21st Century Academic Forum Conference Proceedings
2014 Conference at Harvard

Effects of Computer Simulation Package, Gender and Parental Education on Nigerian Secondary School Students' Attitude Towards Biology

Duyilemi, Augustina Nireti[1] (Ph.D), Olagunju, Alice Morenike[2] (Ph.D) and Olumide, Olubukola Joyce[3]

[1] Department of Science & Technical Education, Faculty of Education, Adekunle Ajasin University, Akungba-Akoko, Nigeria

[2]Department of Teacher Education , University of Ibadan,Ibadan, Nigeria

[3]Department of Teacher Education, University of Ibadan Ibadan, Nigeria

Abstract

The conventional method used by teachers has led to negative attitude towards Biology. Researchers ascertain that students' attitude could be enhanced when they participate in teaching-learning process. This study determined effects of computer simulation package in the teaching of Genetics on students' attitude towards Biology. The study also determined the effect of gender and parental education on students' academic achievement in Biology. The pretest-posttest, control group, quasi-experimental design with 2x2x3 factorial matrix was adopted. Two hundred and forty (240) students from four purposively selected schools in Oyo State, Nigeria, were used for the study. Three null hypotheses were tested at 0.05 level of significance. Five instruments used for data collection were: Teachers Instructional Guides for Experimental and Control groups; Students' Attitude to Biology Scale (r= 0.83), Computer Simulation Package on Genetics in Biology and Assessment Sheet for the research assistants. The procedure for data collection involves 2 weeks for training of research assistants, 1 week for pre-test, 8 weeks for treatment and 1 week for post-test. Data collected were analyzed using Analysis of Covariance (ANCOVA). Treatment had a significant effect on students' post-test attitude score ($F(1,228)=273.495, p<0.05$). Student's attitude towards Biology was significantly improved with computer simulation package. There was also a significant effect of parental education on students' attitude. However, the package was found to be suitable for both sexes. It is therefore recommended that computer simulation instructions can promote positive attitude towards Biology and should be adopted.

Keywords: Computer simulation instructions, Attitude towards Biology, Gender, Parental education

Introduction

The impact of science and technology on education cannot be over-emphasized. The advent of information and technology especially the product aspect has influenced both the content as well as methods of teaching. Most of the developed countries have exploited the potentials of ICT (Information Communication Technology) to transform their educational landscape at the tertiary, secondary and even primary school levels particularly the instructional process (Kosakowski, 1998). Generally, ICT holds out the opportunity to revolutionize pedagogical methods, expand access to quality education, and improve the management of education systems (World Bank, 2002). Nigeria, especially the educational sector has not properly harnessed the potentials of Information Technology (IT) in terms of the educational uses as in developed countries like America and Britain. Unfortunately, in Nigerian classrooms, the typical pedagogical pattern, which reflects an authoritarian didactic approach to classroom management, does not prepare students for the information age and globalization. In other words this pattern is not equipping "students to live effectively in our modern age of science and technology".

The World Bank (2002) also declares that when properly integrated into a broader educational programme, the most important use of ICT in education is as a pedagogical tool. Nigeria, as a developing nation needs her youths- the future generation to be prepared and equipped for the 21st century challenges. This calls for the need to integrate ICT into her educational system. The purpose of education is to produce wholesome, pleasant and understanding individuals who will interact wisely and purposely within and outside the environment and in line with this Biology education aims at helping the child to acquire appropriate skills, abilities and competencies that would enable him to contribute to the development of the society (Ajewole, 1998). Biology teaching is needed in the world today much more than before since its teaching helps the young to understand their environment-physical, biological and human.

Ogunleye (2002) reported considerable students' under-achievement in biology. Although biology is rated to be an important subject among other science subjects since its the science option of many students to satisfy the registration requirements at the Senior Secondary School Certificate Examination (SSCE), yet over the years, several research reports indicate that students achieve poorly in it. Educators have continued to draw attention to the grave consequences of constant decline in students' performance in science subjects especially in public examinations such as National Examinations Council and West African Secondary School Certificate Examinations (Ogunleye, 2002). This is corroborated by finding that the performance level for science subjects did not show any significant rise for a twenty-year period between 1991 and 2011, perhaps because non science students used to register for Biology as a core science subject. The analysis of Senior School Certificate Examinations' result in Table I made available from the West African Examinations Council (WAEC) statistics unit on enrolment of students and their performance in biology revealed the enormity of this problem.

A further analysis of the SSCE results in biology from 2002 to 2012 as shown in table 1 confirms the poor performance of the secondary school students in the examination, although there was an improvement in students' performance in the subject in year 2005 and 2006. Many factors have however, been highlighted as contributing to students' under-achievement in biology – these comprised of inadequate curricular content, topic difficulty, overloaded timetable, teacher-related problems, inadequate preparation on the part of the students, teaching methods, large classes, lack of innovations in teaching strategies such as lack of media resources etc (Okebukola, 1998). The trend of mass failure in senior secondary school biology final examinations therefore warrants a new approach to teaching the subject**.** In spite of all the strategies recommended for the teaching-learning process in sciences especially biology, the results have not been improving. Probably, the potentialities of ICT and active learning strategy have not been fully exploited in the Nigerian educational system at secondary school level.

Effective learning involves students developing the ability to purposefully access information from a variety of sources, analyze and evaluate the information and then integrate it to construct a personal knowledge base from which to make intelligent decisions (Nwosu, 2003). Active learning is a strategy that promotes effective learning among students. Meyers and Jones (1993), define Active Learning to involve providing opportunities for students to meaningfully talk and listen, write, read and reflect on the content, ideas, issues and concerns of an academic subject.

The question now arises, are science teachers, especially biology teachers prepared to use this tool? There is the need for the science teachers to embrace and use ICT as tools in dissemination of knowledge, skills and attitudes. Although, various teaching methods and packages have been recommended in the past for the teaching of secondary school science subjects in Nigeria, Adegbile (2002) however, observed that one of the major problems militating against effective teaching of secondary school subjects in Nigeria is the method of teaching/package adopted by the teachers.

To live, learn and work successfully in an increasingly complex, information-rich and knowledge based society, students and teachers must utilize technology effectively, (UNESCO, 2008). It has also been observed by Youssef (2004) that the foundations of pre-adult attitudes toward learning are formed during childhood and that these attitudes govern behaviour throughout adult life. Duyilemi (2005) therefore advised that students should be given opportunity to be actively involved in the learning process. This has therefore; created room for further search for other instructional strategies that could appeal to the learners and that would help to achieve the objectives of science education.

Computers are sometimes used in biological investigations for collecting data, searching literature, planning experiments and analysing data. These functions are very common in many science and biology laboratories. However, educators recommend simulations for formulating and, improving the conceptual models that scientist and science teachers use in their practice and teaching. This would enable the numerous objectives to be achieved in order to have improvement in the performance of students in external examinations. In lieu of this, there is a need for a boost on the

previous methods of teaching especially in the supposed difficult topics, genetics particularly.

So, it is obvious that there is an urgent need, most especially in Nigeria, to provide education that goes beyond teaching basic literacy and numeracy skills. Education must help to build higher-order cognitive abilities, strengthen processes of inquiry, enable collaborative problem solving and prepare people to compete in global markets and become productive members of societies. New approaches and strategies for change are needed, and computers, mediated communications and related educational technologies are an important part of this approaches and strategies.

The rapid increase in educational computer use has led to changes in the teaching/learning process, curricula and teachers' and administrators' approaches to instruction (Loveless and Ellis, 2002). These changes in instructional techniques are shaped by the fact that computer-assisted learning increases student motivation and creates better learning environments in which rote learning is minimised and meaningful learning can occur (Renshaw and Taylor, 2000). One way of enhancing learning is to help students create models of dynamic systems by combining words with pictures (Schnotz and Bannert, 2003). This approach has assisted in the development of a special type of interactive animation: computer simulations (Nerdel and Prechtl, 2004).

Computer simulations give students the opportunity to take initiative when learning about a given topic. Simulations are important for formulating and, improving the conceptual models that scientist and science teachers use in their practice and teaching.

The conventional method used by teachers has led to negative attitude towards Biology. Researchers ascertain that students' attitude could be enhanced when they participate in teaching-learning process. This is because of the following factors:- inadequate facilities, examination malpractices, decline in academic standards, poor funding of the educational sector by the government, poor parenting, socio-economic status

Using conventional teaching approaches in which the teacher dominates all the class activities right from introduction to conclusion hinders students' initiatives, preventing them from fully exploring and understanding complex principles. Wood and Gentile (2003), Blair, Schwartz, Biswas and Lewlawong (2007), express the opinion that the conventional method of teaching science is inadequate for effective learning in science.

Computer simulations, a sophisticated form of CAL, make it possible for students to experience and experiment with a variety of biological, scientific, weather, mechanical, business, mathematical, social, and political phenomena with less risk, cost, and time than has ever been possible. However, computer simulations make it possible for students to quickly grasp complex concepts and apply their understanding. In the absence of computer simulations, students usually learn the behavior of complex systems passively through general descriptions and definitions of system elements and primary governing rules. Moreover, because most complex systems involve several levels of positive and negative feedback and intricate interrelationships, general descriptions and basic rules are incapable of conveying much understanding

Researchers have come up with different findings on the effect of gender on learning outcomes. Some found no significant differences based on gender, Morribend (2004), Chukwuka (2005), Ogunleye (2002) and Raimi, (2003) individually reported that males perform better than their female counterparts in science subjects. Okeke (2001) and Aremu (2005) also reported significant effect of gender on learning outcomes in favour of the male students. This inconsistency calls for further investigations and clarifications.

Parental education and parental income are seen as moderators of parental affective factors in predicting achievement as they are crucial in providing educational opportunities for children to succeed. Studies have found that there is a strong relationship between parents' role with their children's academic achievement (Phillipson 2009).Therefore, this study arose for further investigations.

Objectives/Purposes

This study is conducted to establish the effect of computer simulation package in the teaching of Genetics on students' attitude towards computer simulation. This study also aims to find out the influence of students' gender and parental education on students' attitude towards Biology.

Hypotheses

The following null hypotheses were tested in the study;

$H0_1$: There is no significant main effect of treatment on students' attitude towards Biology

$H0_2$: There is no significant main effect of gender on students' attitude towards Biology

$H0_3$: There is no significant main effect of parental education on students' attitude towards Biology

Theoretical Framework

Constructivism is a philosophical position that views knowledge as the outcome of experience mediated by one's own prior knowledge and the experience of others. Human cognitive development is a continually adaptive process of assimilation, accommodation, and correction (Piaget, 1968).

The constructivist classroom presents the learner with opportunities for "autopoietic" learning with a view to helping learners to build on prior knowledge and understand how to construct new knowledge from authentic experience—certainly a view in keeping with Rogers' *experiential learning* (Rogers, 1969). For him, the qualities of experiential learning include: *personal involvement; learner-initiation; evaluation by learner; and pervasive effects on learner.*

Rogers' humanistic approach to learning is also conducive to personal change and growth, and can facilitate learning, provided that the student participates completely in the learning process and has control over its nature and direction;

For Dewey (1998), knowledge emerges only from situations in which learners have to draw them out of meaningful experiences. Further, these situations have to be embedded in a social context, such as a classroom, where students can take part in manipulating materials and, thus, forming a community of learners who construct their knowledge together. Students cannot learn by means of rote memorisation; they can only learn by "directed living," whereby concrete activities are combined with theory. The obvious implication of Dewey's theory is that students must be engaged in meaningful activities that induce them to apply the concepts they are trying to learn.

Applying constructivist theory to the classroom situation

Constructivist teachers pose questions and problems, then guide students to help them find their own answers. They use many techniques in the teaching process. For example, they may:

- prompt students to formulate their own questions (inquiry)
- allow multiple interpretations and expressions of learning (multiple intelligences)
- encourage group work and the use of peers as resources (collaborative learning)

The constructivist approach helps students learn HOW TO LEARN.

Relevance of the theory to this study

The constructivism theory contributes greatly to this study; it supports knowledge construction in students and help student in the act of knowing. Concentration, perception, memory and logical thinking are cognitive skills for successful learning that help in construction of knowledge and these are the things that this study focuses its research on by using computer simulation packages.

Methods

The study adopted a pretest, post-test, control group, quasi -experimental design using a 2x2x3 factorial matrix. The design is shown structurally below:

Experimental Group; 0_1 X_1 0_2

Control Group; 0_3 X_2 0_4

Where 0_1 and 0_3 are pretest scores of experimental and control groups respectively.

0_2 and 0_4 are post-test scores of experimental and control groups respectively.

X_1 is the computer Simulation Package.

X_2 is the Conventional Based Instruction.

Analytically designed 2x2x3 factorial matrix of the study is presented in the table II.

Sample Selection

Four public secondary schools from two local government areas in Oyo State Nigeria were randomly selected for this study. Specifically, two schools from Egbeda local government area and two schools from Ibadan North local government area were randomly selected for this study. The criteria used for selecting the schools are;

1. The schools used as experimental group should have electricity facilities.

2. Availability of experienced biology teacher.
3. An evidence that the topic Genetics has not been taught.

Research Instruments

The following instruments were prepared and used for the study;

1. Students. Attitude to Biology Scale
2. Computer Simulation Package on Genetics in Biology (CSPGB)
3. Operational Guide for Computer Simulation Package on Genetics in Biology (OGCSPGB)
4. Operational Guide for Conventional Based Instruction on Genetics in Biology (OGCBIGB)
5. Evaluation Sheet for Assessing Teachers' Performance during Training (ESAPT)

Students Attitude to Biology Scale (SABS)

The instrument was designed to measure the effective domain which is the way of thinking of the students on the use of computer simulation instruction. The instrument is divided into two sections- A and B; Section A consisted of personal data: Name of School, Type of School, Sex, Parents Occupation, and Parents level of Education, and also four factual items. Section B consisted of 20 items on four point- Likert scale. Ten items out of 20 items indicated positive number while 10 indicated negative number. The likert-type response range from; strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD). The instrument was used for both the pretest and the posttest.

Face validity was done by showing it to 2 senior colleagues in science education, my supervisor and finally to a research expert, to determine the suitability in terms of clarity of ideas, use of language, and relevance to the study. The initial 21 items were reviewed to 20 items. The 20 items draft was administered to 20 students at a neutral representative school outside the main sample of the study. The reliability was computed using Cronbach alpha measure. The standardized alpha value of 0.83 was obtained, indicating that the instrument is reliable. Table of Specification for Students Attitude to Biology Scale (SABS) is in table III.

Computer Simulation Package on Genetics in Biology (CSPGB)

CSPGB, a programmed instruction, was developed by the researcher and its mode of instruction is self-learning; it involved the trained teachers as a facilitator to operate during its use. CSPGB was prepared according to behavioural objectives of the topic- genetics in the biology curriculum for senior secondary school.

Conventional Based Instruction on Genetics in Biology (CBIGB)

The mode of instruction of CBIGB is not learning package but the normal traditional way of teaching-learning process in classroom and the instruction is in form of lesson plan.

The instrument was prepared according to the behavioural objectives of the topic-genetics in the biology curriculum for senior secondary school.

Operational Guide for Computer Simulation Package on Genetics in Biology (OGCSPGB)
This instrument was developed by the researcher to guide and ensure uniformity in the use of computer simulation package instruction for a period of eight weeks (One period per week); it also ensures easy operation for all users.
Operational Guide for Conventional Based Instruction on Genetics in Biology (OGCBIGB)
The instrument was developed by the researcher to guide and ensure uniformity in the conventional based instruction especially the steps, teacher activities and students' activities in the schools used as control group for a period of eight weeks (One lesson per week).

Validation of the following 4 instruments:

- **Computer Simulation Package on Genetics in Biology (CSPGB),**
- **Conventional Based Instruction on Genetics in Biology (CBIGB)**
- **Operational Guide for Computer Simulation Package on Genetics in Biology (OGCSPGB),**
- **Operational Guide for Conventional Based Instruction on Genetics in Biology (OGCBIGB**).

All these stimulus instruments were validated by using the comments of my supervisor, experienced biology teachers, and Information Communication Technology (ICT) experts.

Procedure for data collection
Work Schedule

2 weeks	Training of teachers
1 week	Pre-test (using SACSS and SABT)
8 weeks	Treatment (using CSPGB OGCSPGB,CBIGB)
1 week	Post test (using SACSS and SABT)

Training of Teachers

The researchers trained teachers in selected schools on how to adhere strictly to the instruments and experimental procedure. Briefing session was also organized for the students participating in the study in their various schools. Two teachers were trained as research assistants for the experimental group while the teachers for the control group were asked to adhere strictly to the instructional guide

Pre-test

The researchers and research assistants administered the pretest using Students Attitude to Computer Simulation Scale (SACSS) on the subjects of study. The two instruments were administered in such a way that individual's SACSS and SABT were collected together in order to ensure easy analysis of individual's cognitive and attitudinal scores.

Treatment

The researchers used a period of 8 weeks as treatment period in the 4 schools for the study.

Experimental Group

This group includes the two schools that were treated using Computer Simulation Package on Genetics in Biology (CSPGB). After the first week of administering the pretest, Students were grouped and allowed to receive learning instructions according to the Operational Guide for Computer Simulation Package on Genetics in Biology (OGCSPGB).

The CSPGB introduced the topic, taught, and at the end of the instruction, the computer Simulation package also evaluated the students' knowledge so far. The researchers made sure the process of teaching according to the OGCSPGB is followed throughout the treatment period in the two schools used as experimental schools
The steps involved in CSPGB are:

STEP I:- Teacher tells and emphasizes on students adherence to instructions on how to use the Simulation Package.
STEP II:- Teacher monitors the students as they use the Simulation Package
STEP III:- Teacher asks pupils to ask questions based on the topic taught by the Simulation Package.
STEP IV:- Teacher helps the students to close the program.
The 10^{th} week was used for **posttest.** The researchers with the research assistants administered the posttest on the students in the same order of the pretest.

Control Group

This group includes the two schools that were taught with the conventional classroom practices using Conventional Based Instruction on Genetics in Biology (CBIGB). After the first week of administering the **pretest**, students were prevented from consulting internet on the topic genetics. Students were taught using the Operational Guide for Conventional Based Instruction on Genetics in Biology (OGCBIGB) for a period of 8 weeks (2^{nd} – 9^{th} week) and the 10^{th} week was used for posttest. The researchers with the research assistants administered the posttest on the students in the same order of the pretest.

Post Test

The researchers and the research assistants administered the posttest just like the pretest.

Procedure for Data Analysis

The data obtained was analyzed using Analysis of Covariance (ANCOVA) using the 2 x 2 x 3 factorial analysis and pretest scores as covariates. The analyzed data is used to test the research hypotheses. The Multiple Classification Analysis (MCA) was used to show the magnitude of the posttest mean score. Bar charts were used for possible explanations of observed significant differences.

Results

Ho1: There is no significant main effect of treatment on students' attitude to biology.

The summary of ANCOVA of students' attitude to biology by treatment, gender and parental education is shown in table IV.

According to table IV; the effect of treatment on attitude to Biology is significant ($F(1,228)=273.495, p<0.05$) that is student's attitude to Biology was improved. So the null hypothesis is rejected.

.The multiple classification analysis of post achievement score according to treatment, gender and parental education is shown on table V.

Table V shows that students exposed to computer simulation performed better with higher adjusted posttest achievement mean score (mean=72.215; dev.=3.21) than their counterparts who were taught with the conventional teaching method (mean=49.743; dev.=-3).

Figure I shows bar chart of the mean achievement scores of students according to treatment. The magnitude of the distribution indicates Computer Simulation (mean= 72.215) < Conventional (mean=49.743)

Ho2: There is no significant main effect of gender on student's attitude to Biology.

As showed in table IV, the main effect of gender on student's attitude to Biology is not significant ($F(1,228)=2.885, P > 0.05$). This means that there is no significant difference between male students' attitude to Biology and female student's attitude to Biology. The null hypothesis is not rejected.

Figure II shows bar chart of the mean attitude scores of students according to gender. The magnitude of the distribution indicates Male (mean= 66.33) < Female (mean=56.68)

Ho3: There is no significant main effect of parental education on student's attitude to Biology.

As shown on table IV, there was a significant effect of parental education on students' attitude to Biology ($F(2,228)=3.078, P < 0.05$). This means level of parental education has effect on students' attitude to Biology. So the null hypothesis is rejected. Figure III shows bar chart of the mean attitude scores of students according to parents' education. The magnitude of the distribution indicates low (mean= 52.078) < Medium (mean=53.511)< High (mean= 66.288)

Discussion

There is significant main effect of treatment on students' attitude. The significant role of Simulation package may have influenced students' attitude towards science over time. Students' perception of scientists was one of the science-related attitudes that showed significant change. This result is confirmed by prior research into realistic simulations showing the relevance of science and change in how students perceive science (Jarvis & Pell, 2005). Live simulation learning environment has potential for changing students' self-perception and goal orientation. The use of realistic simulation often requires students to apply newly acquired skills while motivating them towards advanced learning (Moreno & Mayer 2007). This finding is in line with previous research of Ozel (2008), Pektas (2008), Pilli (2008) and Azar & Sengulec (2010).This may be due to the effect of simulation package used in teaching Biology that motivates students and gets them to take an active part in the learning process. It helps to develop creativity and problem solving skills, identity and self-reliance in learners.
It was also revealed that there was a significant effect of parental education on students' attitude. Researches like Eamon 2005, and Hochschild 2003 revealed that poor parental education affects students' outcomes including attitude. Eamon 2005 stated that poor parental education prevents access to resources and leads to additional stress and conflict at home that affect all aspects of a child's life.

Scientific/Scholarly Significance of the Study

The findings of this study revealed that computer simulation-based instructions were more effective than the conventional-based instruction in Genetics in Biology. The findings of this study have some implications for Biology teaching in secondary schools. Based on the above, it is the responsibility of science educators, educational practitioners and the practicing science teachers, especially Biology teachers to embrace computer simulation-based instructions. The Biology teacher who is faced with the problem of handling students that are faced with negative attitude towards Biology can embrace computer simulation-based instructions to supplement his or her teaching and also to increase the level of concentration of the students thereby aiding class control. This would promote the enhancement of educational objectives. Teachers are to be trained on how to develop instructional packages with the use of computer simulation.

Curriculum developers and designers should provide instructional designs that are based on computer simulation. This would enhance positive attitude towards educational objectives. Instructional designs that are learner-centered should be provided so as to foster motivation, participation and creativity among students.

Recommendations

Based on the findings of this study, the following recommendations are advanced:

1. Secondary School students in Nigeria should be encouraged and motivated to learn through electronic means.
2. Students should be sensitized and enlightened that computer system and internet access is not only for social pleasures alone but should be seen and used for academic purpose.
3. School principals, administrators and other stakeholders in both public and private sectors should be trained and updated periodically on the use of computer systems in the teaching and learning process.

Conclusion

The focus of this study was to develop ICT-based instructions (in form of computer simulation) and to expose the students involved in the study to electronic learning. The study also determined the effect of gender and parental education on students' academic achievement in Biology. From the findings of this study, it could be deduced that positive attitude towards Biology can be enhanced through the use of the products aspects of Internet and Communication technology (ICT).

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Table I: Percentage Distribution of Students' Performance in May/June Senior School Certificate (SSCE) in Biology in Nigeria: 2002 – 2012

Year	Total Entry	Total sat	Credit Passes 1-6	Percentage Passes
	No of Candidates.	No of Candidates	No of Candidates	% of Candidates
2002	1,240,163	882,119	278,112	31.52
2003	1,006,831	909,101	392,249	44.15
2004	1,005,553	1,027,938	253,487	24.69
2005	1,080,162	1,072,607	375,850	35.04
2006	1,170,522	1,152,045	559,854	48.60
2007	1,270,137	1,238,163	413,211	33.37
2008	1,292,910	1,259,964	427,644	33.94
2009	1,372,567	1,340,206	453,928	33.87
2010	1,331,381	1,300,418	427,644	33.90
2011	1,540,141	1,505,199	579,432	38.50
2012	1,695,878	1,672,224	649,156	38.82

Source: Statistics Section, West African Examination Council (WAEC) National Office, Onipanu, Lagos, Nigeria.

Table II: 2x2x3 Factorial Matrix

Treatment	Parental Education	Gender	
		Male	Female
Computer Simulation package	High		
	Medium		
	Low		
Conventional based instruction	High		
	Medium		
	Low		

Table III: Table of Specification for Students Attitude to Biology Scale (SABS)

S/N	Section/Items	Positive items	Negative items	
Attitude of students towards theoretical Biology			1,2,7,	3
Attitude of students towards practical Biology		15	3,4,5	4
Attitude of students towards Biology as a subject		8,11,12,13	6,9,10,14	8
Total		5	10	15

Table IV: Summary of ANCOVA of Students' Attitude to Biology by Treatment, Gender and Parental Education.

Hierarchical Method					
Source of Variation	Sum of Squares	Df	Mean Square	F	Sig.
Model	16891.863	12	1407.655	330.484	.000
Gender	12.287	1	12.287	2.885	.091
Treatment	1164.916	1	1164.916	273.495	.000
PEDU	26.220	2	13.110	3.078	.048
Gender * Treatment	1.641	1	1.641	.385	.535
Gender * PEDU	18.611	2	9.306	2.185	.115
Treatment * PEDU	4.444	2	2.222	.522	.594
Gender * Treatment * PEDU	.152	2	.076	.018	.982
Residual	971.137	228	4.259		
Total	17863.000	240			

Table V. Multiple Classification Analysis of Post Achievement Score According to Treatment, Gender and Parental education.

GRAND MEAN=60.98

Variable+Category	N	Unadjusted Predicted mean	Adjusted predicted mean for Factors and Covariates	Unadjusted Deviation	Adjusted Deviation for Factors and Covariates	Eta
[Gender=1.00]	107	66.3271	66.427	2.023	3.51	0.879
[Gender=2.00]	133	56.6767	56.576	-2.09	-2.91	0.864
[TM=1.00]	120	72.1250	72.215	0.014	3.21	0.054
[TM=2.00]	120	49.8333	49.743	0.22	-3	.
[PEDU=1.00]	51	52.0784	51.988	0.574	-6.806	0.012
[PEDU=2.00]	43	53.5116	53.421	-0.88	-1.306	0.0104
[PEDU=3.00]	146	66.2877	66.397	-0.447	9.194	0.013

R Squared=0.966, R=0.965

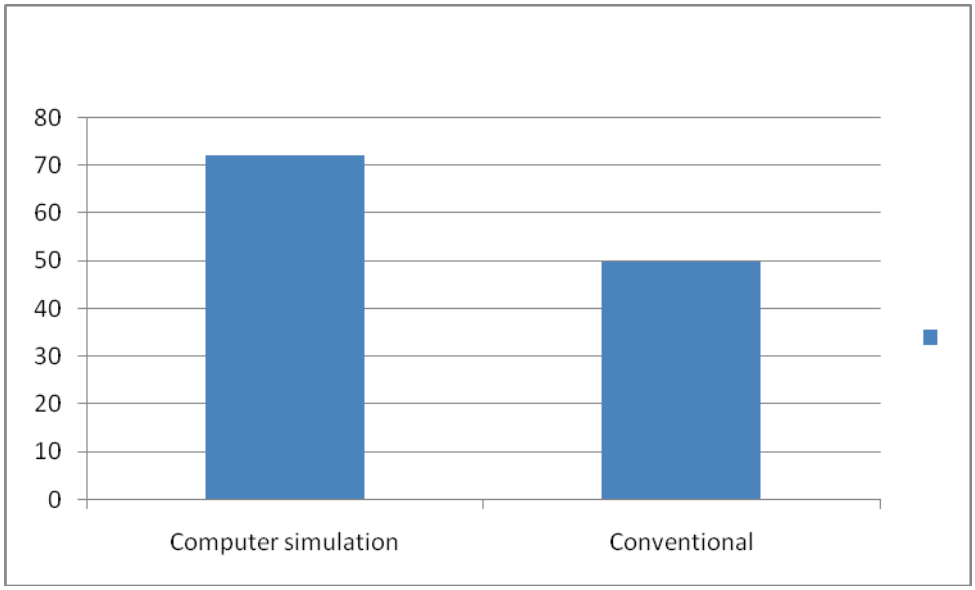

Figure I: Bar Chart Showing the Mean Attitude Scores of Students According to Treatments.

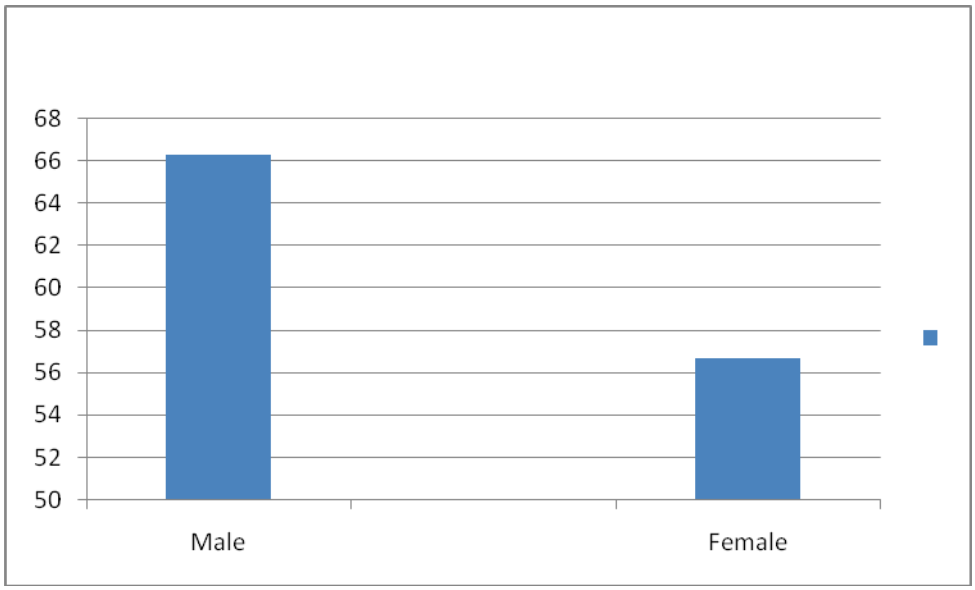

Figure II: Bar Chart Showing the Mean Attitude Scores of Students According to Gender.

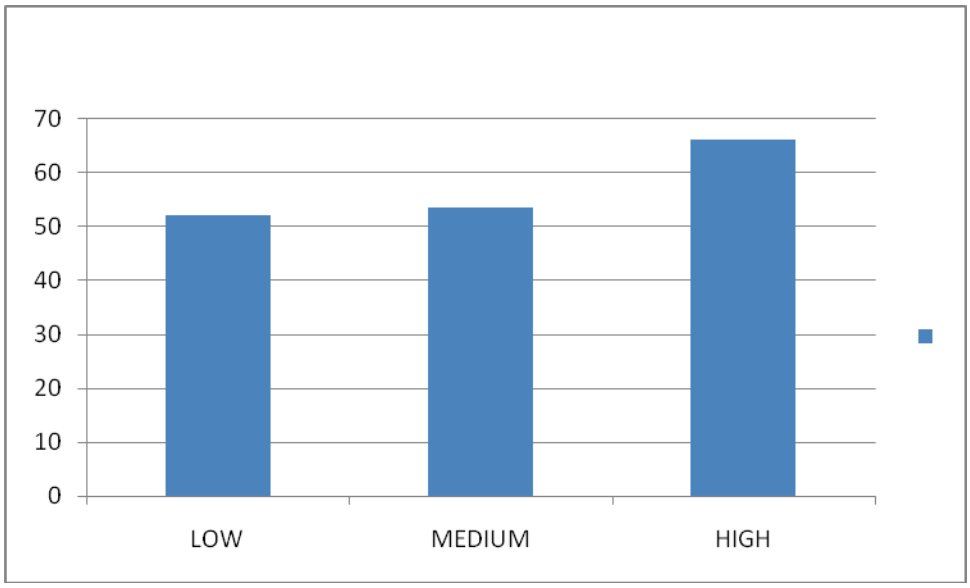

Figure III: Bar Chart Showing the Mean Attitude to Biology Score Across the Three Levels of Parental Education.