5 – 3.49	Merit
45 - 49	D	2	1.5 – 2.49	Pass
40 - 44	E	1	1.0 – 1.49	Low Pass
0 - 39	F	0	0 – 0.99	Fail

Patterns are inescapably found in fantastic variety in the natural world, they show up in everything (Moscovich, 2006: 139). Patterns are the basis of art, we cannot add anything to nature and culture without discovering the patterns underlying in the various phenomena in it, and because patterns are exquisitely beautiful, they attract and make us curious; children call their curiosity play; mathematicians call theirs' research. A mathematician, like a painter or poet, is a maker of patterns (Hardy as cited in Jacobs, 1970: xii).

Research and innovations are essential in any walk of life or field of knowledge for enrichment, progress and development. Education is not an exception to this fact. Discovering the pattern of students' achievement in education is one way of researching for innovation, progress and development. It is one way of improving skill in education for development.

The human talent- for pattern recognition is simply the understanding that there is a systematic relationship between the elements in a group. These patterns like the ones found in nature, indicate an underlying system of order. Science believes that there is order in nature. When this order is sought out, found and expressed, we are speaking the language of mathematics (Moscovich, 2006: 139). When pattern has been discovered in nature, it satisfies the scientific goal of description, prediction and control.

Science, systematic study of anything that can be examined, tested, and verified has three basic goals (1) to measure and describe, (2) to predict and control and, (3) to understand and explain behaviour. The reason for studying human behaviour as in students' achievement does not essentially differ from the general goals of science.

Before we can understand or manipulate a phenomenon, we must first be able to describe and measure it. Much of the teachers' job involves measuring and describing behaviour. All the terms in psychological concepts and processes like anxiety, learning, attitudes, abilities, and so on, must be measured. Patterning distribution is an effort to understand it with the aim of adding something to it.

The second goal of science in education is to be able to predict and thereby control behaviour (knowledge, skills and other abilities). Success in this effort relies heavily on measurement. Indeed, as correlational methods imply, psychologists and educators typically use present or past measurements of behaviour as a primary basis for predicting what a person will do in the future. Behavioural change is often the practicing teachers' primary aim. Anastasi & Urbina, (1997 p.19) had argued that it is logically simpler to regard all tests as behavioural samples from which predictions regarding other behaviour can be made.

The psychotherapist tries to change the patient's behaviour; the industrial psychologist is commonly engaged in an effort to modify the behaviour of employees; the marriage counsellor attempts to modify the behaviour of husbands and wives; and the prison psychologist tries to control and modify the behaviour of criminals. In all these cases, an effort is made to improve the present or future circumstances of the individual in question and of society.

The final goal of psychology or for studying human behaviour is to understand and explain behaviour. That is to isolate the reasons for what is observed. This process involves the formulation of the theories, which organize the known facts. And the development of hypotheses about relationships that are yet to be proved: A good theory helps us make reasonable guesses when we do not know the correct answer.

Educators and educationists seek to understand the most complex part of the world - human behaviour. This enterprise promises both excitement and reward (Bourne and Ekstrand, 1979:15-16).

KNOWLEDGE AND REALITY OF STUDENTS' ACHIEVEMENT

"Reality" and "knowledge", terms that are not only current in everyday speech, but have behind them a long history of philosophical inquiry. It will be enough for our purpose to define "reality" as a quality appertaining to phenomena that we recognize as having a being independent of our own volition (we cannot wish ' them away), and to define "knowledge" as the certainty that phenomena are real and that they possess specific characteristics (Berger & Luckman, 1967:1). It is in this sense that the term, pattern of students' achievement has relevance both to the man in the street and to the scientist. The various stakeholders believe students' achievement as real,• albeit in different degrees, and they acknowledge with different degrees of confidence, that students' achievement possess certain characteristics. The teacher scientist would want to investigate into students' achievement and to discover the characteristics (pattern) of these achievement data. It is the contention here that science develops through objective analysis, such as discovering pattern's of samples instead of through personal beliefs.

ADVANTAGES OF PATTERNS

Patterns play a major role in the solution of problems in all areas of life. Psychologists analyze patterns of human behaviour. Meteorologists study weather patterns, astronomers seek patterns in the movement of stars and galaxies and detectives look for patterns among clues. Finding a pattern is such a useful problem-solving strategy in mathematics that some have called it the art of mathematics. To find patterns, we need to compare and contrast. We must compare to find features that remain constant and contrast to find those that are changing. Patterns appear in many forms. There are number patterns, geometric patterns, word patterns and letter patterns, to name a few (Moscovich, 2006).

Once an experiment has been carried out and data collected and analyzed, scientists look for whatever pattern their results produce and try to formulate a hypothesis that explains all the facts observed in an experiment (Burnie, 2009). In developing a hypothesis, scientists employ methods of induction to generalize from the experiment's results to predict future outcomes, and deduction to infer new facts from experimental results.

Students' achievement results form a big source of data for scientific investigation. These numerical facts are meaningful to the extent we put meaning into them. We need to know the pattern of the achievement as a guide to drawing general conclusions and inferences or making predictions on the basis of the data; Statistics and its methods help the people belonging to education and psychology in carrying out their day-to-day tasks and activities (Mangal, 2002:2). For example; beyond making selection, classification and promotion of students using achievement results, understanding pattern will help a teacher in the following ways:

1. Knowing individual differences of his students
2. Rendering guidance to the students
3. Comparing the suitability of one method or technique of teaching with another
4. Comparing the result of one system of evaluation with another
5. Comparing the function and working of one institution with another
6. Making prediction regarding the future progress of the students and
7. Maintaining various types of records.

This study wants to analyze students' CGPA with a view to' discovering the pattern of the distribution and the characteristics of this pattern.

RESEARCH METHODS

Research Design

The study took advantage of existing data on students' CGPA achievement. The design of the study is an ex-post-facto research design that makes use of archival data on CGPA, gender, and accommodation type from the Exams and Records office of Federal College of Education (Technical), Umunze.

Area of Study

The study was conducted in Federal College of Education (Technical), Umunze in Orumba South Local Government Area of Anambra State.

Purpose of the Study

To describe the characteristics of the data we have gathered for five years in the School of Sciences. The more information of this kind we can learn from our archival data, the better we can understand the population from which it came, and the better we can make decisions on how to improve performance.

Significance of Study

What will be the effect of the study for meeting the MDGs goal of achieving the Universal Primary Education and gender equality?

The study will enable the lecturers to assess the learning effect of their teaching on both gender and accommodation type and to assess the quality of students' learning outcomes. The result will also account for the College performance in terms of meeting the learning needs of the students.

The result of the study will provoke researches on possible ways to keep science education in control and to adjust it to the proper demand curve in these days of globalization.

Scope of the Study

The study covers students' CGPA achievement scores for five years (2004/2005) to (2008/2009) and four (4) departments namely Biology Education, Chemistry Education, Mathematics Education, and Physics Education.

Population of the Study

The population of the study comprised of the six hundred and forty five (645) students in the four departments between 2004/2005 session to 2008/2009. The population comprised of 104 males and 541 females; and 362 out campus and 283 in-campus students. The entire population was used for the study and hence, there was no sampling.

Research Questions

1. What is the mean Cumulative Grade Point Average (CGPA) for the various departments?
2. What is the mean CGPA for the overall achievement of the students?
3. What is the CGPA for the different gender?
4. What is the CGPA for the different accommodation type?
5. What is the nature of the distribution CGPA achievement of the students?

Research Hypotheses

1. The mean achievement CGPA for the departments do not differ significantly from the grading norm
2. There is no significant difference between the overall mean CGPA achievement and the grading norm
3. Gender does not affect the mean CGPA achievement of the students
4. Accommodation type does not affect the mean CGPA achievement of the students
5. The distribution of the CGPA achievement follows the theoretical normal distribution.

DATA PRESENTATION AND DISCUSSION OF FINDINGS

What is the mean Cumulative Grade Point Average (CGPA) for the various departments?

Table 2: Descriptive Statistics of the CGPA for the Departments and overall Achievement

Cumulative Grade Point Average Scores

					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Biology	359	2.6060	1.1196	5.909E-02	2.4897	2.7222	.00	4.86
Chemistry	100	2.8826	1.2478	0.1248	2.6351	3.1302	.16	4.89
Mathematics	128	2.6060	1.2453	0.1101	2.7146	3.1502	.07	4.84
Physics	58	2.8429	1.3689	0.1797	2.4830	3.2029	.11	4.88
Total	645	2.7350	1.1956	4.708E-02	2.6425	2.8274	.00	4.89

Table 2 above shows that the mean CGPA achievement for the different departments are 2.61, 2.88, 2.61, and 2.84, for Biology, Chemistry, Mathematics and Physics respectively. Each of these means fell below the criterion of 3.00

Table 3: ANOVA Test on Difference among the Departments

Cumulative Grade Point Average Scores

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.822	3	4.607	3.257	0.021

Within Groups	906.690	641	1.414
Total	920.512	644	

Table 3 above shows ANOVA test for difference of mean CGPA in the achievement of the different departments F(3, 641) = 3.26, and P<.05, indicating that there is a significant difference among the mean CGPA of the different departments. The test showed that at least, one of the mean CGPA differed from the rest.

Table 4: One-Sample T -Test for test of no difference between Biology Mean CGPA and the Criterion Norm

	Test Value = 3.0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed	Mean Difference	Lower	Upper
Cumulative Grade Point Average Scores	-6.668	358	.000	-.3940	-.5103	-.2778

Table 4 above shows one-sample t-test for the difference between the mean CGPA in Biology and the grading criterion norm of 3.00. Tablel shows that Biology department had (M = 2.61, SE = .0591), t(358) = -6.668, P < .05. This result showed that the mean CGPA for the Biology department differs significantly from the grading norm of 3.0. We accept the hypothesis of no difference in the mean CGPA of Biology students from the grading criterion norm.

Table 5: One-Sample T -Test of no Difference between Chemistry Mean CGPA and the Criterion Norm

	Test Value = 3.0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed	Mean Difference	Lower	Upper
Cumulative Grade Point Average Scores	-.941	99	.349	-.1174	-.3649	-.1302

Table 5 above shows one-sample t-test for the difference between the mean CGPA in Chemistry and the grading norm of 3.000. Table 1 shows that Chemistry Department had (M = 2.8826, SE = .1248), t(99) = -.941, P > .05. This result showed that the mean CGPA for the Chemistry department does not differ significantly from the grading norm of 3.0. We accept the hypothesis of no difference between the mean CGPA of students' achievement and the grading norm.

Table 6: One-Sample T -test of no Difference between Mathematics Mean CGPA and the Criterion Norm

	Test Value = 3.0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Cumulative Grade Point Average Scores	-.614	127	.540	-6.7578E-02	-2.854	.1502

Table 6 above shows one-sample t-test for the difference between the mean CGPA in Mathematics and the grading norm of 3.000. Table 1 shows that Chemistry department had (M = 2.6060, SE = .1101), t(127) = -.614, $P > .05$. This result showed that the mean CGPA for the Mathematics department does not differ significantly from the criterion grade of 3.0. We accept the hypothesis of no difference between the mean of students' CGPA achievement in Mathematics and the criterion grade of 3.00.

Table 7: One-Sample T -test of no Difference between Physics Mean CGPA and the Criterion Norm

	Test Value = 3.0					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Cumulative Grade Point Average Scores	-.874	57	.386	-1.571	-.5170	.2029

Table 7 above shows one-sample t-test for the difference between the mean CGPA in Chemistry and the grading norm of 3.000. Table 1 shows that Physics department had (M = 2.8429, SE = .1797), t(s7) = -.874, $P > .05$. This result showed that the mean CGPA for the Physics department does not differ significantly from the grading norm of 3.0. We accept the hypothesis that there is no significant difference in the mean CGPA of students' achievement from the grading norm.

Table 8: One-Sample T -test for a test of no difference between the Overall Mean and the Criterion Norm

	Test Value = 3.00					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Cumulative Grade point average scores	-5.630	644	.000	-.2650	-.3575	-.1726

Table 8 above shows one-sample t-test for the difference between the overall mean CGPA and the grading norm of 3.000. Table1 shows that the overall CGPA had (M = 2.7350, SE = .04708), t(644) = .000, $P < .05$. This result showed that the overall mean CGPA differ significantly from the grading norm of 3.0. We cannot accept the hypothesis that there is no significant difference in the mean CGPA of students' achievement in the School of Sciences.

Table 9: Descriptives on the Mean CGPA by Gender of Students

	gender of students	N	Mean	Std. Deviation	Std. Error Mean
Cumulative Grade	males	104	2.7238	1.1221	.1100
point average scores	females	541	2.7371	1.2101	5.203E-02

Table 9 above shows that the mean CGPA for males and females are 2.7238 and 2.7371 respectively. The result indicated that females perform better than males.

Table 10: Independent Sample T -test of no difference in the Mean

Table 9: Independent Samples T-Test of No Difference in the Mean CGPA By Gender

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Cummulative Grade	Equal variances assumed	1.751	.186	-.103	643	.918	-1.3241E-02
point average	Equal variances not			-.109	152.752	.914	-1.3241E-02

scores	assumed

Table 10 showed the result of an independent sample t-test of the difference between the mean CGPA of males and females. On average females achieved greater CGPA (M = 2.7371, SE = .05203) than males (M = 2.7238, SE = .1100). This difference was not significant indicating that gender did not affect the achievement of the students in the school of sciences. The table equally shows that by the result of the Levene's Test for equality of variances that the two distributions do not differ in their variances with F-ratio of 1.751 and significant level of P > .05. We accept the hypothesis that there is no significant difference in the mean CGPA of male and female students of School of Sciences.

Table 11: Descriptives for CGPA and nature of achievement by Accommodation type

	Accommodation of students	N	Mean	Std. Deviation	Std. Error Mean
Cummulative Grade point average scores	Out Campus Accommodation	362	2.7472	1.1668	6.133E-02
	In Campus Accommodation	283	2.7192	1.2332	7.331E-02

Table 11 showed that the mean CGPA for out campus and in-campus accommodated students are M = 2.7472, and M =2.7192 respectively. The result showed that the out-campus accommodated students achieved higher than the In-campus accommodated students.

Table 12: Independent Sample T-test for equality of CGPA achievement

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
CGPA	Equal variances assumed	2.315	.129	.295	643	0.768	-2.803E-02
	Equal variances not assumed			.293	589.341	0.769	-2.803E-02

Table 12 shows the Independent Sample t-test for equality of mean CGPA between the Out-campus accommodated students and the In-campus accommodated students. On the average, the Out-campus accommodated students (M = 2.7472) achieved higher than the In-campus accommodated students (M = 2.7192). The difference was not significant t(643) = .768, P > .05. We therefore accept the hypothesis that there is no significant difference between the CGPA achievement of Out-campus and In-campus students.

Table 13: One-Sample Kolmogrov-Smirnov Test for normality

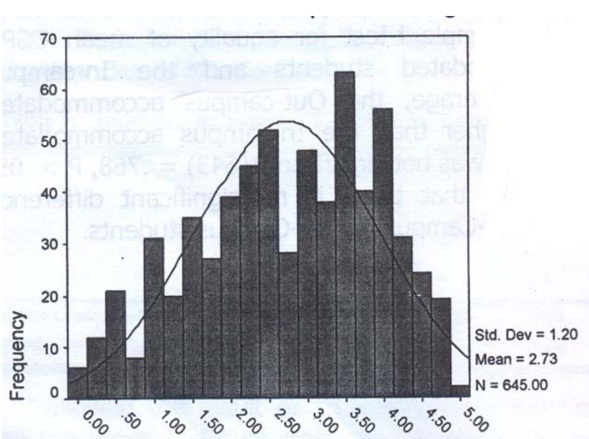
		Cumulative Grade Point Average Scores
N		645
Normal Parameters[a,b]	Mean	2.735
	Std. Deviation	1.1956
Most Extreme Differences	Absolute	0.07
	Positive	0.036
	Negative	-0.07
Kolmogorov-Smirnoz Z		1.767
Asymp. Sig (2-tailed)		0.004

a. Test distribution is normal
b. Calculated from data

Table 13 above shows a One-Sample Kolmogrov-Smirnov Test For Normality of observed CGPA of students' achievement 0(644) = .004, P < .05; indicating that the CGPA of students' achievement does not follow a normal distribution. We therefore would not accept the hypothesis that the students' CGPA follow a normal distribution.

Fig. 1

Cumulative Grade point average scores



Cumulative Grade point average scores

Figure 1: Pattern of Students' CGPA distribution

To further showthat the distribution of the grades did not follow a normal distribution, figure 1 above shows a graphical pattern of the students' grades distribution being negatively skewed and indicating a flat distribution.

Table 14: Descriptive Statistics for the CGPA achievement for the School of Sciences

	N	Minimu	Maximu	Mean	Std.	Varianc	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
cumulative Grade point average score	645	.00	4.89	2.7350	1.1956	1.429	-.302	.096	-.812	.192
Valid N (listwi	645									

The value of the mean M = 2.7350, skewness = -.302; std. Error of skewness = .096; kurtosis = -.812; std. Error of kurtosis = .192 describe further the nature of the distribution of the students CGPA. Considering the descriptive statistics it is obvious that the distribution has a significant skewness and kurtosis problem. The significance of Skewness and Kurtosis indices is established by the result of table 15 below.

Table 15: Skewness and Kurtosis Indices for the Students' CGPA grade distribution

Course	$Z_{stewness}$	$Z_{kurtosis}$	$Z_{critical}$
Biology	-1.58	-2.57	±1.96
Chemistry	-1.54	-2.02	±1.96
Mathematics	-2.59	-1.54	±1.96
Physics	-1.62	-1.67	±1.96
All	-3.15	-4.23	±1.96

The table above shows clearly that the students' grade distribution had a skewness and kurtosis indtces of -3.15 and -4.23 respectively.

FINDINGS

1. The overall mean CGPA for achievement of students in the school of sciences is CM = 2.7350 and SE = .04708).
2. Gender does not affect achievement

3. Type of accommodation does not affect achievement
4. The distribution of the CGPA of the students of the school of sciences differed from the normal distribution.

DISCUSSION OF FINDINGS

The overall CGPA for the School is M = 2.7350. This value fell significantly below the grading norm of 3.0000. The national policy on education uncovered that no education system may rise above the quality of its teachers (FGN, 2004). With this in our consciousness, in a six point scale (0-5), 2.74 which fell within the merit level do not represent the performance of a highly motivated; conscientious and efficient classroom teacher. Except something is done, it is doubtful that the system will meet the goal of producing highly motivated, conscientious and efficient classroom teachers for the Universal Basic Education. Something will need to be done to step up achievement above the norm.

This poor achievement affect both gender and both types of accommodation as the hypotheses testing showed no significant difference in both gender and accommodation type. This finding suggested that the possible cause of this poor performance may be sought outside of gender and accommodation type to other possible independent variable that determine achievement like methods of teaching, evaluation and interest.

The distribution of the CGPA showed a significant deviation from normality. Table 10 showed a standardized Kurtosis index of -4.23 and standardized Skewness index of -3.15. Although negatively skewed about its norm, the distribution is a Platykurtic distribution, showing that very few scores fall around the mean of the CGPA distribution and that the students' grades differed significantly among themselves. This further suggested evidence of individual differences among the students' CGPA.

Following from the distribution pattern of CGPA achievement, the future progress of these students remains undesirable except something is done. Because the quality of education very much depends on the quality of the teachers particularly, these NCE teachers who are at the basic level of our education system need to be motivated.

RECOMMENDATIONS

Since gender and accommodation type did not affect the CGPA achievement or even the course offered as could be seen from the result of the hypotheses and the mean scores, it can be safely assumed that other factors will need to be tested for significance such as method of teaching, assessment, class size and teacher variables. It is suggested that experiment and survey be carried out in the school of sciences to discover the sources of these individual differences within the students' CGPA.

Lecturers could adopt the use of individualized system of instruction in their lectures as a way of solving the problem of individual differences within the students' CGPA and enhancing behaviour in academic performance.

Lecturers should provide activities of sufficient variety and depth to allow for different levels of learning to take place.

Lecturers should differentiate by trying to use various starting points and tasks for different ability levels.

The College management should acknowledge that all students will need varying lengths of time to complete activities.

Lecturers should group pupils in different ways for different task.

Lecturers should use assessments to set individual, group and class targets.

Lecturers should use marking creatively to inform pupils about their standard of achievement.

By employing these recommendations, it is possible to monitor students' effectiveness and to begin to make improvements.

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