PhET Simulation-Aided lessons and Demonstrations: Approach to Enrich Students’ Understanding on the Least Learned Competency in Physics Education

Bernabe L. Linog
1 Agusan National High School
2 Saint Joseph Institute of Technology
1 A.D. Curato St., Butuan City, Caraga Region, Philippines
2 Montilla Boulevard, Butuan City, Caraga Region, Philippines
blinog@yahoo.com.

Myrna E. Lahoylahoy Ph.D.
College of Education, MSU-Iligan Institute of Technology
Tibanga, Iligan City, Philippines
myrna.lahoylahoy@gmail.com.

and Arnold C. Alguno Ph.D.
College of Sciences and Mathematics, MSU-Iligan Institute of Technology
Tibanga, Iligan City, Philippines
alphaarnie@yahoo.com.

Abstract: The study focuses on Physics Education Technology simulation-aided lessons and demonstrations as approach to enrich students’ understanding about sound and the utilization of developed enrichment activities as instructional materials to address least learned competency in physics education.

There were two groups (control and treatment) exposed to teaching-learning engagements. The control group was exposed to traditional method while the treatment group was exposed to PhET simulations and PhET-aided developed enrichment activities.

Results showed that the PhET-aided developed enrichment activities are usable, acceptable and could be used as instructional materials based on the evaluation of public secondary physics teachers. Furthermore, there exists homogeneity between two groups. Although both groups have gained significantly in their post achievement tests, the treatment group had a bigger increase as compared with the control group. It implied that learning is best achieved and observed when misconceptions are addressed, concepts are visualized and interactive environments are experienced through PhET simulations.

Keywords: Developed Enrichment Activities, Least-learned Competency, PhET Simulations and Demonstrations, Physics Education.
I. INTRODUCTION

For many years, the prevalence of issues and concerns within the educational system of the Philippines has been resonating even through the recent times. Still, the country should increase the population of competent teachers, should address the insufficiency of classrooms and textbooks, must improve the quality of education and should meet the demands of globalization. In science education, quality and quantity of instruction remain the threats to our educational standards. There exists a difficulty in delivering science concepts and applications because in most areas, science teachers who are non-major professionals are deployed in the workplace. The lack of advanced laboratory materials and equipment also exacerbate the poor condition of teaching-learning process and the insufficient resources of teaching tools, techniques and strategies in science aggravate the difficulty to achieve the desired skills and competencies. These are determined factors that contribute to the increasing least-learned areas in science and technology that eventually affect the poor National Achievement Test results of both private and public secondary institutions in the Philippines.

As revealed in the study conducted by Orleans (2007) on the conditions of secondary school physics education in the Philippines: recent developments and remaining challenges for substantive improvements, the current state of science education in the Philippines, particularly in the basic education level, lags behind other countries in the world. The results of the Second International Science Study (SISS) and Third International Mathematics and Science Study (TIMSS) placed the Philippines in disadvantaged positions among participating nations. In the SISS, the Philippines ranked almost at the bottom of the list of seventeen (17) nations which took part in this large-scale evaluation of educational achievement. Similar outcomes were revealed in the 1995, 1999 and 2003 TIMSS. In different science subject areas, achievements in Physics of Filipino students appeared below the international standards (US Department of Education National Center for Education Statistics 2000, International Association for the Evaluation of Educational Achievement 2004).

Further, the Department of Education (DepEd) through the National Education Testing and Research Center (NETRC) disclosed that in the entire trend of National Achievement Test (NAT) since 2004 until the most recent results, huge numbers of examinees have low mastery in science and technology. Fact, in 2004-2005, 74.26% of the total population scored below 50 percentages while in 2005-2006, 77.03% fall within the same stratum.

The depth and breadth of least learned competencies in physics education in the Philippines vary by institution, by curriculum and in a smaller scale by section. Mostly, secondary students have difficulty in grasping electromagnetism because of its intricate mathematical requirements, in waves because of media having different molecular structure and orientation that require analysis especially if waves have to travel through various non-uniform media and in electronics because foundations in chemistry and physics are necessarily intact and substantial.

The influx of proven teaching methodologies and strategies to address the least learned competencies in our educational system mushroomed rapidly and are already utilized as tools to enrich students’ understanding. Variations in the approaches to fit the learning styles of the learners have been taken into action. Authorities have exhausted means and programs to respond this educational malady. Yet, researchers are still in the process of looking for an effective measure to enrich students’ understanding on the least learned competencies.

The advent of Physics Education Technology (PhET) opens a gateway to
respond the increasing least learned competencies through computer simulations. Several studies and researches about its utilization and effectiveness have been conducted by different educational institutions and identified educational researchers worldwide. The study of C. Weiman et.al., (2010) about teaching physics using PhET simulations revealed that PhET sims can help introduce a new topic, build concepts or skills, reinforce ideas and provide final review and reflection. Sims are unique in the way they can blur the boundaries between lecture, homework, class activities and laboratory because one sim can be used in similar ways in all of these. They also can provide a common visualization between students and teachers that can facilitate all communication and instruction. They further disclosed that there are some unique characteristics of sims that can be capitalized when designing activities. The most significant differences from other media are that sims are quite engaging; expert-like models are made more explicit; addressing common misconceptions is often built into the design and considerable guidance and feedback is built into the sim (only specific parameters can be adjusted and students see an immediate response to changes). These unique characteristics of sims make them a unique learning environment. Students will explore sims more productively on their own than they would on textbooks or most lab experiments. They also found out that it is important to not “over-guide” sim use. With guidance that is too explicit and structured, students actually explore and learn less. Because the amount of guidance needed with a PhET sim is less than with traditional materials, they suggested to use sim with students with less guidance than teachers normally would. The key is to engage the students in productive self-driven exploration.

In this study, the researchers utilized the developed enrichment activities aided with PhET lessons and demonstrations to enrich students’ understanding on the identified least learned competency in physics education. This is a quasi-experimental pretest-posttest with unequal groups type of research where two unequal population of students were introduced into two different teaching-learning engagements; one was exposed to traditional method while the other was introduced to PhET lessons and demonstrations. The primary focus of this study was to determine whether PhET simulation-aided lessons and demonstrations would augment students’ understanding given the same learning parameters through pretest and posttest measures.

II. METHODOLOGY

A. Designing Pre and Post Achievement Tests

In this stage, pretest and posttest were designed uniformly based on the learning competencies in teaching secondary physics. The researchers framed the Table of Specification (TOS) that indicated the included competencies, corresponding percentages of questions based on institutional time-frame requirement and the assigned specific type of question emphasizing the taxonomy of learning. Questions were formulated with much regard on the Higher Order Thinking Skills (HOTS). The achievement tests went through face validity, a simple form of validation that determined if the test seemed to measure what it is intend to measure. In here, the researchers considered that certain criterion and targeted variables were included and could be measured by the instrument. Also, the instruments were validated by some physics teachers where comments and suggestions polished and improved its applicability in this study.

B. Developing Enrichment Activities

The developed enrichment activities on sound started with mapping the standards based on the Philippine Secondary School Learning Competency (PSSL) at the same time revisiting the simulations about waves and sound already designed by Physics
Education Technology (PhET). It contained parts such as objectives, conceptual guides, definitions of terms and procedures. These developed enrichment activities were utilized by the students during the teaching-learning engagements with some physics teachers observing the conduct of the lessons and validating the acceptability and applicability of the developed enrichment activities.

C. Rubrics for Validating the Enrichment Activities

Validation of the developed enrichment activities was based on the researcher-made rubrics, which used a five-point Likert scale. Inclusive of the rubrics were the statements indicating whether the objectives were clearly stated and would be achieved within the time frame of the actual teaching-learning engagements; whether the concepts involved were thoroughly observed during the conduct of the activity; whether it substantially explained its methodology; whether the students could easily understand the procedures of the developed activities; whether the simulations are functional and could elicit students’ interest; whether it could reinforce students’ understanding about sound as one of the least learned competencies in physics; whether the developed activities are applicable to any curriculum offered at the school; and whether they can be used as classroom instructional materials. The rubrics underwent validation with some master teachers in physics and teachers who finished Master of Science education major in physics.

D. Teaching-Learning Engagements

The control group was exposed to traditional method where the teacher/researcher used the chalk-talk approach, expositions were made and students’ activities were conducted. Lessons delivered were based on the prepared lesson plan per session indicating the teacher’s objectives, specific subject-matter, considered references, lesson proper, designed activities, evaluation of learning outcomes and learning engagements.

On the other hand, the treatment group was exposed to a learning experience using PhET simulation-aided lessons and demonstrations and the developed enrichment activities. The teacher prepared lesson plan for every session; however, variation is made in the lesson proper. Selected Physics Education Technology simulations were utilized. The same evaluative tool was used to measure the understanding of the learners per session on specific subject matter. There were physics teachers observing during the teaching-learning engagements on both groups.

III. RESULTS AND DISCUSSIONS

![Fig.1](image1.png)

Fig.1. Pretest Measures of Both Groups

Both groups have the same highest score. Although the control group scored higher than the treatment group, it is not statistically significant. Both are negatively skewed, meaning more students scored below the mean. In the Levene’s Test of Equality of Variance, F-value is 0.963 and p-value is 1.330. Since the p-value of 0.061 is greater than 0.05, data show no difference on the average scores of two groups. Their pretest performances were comparable.
lessons and demonstrations. It has been posited by Bruner in the discovery learning theory that when students interact with the world by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments, it would result that students would likely to remember more concepts and knowledge discovered on their own. Furthermore, this also confirms multimedia learning theory that if both visual and auditory channels are presented with information, more knowledge is retained.

IV. CONCLUSIONS

Based on the results of the study, the following conclusions were drawn:

1. The developed enrichment activities are usable, acceptable and applicable based on the evaluation conducted by some select physics teachers.

2. The students of the treatment group performed better based on the revealed scores after exposing them to the developed enrichment activities with the aid of Physics Education Technology (PhET) simulations.

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REFERENCES


