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Implementation of Online Problem Based Learning Module in Physics for Grade 9

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Abstract The study used a quasi-experimental design with the purpose of assessing the effectiveness of the developed online PBL module in teaching Physics. The development of the online PBL module made us of Neo LMS as its learning platform. The compliance to ISO 9126 software standard and to its content characteristics were evaluated by twenty (20) Information Technology and Physics teachers, respectively. In this study, statistical procedures and techniques using IBM SPSS Version 20 were used. A sample of sixty (60) Grade 9 students were purposively selected to determine the significance of the developed online lessons using PBL approached. They were divided into Control Group and Experimental Group. The Control group was taught the lessons using 'face-to-face" mode of delivery while the teaching and learning process of the Experimental Group made use of the electronic platform. The instruments used in this study were adopted from ISO 9126 survey questionnaire, content evaluation form, and a pre-test and post-test. Data were analyzed using frequency, percentage, Mean, and paired t-Test. Result of the validation of the developed online PBL module showed that the Mean ratings of expert evaluators revealed that the online module contain qualities of a strongly agree for technical characteristics and agreeable for lesson content. The post-test scores of the Experimental Group were less than Control Group's scores. It suggested that the use of the developed online PBL module, as a supplementary tool in learning Physics for Grade 9, did not improve the learning outcome of the students.

Keywords multimedia tools, technical characteristics, learning theories, kinematics, dynamics

Introduction

Rapid development in technology have given education a major upgrade as it offered teachers new resources and teaching tools. Within the same breadth, it also presented students new and more interactive instructional materials to learn ideas and skills which characterizes the learning environment of the 21st century. In current physics education, experiments in the laboratory alone is not enough in providing an authentic research experience. Moreover, providing opportunities for learners to participate in contextual based inquiry through direct observation and inquiry into the real world is very supportive in developing the ability of understanding the concepts of physics and scientific skills. Experiments enhancing the understanding of presented lesson in an e-learning environment will give students another avenue for learning. It will also teach the students not only the science concept but also problem solving, creative, and collaborative skills which is one of the 21st century skills [8].

In the onset of globalization, learning has transformed into e-learning that is mobile learning, augmented reality, virtual learning, gaming and other technology-supported learning which is still on the move. Dr. Coburn said that education needs to be able to respond to additional demands of a rapidly globalizing world because of the present borderless information society [4]. This can be done by making a way to save the environment, harmony with everyone, cultural and social diversity, augment healthy competitiveness, and the concept of a global community. He further stressed that education develops the student to connect and live in harmony with the environment around him because globalization has changed the size nature and quality of the environment.

Use of Information Technology in Education

Recent review studies have indicated that learning environments can be enhanced by advanced computer technology such as simulations, probe ware, augmented reality, and virtual reality applications, to facilitate learning and to shape instructional practices [1, 25]. The use of computer-based interactive media plays an important role in teaching physics concepts related to dynamics and kinematics because by using video recording and image modeling, one can observe physical phenomena of physics. The use of the Web as an educational tool has provided teachers with a wide range of new and exciting teaching experiences that are not possible in traditional classroom [15]. Owing to the rapid growth of advanced educational technologies, the features of learning environments have undergone significant changes. For example, internet technology may create an environment wherein collaborative, distant, interactive and inquiry-based activities are provided to foster knowledge construction and meaningful learning [16] which are needed for the 21st century learning.

Educators are aware of the challenges and opportunities that arose with the wide available high-performance computers on school campuses and homes. Despite the growth in understanding ICTs, there is still much not known about online learning. Online learning as a modern strategy for teaching and learning is multi-dimensional and dynamic, changing according to context, circumstances and interest. Learning using the web can be used in association with 'face-to-face' teaching [20] which is commonly called blended learning. According to Wheeler, educational tool and approaches must be used appropriately and effectively, and students do not really care what the learning is called or whatever tools are used, as long they learn, and ultimately pass their examinations and achieve a high grade [24]. Learning will happen if the conditions are right, and it will happen whether and technology are present or not.

Problem-Based Learning (PBL) as Instructional Strategy

The characteristic of problem-based learning (PBL) can be found into the progressive thinking, especially to John Dewey's belief that the learners must be taught in their own way of understanding, investigating, and creating knowledge [6]. In the country, PBL is made available to K-12 teachers with a structured procedure to assist student's build critical thinking and problem-solving skills while students capitalized on acquisition of important knowledge. Importantly, Duch, Groh, and Allen had figured out the steps used in PBL and had designed particular skills that require them to find needed information, think through a situation, solve the problem, and develop a final presentation critically, cooperatively, and effectively [7]. Torp and Sage described PBL as focused, experiential learning organized around the exploration and resolution of a complex, real-world problems [23].

In a PBL environment, the use of multimedia had helped and convinced students to communicate, discuss and collaborate and share the knowledge from their collected information. With the online communication, they were able to seek solution to the problems in learning activities [19]. The study conducted by Sendag &Odabasi centered on the effects of online learning environment on undergraduate students' and how online learning environment affect their critical thinking skills and content knowledge acquisition. Results showed that learning in an online PBL had improved remarkably their critical thinking skills [21]. An exploratory study done by Ertmer P. et al examined the perception and practices of five successful middle school PBL teachers regarding the specific difficulties encountered with PBL teachers and the strategies they used to address them [10]. Although PBL teachers had faced multiple challenges when implementing PBL, however these teachers were resourceful enough to discover and apply the useful instructional strategies to challenge their students in interdisciplinary content and learning processes that met or exceeded required academic standards.

The Learning Theories: Constructivism and Connectivism

The main target of this study was to design and develop instructional materials in teaching Physics for Grade 9 through infusing technology into the curriculum and integrating a blended learning environment using a variety of rich online educational multimedia resources. Considering that the present generation of students is tech savvy, having inhabited, navigated, and communicated using these advanced technology tools in an information-rich world, it is beneficial to be able to grasp their needs so as to affect educational efforts in its maximum potential. Thus, this study anchors on the theories of constructivism, connectivism and IPO Model of Instructional Design [18] was used for the method (figure 1).

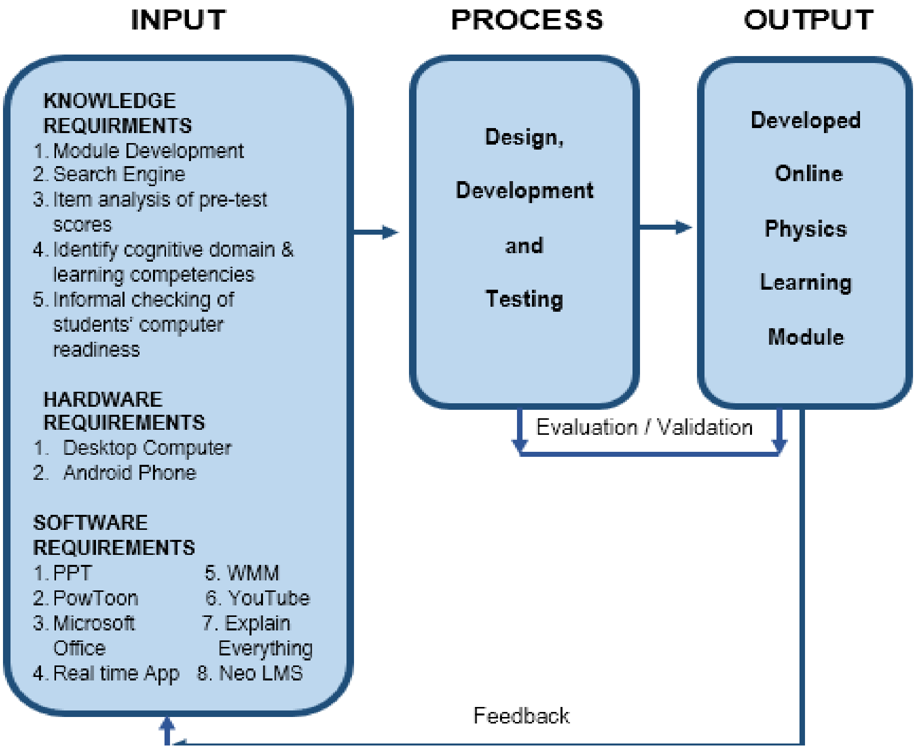

Figure 1: The Conceptual Paradigm Using IPO Model

In the constructivist paradigm, the learner, rather than the teacher, is the focus of the event. It is the learner who interacts with the environment and thus gains an understanding of its features and characteristics [14]. Ertmer pointed out that teachers who had intense constructivist pedagogical conviction were more likely to apply multimedia elements in the classroom than teachers who maintained the traditional pedagogical belief [9]. Another evidence had shown that teachers who are believers of the constructivist's approach triumphantly integrated technology into the learning process [13].

Another model for learning that acknowledges the tectonic shifts in society is called connectivism. In this model, learning is no longer an internal, individualistic activity. Learning is determined by the impact of new learning tolls and the environment changes. Cognitivism is more concentrated on Piaget's notion of age-dependent "stages of development" to define the mental abilities of learners.

Learning Management System

One of the biggest trends in the use of information technology (IT) in schools and universities within the remaining decade has been the adoption of learning management systems (LMSs) to support the teaching and learning process [3]. LMS is an information system that facilitates online learning that processes, stores and disseminates educational material and support administration and communication associated with teaching and learning. In this developed system, Neo LMS was used as the learning platform [12]. NEO LMS is a cloud-based learning management system for managing all classroom learning tasks, assessing students' learning through formative tests, facilitating collaboration, or tracking student achievement. It has the following features such as skills tracking, synchronous learning, assessment, social learning, blended learning and learning paths, mobile learning applications, and classroom management (figure 2).

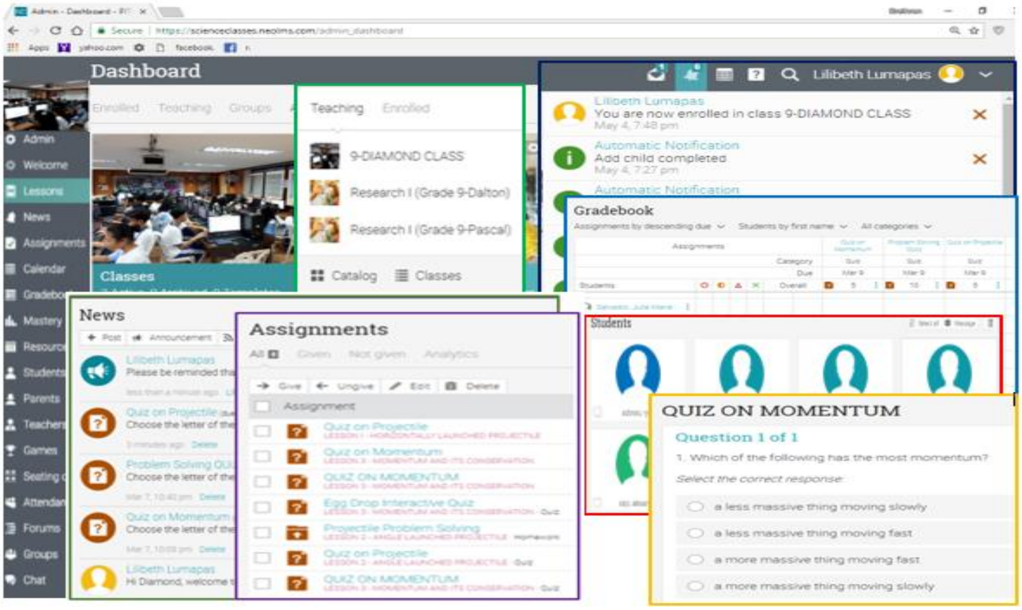

Figure 2: The Neo LMS Site

Using Neo LMS, the most appropriate approach to carefully examine the context of the online PBL module developed was to look into the totality of relationships between the students and surrounding elements, that is, everything the learners can act upon, within a teaching and learning situation. This forms the very basis for the process underlying the design, development, use, and evaluation of the online learning materials (figure 3).

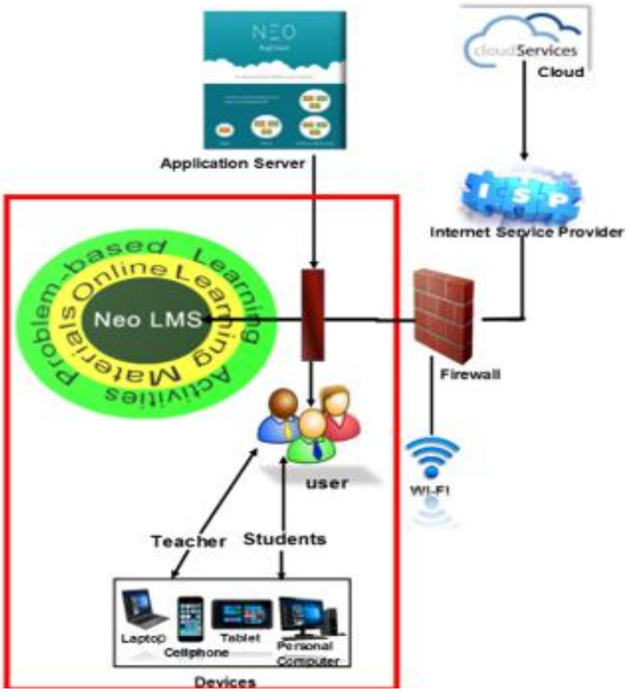

Figure 3: Context of use of online module and relationships between various elements

Capitalizing the traits of the net generation students and the availability of technologies in addressing challenges of globalization, hence, this study aimed to design and develop an online PBL module with the use of different multimedia elements in teaching Physics for Grade 9 students (figure 4). Further, this study was limited to face and content validation of the online PBL module in Physics. The evaluation of the NEO LMS and the online instructional module was measured solely on the basis of the applications that was applied and covered by its content, technical characteristics, and functionality, and the effectiveness of the online instructional module in the knowledge acquisition of the students.

Figure 4: The Lesson Interface with the Different Multimedia Elements

Materials and Methods

The study was conducted at Pitogo High School in Makati City, Philippines. It is one of the ten (10) secondary schools and one of the biggest high schools in the Division of Makati with an approximate population of 3 800 students enrolled for the School Year 2017-2018. Currently, there are a total of 150 employees (teaching and non-teaching staff) of the school in which 140 of them are teachers who are computer literate.

Both developmental design and quasi-experimental design were applied. The developmental design used the Input-Process-Output (IPO) instructional model to design and develop the online PBL module in Physics for Grade 9. The quasi-experimental design used a pre-test and post-test design involving two groups – the Experimental Group and the Control Group. From the sixty (60) total sample size of student respondents, thirty (30) were purposively categorized as the Control Group and the other half was the Experimental Group. A purposive sampling was employed which was based on the easy availability and accessibility of the participants. Students' demographic information was culled to assess students' characteristics (gender, age, and third quarter grade).

In the Experimental Group, students were given an access to the Neo LMS electronic platform. The blended learning mode (combination of face-to-face and Internet-based learning) was adopted in the teaching and learning process. The 'face-to-face' meeting of the students with the teacher was done during a normal class time four times a week. On the other hand, the Control Group was taught using the 'face-to-face' mode of delivery with the lecture, demonstration and illustration methods dominated most of the lessons.

To assess the efficacy of the newly developed online learning module in Physics, this study collected the students' pre-test and post test scores, and the expert evaluation of the developed system using an adopted ISO 9126 software standard survey questionnaire [2] and Physics content survey questionnaire[5].Other data gathering sources were ideas collected from teaching experiences, previous meaningful lesson plans and activities, teacher's quality circle, internet, and libraries of the different universities in Metro Manila**,** Philippines.

Both descriptive and quantitative methods were used to analyze the data gathered. Differences between pre-test and post-test scores was computed for each student and both scores were compared. All data were entered and analyzed using Statistical Package for Social Sciences (SPSS) Version 20.0.

Results and Discussion

This study focused on the implementation of online PBL module that was developed which was validated by experts as supplementary tool for classroom teaching and its effects on the academic performance of Grade 9 students. Both groups had taken the pre-test and post-test composed of 30-item multiple choice questions which covered information in Kinematics and Dynamics concepts. This study utilized the descriptive quantitative method. The frequency and percentage distribution of the student respondents were identified according to age, gender, and the third quarter grade.

Frequency and Percentage Distribution of the Respondents According to Gender and Age

Table 1: Frequency and Percentage Distribution of the Respondents according to Gender and Age

Category	Gender		Age	
	Male	**Female**	**15 years old and above**	**16 years old and below**
Experimental	15	15	29	1
Control	11	19	27	3
Frequency, f	26	34	56	4
Percent, %	43.3	56.7	93.3	6.7

From table 1, according to gender, it shows that there are more female which constitutes 56.7 % of the total number of respondents than male respondents. In terms of the age of the respondents, it revealed that there were more young respondents between the ages of 15 years old and below which constitutes 93.3 % of the total number of respondents. The selected students in the control group had an average third quarter final grade of 1.867 with standard deviation of 0.6288. The average third quarter final grade of the experimental group was 1.900 with standard deviation of 0.7120. It can be gleaned from the profile of the respondents that there are more female respondents, and that the ages of these respondents are 15 years old and below. Moreover, their level of cognitive performance during the last quarter was homogenous and comparable within the groups.

Comparison of Pre-Test Scores of Experimental and Control Group

Table 2: Pre-Test Scores of the Experimental and Control Group

Groups	N	X	SD	Computed t	*p*-value
Experimental	30	10.033	2.8465	2.653	0.013
Control	30	12.067	3.1065		

Table 2 shows that the experimental and control groups do not have the same level of performance prior to experimentation. It can be gleaned from the result the control group obtained a Mean of 12.267 while the experimental group had a Mean of 10.033. Thus, the respondents in the control group had a greater prior knowledge on the topics than in the experimental group.

Comparison of the Pre-Test and Post-Test Scores of the Control Group

Table 3: Pre-Test and Post-Test Scores of the Control Group

Tests	N	X	SD	Computed t	*p*-value
PreTest	30	12.067	3.1065	- 0.167	0.869
Post-Test	30	12.167	2.4925		

Table 3 shows that there is no significant difference in their pre-test and post-test results. The pre-test scores obtained a Mean of 12.067 while the post-test scores had a Mean of 12.167. The computed t of – 0.167 with a p = 0.869 showed that the respondents post-tests scores had no improvement in their performance as compared to their pre-test results using the face-to-face mode of delivery.

Comparison of the Pre-Test and Post-Test Scores of the Experimental Group

Table 4: Pre-Test and Post-Test Scores of the Experimental Group

Tests	N	X	SD	Computed t	*p*-value
Pre-Test	30	10.033	2.8465	- 2. 521	0.017
Post-Test	30	11.867	3.0483		

Table 4 shows that the experimental group has a slight improvement in their performance using the online PBL module. From the computed t of – 2.521, there is evidence to suggest that the respondents showed statistically higher scores obtained in the post-test (p = 0.017) than the pre-test.

Comparison of the Post-Test Scores of the Experimental and Control Group

Table 5: Post-Test Scores of the Experimental and Control Group

Groups	N	X	SD	Computed t	*p*-value
Experimental	30	11.867	3.0483	0.416	0.680
Control	30	12.167	2.4925		

Table 5 shows that there is a significant difference in the post-test scores of the experimental and control groups. The control group obtained a greater Mean of 12.167 than the experimental group with a Mean of 11.867 which showed that at 5% significant, the online PBL module is not effective (p=0.680) as an instructional teaching aid.

Evaluation of the Learning Materials in Physics for Grade 9

Table 6: Evaluation of the Learning Materials in Physics for Grade 9

Statements	X	Interpretation
1. The purpose of the learning objects approach and material used is well-defined.	4.55	SA
2. The learning goals are appropriate and aligned with the intended learning outcomes.	4.64	SA
3. The objectives of using the learning objects approach and materials are attainable.	4.55	SA
4. Learning commons and activities are clear and logical.	4.46	SA
5. Level of difficulty is appropriate for the target audience.	4.55	SA
6. Use of learning objects approach is motivational.	4.73	SA
7. The active learning objects approach stimulates student creativity.	4.64	SA
8. The content is accurate and grammatically correct, and sufficient for intended use.	4.55	SA
9. The style and readership of writing is clear and concise.	4.36	A
10. The content is sequence logically.	4.64	SA
11. Feedback on student's responses uses constructive language.	4.46	SA
12. Feedback provides positive learning outcomes.	4.64	SA
13. Corrective responses are provided in a timely manner.	4.73	SA
14. The learning environment encourages engagement of learners.	4.73.	SA
15. Learning environment provides support system for interactivity and offers new knowledge and skills	4.64	SA
Total Mean	**4.23**	**Agree**

Legend: 1-Strongly disagree (SD); 2-Disagree (D); 3-Neither agree nor disagree; 4-Agree (A); 5-Strongly agree (SA)

Table 6 shows that the learning material used in the developed online PBL module in teaching Physics for Grade 9 in aid of the learning process was favorable to the experimental group as far as content, objectives, appropriateness, relevance, interactivity and usefulness are concerned. This implies that in order for a lesson to be of excellent or a very good quality, a series of evaluation should be done for improvement.

Evaluation of the Learning Management System based on ISO/IEC 9126 Software Standard

Table 7: Evaluation of the Learning Management System based on ISO/IEC 9126 Software Standard

Criterion	X	Interpretation
Functionality	4.27	SA
Reliability	4.68	SA
Usability	4.58	SA
Efficiency	4.60	SA
Maintainability	4.30	SA
Portability	4.73	SA
Total Mean	**4.53**	**SA**

Legend: 1-Strongly disagree (SD); 2-Disagree (D); 3-Neither agree nor disagree 4-Agree (A); 5-Strongly agree (SA)

Table 7 presents the summary of the validation of the developed online PBL approach in teaching Physics using ISO 9126 software standard. The overall Mean is 4.53 which means "strongly agree", as evaluated by the IT professionals. For Functionality, it shows a Mean of 4.27. For Reliability, it shows a Mean of 4.68. For Usability, a Mean of 4.58 was obtained. For Efficiency, it demonstrates a Mean of 4.60. For Maintainability, it displays a Mean of 4.30. For Portability, a Mean of 4.73 was obtained. This implies that the online learning module passed the standard established by ISO 9126 software standard. Thus, the online learning module using Neo LMS as the learning platform is user-friendly that can easily interact with another system, capable of handling errors over time, and it can be accessed everywhere, anytime as long as internet connection is available.

Conclusion

There are numerous online educational state-of-the-art technology resources available today to aid in the teaching-learning process. It was presented in this study that the multimedia tools/elements chosen, such as visual, audio, and animation included in the developed online module can provide an environment of fun and learning that holds a strong constructivist and connectivist pedagogical beliefs. The developed online problem-based learning in Motion in Two-Dimension and Momentum and Its Conservation module were validated by IT experts and experienced Physics teachers which certainly had enhanced the quality of the developed lessons through their positive responses. The IT evaluators gave an overall composite Mean of 4.53, interpreted as "Strongly Agree" in terms of functionality, reliability, usability, efficiency, maintainability, and portability, and an overall Mean of 4.23, interpreted as "Agree" by the Science teachers in terms of content, presentation, readability, and ease of use. From the results of the t-test analyses of the post-test scores of the experimental group (X=11.867, SD=3.05) and control group (X=12.167, SD=2.49) showed less improvement on the experimental group and that that the use of online learning materials implemented in the e-learning management system was not effective after the intervention.

One of the problems encountered during implementation was the access to internet connection. It was noted that the respondents were less motivated to support the online learning module because of no definite access to wireless connectivity either in school or at home. Hence, students' problem-solving skills on Kinematics and Dynamics were mastered the least, thus, having a low performance in these topics. The online learning module may be further broadened in terms of content and substance to cover all levels in high school to ensure mastery of skills and knowledge. Additional features can be added to the developed online learning module in Physics to further improve the characteristics of the lesson and the accessibility of free internet connection.

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