CLOSING THE ACHIEVEMENT GAP: EXPLORING BLOOM'S MASTERY LEARNING MODEL IN TEACHING GENETICS CONCEPTS IN SECONDARY SCHOOLS IN KATSINA STATE

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Abstract

This study described the distribution of students' achievement in genetics concepts using Bloom Mastery Learning Model. Two research questions and two null hypotheses were analyzed. The study adopted a pretest post-tests randomized quasi experimental design. The experimental group (n = 29) was treated using Bloom's Mastery Learning Model, while the control group (n = 30) was treated using traditional lecture method. Genetics Achievement Test (GAT) with Cronbach alpha reliability coefficient of 0.802 was used to collect data. The data collected were analysed using Skewness, Kurtosis and Shapiro-Wilk test for normality at 0.05 level of significance. The result of the study showed that, the control group achievement was approximately normally distributed before treatment (W = 0.940; p>0.05) and after treatment (W = 0.970; p>0.05). The experimental group achievement was approximately normally distributed before treatment (W = 0.943; p>0.05) but negatively skewed after treatment (W = 0.859; p<0.05). It was concluded that, Bloom's Mastery Learning Model has the potential to reduce the variation in students' achievement in genetics. It was recommended among others that, teachers of biology should always use formative evaluation to identify areas where students have difficulties and provide corrective measures to help the so-called weak students to achieve instructional objectives.

Keywords: *Achievement Gap, Mastery Learning, Genetics, Normal Distribution, Katsina State*

Introduction

The normal distribution curve (also called the Gaussian distribution) is now taken as a sacred entity to judge almost every (if not all) variables in a population. Based on this distribution, students' academic achievement falls under three categories: positively skewed, negatively skewed or normally distributed. The irony behind the nomenclature of the distribution is that, a positively skewed distribution mean that, the good students along with the so called "weak students in the class scored below the expected average. For a negatively skewed distribution, almost all the students including the so-called "weak students" scored above the expected average. But the normal distribution divides the students' achievement into three categories; few (about 16%) under-performed students, majority (about 68%) of the students performed averagely and few (probably 16%) good students performed excellently. This impression has been infused in the minds of the teachers and the students even at the beginning of the school session. Bloom (1968) called this kind of system, the most wasteful and destructive aspect of educational system because, the system does not only reduce teachers and students' aspiration and motivation, but it also destroys the ego and self concept of the larger group of students. As a matter of fact, the fundamental function of the school is to identify learning needs, define learning objectives and use the teachers' potential to help all students learn and achieve the objectives. Since students' achievement is often used to measure teacher's effectiveness, in the teaching and learning process (Veloo, Perumal and Vikneswary, 2013), variation in students' achievement would therefore signifies weakness in the instructional approach and failure of the school system to absolutely achieve its objectives.

Bloom (1968) opined that, variation in students' achievement or achievement gap, is a function of difference in background knowledge accelerated by uniform classroom instructions for all students. Students' aptitude and learning styles varies naturally. If students' achievement must be kept constant (i.e. reduction in achievement gap), time needed for learning and classroom instructions should vary (Bloom 1968). The same instructional strategy for students with varying aptitudes and learning styles will probably lead to variation in achievement and vis visa (Guskey, 2007). This philosophy led Bloom to develop the Mastery Learning Model initially called learning for mastery.

Mastery learning model is an instructional model based on the assertion that, if students are given enough time and attention while using appropriate teaching methods, most students can master any learning objective (Johnson, 2010). Mastery learning is a deviation from the normal distribution curve theory. The assumption is that, if the school system is effective and the quality of instruction is effective, students' achievement will not produce a bell-shaped curve. Instead, the measure of effectiveness of teachers, schools, or school systems will be how close they can get 80-90% of the students up to mastery levels that are reached by only about a tenth of the students. That is, the shape of the distribution of students' achievement will be negatively skewed. The framework to implement mastery learning is presented in figure 1 below:

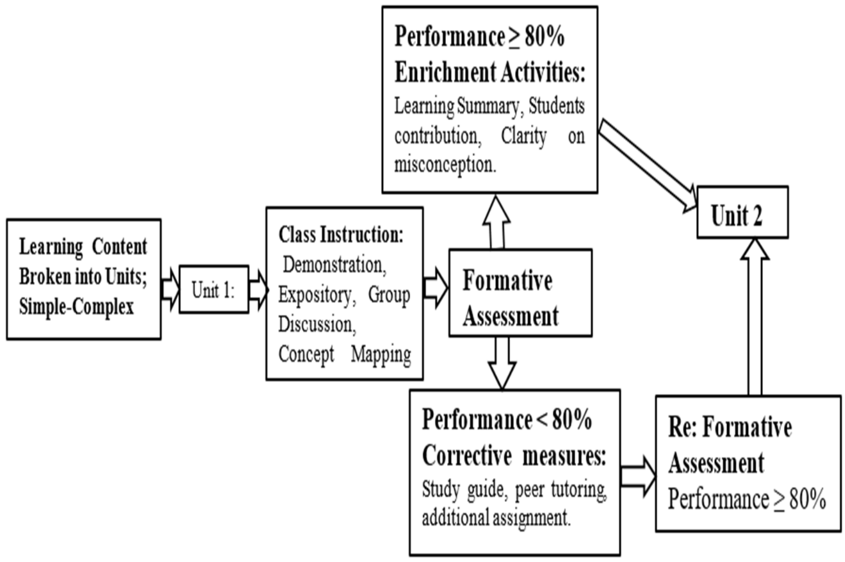

Figure 1: Mastery Learning Instructional Process (Adapted from Guskey (2005)

Several studies have investigated the effect of Mastery Learning on students' academic achievement. For instance, Adeniji, Ameen, Dambatta and Orilonise (2018) and Nnorom and Uchegbu (2017) reported significantly better achievement for students exposed to mastery learning. Also, Mitee and Obaitan (2015) reported that 69% of the mastery learning group scored 80% and above in achievement test against 50% of the conventional learning group who scored between 40% and 49%. Johnson (2010) previously opposed the conventional learning models as being limited in the sense that, they do not account for the variability in students' knowledge, ability, interests and learning styles.

Bloom's Model of Mastery Learning was employed to verify the level of students' academic achievement in secondary school genetics concepts because, various studies diagnosing students' learning difficulties reported that genetics is difficult to learn (Paul, 2018; Agbowuro, Jiwan and Amos, 2016; Agboghoroma and Oyovwi, 2015) due to its abstractness (Musonda, 2012), numerous foreign terminologies involved (Awang-Kanak, Masnoddin, Matawali, Daud and Jumat, 2016; Knippel, 2002), poor teachers' instructional practices (Paul, 2018; Agboghoroma and Oyovwi, 2015), students' negative attitude in learning genetics (Etobro and Fabinu, 2017) and distance between prerequisite (Meiosis) to learn genetics and the actual teaching of genetics concepts. While meiosis deals with the separation of allele during sexual reproduction, genetics traces the allele from parents to offsprings (Knippels, 2002). In Nigerian Secondary School Biology Syllabus, students are often exposed to cell division (Meiosis) in their second term in Senior Secondary Two (SSII) and exposed to genetics concepts in first term SSIII. With such delay, students will be unable to make connection between the two concepts. Tandem to these menace, students were neither able to grasp genetics concepts and demonstrate crossing to produce offsprings, nor were they able to use genetics terminologies and symbols to describe genetics process (WAEC, 2017 and 2018). This study therefore explores Bloom Mastery Learning Model to describe the distributions of students' achievement in secondary school genetics.

Research Questions

The following research questions were answered in this study:

1. What are the distributions of control group performances before and after treatment?
2. What are the distributions of experimental group performances before and after treatment?

Null Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

$H_0$1: There is no significant difference of the distributions of the control group performances from normality before and after treatment.

$H_0$2: There is no significant difference of the distributions of experimental group performances from normality before and after treatment.

Methodology

This study adopted a pre-test post-tests randomized quasi experimental design. The same multiple-choice objective test items were administered to the students in the two groups as pre- and post-tests. The students were randomized to experimental and control groups before administering the pre-test. The experimental group was treated using Bloom's Mastery Learning Model while the control group was treated using the conventional teaching method. Table 1 shows the research design of the study.

Table1: Randomized Quasi-Experimental Control Group Pre-test Post-test Design

Group	Pre-test	Treatment	Post-test
Experimental group	O_{1ML}	X_{ML}	O_{2ML}
Control	O_{1L}		O_{2L}

Where: $\mathbf{O_{1ML}}$ represents pre-test for mastery learning group

$\mathbf{X_{ML}}$ represents treatment for Mastery learning group

$\mathbf{O_{2ML}}$ represents post-test for Mastery learning group

$\mathbf{O_{1L}}$ represents pre-test for control group method

$\mathbf{O_{2L}}$ represents post-test for control group method

The target population for this study comprised of all the senior secondary three (SS3) students in Katsina Local Government Area, Katsina State. The population comprised of twelve senior secondary schools with 10,770 (male = 5091 and female = 5679) students.

In selecting schools to participate in this study, purposive sampling technique was used to select two schools from the list of co-educational senior secondary schools. The researchers randomly picked 18 boys and 18 girls from the population of the students in each school both for the experimental and control groups. However, 13 students dropped before the completion of the study. The sample size of the study constituted 59 students.

In this study, Genetics Achievement Test (GAT) was used to collect data. GAT is a twenty-five (25) item multiple-choice objective questions developed by the researchers. The items in GAT were constructed reflecting some five selected topics in genetics aspect of secondary school biology curriculum. These topics are: 1) Chromosomes as the basis of heredity; 2) Transmission and Expression of Characters; 3) Sex determination in human beings, 4) Sex linkages in human beings and 5) Application of the principles of heredity. Each question in GAT was scored one mark. Examples of items of GAT are:

1. Characters which are expressed in the presence of the contrasting characters are called a) Hybrid b) Allele c) Recessive Characters d) Dominant Characters
2. Sex in human being is determined by: a) Inheritance b) Linkage c) Alleles d) Mutation
3. Which of the following is NOT a heritable character? a) Voice b) Language c) Height d) Skin colour

The initial drafts of the instruments were validated by two experienced biology teachers and an expert in psychometrics to check the relevance, adequacy and structure of the items before the pretest. The content validity of GAT was ascertained following strictly the number of items per topic as specified in the test blueprint on table 2. The recommendations and suggestions made by the experts were used to modify the final draft of the instrument.

Table 2: Test Blueprint of 25 Items Genetics Achievement Test (GAT)

S/N	Content	Remember	Understand	Apply	Analyze	Evaluate	Total
1	Chromosomes; the basis of heredity	3	2	0	0	0	5
2	Transmission and expression of character in organisms.	2	2	1	2	1	8
3	Sex determination in human beings	0	2	1	0	0	3
4	Sex linkage in human beings	0	0	0	1	2	3
5	Application of the principles of heredity	1	1	2	1	1	6
	Total	6	7	4	4	4	**25**

The reliability co-efficient of GAT was determined using Cronbach alpha method of establishing reliability. The data from the pilot study was used to conduct the reliability of GAT. Using Statistical Packages for Social Sciences (SPSS) to analyze the data collected, the Cronbach alpha reliability coefficients of 0.802 was obtained for GAT.

The data collected were analyzed using descriptive statistics (Mean, Skewness and Kurtosis) and Shapiro-Wilk test for normality. SPSS version 23 was used to carry out the analysis.

Findings and Discussion

Interpretation of the Findings

R.Q 1: What are the distributions of control group performances before and after treatment?

On table 3, the shape of the control group achievement distribution has a moderate skewness of -.479 (SE = .434) and Kurtosis of .081 (SE = .845) before treatment. After treatment, the shape of the distribution has an approximately symmetric skewness of -.042 (SE = .434) and kurtosis of -.470 (SE = .845). Figure 2 and 3 shows the histogram plot and how fit is the shape of the distributions on a normal curve before and after treatment.

Table 3: Descriptive Statistics of the Control Group Academic Achievement

		After Treatment	Before Treatment
N	Valid	29	29
Mean		6.5862	5.4138
Std. Deviation		1.70120	1.40197
Skewness		-.042	-.479
Std. Error of Skewness		.434	.434
Kurtosis		-.470	.081
Std. Error of Kurtosis		.845	.845

Note: Std. Error = Standard Error

R.Q 2: What are the distributions of the experimental group performances before and after treatment?

Table 4 showed moderate skewness of .745 (SE = .427) and kurtosis of 1.155 (SE = .833) before treatment. After treatment, a highly negative skewness of -1.311 (SE = 0.427) and Kurtosis of 1.218 (SE = 0.833) was observed. Figure 4 and 5 shows the histogram plot and the shape of the distribution of the students' achievement before and after treatment.

Table 4: Descriptive Statistics of Mastery Learning Group Academic Achievement

		After Treatment	Before Treatment
N	Valid	30	30
Mean		18.2000	5.3333
Std. Deviation		3.75454	1.91785
Skewness		-1.311	.745
Std. Error of Skewness		.427	.427
Kurtosis		1.218	1.155
Std. Error of Kurtosis		.833	.833

Interpretation of Hypothesis One

$H_0$1: There is no significant difference of the distributions of the control group performances from normality before and after treatment.

On table 6, there is no significant difference of the distribution of the control group performance from normality before treatment (W = .940; p>0.05). There is also no significant difference of the distribution of the control group performance from normality after treatment (W = .970; p>0.05). This shows that, the control group performances before and after treatment are approximately normally distributed. In other word, the control group performance retained the principle of the normal curve (few underperformed students, majority average students and few good students).

Table 6: Tests for Normality of Experimental and Control Group Achievement

		Kolmogorov-Smirnov			Shapiro-Wilk		
	Treatment	Statistic	df	Sig.	Statistic	df	Sig.
After Treatment	Experimental Group	.245	30	.000	.859	30	.001
	Control Group	.118	29	.200*	.970	29	.557
Before Treatment	Experimental Group	.136	30	.167	.943	30	.113
	Control Group	.177	29	.021	.940	29	.099

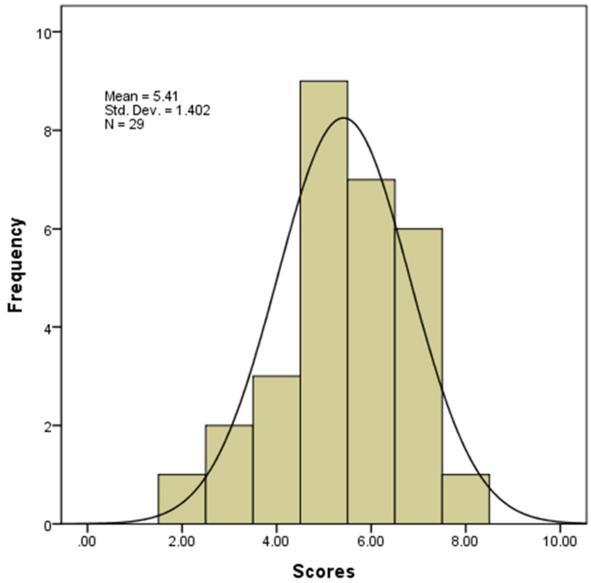

Fig 2: Distribution of Control Group Academic Achievement Before Treatment

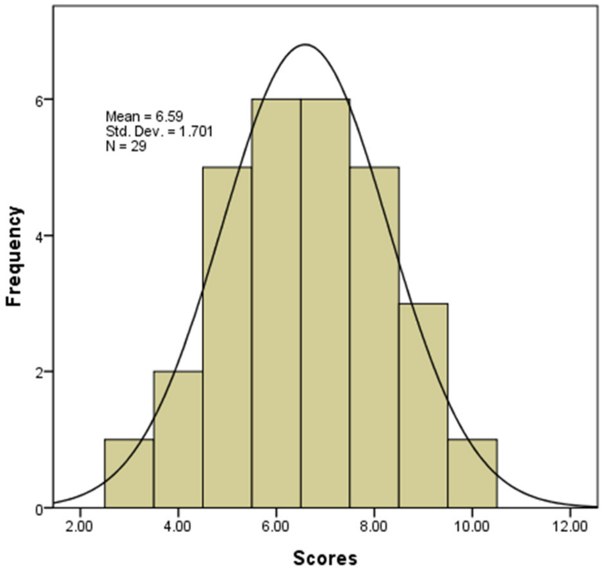

Fig 3: Distribution of Control Group Academic Achievement After Treatment

Interpretation of Hypothesis Two

$H_0$2: There is no significant difference of the distributions of experimental group performances from normality before and after treatment.

On table 6, there is no significant difference of the distributions of experimental group performances from normality before treatment (W = .943; p>0.05). However, there is significant difference of the distributions of experimental group performances from normality after treatment (W = .859; p<0.05). In other word, the mastery learning group scores deviated significantly from normality after treatment. This means that, the experimental group mean score clearly moved away from the centre of the distribution, and the distribution of the students' performance was purely negatively skewed distribution.

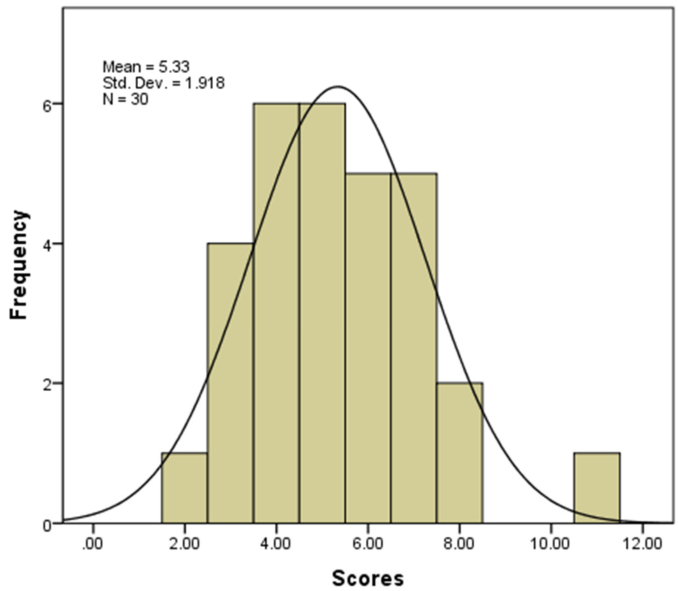

Fig 4: Distribution of Mastery Learning Group Academic Achievement Before Treatment

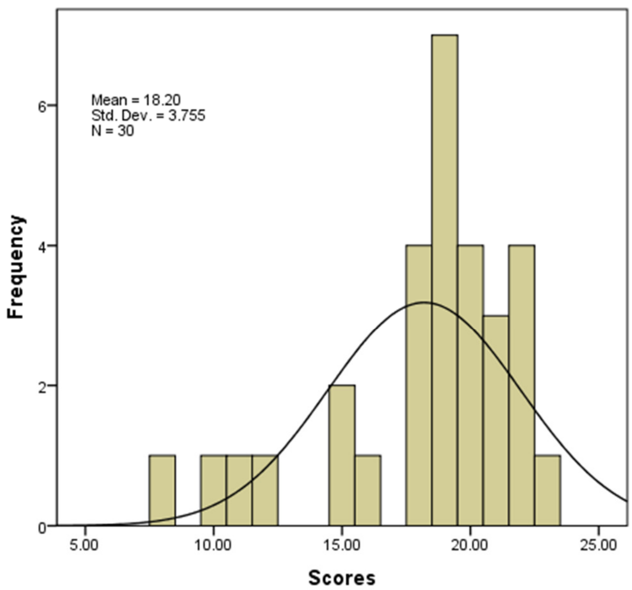

Fig 5: Distribution of Mastery Learning Group Academic Achievement After Treatment

Discussion of Findings

This study revealed that, the distribution of students' academic achievement does not deviate from normality when the conventional lecture teaching method was used. This finding is just a reflection of the general assertion that students' achievements are normally distributed, with a significant large number of average scorers. Johnson (2010) criticized the conventional learning models as it does not account for the variability in students' (prior) knowledge, aptitude, interests, and learning styles. Since the students varied in their aptitude, a variation in instruction, additional time and attention will be needed to reduce the achievement gap. Conventional lecture method is therefore, not capable to reduce variation in students' achievement.

However, the distribution of students' academic achievement deviated from normality when mastery learning model was used. A significant large number of the mastery learning group scores move away from the centre of the graph while clustering at the right side of the mean, reducing the achievement gap between the students. It has been asserted earlier that, students' academic achievement will not produce a bell-shaped curve when classroom instruction varies along with the variation in students' background knowledge, aptitude and learning time (Bloom 1968 in Guskey, 2007). In order to effectively use Bloom's Mastery Learning Model, the teacher should consider the following:

1. Ensure students have pre-requisite knowledge of the subject matter.
2. Breakdown the learning content into units and spelt out clearly the objective(s) of each unit.
3. Explain to the students clearly the objectives of each unit at the beginning and during the lesson. Ensure students understand the objectives of the lesson.
4. Use different instructional approaches and methods with relevant instructional materials.
5. Use formative evaluation to diagnose students' learning difficulties.
6. Provide corrective measures to students who do not meet up with expected learning objective. Engage students in cross ability peer tutoring, individualized instruction or assignment. Re-evaluate the students for mastery level.
7. Provide enrichment activities (e.g. educative videos, group discussion, questions and answers, short quiz) to students who scored 80% and above in the formative test.

Conclusion and Recommendations

Bloom's Mastery Learning Model was asserted to be a deviation from the Normal Distribution Curve Theory. The cause of variation in students' achievement can be inferred as a function of variation in students' background knowledge, psychological preparedness and time needed to attain instructional objectives. Despite genetics concept was tagged as difficult to learn, Bloom's Mastery Learning Model has the potential to reduce the variation in students' achievement in genetics and bring a significant large number of students to achieve between 70-80% of instructional objectives.

Based on this conclusion, it is hereby recommended that, teachers of biology should always use formative evaluation to identify areas where students have difficulties and provide corrective measures to help the so-called weak students to achieve instructional objectives.

Also, enrichment activities should be provided to students to help students retain concept learned. Teachers should be encouraged and/or mandated to attend workshops and seminars to acquaint themselves with requisite skills to use Bloom's mastery learning model in classrooms. Curriculum planners should design curriculum in such a way that, mastery learning strategies can be used to fully implement biology curriculum**.** School principals and other heads of educational institutions should encourage and supervise the implementation of mastery learning strategy.

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