Development and Validation of a Worktext in Electromagnetism

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ABSTRACT

This experimental and developmental study aimed to develop and validate a worktext in Electromagnetism. Thirty-nine students underwent the traditional approach, while a total of 40 students used the worktext in Electromagnetism. Mean, mean percentage scores, Analysis of Covariance (ANCOVA), and the coefficient of concordance were used to analyze the data gathered. Findings revealed that the worktext in Electromagnetism is valid and can be used by Physics students and teachers to supplement the teaching-learning process. After exposure to the two teaching methods, the students' performance in the experimental group improved from Did Not Meet Expectations to Very Satisfactory and from Failed to Passed. In contrast, the performance of the control group improved from Did Not Meet Expectations to Satisfactory and from Failed to Passed. The control and experimental groups are comparable in terms of their performance in Electromagnetism. Though there is no significant difference in the posttest mean scores of the two groups, it is worth noting that the experimental group has a higher mean score than the control group. In addition, the experimental group performed as well as the control group, which consisted of performing students. Instructional materials like worktexts and textbooks are effective materials in enhancing and facilitating the learning process. The validators are in agreement in their evaluation of the worktext.

Keywords: Development, electromagnetism, worktext, validation

INTRODUCTION

Science education plays a significant role in this universe because of its relation to technology and industry, which are areas of high priority for development. Strong science education has propelled the economies of Asian countries like Japan and China. It is for this reason that the Philippines ought to have a strong science education because it is a tool for progress. Strong science education means better things for society by helping students become accountable citizens. They will help build a better economy, contribute to a healthier environment, and bring about a positive future for everyone.

The goal of science education in the past was mainly to train only a small part of the population that would become future scientists and inventors. Today, the goal is to improve science education so that more and better-educated scientists and engineers will be produced. In order to achieve this, there is a need to transform science education by making students understand and appreciate science.

According to Robles (1993), as stated by Lim (2016), if one has to solve the contemporary problem of how to improve the quality of science education, no matter what the discipline is, the answer lies in the right educational objectives and effective evaluation at the two ends, and instructional procedures and materials at the middle.

Educators, while aiming for quality, undertake several measures for the improvement of the educational system. Curricular revision and syllabus enrichment have to be done to catch up with the fast modernization of time. Thus, the individual teacher is a part of the curricular decision, and one aspect of this is instructional material development. Instructional materials like modules, computer-aided instruction, worktexts, and the like are used to facilitate the teaching-learning process. These instructional materials are carefully and logically arranged and structured, and it emphasizes practice and drills, for learning begins and progresses through experience. Adalikwu and Iorkpilgh (2013) pointed out that the use of instructional materials will significantly improve the performance of the students and that it will generally improve students understanding of concepts, which will lead to high academic achievement.

One of the branches of science, which lacks instructional materials, is Physics. Physics is the most basic of all the sciences. It is the foundation of chemistry, which in turn, is the foundation of biology. It is a general education subject aimed to give discipline to the mind. It develops logical and critical thinking, sound reasoning, keen observation, and unbiased judgment. However, it is still a sad fact that students perform low in physics. Orleans (2007) reported that the achievements of Filipino students in Physics are lower than international standards. The Philippines ranked third in the 1999 TIMMS and fourth to the last in 2003 TIMSS. Philippine-based studies also present the same conclusion of low performance in Physics.

There are many reasons why students perform low in physics. Al-Methen and Wilkinson, as cited by Mekonnen (2014), reported that students' low performance in Physics is due to the lack of conviction and reliance on the knowledge they possess, which could affect their level of performance in the classroom. Owolabi (2012) pointed out that failure of students in Physics globally is basically due to lack of participation of students in the teaching-learning undertakings from the beginning of a new concept to be taught, lack of capable and trained teachers, and unavailability and dearth of materials. Marzan (2016) mentioned that schools lack instructional materials and apparatus, training for the teachers who are major implementer of the curriculum is inadequate, and teachers do not have enough time for instruction which prevents them from finish all the topics and meeting all the learning competencies stipulated in the curriculum guide. An initial survey was conducted, and it was found out that not all the content areas in Physics are being discussed by the science teachers. If this is the case, this will result again in the low performance of the students in Physics.

In response to these problems, the researcher feels the need to develop a worktext in Electromagnetism. A worktext is an instructional material carefully sequenced according to the course syllabus that contains brief concepts and practice drills and exercises. The use of worktext is not only beneficial in attaining higher scores on standardized exams. It will also result in the increased power of self-direction, retention of concepts, skill in fundamental processes, reasoning ability, and solving problems. The researcher believes that with the aid of the worktext, learning could be made optimal for a variety of students by allowing the fast learners to proceed to more difficult problems and to read in advance the succeeding lessons, and letting the slow learners read further and trying out the examples themselves for better comprehension. Through this worktext, teachers would cover all the component topics included in the science curriculum, and students could learn the concepts in Electromagnetism in a shorter period. It will also contribute to making Physics instruction more comprehensible, exciting, and simple, without sacrificing quality.

FRAMEWORK

This study is governed by the following theories and principles: Skinner's Programmed Instruction, The Individualized Instruction Model, Conditions of Learning, and the Cognitive Humanism Theories.

Skinner's Programmed instruction is a learning technique in which a material is organized in sequential and graduated steps, and the learner is expected to make a response after absorbing each step. If the answer is correct, the learner advances, and if not, the learner further reviews the material.

The abilities and interests of learners are the basis of content, instructional materials, instructional media, and pace of learning of individualized instruction. This is different from a one-to-one student/teacher ratio or tutoring because it is impossible to have a teacher for each student. Individualized instruction depends upon instructional materials which are carefully prepared and sequenced. It is recommended for students in the junior high school level since they are more disciplined to study independently. Individualized instruction is in line with the constructivist theory, which states that a student should construct his or her learning or knowledge. The key idea behind this model is that learners will better understand the materials and effectively retain information for much longer. The fast learners or those who can grasp a particular concept in a short amount of time can move on to the next subject. In contrast, those who are having difficulty understanding the concept can move at a slower pace in order to dig further into the topic. In this model, every learner has the opportunity to get the most out of the experience, even if the learner is in a group with other learners who possess different skill levels or strengths (Individualized Instruction, 2010).

In addition, there are other important forces that are driving these new trends in teaching and learning within today's educational profession. Some of the new and emerging educational theories and practices have their roots in research, conducted from the mid-1980s, primarily in cognitive psychology, which has resulted in increased attention to the social, cultural, and personal factors of learning. These more recent theories cannot be categorized into the more traditional approaches of behaviorism, cognitivism, and humanism. Rather, these new and emerging theories and approaches, often adapted from cognitive, social, and humanistic learning processes, have evolved into a new category of learning theory referred to as "cognitive humanism." These cognitive-humanistic theories integrate the core components of cognitive learning with social learning and learner-centered humanistic principles. The emerging theories of cognitive humanism include constructivism, social learning theories, cooperative learning approaches, and transformational learning theory. The teaching-learning process will focus on the mastery of the learning standards, the role of the teacher as a facilitator, developing the problem-solving skills of the students, relating new ideas to previous knowledge, and providing opportunities for students to pursue topics in depth so that they can understand the material for themselves.

According to Ornstein (1997), as cited by Pablico, developing an instructional material is essential and an ingredient of good teaching. In developing instructional materials, needs or problems must be addressed, objectives developed, methods and materials determined, tests and evaluation conducted, and parts of the program and materials revised.

Instructional materials like modules and worktexts are claimed by proponents as factors that can increase the self-reliance and intrinsic motivation of the students. Aside from this, these materials, according to Lardizabal (1999) as stated by Pablico (2002), also illustrate the following sound principles of learning such as it is best practiced by doing and best facilitated through the psychological feedback afforded to a learner. In addition, learning experiences provide many opportunities for the learners to progress at their own rate and simulate the learner's immediate environment. Learning situations being utilized provide for the needs of both the slow and fast learners. Consequently, fewer frustrations are experienced, particularly by the slow learners who are given chances to beat their own records.

Pablico (2002) also stated the outstanding characteristics of programmed instruction. It requires clearly defined objectives in terms of student behavior. What is worth teaching must be considered by the teacher. It represents the materials to the students in an organized and logical sequence. It requires the student an overt response to the materials presented. In other words, an active response to the stimuli is required on the part of the learner. It provides feedback to the student to know if the response is correct. Immediate knowledge of the correct answers must be made available to the learner.

Instructional materials are particularly beneficial as a strategy in introducing basic information to an entire class, freeing the lecture discussion for hours. The strategy is an enrichment activity for talented students, a strategy to make-up for a student who has been absents and a strategy for a student in need of remedial lectures. It is explained that instructional materials offer the best means by which a teacher can provide direction in her students' daily search for new understanding and verifications.

Gustiani, Widodo, and Suwarma (2017) developed and validated an instructional material based on Science, Technology, Engineering, and Mathematics (STEM) Framework to help students learn. The acceptability of the instructional material by the students was rated very high. Pretest and posttest results revealed that students retained a significant amount of information upon completing the STEM instructional material. It was concluded that the instructional material is valid enough to be used in STEM classes.

Vlachos, Dracopoulou, Kokkotas, and Plakitsi (2015) developed instructional materials based on multimedia technologies, which assist the active engagement of pupils in the learning process of Physics in secondary schools. The theoretical framework used was the constructivist perspective for teaching and learning and within this framework, they studied the problems on teaching kinematics. The result was implemented in a multimedia environment, which offered the students tools for creating representations of motion and other related concepts and laws. The developed software showed that the interface is user-friendly, and the teachers involved in the study agreed on the benefits it brought.

Auditor and Naval (2014) developed and validated tenth-grade Physics Modules based on selected least mastered competencies, which covered six major areas of Physics. The development and validation were anchored to the ADDIE Model, which involved four stages: preparation, development, validation, and try-out. Selected Physics experts from Philippine Normal University and teachers from Tibagan High School in the Philippines were the sample used for the validation of the modules, which were further tried out on 96 students of Tibagan High School. The result of the study showed that the developed modules were found acceptable for the 10th-grade physics students. There was no statistically significant difference between the evaluation of the students, peers, and experts on the module's acceptability. The developed set of modules was found to be effective in terms of knowledge acquisition.

Figure 1 displays the paradigm of the study, which employs the CIPO model. The content functions as a source of inputs and sets the situations and conditions of the present educational set up. Since the researcher conceptualizes the development and validation of a worktext in Electromagnetism, instructional designs, models, and theories are reviewed.

The inputs included all the sources that contributed to the development and validation of the worktext and improvement in the performance of the students in Electromagnetism.

In the process, the development and validation of the worktext were based on the context and inputs of the study. The students in the experimental and control groups were given the pretest. After the development of the worktext, it was validated by knowledgeable persons and implemented in the experimental group. After the administration of the posttest, the performance of the students was determined. The output of the study was the developed and validated Worktext in Electromagnetism.

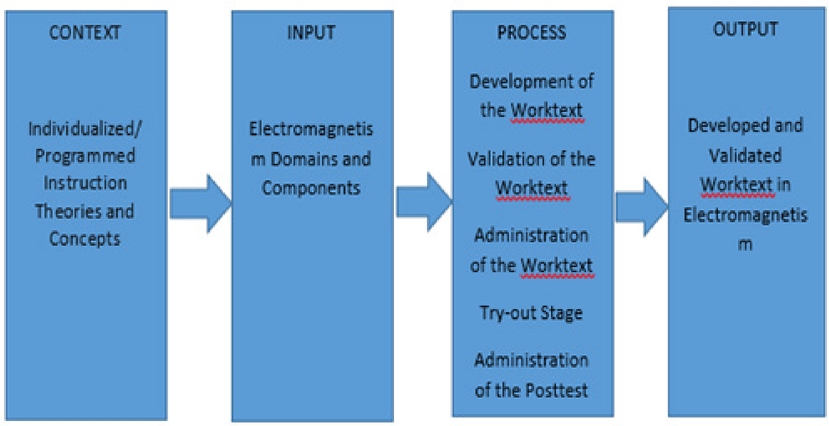

Figure 1. Paradigm of the Study.

OBJECTIVES OF THE STUDY

The main objectives of this study were to: (a) determine the level of validity of the developed worktext in terms of content, format, presentation, and organization, and accuracy, and up-to-datedness of information; (b) determine the mean scores of the two groups as to pretest and posttest; (c) compare the posttest mean scores with the pretest scores as the covariate between the control and experimental groups; and (d) determine if there is a significant agreement among the evaluation of the Physics faculty on the worktext.

METHODS

This study focused on the use of experimental research design, specifically the pretest-posttest control group design. The experimental design was used to test the effectiveness of the worktext in Electromagnetism to the performance of the students in Physics since experimental designs show cause and effect relationships. The developmental method was also used since a worktext in Electromagnetism was developed in this study.

Two intact classes were used in this study. There were 39 students in the control group while there were 40 students in the experimental group. The developed worktext was used by the experimental group, while a textbook in Physics was used by the control group. The pretest/posttest was content validated by four experts. For the reliability testing of the instrument, one section of the Physics class was utilized. For the validation of the worktext, six experts served as validators. Based on the content evaluation done by the validators, the test in Electromagnetism was rated Very High with a mean of 4.71. Several items were revised as suggested by the evaluators. For the reliability of the tests, Kuder Richardson Formula 20 (KR-20) was used. The reliability coefficient of 0.71 indicates that the test obtained High Reliability in terms of consistency of the responses.

In the development and validation of the worktext, the following stages, as seen in Figure 2 was followed by the researcher:

Stage 1. Planning Stage. This stage consisted of preliminary preparations that included proposal making and outlining of the topics to be tackled. It included the gathering of information from related researches.

Stage 2. Development Stage. This stage included the construction of the worktext. It covered the formulation of the general objectives of the worktext and the objectives for each chapter. After the presentation of concepts, exercises were included. The worktext included interactive simulation websites to provide additional insights, which the students can browse or visit. This stage also included the content validation and revision of the worktext by six competent evaluators. They evaluated the worktext on content, format, presentation and organization, and accuracy and up-to-datedness of information. The revision of the worktext was based on the comments and suggestions of the panel of evaluators.

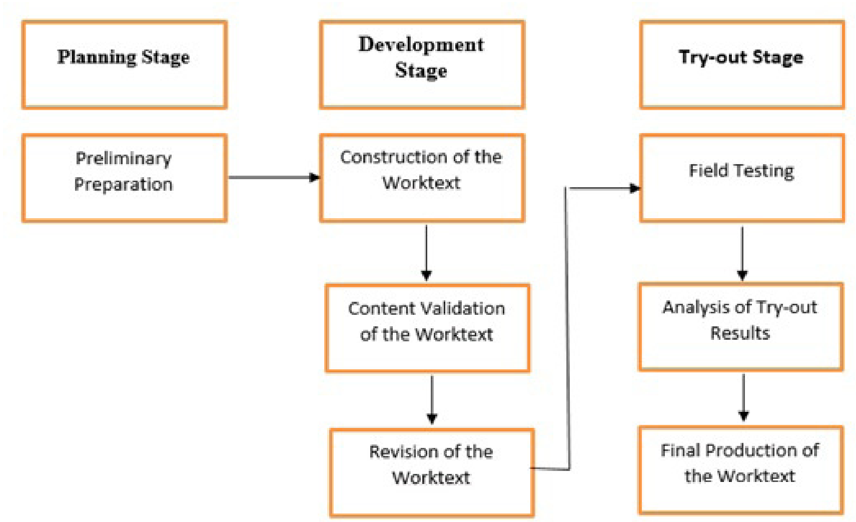

Figure 2. Flowchart of the Stages of Worktext Development and Validation.

Stage 3. Try-out Stage. This stage included the field testing of the worktext using two intact classes. After finishing the topics, a posttest the same as the pretest was given again to both classes. After the field testing, try-out results were analyzed statistically. The post-test mean scores of the two groups were compared. After the field testing and analysis of try-out results, the final step was the modification and final production of the worktext.

The data gathered were tabulated, carefully analyzed, and statistically interpreted. The data were treated using mean, mean percentage, Analysis of Covariance (ANCOVA), and the coefficient of concordance. Mean was used in expressing the general evaluation of the validators on the worktext and on the test items. Mean percentage was used in describing the pretest and posttest scores of the students. The Analysis of Covariance (ANCOVA) was used to determine if there is a significant difference in the posttest mean scores with pretest scores as the covariate between the control and experimental groups. The coefficient of concordance was used to determine the significant agreement among the validators in their evaluation of the worktext.

RESULTS AND DISCUSSION

Validity of the Worktext in Electromagnetism

Table 1 gives the summary of the validation of the worktext in Electromagnetism. The worktext passed all the criteria for print resources. Cruz (2014) stated that a validated worktext is considered to be of quality if it possesses characteristics that would enhance the performance of the students.

The content quality of the developed worktext in Electromagnetism was rated Passed by the evaluators with a grand mean score of 27.40 out of 28 points. This result implies that the worktext has satisfied the indicators for content quality. The worktext is appropriate to the learning needs of the target audience, promotes the achievement of objectives in General Physics 2, helps develop higher-order thinking skills, and stimulates the interest of target readers. The material has no ideological, cultural, religious, racial, and gender biases and prejudices and follows the Social Content Guidelines of the LRMDS Assessment and Evaluation. One evaluator commented that the worktext is appropriate to the level of the students and that the learning competencies are attainable. Further, the exercises are not only intended to check the understanding of the students in the lesson but will also enhance their scientific and numerical literacy and creative thinking.

Table 1

Summary of the Validation of the Worktext in Electromagnetism

Indicators	Mean	Remarks
Content	27.40	Passed
Format	70.40	Passed
Presentation and Organization	20.00	Passed
Accuracy and Up-to-Datedness of Information	24.00	Passed

As to format, it was rated Passed by the validators with a mean score of 70.40 out of 72 points. The worktext has satisfied the format quality of prints, illustrations, design and layout, paper binding, and size and weight of resource. The font size of the letters is appropriate to the intended user, the font style is easy to read, and spaces between letters and words facilitate reading. Illustrations used in the worktext include colored pictures, graphs, and diagrams. The design and layout of the worktext are simple, and there is an adequate illustration of the text. Illustrations are significant since they can explain content that cannot be easily explained in words. As to paper and binding of the worktext, the paper used contributes to easy reading, and the binding was durable to withstand frequent use. The paper used did not tear easily in the folding and binding. The worktext has a rigid cover.

The worktext also passed the criterion on Presentation and Organization with a score of 20.00. The presentation of the topics promotes engagement and supports understanding by the target user. The validators agree that the presentation of ideas is clear, a logical and smooth flow of ideas, and the vocabulary level is appropriate to the student's understanding. The length of the sentences is suitable to the target reader, and sentences and paragraph structures enhance meaning making. In order to make the topics more interesting and understandable, websites on interactive simulations were included in the worktext. Students were encouraged to visit interactive simulation websites to provide additional insights on the topics presented.

The material passed the criterion on Accuracy and Up-to-Datedness of Information with a score of 24. The validators agree that the worktext will not lead to the development of misconceptions or misunderstandings by the students. During the first evaluation of the worktext, the evaluators found conceptual, grammatical, typographical, and computational errors. The comments and suggestions during the validation were used to correct most of the errors. Thus, the presentation of the content of the revised worktext is accurate and up-to-date.

Pretest and Posttest Mean Scores of the Experimental and Control Groups

As observed in Table 2, the pretest results of the students in the experimental group failed in all the content areas and the overall. The said students did not meet the expectations (DNME), with a mean percentage of 24.65 percent.

The overall percentage score of 27.82 percent means that the control group also failed in the Electromagnetism test before the experimental phase. The students also failed in all the Physics concepts.

Table 2

Pretest Results of the Experimental and Control Groups

Content Area	Experimental Group		Control Group	
	Mean % Score	DR/ Remarks	Mean % Scores	DR/ Remarks
Electric Force and Electric Field	23.91	DNME/Failed	30.45	DNME/Failed
Electric Potential	29.38	DNME/Failed	27.88	DNME/Failed
Capacitance	23.61	DNME/Failed	27.92	DNME/Failed
Ohm's Law and Electromotive Force	25.00	DNME/Failed	28.35	DNME/Failed
DC Circuits	20.71	DNME/Failed	27.84	DNME/Failed
Magnetic Fields	23.38	DNME/Failed	27.60	DNME/Failed
Magnetic Induction	27.05	DNME/Failed	23.31	DNME/Failed
Overall	24.65	DNME/Failed	27.82	DNME/Failed

After the experimental phase, a posttest the same as the pretest was given to both groups. As seen in Table 3, the experimental group passed the posttest in Electromagnetism and was rated Very Satisfactory overall with a mean percentage score of 76.66 percent. Taken singly, the students were rated Very Satisfactory in Capacitance (76.39%), Ohm's Law and Electromotive Force (76.53%), DC Circuits (83.57%), and Magnetic Fields (80.00%). These results imply that the developed and validated worktext helped improve the performance of the students in the experimental group from did not meet expectations to a very satisfactory level and from Failed to Passed.

Table 3

Posttest Results of the Experimental and Control Groups

Content Area	Experimental Group Mean % Score	Experimental Group DR/ Remarks	Control Group Mean % Scores	Control Group DR/ Remarks
Electric Force and Electric Field	74.69	Satisfactory/ Passed	72.60	Satisfactory/ Passed
Electric Potential	75.56	Satisfactory/ Passed	73.72	Satisfactory/ Passed
Capacitance	76.39	Very Satisfactory/ Passed	65.34	Fairly Satisfactory/ Passed
Ohm's Law and Electromotive Force	76.53	Very Satisfactory/ Passed	79.06	Very Satisfactory/ Passed
DC Circuits	83.57	Very Satisfactory/ Passed	79.85	Very Satisfactory/ Passed
Magnetic Fields	80.00	Very Satisfactory/ Passed	75.11	Satisfactory/ Passed
Magnetic Induction	69.32	Satisfactory/ Passed	61.07	Fairly Satisfactory/ Passed
Overall	76.66	Very Satisfactory/ Passed	72.90	Satisfactory/ Passed

Since the experimental group utilized a worktext, the control group was also given an instructional material, a book in General Physics II.

As can be seen from Table 3, the control group also passed the posttest and was rated Satisfactory overall with a mean percentage score of 72.90 percent. The group has a Very Satisfactory performance in Ohm's Law and Electromotive Force (79.06%) and DC Circuits (79.85%). However, they have a Fairly Satisfactory performance along Capacitance (65.24%) and Magnetic Induction (61.07%). The students also improved their performance from Did Not Meet Expectations to Satisfactory and from Failed to Passed.

To summarize, as shown in Table 4, the two groups failed in the pretest, but after the experimental phase, they passed the posttest exam. The experimental group has a higher mean percentage score of 76.66 percent than the control group, which has a mean percentage of 72.90 percent. With these findings, there is a need to support students with instructional materials like worktexts and textbooks to enhance learning in Physics.

Table 4

Summary of the Pretest and Posttest Results of the Experimental and Control Groups

Result	Control Group		Experimental Group	
	Pretest	Posttest	Pretest	Posttest
Mean	27.82	62.69	21.20	65.93
Mean % Score	27.82	72.90	24.65	76.66
DR	DNME	S	DNME	VS
Remarks	Failed	Passed	Failed	Passed

The Difference in the Posttest Scores of the Experimental and Control Groups

Table 5 presents the unadjusted and adjusted posttest mean scores of the students in the two groups. Using ANCOVA, for the groups to have equal footing and for comparison to be made possible, the posttest scores were adjusted using the pretest as the covariate. As observed from the table, the adjusted posttest mean score of the traditional group is 62.83 (MPS = 73.06), described as Satisfactory. At the same time, the students who utilized the worktext obtained a mean score of 65.78 (MPS = 76.49), which is described as Very Satisfactory.

Table 5

Unadjusted and Adjusted Posttest Mean Scores of the Students

	Teaching Approach	
	Traditional	Experimental
Unadjusted Scores	62.69	65.93
Adjusted Scores	62.83	65.78
Difference in the Adjusted	2.95	

Table 6 presents the result of the contrast analysis between the post-test mean scores of the two groups. The p-value of 0.209 is higher than the 0.05 level of significance, which means no significant difference in the adjusted posttest mean scores of the control and experimental groups. This result means that the two groups are comparable in terms of their performance in the posttest in Electromagnetism. The two groups performed equally well in the posttest in Electromagnetism. Though there is no significant difference in the posttest mean scores of the two groups, it is worth noting that the experimental group has a higher mean score than the control group. Further, considering the general weighted average of the students in all their subjects, the students in the control group have a higher GWA compared to the students in the experimental group during the first and second semesters of the school year. This implies that the experimental group performed as well as the control group, which consisted of performing students.

Table 6

ANCOVA Results in the Posttest Scores of the Two Groups

	F	Sig
Contrast (Traditional and Experimental)	1.605	0.209

Since the control group used a textbook while the experimental group used a worktext, it implies that the use of such instructional materials can help improve the performance of the students. Worktexts, modules, and other forms of instructional materials are good partners of the teacher imparting knowledge to the students. They can serve as enrichment for the highly motivated students and as remedial instruction for the slow learners. They indicate a systematic way in the design, how to carry out and employ the teaching-learning process to promote effective and meaningful instruction. Instructional materials hold power to either engage or demotivate students.

In this study, using the developed worktext in Electromagnetism enabled the students to learn more in a limited period. Worktexts, as supplementary instructional materials, are therefore effective in enhancing and facilitating the teaching-learning process. The textbook used by the control group has already been designed to align with the standards and is therefore reliable in addressing classroom goals.

Test of Significant Agreement Among the Validators' Evaluation of the Worktext

To test the reliability of the evaluation of the validators on the worktext in Electromagnetism, Kendall's Coefficient of Concordance, W, was used. It is a non-parametric statistic used to assess agreement between different raters. In this study, this is used to test whether the validators significantly agree with each other in their evaluations of the worktext. The computed value of Kendall's Coefficient of Concordance (W) is 1.00, which implies that the evaluations of the validators on the worktext in Electromagnetism are the same. To determine the significance of the computed coefficient of concordance, $\chi 2$ was used. The p-value of 0.002 is less than the 0.05 level of significance, which means that there is a significant agreement among the evaluation of the validators on the worktext. The data gathered in establishing the validity of the worktext is reliable since there is a significant concordance or agreement among the validators.

Table 7

Significance of the Coefficient of Concordance

W	χ^2	Sig
1.00	15.00*	0.002

CONCLUSIONS

This study developed and validated a worktext in Electromagnetism. The worktext in Electromagnetism is valid and can be used by Grade 12 students and Physics teachers to supplement the teaching-learning process. The performance of the students improved after using the worktext in Electromagnetism and the textbook in General Physics 2. The control and experimental groups are comparable in terms of their performance in Electromagnetism. Instructional materials like worktexts and textbooks are effective materials in enhancing and facilitating the learning process. The validators are in agreement in their evaluation of the worktext.

RECOMMENDATIONS

The developed and validated worktext in Electromagnetism is recommended for use in Physics classes. It is highly encouraged that teachers make their own instructional materials in order to facilitate the teaching-learning process and to improve the performance of students. Seminar-workshop on the construction of instructional materials may be conducted to motivate teachers and equip them on the significance of instructional materials. Students may also evaluate the worktext as to its acceptability. The worktext should be subjected to other evaluation instruments in order to become more valid and reliable.

LITERATURE CITED

Adalikwu, S. and Iorkpilgh, I. (2013). The Influence of Instructional Materials on Academic Performance of Senior Secondary School Students in Chemistry in Cross River State. Retrieved from https://search.proquest.com/docview/1509205756/60F34B5790D443A2PQ/1?accountid=173015

Auditor, E., & Naval, D. J. (2014). Development and validation of tenth grade physics modules based on selected least mastered competencies. *International Journal of Education and Research. 2* (12). Retrieved on April 26, 2017 from www.ijern.com/journal/2014/December_2014/14.pdf

Cruz, E. (2014). Development and Validation of Worktext in Drawing 2. *International Journal of Scientific and Research Publications, 4* (9). Retrieved from www.ijsrp.org/research-paper-0914/ijsrp_p33104

Gustiani, I., Widodo, A., & Suwarma I. R. (2017). Proceedings from AIP. *Instructional materials development, 1848*(1). Retrieved on May 30, 2018 from https://aip.scitation.or /doi/10.1063/1.4983969

Individualized instruction. (2010). Retrieved on July 5, 2017 from www.k12academics.com/pedagogy/individualizedinstruction#.WVzrlfmGPIU

Lim, E. J. (2016). Effectiveness of modular instruction in word problem solving of beed students. I*OSR Journal of Mathematics. 12*,(5), 59-65. Retrieved from iosrjournals.org/iosr-jm/papers/Vol12-issue5

Marzan, J. N. (2016). Development and Validation of Modules in Physics for Grade 9 Students. Unpublished Master's Thesis, University of Northern Philippines

Mekonnen, S. (2014). Problems challenging the academic performance of physics students in higher governmental institutions in the case of Arbaminch, Wolayita Sodo, Hawassa and Dilla universities. Retrieved from www. researchgate. net/publication/273742501

Orleans, A. (2007).The Condition of Secondary School Physics Education in the Philippines: Recent Developments and Remaining Challenges for Substantive Improvements. Retrieved from search.proquest.com/ docview/ 1889726587/2782D9475BE643C2PQ/1?accoutid=17305

Pablico, J. (2002). Development of a worktext in heat and thermodynamics for tertiary students. (Unpublished Master's Thesis). University of Northern Philippines, Tamag, Vigan City

Owolabi, O. T. (2012). Effect of Teachers Qualification on the Performance of Senior Secondary School Physics Students: Implications on Technology in Nigeria. *Canadian Center of Science Education,* 5(6); June 2012, ISSN 1916-4742. Retrieved from https://files.eric.ed.gov/fulltext/EJ1079503.pdf

Vlachos, I., Kokkotas, P., Dracopoulou, M. and Plakitsi, A. (2015). The development of instructional materials which assist the active engagement of pupils in the learning process of physics in secondary schools. Retrieved on June 6, 2018 from https://www.researchgate.net/publication/237535380

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