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EFFECT OF THREE TEACHING METHODS ON PERFORMANCE OF SENIOR HIGH SCHOOL THREE STUDENTS IN GENETICS FROM A SCHOOL IN THE OTI REGION, GHANA

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ABSTRACT

The study examined the effect of three teaching methods on the performance of Senior High School three students in genetics from a selected school in the Oti Region of Ghana. **Q**uasi-experimental pretest-posttest nonequivalent design was used. A sample of 82 students from three intact classes of 27, 26 and 29 were selected and randomly assigned A, B and C. One Biology teacher was purposively selected from the selected school, making a total sample of 83. The teacher did the teaching in all the three classes. A pre-test was conducted followed by the teaching using lecture method only, lecture and video method combined and video method only for the classes. After this a post-test was conducted to determine the effect of the methods. Means and standard deviations were calculated for pre- and post-test scores and one-way analysis of variance conducted. Performance of the three groups drastically improved after the teaching (mean of 33.96 for lecture-video method, 26.11 for video method only and 21.00 for lecture method only). There were statistically significant differences between the performances of the three groups ($F= 44.14$; $df = 2/77$; $P < 0.05$). The use of lecture-video method in teaching Genetics recorded the highest significant improvement in learning outcomes of students compared to lecture and video methods only. It can be concluded that the combination of lecture and video methods of teaching Genetics drastically improved performance of students in Genetics. Hence, the School authorities should support Biology teachers to acquire adequate and appropriate ICT tools for innovative teaching of Genetics in the School.

KEYWORDS: Genetics, Lecture-Video method, Biology, quasi-experiment, intact classes.

INTRODUCTION

Biology is the branch of natural science which deals with the study of life. For the past two decades, knowledge of biology has increased exponentially with a deeper understanding of life on our planet (Cassey, García-Díaz, Lockwood, Blackburn, Jeschke & Heger, 2018). By this, scientists have tried to apply biological knowledge in various forms such as mapping the human genome, cloning of animals, and developing new therapies for many diseases (Roche, Phillips & Gibney, 2005).

Biology is one of the elective subjects in Ghana which has received a lot of endorsement because of its enormous advantages. However, just like other parts of the world, our classrooms are still based on teachers' oral explanations, and they also present inadequate learning environments to learners (Bester & Brand, 2013; Hong, Hwang, Liu, Ho & Chen, 2014).

The lecture method which is the most used approach by biology teachers has gained some dominance (Kapri, 2016). Yet when it comes to teaching genetics the result is much to be desired because of the fact that genetics is abstract and requires multi-level thinking. Genetics and its related topics, such as molecular biology, cell biology and biotechnology are closely connected with our everyday life and are related to medicine, agriculture, industry, technology as well as ethics. Though genetics is interesting, it is an analytical and even abstract discipline. That is why it is complex to teach and to learn at high school level. According to some students, genetics is the greatest challenge that they encountered in their study (Ruiyong, 2004; Tsui & Treagust, 2007). Many teachers share the same opinion and regard genetics as a subject that is conceptually and linguistically difficult to teach (Fink, 1990; Rode, 1995; Malacinski & Zell, 1996; Marbach-Ad, 2001; Tsui & Treagust, 2004, 2007). In order to facilitate the conceptualization of structures and processes in genetics,

new and updated technologies in teaching and education, such as multimedia are being introduced into the teaching process.

According to Ndioho (2005), the main challenge that confronts the teaching of biology (Genetics) has to do with the use of the traditional instructional approach. This approach often requires that students memorize large amounts of factual information without going beyond a superficial level of understanding (National Research Council, 2012).

In Ghana, over the years, the number of students who enroll for biology has greatly improved over time. However, these numbers do not match students' achievement in the subject as revealed by West African Examinations Council (WAEC) Chief Examiners Reports (2017-2020). The WAEC Chief Examiners reports over these years have revealed that students do not perform creditably in Biology due to how they perceive some topics as difficult. A particular notice was drawn to teachers' pedagogy when it comes to teaching some of these topics which are tagged by students as difficult (Ihejiamaizu, Ukor & Neji, 2018; Eshiet, 2007 & Samba & Eriba, 2012). According to WAEC Chief Examiner's Reports (2017-2020), biology students' could not perform creditably in Genetics. To this, the main challenge students encountered was poor grasp of tested items in the concept genetics and this implies that biology teachers have either avoided the teaching of Genetics or employed ineffective pedagogies.

The fact is that any topic in the biology syllabus tagged by teachers as difficult has the highest tendency to be avoided by them or taught in a confused manner. Whilst the repercussion of teachers' avoidance of teaching genetics to students or otherwise using ineffective pedagogy is obviously negative on students' performance, some Biology teachers in Oti Region of Ghana are of the view that genetics is a difficult topic in the Biology syllabus for Senior High Schools and thus find it difficult to satisfactorily teach this topic.

To this, a study to determine the effect of lecture method (LM), video method (VM) and lecture-video method (L-VM) as instructional approaches of genetics to some selected SHS3 students' in Oti Region, Ghana was conceived.

Purpose, objective and research question of the study

The purpose of the study was to measure the effect of LM, VM and L-VM on the performance of Senior High School three students in genetics from a selected school in the Oti Region of Ghana. The specific objective was to determine the extent to which the use of LM, VM and L-VM impact SHS3 students' achievement in genetics. The research question which the study provided answers to was 'to what extent did the use of lecture method, video method and lecture-video method of teaching selected topics in genetics significantly impact SHS3 students' achievement after treatment?'

Hypotheses

The null hypotheses of the study tested at 0.05 alpha level were:

Ho_1: There is no statistically significant difference in the mean achievement scores of students' taught genetics using lecture method, lecture-video method and video method.

Ho_2: There is no statistically significant difference in the mean achievement scores of students taught genetics using lecture method and those taught using video method.

Ho_3: There is no statistically significant difference in the mean achievement scores of students' taught genetics using lecture-video method and those taught using video method

Ho_4: There is no statistically significant difference in the mean achievement scores of students' taught genetics using lecture-video method and those taught using lecture method.

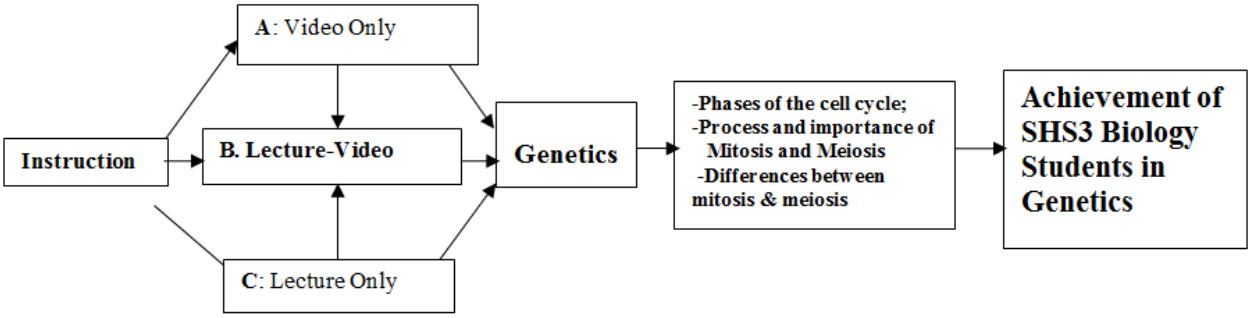
Scope of the study

The study was restricted to the use of only lecture method, video method and lecture-video method to teach selected sub-topics in genetics to SHS3 students offering Biology in only one school located in Oti Region, Ghana. Genetics is a section 2 unit 4 topic in Senior High School year 3 Syllabus (Curriculum Research Development Division, 2010.p.61). The following sub-topics were covered by the lessons:

a) Phases of the cell cycle;
b) Process of mitosis and its importance; and
c) Process of meiosis and its importance.

Conceptual Framework

The study was focused on the use of three instructional approaches in teaching SHS3 students some selected sub-topics in genetics and to determine their efficacy. In this regard the Trimodal Approach Conceptual Framework (TACF) was used. This approach considered video method and lecture method as independent variables but combined to form another instructional approach called lecture-video method. All the three independent variables (lecture method, video method and lecture-video method) were employed separately to teach selected topics in genetics and determined their impact on the achievement (dependent variable) of three groups (A, B and C) of SHS3 students.



Key: **A**: Experimental; **B**: Experimental; **C**: Control

Figure 1: Three Method (Trimodal) Approach Conceptual Framework (TACF).

RESEARCH METHODOLOGY

Research Design: The study adopted a quasi-experimental pretest-posttest nonequivalent design because intact classes were used and there was no randomization. This design involves both experimental and control groups and is quite similar to the experimental design except that it does not involve random assignment of research participants to groups. However, the assignment of which group qualifies to be experimental and control group was done randomly.

Sample size and sampling: Out of all the Senior High Schools in the region, one school was purposively selected for the study based on the following criteria:

a) availability of the school for the research;
b) availability of school's biology teachers for the research; and
c) the school having three SHS3 intact classes that offer Biology with an average class size not more than 30 to enable good class control throughout the study.

Based on the criteria as outlined above, one school with a total of 82 students representing three intact classes was selected for the study. The intact classes had 27, 26 and 29 class sizes and were randomly assigned A, B and C respectively. Again, one teacher was purposively sampled to do the teaching. The selection of this teacher was based on the fact that the school where he or she was teaching SHS3 students Biology was selected for the study. In all, the sample size for the study was 83.

Data Collection Instruments

Pretest: This test comprised 50 multiple-choice items with 4 options (A-D). It was titled as "Students' Achievement in Genetics Test (SAGT)" and developed by the researcher around the content area of the study which borders on the definition of cell cycle, the process and importance of mitosis and meiosis and differences between mitosis and meiosis. It was administered before the treatment.

Posttest: This test was the same as the pretest but the test items were re-shuffled to overcome the problem of familiarity and was only administered after the treatment.

All test instruments were first validated by well experienced biology teachers using standard measures to check for clarity, appropriateness, correctness, relationship of questions with the topic of the research and other necessary criteria for validity before they were administered at various stages of the study. Again, the demands of the test items were compared to the demands of the Biology syllabus for Senior High Schools and West African Senior School Certificate Examination (WASSCE). Furthermore, the 50 items were subjected to test of reliability using test-retest procedure. By this, the test instruments were pilot tested on the same level of students in another school with similar characteristics and IBM SPSS Statistics version 25 used to calculate Cronbach's Alpha estimated value for both pretest and posttest. The pretest yielded Cronbach's Alpha estimated value of 0.69 whilst the posttest yielded 0.75.

The teaching process/Treatment

Group A: This was an experimental group taught Genetics using video lessons. By this approach, carefully selected short videos from You Tube on the various subtopics of genetics were employed to teach students. In this group, students were made to watch short videos on the selected topics and allowed to ask questions thereafter. Again, students were allowed to have a replay of any portion of the lessons as they so wished. For each of the lessons, the total time spent was one hour.

Group B: This was also an experimental group taught selected topics in genetics using combination of lecture and video lessons. Here, students' were made to watch short video lessons as was employed in treatment Group A. However, students were taught alongside using lecture method. Each of the lessons taught to this group, lasted for one hour.

Group C: This group was the fundamental control group which was taught selected topics in genetics using only lecture method. For this group, students were taught the same sub-topics just as in Groups A and B but no videos

were used. The students were taught for a period of one hour in this case also.

In all, the teaching process lasted for a period of four weeks with three hours every week for each group.

Control of Extraneous variables

Since differences in teacher characteristics particularly experiences (years), pedagogical knowledge and skills could introduce error into the study, only one teacher who used to teach SHS3 Biology in the school was selected to teach all the three groups after the teacher was taken through pre-lesson preparation in order to be conversant with what to do.

Data Collection and Analysis

To collect data for analysis, both the researchers and the Biology teacher selected for the study administered the pretest (SAGT) to each of the treatment groups (A, B and C) concurrently a day before treatment commenced. The test lasted for 50 minutes and students were required to provide answers to the questions. At the end of the 50 minutes, the test papers were retrieved. The retrieval percentage was 100. Again, the posttest was administered by both the researchers and the subject teacher to all the treatment groups (A, B and C) concurrently after treatment. This was to ensure that questions did not leak so that a certain group would have advantage over the others. The retrieval percentage at this point also was 100.

All quantitative data collected before and after treatment were analyzed using IBM SPSS Statistics version 25. Specifically, mean and standard deviation were used to answer research questions while One-way ANOVA was used to test the hypotheses at 95% confidence level.

RESULTS

The research question: **'**To what extent did the use of lecture method, video method and lecture-video method of teaching selected topics in Genetics significantly impact SHS3 students' achievement after treatment?' was answered and the findings are in Table 1.

Table 1: Students' performance before and after treatment.

Type of Test	Treatment Group	N	Mean	Std. Deviation	Std. Error
Pretest	Lecture Method (LM)	29	12.24	.637	3.429
	Video Method (VM)	27	12.26	.615	3.194
	Lecture-Video Method (L-VM)	26	12.15	.617	3.146
Posttest	Lecture Method (LM)	29	21.00	2.577	.479
	Video Method (VM)	27	26.11	4.652	.895
	Lecture-Video Method (L-VM)	26	33.96	5.517	1.082

The pre-treatment results are LM = 12.24; VM = 12.26 and L-VM = 12.25. The pre-treatment results showed that students in the three groups were of almost the same standard and had some prior knowledge of the topic Genetics before the treatment. The standard deviation at the pre-test level ranged between 0.615 and .0637 showing that the scores were very close to one another. However, achievement in the three groups after treatment improved drastically with LM improving to 21.00; VM = 26.11 and V-LM = 33.96. The standard deviation ranged between 2.577 and 5.517, suggesting that the post-test scores were further apart compared to the pre-test scores. Differences between the means at the post-test stage were as follows, LM=8.76; VM=13.85; L-VM = 21.81 respectively. The indication is that students who were taught using lecture-video method experienced highest statistical mean improvement (M=21.81) compared to those taught using lecture method only (M=8.76) and video method only (M=13.85). Thus, the instructional approach that yielded the least improvement after treatment was lecture method (LM).

When the null hypothesis (Ho_1), "There is no statistically significant difference in the mean achievement scores of students' taught Genetics using lecture method, lecture-video method and video method" was tested using one way analysis of variance of students' scores in posttest the results in Table 2 were obtained.

Table 2: Analysis of variance of students' scores after treatment (post-test).

Source of variation (score of student)	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	2011.239	2	1005.620	44.140	.000
Within Groups	1754.248	77	22.782		
Total	3765.488	79			

From Table 2, the results reveal an F ratio of 44.14 at 2/77 degree of freedom and p =.00. Thus, the differences between the means were highly significant (p=.00). This implies that the null hypothesis (Ho_1) was not supported ($P < 0.05$) and hence rejected. Thus, there is a statistically significant difference between the performances of the three groups of students taught Genetics using lecture method, lecture-video method and video method. Based on this, a follow-up test which was Scheffe post hoc test to identify which student groups showed statistical mean differences was carried out and the results presented in Table 3. The results in Table 3

were used to provide answers to null hypotheses Ho_2, Ho_3 and Ho_4, which stated as follows:

Ho_2: There is no statistically significant difference in the mean achievement scores of students taught Genetics using lecture method and those taught using video method.

Ho_3: There is no statistically significant difference in the mean achievement scores of students' taught Genetics using lecture-video method and those taught using video method

Ho_4: There is no statistically significant difference in the mean achievement scores of students' taught Genetics using lecture-video method and those taught using lecture method.

Table 3: Scheffe Post Hoc Multiple comparison of significance of groups.

Comparisons	Mean Difference	Std. Error	Sig.	95% Confidence Interval		Remark
				Lower Bound	Upper Bound	
LM & VM	4.529***	1.289	.003	1.31	7.75	Ho_2 Rejected
L-VM & VM	7.645***	1.337	.000	4.31	10.98	Ho_3 Rejected
L-VM & LM	12.174***	1.303	.000	8.92	15.43	Ho_4 Rejected

Differences tested at 0.05 level of significance and were all highly significant (***). Null hypothesis rejected.
Key: LM= Lecture Method; VM=Video Method; L-VM= Lecture-Video Method

As can be gleaned from Table 3, the results indicate that high significant statistical mean differences existed between the scores of two groups of students taught Genetics using lecture method and those taught using video method (P=.003). To this, the null hypothesis (Ho_2) was therefore rejected.

Also, the results in Table 3 show that higher significant statistical mean differences existed between the scores of groups of students taught Genetics using lecture-video method and those taught using video method only (P =.000). Here also, the null hypothesis (Ho_3) was rejected.

Furthermore, the results reveal that high significant statistical mean differences existed between the scores of students taught Genetics using lecture-video method and those taught Genetics using lecture method (P =.000) and thus the null hypothesis (Ho_4) rejected.

DISCUSSION

The findings of the study showed that there existed differences in the learning outcomes of students taught Genetics using the three instructional approaches (LM, VM and L-VM). However, the use of lecture-video method (L-VM) in teaching Genetics recorded the highest significant improvement in learning outcomes of students compared to lecture and video methods only. This implies that the lecture-video method might have simplified the Genetics concepts to students and thereby improving their learning outcomes better than the lecture method and video method only. Although, the use of video method also yielded some appreciable significant improvement in students' learning outcomes, the truth remains that the Lecture-Video Method had more positive impact on learning outcomes. This agrees with the work of Husson (2018) who intimated that bimodal method helps to support reading fluency of L2 learners at various levels of their development.

In any case, the statistical significant differences between the means also suggest that the differences were not due to chance or experimental error. This emphasizes the point that combination of lecture and video methods is a superior way of teaching that will enhance the understanding of the lesson by students and thus helping them to score high marks when tested.

The traditional method of teaching Genetics using the lecture method has long been criticized because it only affords students the opportunity to memorize concepts instead of concrete understanding (Zheng, Lawhorn, Lumley & Freeman, 2008). When students have deficiency in their conceptual development as a result of the use of lecture method, their performance obviously would be impeded and the result is always negative.

Many researchers (Yu-Chien, 2008; Lewis & Leach, 2004; Schwartz, Lederman & Graford, 2004; Lewis & Wood-Robinson, 2000) have reported that Genetics concepts require abstract thinking and therefore must be taught using concrete materials which are made available by Information and Communication Technology (ICT). To this, the combination of video and lecture methods to teach Genetics, was a better option. Again, according to Robertson and Flowers (2020), students' outcomes are higher when instructors supplement written (lecture) materials with video.

To Johnstone (1991), one of the reasons why learning concepts in Genetics are particularly difficult is because it requires multilevel thinking. To this, the combination of lecture lesson and video lesson as employed in this study makes it possible to provide students with multilevel thinking strategies and thus, tremendously improved their achievement in Genetics concepts. Again, the results of the study are consistent with the assertion made by Russell (1997) when he intimated that, the use

of varied and appropriate instructional methods have positive impact on students' achievement.

CONCLUSIONS

Based on the findings of the study it is obvious that the students already had some prior knowledge of the topic Genetics before the teaching. It can further be concluded that, though video method is able to improve students' understanding of the concept Genetics, a combination of the lecture method and the video method is able to help learners to understand the concept better than employing only lecture method or only video method.

RECOMMENDATION

Based on the findings of the study, it is hereby recommended that:

1. Biology teachers in the school should employ the use of lecture-video method in teaching Genetics to their Biology students.
2. The School authorities should provide support systems that include the provision of adequate and appropriate ICT tools to encourage Biology teachers to use the lecture-video method in teaching Genetics to their students for better results.

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