EFFECTIVENESS OF COMPUTER-SIMULATED EXPERIMENTS (CSE) IN TEACHING HIGH SCHOOL PHYSICS

SHIRLEY PASION CADAY

Presented to the 1st National ICTs
In Basic Education Congress
Cebu City, Philippines

December 6-7, 2004

THE PROBLEM

Background of the Study

In the 21st century, the world is becoming more and more technologically oriented. Thus, the Industrial Age gave way to the Information Age, an info-tech era which is as vital as the air we breath because this has brought changes to society, business, education, and our lives.

Indeed, the education sector is no exemption in the participation of an information-rich computerized society. To keep abreast with the emerging technological changes in the global, national and regional environment, our present educational system is continuously upgrading the resources through the modernization of the various elements of the system. Modernization can be pursued through the introduction of modern instructional aids and materials such as multimedia gadgets like computers. VHS, CD-ROM, TV, internet and the like.

Hence, the Department of Science and Technology (DOST), the Department of Education, the Commission on Higher Education (CHED), and the Technical Education and Skills Development Authority (TESDA) unanimously endorsed a new proposal on the use of more technologically

oriented instruction in the government schools. This is contained in a document entitled, “Education Technology Master Plan.”

Past Secretary Ricardo T. Gloria conceived the “Schools of the Future” to meet the needs of the modern times for the purpose of improving the quality of education particularly Science and Technology so as to produce graduates who are proficient in basic literacy, numeracy and critical thinking skills. This is to enable them to compete in the domestic and international labor market.

The schools of tomorrow shall be equipped with facilities, equipment, materials as well as new learning or delivery system like science laboratories, language laboratories and computer laboratories. It also aims to improve the quality of education to produce globally competitive graduates through its major features: the use of more instructional interventions using multi-media technology, redefinition of the role of the teacher from provider of knowledge to facilitator of learning and greater opportunities for individualized learning.

During the administration of former President Joseph Estrada, the then Department of Education, Culture and Sports launched a comprehensive education program that helped spread IT in public education (Gonzales, 1998). Dubbed as ERAP, this ambitious DECS project stands for Educational Resources Assistance Program. It seeks to provide learners from public and poor private schools more equitable

access to effective educational technologies to improve the teaching and learning process. Its national mission is to make the Filipino students from second to bottom among the 42 countries included in the Third International Mathematics and Science Survey (TIMS) (Gonzales, 1998). Hence, the urge to improve science education has stepped up the production of computer-related materials like Computer-Aided Instruction (CAI) which gears towards the modernization of education.

Computer-Aided Instruction is one of the new approaches of instruction, computer-based instruction, computer-assisted learning and other combinations of these words (Lockard et al., 1990). This study involves not only computer hardware but also softwares such as operating systems, programmed wares and other new ways of teaching, learning and organizational classroom experience.

It does not only concern the state of the art instructional materials but it is also concerned in making the teachers modern in their outlook, thinking and behavior. Therefore, a modern teacher in science is the challenge of the 21st century, one who can integrate technology and information into teaching and learning, on e who can adapt modern ways and employ invigorating teaching and learning approaches that facilitate efficient science education, a teacher who can capture students desire to acquire and use targeted skills making them more pleasant and scientific in their attitudes.

Science and Technology teachers then must make science interesting and challenging by introducing computer-aided instruction in the teaching and learning process. This challenge to reengineer and reinvent our educational system aims to improve the academic performance of students.

The use of the computer as an instructional aid offers hope to students who could grasp science concepts through the traditional methods. Hence, its growing applications at Sarrat National High School motivated the researcher to determine its effectiveness in teaching physics concepts, science processes and scientific attitudes.

STATEMENT OF THE PROBLEM

This research study aimed to investigate the effectiveness of computer-simulated experiments as one of the applications of CAI in the teaching of high school physics.

Specifically, it attempted to answer the following questions:

1. How effective is Computer Simulated Experiments (CSE) in the teaching of physics concepts, science processes and scientific attitudes?

1.1 Is there a significant difference between the mean pretest and mean posttest scores of students of the experimental and control groups?

1.2 Is there a significant difference between the mean posttest scores of the experimental and control groups?

2. What are the students' reactions toward CSE?

METHODOLOGY

This study used the experimental-control design. It made use of two groups of samples, the experimental group and the control group. The first group comprised the experimental group; the second group comprised the control group. The two teaching strategies were randomly assigned to the groups. The CSE strategy was assigned to the experimental group while the traditional laboratory strategy was assigned to the control group.

Three sets of pretests were administered to both groups to evaluate students' academic performance in the acquisition of physics concepts, development of science process skills and scientific attitudes. Computer-Simulated Experiments Questionnaire was administered to the experimental group to evaluate their reactions on the use of CSE strategy. After the pretest, the two groups were subjected too different strategies of teaching that served as the intervention. The students in the experimental

group performed activities using the computer while the students in the control group set up actual materials to perform similar experiments. Both groups were given the same posttests after being taught lessons on the five topics on velocity, inertia, freely falling bodies, momentum and Hooke's Law.

Both groups had similar steps in performing the planned activities of the five topics used in the study. They differed only in the third step. The experimental group used the computer in performing the activity while control group manipulated actual materials in performing the activity. Just like topic on Hooke's Law, the experimental group worked with the computer by changing the numerical variables in the programmed material to verify Hooke's Law while the control group set the needed materials and observed the elasticity of a material by using the rubber bond and spiral spring.

Locus of the Study

The locus of the study is the Sarrat National High school, one of the established Pilot Schools of the Future, a Pilot School for the Engineering Science Education Project (ESEP) and the Divisional Leader School of Ilocos Norte. It has projectors, LCD, VHS players and 22 sets of computer

with computer simulated experiments copied and installed by the researcher.

Computer-Simulated Experiments Package. These are simulated experiments copied and installed by the researcher to the window environment of the fifteen Personal Computers of Sarrat National High School. The module contains five physics experiments on Velocity, Free Fall, Inertia, Momentum and Hooke's Law. These were made and compiled by Abdull Khalinn Ishak of the Educational Technology Division_SEAMEO RECSAM, Penang, Malaysia and were shared to Sarrat National High School through the Department of Science and Technology. They are programmed simulated-experiments that approximate real-life situations and based upon realistic models. They can be worked on by an individual or small group of students. The programmed simulated experiments that were used in this study played roles of falling objects, moving objects and colliding cars without the risks otherwise involved. Changing the variables on mass and velocity of the programmed activities in momentum has effects on the collision of the models that can be seen by the student. The changing of variables is made through typing figures through the keyboard. This program requires students to record measured data, calculate expected values, and answer a series of thought-provoking questions designed to reinforce the theory behind each experiment. The learners of the experimental group did not do actual

manipulation of materials unlike those in the control doing typical laboratory work.

Data Gathering Procedure

The lesson plans for each topic for both the experimental and control groups were similar and have the following parts: (1) Pre-laboratory discussion, (2) Observation/Activity, (3) Post-laboratory discussion, (4) Generalization, and (5) Application. The experimental group used the CAI-Laboratory Strategy or the CSE and the control group used the typical laboratory strategy.

The researcher used her class schedule such that the experimental group and the control group were met daily. The two sections were scheduled successively to minimize communication or interaction between the students. Guided by the researcher, the experimental group worked in the computer room while the control group performed in the laboratory classroom. However, the researcher made it a point that the learning environments were conducive for both groups.

Before the actual study, a pretest on science concepts was carried out for both the control and experimental groups. The pretest helped to determine what knowledge the students possessed on the topics of Velocity, Free Fall, Inertia, Conservation of Momentum and Hooke's Law and helped to identify any possible misconceptions held by students. This

test was also used to determine whether or not the prerequisite knowledge needed by the students before the cited topics have been mastered.

The same tests were administered as posttests to both groups after they had completed all the laboratory activities and exercises in the courseware in the experimental group and all the laboratory activities in the control group. The scores that were obtained before and after the study indicated how the students benefited from interacting with the courseware or CSE and in performing activities with the typical laboratory strategy or traditional method. It also gave indications of the effectiveness of both methods in teaching the topics concerned.

Statistical Treatment of Data

Several statistical procedures were used in the experiment.

The weighted means were used to describe the extent to which the students developed the scientific attitudes.

Frequency distributions were used to describe the performance of the students in the experimental and control groups in physics concepts, science processes and science attitudes.

In the inferential aspect, the t-test for correlated means was used to determine if there is a significant difference between the pretest and posttest mean scores of the two groups along the following areas: (1)

physics knowledge, (2) science process, (3) attitude toward physics and (4) in comparing mean posttest scores of the two groups.

All data were processed by using SPSS for Windows.

Findings

1. There is a significant difference between the mean pretest scores and mean posttest scores of the experimental group in the test on science concepts. This is evident from the computed t-value of 16.07 of the observed difference between the computed means of 14.44 and 23.44

2. The experimental group also showed a significant increase in their posttest scores on science process skills as indicated by the computed means of 14.39 (pretest) and 18.00 (posttest). This difference yielded a t-value of 5.45 which is again significant at the .05 probability level.

3. An insignificant difference is formed along science attitude of the experimental group as evidenced by the calculated t-value of 1.22.

4. The increase of the mean score of the control group in physics concepts (14.28) in the pretest, and 23.78 in the posttest revealed a significant difference between the two mean scores as suggested by the t-value of 10.54.

5. There is a significant difference between the mean pretest (12.72) and mean posttest (18.94) scores of the control group in the science process skills test.

6. The attitude towards science of the control group did not improve as shown by the calculated mean of 109.50 and 109.78 and the t-value of .08.

7. The computed t-values of the posttest scores of the two group in the teaching of science concepts (.34), science processes (.68) and scientific attitudes (.24) are not significant.

8. The computed overall mean (3.52) of the posttest of the experimental group's attitudes toward computer-simulated experiments shows that the students of the experimental group have positive attitude with the CSE materials.

Conclusions

In the light of the findings of the study, the following conclusions were drawn:

1. In view of the aforementioned findings, it is concluded that CSE is an effective tool to capture the interest of students toward the learning of physics as a subject. The traditional method of teaching laboratory physics, on the other hand, remains to be one effective method

in imparting the basic science concepts and science process skills to students.

2. Although the CSE provides favorable outcomes in the realm of physics education, there is no significant to claim that the CSE is more effective than the traditional; method. However the CSE can be one best alternative in teaching the subject in the most modern way using high-tech scheme of academic instruction.

3. The development of science skills and knowledge in science processes are feasible to attain with any of the two methods. Most importantly, the two methods are equally capable of extracting the academic potentialities of the students toward physics learning.

Recommendation

In the light of the findings of this study, the following recommendations are hereby presented:

1. It is hereby recommended that teachers should be encouraged to use the CSE strategy in order to provide alternative challenging lessons in physics.

2. Introducing the CSE in the physics laboratory is one way of orienting the students to our fast developing and advancing technological world. It is therefore recommended that the government should support

the DECS thrust of modernizing instruction by allocating national and local funds to public schools to purchase computer units and other computer paraphernalia.

3. Computer education should be enhanced in schools to expose students to computer-aided instruction.

4. There should be in-service seminars and training of teachers on the use of computer in teaching their subjects specifically physics.

5. More researches must be done to test the effectiveness of other CSE materials in other physics topics or in other science subjects.

6. The design and development of CSE materials/modules is encouraged. Filipino teachers know better than foreign teachers about the strengths and weaknesses of Filipino students. Hence, we should not depend solely on the CSE products developed by foreigners.

BIBILIOGRAPHY

Gonzales, Andrew. "the Role of IT in Reforming our Teaching and Learning Infrastructure." *Eduviews 9,* (1998).

Pascua, Gregorio (1985). "Effectiveness of Computer." *MMSU Insights,* Vol. I.

Borja, Eduardo T. (1995). "Validated Programmed Materials to Improve Teaching Competence." Unpublished Doctoral Dissertation. Mariano Marcos State Univerfsity, Laoag City.

Diculen-Baraoidan Ligaya R. (1999). "Design, Development and Summative Evaluation of Computer-Assisted Instruction (CAI) Modules on Selected Topics in High School Physics." Unpublished Doctoral Dissertgation. De La Salle University, Manila, Philippines.

Ishak, Abdull Khalim (1996). "Velocity, Free Fall, Hooke's Law, Momentum, Inertia." *A Module on Physics Experiments in Computers*, RECSAM, Penang, Malaysia.