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EFFECT OF COMPUTER-ASSISTED INSTRUCTION AND SIMULATION/GAMES ON THE ACADEMIC ACHIEVEMENT OF SECONDARY SCHOOL STUDENTS IN BIOLOGY

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Abstract

This study investigated the effect of Computer Assisted Instruction (CAI), Simulation/Games and Conventional Methods on the academic achievement of students in Biology. The treatment at the three levels of CAI, Simulation/Games and Conventional Method was crossed with gender at the two levels of male and female, and locus of control, at the two levels of internals and externals. Data analysis involved Analysis of Covariance as well as Multiple Classification Analysis as a post-hoc measure. The findings revealed no significant two-way and three-way interactions of treatment and gender and locus of control. However, there were significant main effects of treatment and locus of control on students' achievement in Biology. The MCA further revealed that students taught with the Computer-Assisted Instruction achieved highest while students taught with Simulation/Games achieved better and those students taught with the Conventional Method had the lowest adjusted post-test mean score. Based on these findings, the use of Computer Instruction and Simulation/Games are recommended for teachers in Biology classrooms irrespective of the students' gender and locus of control. The government is further enjoined to provide computers, programs, instructional packages, costumes and enabling environment for the use of these instructional strategies in schools.

Background To The Problem

Prominent among factors documented by researchers for contributing to under achievement in Biology is the teachers' instructional strategies which have been severally criticized as being inadequate and inappropriate for the current biology curriculum. (Adeyegbe, 1993 and Olagunju, 1994). As means of diversifying the teachers' instructional strategy and in response to modem technologically based strategies, such methods like Computer-Assisted Instruction, (CAI), Simulation/Games have been advocated by Bilesanmi-Awoderu (1996).

Afe (1989) revealed that in developed countries the computer technology has pervaded every aspect of their life. He gave example in 1983, that there were

325,000 personal computers in American elementary and secondary schools. It is expected that the numbers will double every year for the next four years. But in Nigeria, it is a recent phenomenon and its use in education is just beginning (Lawal 1997). According to Handler (1993), educational agencies and accrediting bodies, numerous professional organizations, researchers, scholars and public policy makers have noted the growing need to integrate computer technology into all facets of organized learning in America by preparing teachers for the information age.

Hawkridge (1990) asked the question, why do Third World Countries (like Nigeria) want to put computers into their school?: the reason proffered first is that children should be aware and unafraid of how computer works because computers are pervading industrial societies and are likely to be important everywhere. Since schools prepare students for life, they should prepare them to deal with computers, which ought to be demystified. One of the reasons he also advanced to the question is that children will learn Chemistry, Physics, Art or any other subject better through Computer-Assisted Instruction (CAI). This is the pedagogical rationale, calling for improved teaching and learning. Computer software can be used to simulate scientific experiments that would be impossible in a laboratory and complete complex statistical analyses quickly (Watkins 1992). However, Duffy and Barowy (1995) in their study of students' academic performance using three strategies of traditional, constructivist and computer-facilitated concluded that since there was no significant difference among the post-test gain, open ended scores and the critical thinking in biology test, it might be implied that each strategy is as effective as the other in promoting conceptual change and critical thinking skills.

Also, Lazarowitz and Huppert (1993) investigated the impact of Computer-Assisted Learning (CAL) integrated with classroom-laboratory work alone on students' achievement and mastery of science process skills in a microbiology course. Results show that post-test scores were higher in CAL with classroom-laboratory than classroom laboratory instruction only. Furthermore, Jegede (1991) compared the attitudes toward computer use and achievement in biology for three groups of Nigerian students:

(i) working alone with computer
(ii) working in groups of three on the computer
(iii) and a control group that received normal instruction (lecture).

Result show that students in the second group had the highest scores on attitude while no significant differences were found in achievement.

There is no doubt that there is a great need to equip the teachers for Simulation/Games to be used effectively, teachers must know the framework for

developing simulation and the following have been identified by Yee and Geekin (1992), that is: Computer Games, Computer System Design, Database Development, Decision Support Systems, Data Dictionary Systems and Simulation Games.

An advantage of gaming is full participation by the students. It makes the activity student-centered and the students found biology class interesting and funny. As a result, they learn smiling and laughing. Also, to note is the fact that simulation/games keep students of various abilities challenged and interested and also change passive learners to active learners, that is: developing socio-dramatical area of the students and academic performance at the same time. (Bilan and Bohdan 1994).

Anisa and Trisha (1995) reported that there were benefits of establishing computer centers in early childhood classrooms to enhance cognitive learning, develop self-esteem and stimulate divergent thinking. They further opine that the instructor should be knowledgeable in such aspects as computer uses in education, educational innovation and educational technology. Cabrales, Eusebio, Eddy and John (1993) also looked into a computer-based simulation model that can be used for the training of higher education administration. They described simulation games as an instructional and training model.

The effectiveness of games in educational purposes has been favoured by Randel and Josephine (1992). They reviewed empirical research from 1963 to 1991 comparing the instructional effectiveness of games to conventional classroom instruction. It was concluded that subject matter areas where very specific content can be targeted, especially Mathematics, are more likely to show beneficial effects for gaming.

Bilan and Bohdan (1992) in the article "Computer Simulations: an integrating tool" introduced computer simulations as an integrated learning experience reported on their use with students in grade five through ten using commercial software packages such as Simcity, Simant, Simearth and Civilisation. Students spent an average of 60 hours with simulation games and reported their experiences each week in a personal log. Student become actively involved in problem solution through accessing online helps, reading manuals, doing independent research and discussing innovation techniques with each other.

Though, in the Western World, many researchers such as Bilan and Bohdan 1992, Randel and Josephine 1992, and Lazarowitz and Huppert 1993 have established better/greater efficiency for Computer-Assisted Instruction and Simulation/Games over the Conventional methods in students' learning in many subject-matter areas, it is still important to verify this plausible view with

Nigerian data. This is especially necessary when we consider the fact that studies on Computer learning in different subject areas are very sparse in Nigeria.

Perhaps gender is a variable to be investigated in this study based on the fact that there has not been a consensus of opinion on its effect on students' acquisition of biological concepts. However, the inclusion of the variable, locus of control, is borne out of the fact that students' type of locus of control is likely to affect the degree of effort exerted on their academic pursuit.

The problem of this study therefore was to investigate the effects of Computer Assisted Instruction, Simulation/Games and Conventional Method on students' academic achievement in biology. It further tested the main and interaction effects of treatment, gender and locus of control on students' academic performance.

Conventional method in this context is the lecture method modified with very few sketch diagrams and demonstrations.

Research Hypotheses

Ho_1: There is no significant main effect of:

(i) treatment (Computer-Assisted Instruction, Simulation/Games and Conventional methods).
(ii) gender (male and female) and
(iii) locus of control (internal and external) on students' academic performance in biology.

Ho_2: There is no significant interaction effect of:

(i) treatment and gender
(ii) treatment and locus of control and
(iii) gender and locus of control on students' academic performance in biology.

Ho_3: There is no significant interaction effect of treatment, gender and locus of control on students' performance in biology.

Methodology

Research Design

This study employed the 3 x 2 x 2 non-randomised control group pretest-post test quasi-experimental design.

Modes of instruction (Computer-Assisted Instruction, Simulation/Games and Conventional method) were crossed with gender at two levels (male and female) and locus of control also at two levels (internal and external).

Sample

The sample consisted of ninety (90) secondary school II students randomly selected from three co-educational schools in Ijebu-Ode metropolis of Ogun State, Nigeria. The three schools selected were distantly located from one another and also comparable in terms of year of establishment, facilities on ground and senior certificate school results. This precaution was painstakingly taken to cater for the internal validity of the experiment. The choice of school was further influenced by the willingness of the schools to participate.

From each school, thirty students were randomly selected. Out of the sample, forty-five were male and forty-five were female. Also, thirty-three exhibited internal locus of control while fifty-seven had external locus of control after they had responded to the locus of control scale.

Instruments

Two instruments were used for this study. The first was the Test of Achievement in Biology (TAB), which consisted of forty multiple choice items. The TAB was developed by the investigator and was used to determine the academic performance of the students.

Following the Educational Testing Service (ETS) of United States pattern of classifying the educational objectives, the items were classified into one of the three levels of Remembering, Understanding and Thinking. The outcome yielded 12 items (30%), 13 items (32.5%) and 15 items (37.5%) at the cognitive levels of Remembering, Understanding and Thinking. The reliability value for TAB using K-R 21 was 0.82. The scoring of TAB was such that I mark each was assigned to any correct response while 0 was given to a wrong answer.

The second instrument is the Internal-External (I-E) locus of Control Scale (LOCS) developed by Rotter (1966) and adopted in this study. The scale is made up of twenty-nine (29) pairs of statements out of which six (6) are filler statements. These filler statements reveal neither locus of control pattern nor dimension. Nigerian researchers have established both the validity and reliability of LOCS (Igwe 1991 and Eso 1998). However, this investigator further established a test-retest reliability co-efficient of 0.83 for LOCS.

During administration, the students endorsed one of the two statements – a or b. Internal statements are arranged as (a) while external statements are arranged as (b) Scoring is by assigning one point each for external statements and zero for each internal statement endorsed. The total scores ranged from 0 to 23. If a student scores 12 and above, he is classified as external locus of control student while one who scored below 12 was classified as an internal locus of control student.

Procedure

During the second term of the session, the investigator visited the schools and selected five topics from the biology scheme of work presented to her. The selection was mainly based on the condition that the topics have not been taught in any of the elected schools. Due to the non-availability of existing programs for teaching, the investigator had to employ the services of a computer programmer to program the topics into an instructional package.

Students from each of the selected schools represented a group. Thus. Group A was the Computer-Assisted Instruction (CAI) group. The peculiarity of this group is that the students were exposed to Computer Instruction. Group B was the Simulation/Games group. The peculiarity of this group was that students were taught in a drama/gaming set up. Group C was the Conventional Method group in which students were exposed to the modified lecture method of teaching. The students in all the groups were given a pre-test to determine their level of comparability. The duration for administering the treatment was six weeks.

Data Analysis

Analysis of covariance (ANCOVA) statistics was employed to analyse the data collected in this study. In case of significant main effect, the Multiple Classification Analysis (MCA) was employed to determine the direction of differences between the different groups.

Results

Table I provides the 3 x 2 x 2 ANCOV A results for the test hypotheses.

Table I – ANCOVA summary Table for Post-test Biology Achievement scores according to treatment, gender and locus of control.

Sources of Variations	SS	DF	MS	F	Sig. of F
Covariates pretests	405.689	1	405.689	20.324	.00
Pretest	405.689	1	405.689	20.324	.00
Main Effects	355.433	4	88.858	4.452	.00
Treatment	189.252	2	94.626	4.740	.01*
Gender	.031	1	.031	.002	.96
LOC	104.609	1	104.609	5.241	.02*
2-Way Interactions	170.276	5	34.055	1.706	.14
Treatment x Gender	93.260	2	46.630	2.336	.10
Treatment x LOC	30.363	2	15.182	.761	.47
Gender x LOC	16.072	1	16.072	.805	.37
3-Way Interactions	64.878	2	32.439	1.625	.20
Treatment x Gender x LOC	64.878	2	32.439	1.625	.20
Explained	996.276	12	83.023	4.159	.00
Residual	1537.013	77	19.961		
Total	2533.289	89	28.464		

* Significant at $P < .05$

Table I shows that the students' academic achievement in biology is significantly influenced by the treatment ($F_{2, 89} = 4.740$) and their Locus of control ($F_{2, 89} = 5.241$). However, the results show no other significant interaction effects be it 2-way or 3-way interactions of the variables on the students' achievement.

Nevertheless, as a result of the significant main effect recorded on treatment and locus of control, the data were subjected to Multiple Classification Analysis (MCA) to detect the direction of differences between the groups.

Table 2: Multiple Classification Analysis on Biology. Achievement Score according to Treatment group, gender and locus of control. Grand mean = 17.911

Variance + Category	N	Unadjusted Deviation	ETA	Adjusted for independent + Covariates	BERA
Treatment					
1. Computer-Assisted Instruction	30	2.02		1.11	
2. Simulation/Games	30	1.29	.44	1.15	.30
3. Conventional Method	30	-3.3		-2.25	
Gender					
1. Male	45	1.84		1.16	
2. Female	45	-1.84	0.35	-1.16	.22
Locus of Control					
1. Internal	33	-.24	.04	.02	.00
2. External	57	.14		-01	
Multiple R2					.300
Multiple R					.548

Table 2 shows that the direction of increasing effect of the mode of instruction which is the treatment is from the lecture method to Simulation/Games to the Computer Assisted Instruction. The adjusted mean scores of the treatment groups are 14.601, 19.201 and 19.931 respectively. This study thus establishes that Simulation/Games has an advantage over the lecture method while Computer-Assisted Instruction also has an advantage over Simulation/Games. In all, MCA reveals a Multiple R squared value of 0.266 and Beta values of 0.39, 0.27 and 0.01 for treatment, gender and locus of control respectively.

Discussion And Implication Of Findings

1. Mean Effects of Treatment, Gender and Locus of Control

Table 1 shows a 3 x 2 x 2 analysis of covariance of biology achievement scores by treatment at three levels, gender at two levels and locus of control also at two levels. The table further shows a significant main effect of treatment

[F(2,89) = 4.740, P < 0.05] and locus of control [F(2,89) = 5.241, P < 0.05] on students' achievement in biology. Thus hypothesis one was rejected. In order to determine which of the treatment groups (Computer-Assisted Instruction, Simulation/Games and Conventional Method) achieved highest, the data were subjected to Multiple Classification Analysis (MCA) in Table 2.

Table 2 shows that students taught with the Computer-Assisted Instruction achieved highest with an adjusted post-test mean score of 19.931 while students taught with Simulation/Games achieved better with post-test mean score of 19.201 and those students taught with the conventional method had an adjusted post-test mean score of 14.601.

The finding of this study which showed that students taught with the Computer Assisted Instruction (CAI) performed best is consistent with the finding of Thompson (1991), Suppes (1992), Lazarowitz and Huppert (1993) and Ajelabi (1998) who documented that students learn best using CAL. Moreover, Hawkdridge (1990) lends support to this assertion when he opine that computers should be used for teaching students because pedagogically, it serves as a means of achieving improved teaching and learning. He also concluded that children will learn any subject whatever better through Computer-Assisted Instruction. However, this finding does not conform with the result of Jegede (1991) who found no significant difference in the achievement of the students taught with the Computer and the Conventional methods.

Another observation is that students using Simulation/Games performed better than those taught with the lecture method. This in line with the submissions of Randel and Josephine (1992), Oritz (1994), Pulos and Sneider (1994) and Bilian and Bohdan (1994) who claimed that Simulation/Games is a better teaching strategy that makes students learn smiling and laughing. They also state the strategy's advantage as developing socio-dramatical area of the students and academic performance at the same time.

This study shows that the main effect of gender on student's achievement in biology is not significant. This is consistent with the findings of Akinsola (1994), Doran, Fraser, Giddings and Detuse (1995) and Oden (1998) who documented no significant effect of gender on students' achievement in their subject areas. However, studies such as those of Harding and Parker (1985) and Kamler (1993) documented significant gender difference in students' achievement. There is need for further researches in this area.

Moreover, this study shows that the main effect of locus of control on students' achievement in biology is significant. [F (2.89 = 5.241) P < 0.05]. This is consistent with the finding of Igwe (1991) that achievement creates positive locus of control that is in favour of the internals. However, this result does not

conform with the findings of Magnusson and Perry (1984) and Perry and Penner (1990) who documented no significant locus of control difference on students' achievement.

2-Way Interaction

The hypothesis on treatment and gender interaction effect on achievement in biology was not rejected. This is because the 2-way interaction was not significant [F (2,89) = 2.336 P < 0.05]. This is an indication that all the treatments employed in this are not gender sensitive as far as students' achievement in biological concepts is concerned. Since the effect of Computer-Assisted Instruction and simulation/Games do not vary from boys to girls, biology teachers are advised to freely employ these instructional strategies in their teaching since a student gender does not inhibit the extent to which the students achieve with these strategies. This finding tends to support the previous study of Finkelstein and Martin (1998) who documented no gender differences in students' achievement in Computer-Assisted Learning. Also, in Mathematics, such studies such as those of Opyene and Akurut (1995) and Park and Norton (1996) documented no significant gender differences.

The hypothesis on treatment and locus of control was not rejected. This is because the two-way interaction was not significant. [F (2,89) = 0.761 P. 0.05]. This implies that Computer-Assisted Instruction and Simulation/Games can be used to teach the students irrespective of their locus of control. Hence, biology achievement using those instructional strategies does not depend on students' locus of control. In order words, students that are internals and those that are externals would achieve equally when the treatment is given within the classroom environment. The explanation for this position is based in the concept of ability attribution on the part of internal students put forward by Perry and Panner (1990). To them, ability attribution is a situation where a student believes that his or her ability is sufficient to ensure success without trying hard. Hence, such perception like "I'm smart" and "I don't need to work" would lower motivation and impair optimum performance on the part of internal students.

The hypothesis on gender and locus of control was rejected. This is because the two-way interaction was also not significant. [F = (2,89) = 0.805, P < 0.05]. This implies that the factors of gender and locus of control do not mutually influence the dependent measures to produce a joint effect. The results of the two-way interaction when viewed against the background of the significant main effect of treatment tend to suggest that biology teachers should employ Computer-Assisted Instruction and Simulation/Games, irrespective of the students' gender and locus of control to enhance high level of performance in biological concepts.

3-Way Interaction

The findings revealed no significant interactions of Treatment, Gender and Locus of Control. [F 92,89) = 1.625; P < 0.05]. In other words, the 3-way interaction was not significant. This is an indication that the treatment, gender and locus of control do not mutually influence the dependent measure (achievement in biology) to produce a joint effect. Therefore, the null hypothesis that there is no significant three-way interaction effect is thereby not rejected. This result, when viewed against the significant main effect of the treatment thus suggests that biology teachers should use Computer-Assisted Instruction and Simulation/Games irrespective of the students' gender – locus of control groupings or combinations.

Conclusion

From the results of this study, it can be concluded that Computer-Assisted Instruction is a versatile strategy for improving achievement in biology. In addition, simulation/games is a potent strategy for biology instruction whereas the conventional method is not appropriate for biology teaching because of the poor performance exhibited by the group of students taught with the method. The use of Computer Instruction and Simulation/Games is therefore recommended for teachers in biology classrooms and can be used freely irrespective of some students' characteristics such as gender and locus of control.

Based on the findings of this study, it is recommended that the Nigerian government should provide computers, programs, instructional packages, costumes and enabling environment for the use of Computer-Assisted Instruction in the school. It is a matter of importance and urgency for the teachers to be trained in the use of computer and simulation/games for biology teaching through seminars, conferences and symposia organized by the government in collaboration with the Teaching Service Commission. This is essential because if the materials are available and the personnels are not trained, they would not be able to put them into proper use.

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