WEST VISAYAS STATE UNIVERSITY
COLLEGE OF EDUCATION
GRADUATE SCHOOL
Iloilo City

LEARNERS' LEARNING PROGRESSION AND SCIENCE TEACHERS' FORMATIVE ASSESSMENT PRACTICES: BASES FOR THE DEVELOPMENT OF A MODULE IN PHYSICS

A Dissertation Presented to the

Faculty of the Graduate School

College of Education

West Visayas State University

La Paz, Iloilo City

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy in Science Education

(Physical Science)

by

Anthony M. Macaya

March 2020

APPROVAL SHEET

A Dissertation for the Degree

Doctor of Philosophy in Science Education

(Physical Science)

by

ANTHONY MELANCIO MACAYA

Approved by the Research Committee:

VILMA F. TEMPLORA, Ph. D., Chair

ELVIRA L. ARELLANO, Ph. D., Member

LARRY D. BUBAN, Ph. D., Member

LOURDES N. MORANO, Ed. D., Outside Expert

CHIVE G. GABASA, Ph. D., Adviser

MA. ASUNCION CHRISTINE V. DEQUILLA, Ph.D.
Dean

March 2020

ACKNOWLEDGMENT

There is no short cut. But to one who has patience, the end is well worth the journey; thus, the researcher gives proper credit to all those whom he is greatly indebted. For sharing their precious time, knowledge, expertise, and encouragement in the realization of this study, the researcher conveys his sincere appreciation and deepest gratitude, especially to the following:

Dr. Chive G. Gabasa, dissertation adviser, mentor, and friend for his unselfish time, guidance, assistance, steady effort in correcting the errors, and for his words of encouragement which made this dissertation possible;

Dr. Vilma F. Templora, program adviser, mentor, and friend whose words of wisdom, encouragement, and helping hand inspired and motivated the researcher from the very beginning to pursue and finish this study;

Dr. Lourdes N. Morano, Dr. Elvira L. Arellano, Dr. Larry D. Buban, and Dr. Vilma F. Templora, panel members, for their expertise, valuable comments, suggestions, and unwavering support towards the refinement of this study;

Dr. Rovel R. Salcedo, Dr. Aris L. Larroder, and Dr. Grace A. Manajero for sharing their expertise in validating and refining the researcher's instruments;

Dr. Delia C. Bombita, principal II of Maasin National Comprehensive High School, for giving the researcher the chance to conduct his study and implement the module to the students;

Dr. Sarah D. Ganancial, principal I and all Science teachers of Remedios E. Vilches- San Lorenzo National High School, for the permission to allow the researcher to conduct the pilot testing and for facilitating the researcher's instrument;

Dr. Ruby T. Llave, Prof. Edsel Llave, and all Ph.D. in Physical Science students of WVSU, for their active participation, cooperation, valuable comments, and suggestions in the refinement of the research module;

The Grade 11- Earth (Humanities and Social Sciences A), Jupiter (Accountancy Business and Management), and Neptune (Humanities and Social Sciences B) students of Maasin National Comprehensive High School, for their active participation, patience, and cooperation and for doing their best during the implementation of the module;

Mrs. Karen M. Ricaforte, for her acceptance as implementing teacher and all-out support to the researcher's study;

Science teachers of Maasin National Comprehensive High School: Mrs. Karen M. Ricaforte, Ms. Charlyn S. Mediana, Ms. Ma. Manuela M. Aloquin, Mrs. Joesa M. Ardiente, Mrs. Lucia M. Cebretas, Mrs. Janette M. Diaz, and Ms. Judy D. Caldito, for their support and willingness as interviewee or participants in the data gathering of the study;

Madam Arlene R. Memorando, Madam Concepcion G. Antenorio, Mrs. Sheila Mae M. Banzil, Mrs. Iris C. Mojica, Mrs. Jennifer C. Bermudo, Mrs. Nancy P. Fuentes, Ms. Hyra V. Lorca, Ms. Deseree B. Marco, and Ms. Christy Joy M. Garino, for the assistance, understanding, and cooperation during the implementation of the developed instructional material; the rest of the senior and junior high school faculty and staff of Maasin National Comprehensive High School, for the concern, guidance, and belief in the researcher;

Ms. Little Rose G. Santiago, the researcher's friend and classmate for facilitating the pilot testing of the research instrument and for her constant encouragement, support, and help in times of difficulty;

Ms. Kei Espinosa and Ma. Trixie Espinosa, for their help in the lay-out of the cover and icons in the module;

Prof. Myra Angelie Oliveros, Prof. Alan N. Munoz, Mrs. Hope C. Logronio, Mrs. Jean S. Larroder, Mr. Marlon D. Arevalo, Ms. Ma. Theresa Sembrano, Mrs. Jenelyn S. Banavo, Ms. Rahjni Faith S. Escare, Mrs. Ma. Daphne Salome L. Segura, Mrs. Little Rose G. Santiago, Mrs. Karen R. Ricaforte, Ms. Charlene S. Mediana, Ms. Ma. Manuela M. Aloquin, Mrs. Lucia M. Cebretas, Mrs. Janette M. Diaz, and Ms. Judy D. Caldito, for the evaluation of the researcher's module;

Retired Professor Tim O. Gasacao, for the final editing of the manuscript;

Researcher's classmates – Madam Jenelyn Banavo, Madam Isah Lou Nocal, Madam Mercy Japitana, Madam Mary Ann Navarra, Sir Denmark Agudera, and Sir Vicris Oliva, for making graduate school memorable and enjoyable moments;

Madam Elsie Retotar, Ms. Melruz Manzano, and the rest of the staff of WVSU COE-Graduate school, for their willingness and kindness in facilitating the researcher's needs;

Researcher's parents, Mr. Francisco, Sr. and Mrs. Nita Macaya, his brothers, Ruel and wife Cherry, Francisco, Jr; his sister Brenda and husband Arnold Mones; his sister Anarose and husband Nick Retotar; nieces – Aedryn, Ahby Easter, Arnbryl, Aevry, Ruche Faith, and Chloe Jane –;nephews – Andrei Nicole and Prince Zion– for their understanding, financial and moral support, and inspiration; and

Above all, the Almighty God, for His gift of life, enlightenment, countless blessings, and strength to embrace all challenges and make this dissertation possible.

In Omnibus Amare Et Servire.

ANTHONY MELANCIO MACAYA

March 2020

Macaya, Anthony M. *Learners' Learning Progression and Science Teachers' Formative Assessment Practices: Bases for the Development of a Module in Physics* Disseration for Doctor of Philosophy in Science Education major in Physical Science, West Visayas State University, La Paz, Iloilo City, March 2020.

Abstract

This study aimed at developing a module in physics based on the assessment of the learning progression of students in physics and science teachers' formative assessment practices. The participants in this study were the Grade 11 students and Junior High School science teachers for the data gathering, science teachers for the design and development of the module, Grade 11 students and science teachers for the implementation of the module, and science teachers for the evaluation of the module. Two sets of instruments were utilized in Phase 1 of the study; these were: Learning Progression Test in Physics (LPTP) and Formative Assessment Practices Checklist (FAPC). Results revealed that the Grade 11 students had not mastered skills in inferring how the movement of particles of an object affects the speed of sound through it, investigating relationship between the angle of release and the height and range of the projectile, inferring the relationship between current and charge, describing the horizontal and vertical motions of a projectile, and inferring that the total momentum of the system before and after collision is equal. Meanwhile, the formative assessment strategies of science teachers were classroom discussion, problem solving, observation, rubrics, Venn diagram, multiple-choice, and self/peer assessments. Science teachers utilized the results of these formative assessments to elicit evidence about students' learning and to modify or adjust teaching and learning instruction. In Phase 2, the researcher designed a teaching module in physics based on the identified least-mastered competencies and science teachers' formative assessment practices. The development of the module was done though a seminar-workshop, participated in by secondary and tertiary physics teachers. The implementation of the final draft of the module was done through pilot testing. Overall, the developed module was rated excellent by the teachers in terms of objectives, content, activities, assessment, design, and presentation. Teachers' and students' evaluation of the module reveal that the objectives were suited to the particular topic, level, and needs of the learners and were clear and simple. The content of the module was good, easily understood, clear, and well-organized. The activities were interesting, enjoyable, self-motivating, within the context of the learners, and helped enhance students' knowledge, skills, and understanding of the lesson. The assessments challenged the students to think critically. Hence, the teaching module was developed as support instructional material for teachers to bridge the gaps in the learning progression of students in physics. With these results, it is recommended that students engage in daily instructional activities that would best move them to deeper learning and application of knowledge. Further, the developed module can be used as supplementary material for students towards progressive mastery of ideas, concepts, and skills in their physics lessons.

Table of Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF PHOTOGRAPHS

LIST OF APPENDICES

Learners' Learning Progression and Science Teachers' Formative Assessment Practices: Bases for the Development of a Module in Physics

Anthony M. Macaya

Chapter I

Introduction to the Study

Chapter One consists of five parts: (1) Background and Theoretical Framework of the Study, (2) Statement of the Problem, (3) Significance of the Study, (4) Definition of Terms, and (5) Scope and Delimitation of the Study.

Part One, Background and Theoretical Framework of the Study, presents the introduction and rationale for the choice of the problem as well as the theoretical framework of the study.

Part Two, Statement of the Problem, states the general and specific problems or questions that the investigator attempted to find answers to.

Part Three, Significance of the Study, cites the benefits that may be derived from the result of the study.

Part Four, Definition of Terms, gives the conceptual and operational definitions of the terms used in the study.

Part Five, Delimitation of the Study, sets the inclusive limits of the study.

Background of the Study

The United Nations Millennium Development Goals (MDGs) give way to a new set of Sustainable Development Goals (SDGs). These encompass the eight-millennium development goals, one of which is quality education that is inclusive and equitable. Under this goal is the global attainment of literacy which must "stand at the heart" of new sustainable development agenda, numeracy, and basic skills needed in the 21st century (UNESCO, 2017). Education systems must respond to this pressing need by defining relevant learning objectives and learning contents, introducing pedagogies that empower learners, and urging academic institutions to include sustainability principles in their management structures (Tang, 2017).

To address this call, the Department of Education considers and responds to this as a need to attain and improve the status of education in the country in a way through quality science education. Science education aims to develop scientific literacy among learners to prepare them to be informed and participative citizens capable of making judgments and decisions on the application of scientific knowledge and its impact on human lives. The K to 12 science curriculum is designed to attain this objective by providing students with knowledge, skills, attitudes, and values as domains of learning in science (DepEd, 2012).

Science content and processes are intertwined in the K to 12 curricula. The scope and the content are developed such that concepts and skills are revisited at each grade level with increasing depth. Through this, learning is extended, reinforced, and broadened each time a concept is revisited (DepEd, 2016).

To keep track of students' learning performances and to facilitate the development of students' higher-order thinking skills and 21st -century skills, assessments are given. In the same way, assessment ensures students' success in moving from guided to independent display of knowledge, understanding, and skills, and to enable them to transfer this successfully in future situations.

Teachers should know how to provide appropriate assessments in aiming and guiding students' success in learning. The benefits of assessment for both students and teachers will be boundless when it becomes an integral part of the instructional process and a central ingredient to help students learn (Stigins, 2002).

The Enhanced Basic Education Act of 2013 of the Department of Education adopts the policy guidelines on classroom assessment for the K to 12 Basic Education Program. It provides the kinds of assessments and their components such as the formative and summative assessments as well as the learning standards comprise of content, performance, and learning competencies outlined in the curriculum which shall be used appropriately for different learners towards their learning progression (DepEd Order no.8, s. 2015).

Despite a plethora of standards and curricula, many teachers are unclear about how learning progresses in specific domains. Too little attention is given to how students' understanding of a topic can be supported from grade to grade. This is an undesirable situation for teaching and learning, and one that particularly affects teachers' ability to engage in assessment (Melmer, 2008). The use of standards and assessments has led to the use of curricula that are thin and attempt to cover too much in each grade, and this, in turn has encouraged instruction that focuses on coverage of topics rather than providing the careful scaffolding required for students to develop an integrated and sophisticated understanding (NRC, 2001:256). Consequently, students do not spend sufficient time engaged in complex cognitive tasks such as inquiry, argumentation, and explanation and, therefore it should be no surprise that many of them do not develop the critical thinking skills teachers hope they will attain (Kuhn, 2005; NRC, 2007).

Based on the researcher's own experiences, observations, and assessments given to the students and those observations gathered from the experiences of other science teachers, one of the common complaints and problems they encounter in science classes nowadays is the low retention of science concepts among students as they move from one grade level to the next. Because of this, teachers have to repeat the past lessons and review the students again before moving on as these topics are prerequisites for the next lesson. Other problems raised during the learning action cell (LAC) session of science teachers were the poor acquisition and transfer of science process skills, limited reasoning, and analytical skills among students which hinder their learning in science and in moving from basic to more complex learning tasks.

These endemic problems with the content standards, curriculum, and assessments are exacerbated by inadequate teacher preparation and other requirements for teachers that fail to develop or require the understanding of content, students' learning, and the pedagogical approaches that teachers need to support students' learning (Corcoran, Mosher, & Rogat, 2009).

Research findings on formative assessment in the Philippines show that in terms of assessment practices observed in class, minimal emphasis was given to formative assessment and most assessments were summative and recorded as scores or percentage correct. Teachers' assessment skills were largely uniform across classrooms. This was brought about by the pressure of an intense content-focused curriculum, a formulaic lesson plan and structure, large class sizes, regular and mistargeted assessments, and a lack of accountability for student learning (Cagasan, Griffin, Nava, Vista, & Care; 2016).

Learning progression as a tool for assessment and learning requires that assessments be based on an underlying model of learning. It is a description of skills, understanding, and knowledge in the sequence in which they typically develop: a picture of what it means to "improve" in an area of learning and predicts how knowledge builds over time (Masters & Foster 1997; Stevens, et al., 2007).

While the Department of Education emphasizes that no students should be left behind in progress and education, learning progressions are important resources for teacher learning. It helps teachers engage their students in richer and more equitable learning experiences, their skills in setting learning goals, interpreting student ideas to progression, and responding to student ideas with specific interventions that serve to move to learn forward (Shepard, 2018).

In learning progression of Molecular- Atomic Theory by Smith, Wiser, Anderson, and Krajcik (2006), progression helps teachers see connections between what comes before and after a specific learning goal, both in the short and long terms. This provides teachers an opportunity to build explicit connections between ideas for students that thread the development of increasingly complex forms of a concept or skill together.

Heritage, Kim, & Vendlinski (2008) underscored the importance of learning progression by providing a sequence for learning that undergirds instruction.

The teaching and learning process is facilitated and enhanced through the use of quality instructional materials. Instructional materials are relevant materials utilized by a teacher during the instructional process to make the contents of the instruction more practical and less vague (Ogbaji, 2017). These materials are integral components of teaching-learning situations and are not just to supplement learning but to complement its process. If there must be an effective teaching-learning activity, the utilization of instructional materials would be necessary. Quality instructional materials allow teachers to better help students master the skills, knowledge, and experience that will support them in school and life especially when they are implemented effectively in schools that address the student's needs. Furthermore, the use of an instructional material (module) helps informs teachers of the extent to which a learner has attained an instructional objective or competency (Kibe, 2011).

The main objective of this study was to develop a module in physics based on learners' learning progression and science teachers' formative assessment practices in the implementation of the K-12 science curriculum.

Theoretical Framework

Learning is a constructive process and it is an activity that is individual to the learner. According to the constructivist theory of learning, learning is a dynamic and social process in which learners actively construct meaning from their experiences in connection with their prior understanding and the social setting (Driver, Asoko, Leach, Mortimer, & Scoot, 1994). Constructivism uses the spiral progression; new concepts are built on learners' prior knowledge and skills to allow gradual mastery from one grade level to the next. Through these, learners continuously reflect on their experiences while developing the needed abilities and skills to achieve learning (Datu, 2016). From this perspective, learning is a process of acquiring new knowledge, which is active and complex through the result of the active interaction of key cognitive processes.

Progressive learning is envisioned as the development of progressive sophistication in understanding and skills within a domain. Progressivism aims to develop learners who are armed with sufficient competencies which could be achieved by actively applying and utilizing them in real-world, actively testing ideas or concepts learned. Progressivists believe that education should focus on the whole child, neither content to be taught nor the teacher. The learner is a problem solver and thinker who makes meaning through his or her individual experience in the physical and cultural context (Datu, 2016).

This study is also anchored on instructional design theory. Instructional design theory is a set of design theories that pertain to various aspects of instruction. One perspective is that those aspects include: (a) What the instruction should be like, which could be called instructional-event design theory (DT), or instructional-program DT, or instructional- product DT ; (b)what the process of gathering information for making decisions about instruction should be like, which could be called instructional-analysis DT; (c) What the process of creating the instructional plans should be like, which could be called instructional-planning DT; what the process of creating the instructional resources should be like, which could be called instructional-building DT; (d) What the process of preparing for implementation of the instruction should be like, which could be called instructional-implementation DT; (e) What the process for evaluating the instruction should be like (summative and formative), which could be called instructional-evaluation DT (Reigeluth & Chellman, 2009). This theory is conceptually helpful to the researcher to serve as a guide to integrate and develop an instructional material in physics.

Based on the aforementioned theories, concepts, and ideas, the researcher ascertained learners' learning progression as a learning approach in physics and science teachers' formative assessment practices as bases for the development of a module.

The paradigm of this study is shown in Figure 1.

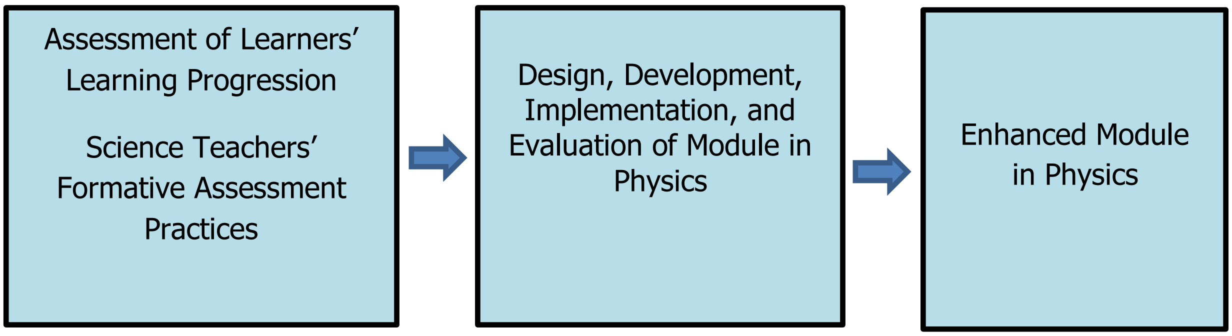


Figure 1. The paradigm upon which the present study is anchored.

Statement of the Problem

Generally, this study sought to develop an instructional material in physics based on the assessment of learning the progression of students in physics and science teacher's formative assessment practices.

Specifically, it sought answers to the following questions:

1. What are the least-mastered competencies of Grade 11 learners in their learning progression in Physics?

2. What are the formative assessment practices and how are the results of formative assessment utilized by the teachers in the classroom to promote developmental learning?

3. What instructional material in physics can be developed on the basis of the least-mastered competencies and formative practices used by the teachers?

4. How do teachers and students evaluate the module in terms of (a) learning objectives, (b) content and activities; and (c) assessment?

Significance of the Study

This study aimed at developing an instructional material in physics based on the learning progression of Grade 11 students in physics and science teachers' formative assessment practices. Specifically, the findings of this study may be beneficial to the following:

Department of Education. This study may help improve the quality of science education of the Department and could be replicated in other schools which would be of help in a way that would redound to better performance in schools and for the life-long acquisition of knowledge and skills of the students. They may also draft policies to improve the current education status and performance of the students, particularly in science.

School Administrators. School administrators may make use of the findings of the study as a means of improving their schools' performance and promote a better learning environment. Hence, by using progressions as a guide, they could improve the alignment among the policy tools of the DepEd and the instructional support for teachers. Also, by knowing the benefits of learning progression and the appropriate uses of formative assessment, they can plan out and include these in their learning agenda (e.g. In-service Training and Learning Action Cell session) and eventually consider more relevant approaches which could determine where the students are, what kind of intervention they need, and when they need it.

Science Teachers and Non-science Teachers. This study may provide an informed framework for teachers to gain better understanding of how students' ideas develop and provide them with the assessment to track student understanding which would make them better informed and more precise decision-makers about their students' needs and how to respond to them instructionally.

Textbook Writers. Textbook writers may benefit from the result of this study by highlighting teaching strategies that would include learners' learning progression on a lesson and employ appropriate formative assessment that affects learning in the classroom advancing more student-centered guiding students to excel beyond their current skill level.

Curriculum Designers and Policy Makers. Knowing the impact of learning progression, curriculum designers and policymakers may benefit from the result of the study by being able to rethink curriculum design so that it is more focused, better sequenced, and more coherent. By taking into consideration the progress in learning of the students from one level to another, they may be able to improve students' life-long acquisition of knowledge, understanding of concepts and skills.

Learners. This study may provide learners the opportunity to discover, innovate some points, and motivate them to excel beyond their current skills, and improve their assimilation of knowledge that may translate into actual living conditions and real-life situations.

Other Researchers. This study may provide future researchers baseline data and inputs not only on the results but also the process of learning progression. It may also serve as a guide for those who are interested in knowing and exploring different learning progressions in other areas and fields of education.

Definition of Terms

For clarity and precision, the following terms are given their conceptual and operational definitions:

Learning Progression refers to empirically-grounded and testable hypotheses about how learners' understanding and ability to use core scientific concepts and explanations and related scientific practices grow and become more sophisticated over time with appropriate instruction (NRC, 2007).

In this study, "learning progression" refers to the development of skills, understanding, and knowledge of Grade 11 learners in learning physics from Grades 7 to 10 in increasing levels of complexity, following the sequence of competencies in the K to 12 Curriculum Guide in Science in which they are typically to develop. It was measured using a researcher-made learning progression test in physics (LPTP), 60-item multiple-choice test.

Formative assessment may be seen as an assessment for learning so teachers can make adjustments in their instruction. It is also assessment of learning wherein students reflect on their progress (DepEd Order No.8, 2015).

In this study, "formative assessment" refers to the type of classroom assessment used by science teachers in assessing students' knowledge, understanding, and skills in physics or to promote developmental learning.

Formative assessment practices- are teacher techniques designed to quickly inform instruction by providing specific and immediate feedback through daily, ongoing instructional strategies that are student and classroom-centered, and that answer "what comes next for student learning?" (Wisconsin Department of Instruction, 2017).

In this study, “formative assessment practices” refers to the different strategies used by science teachers to assess students’ learning progression in physics. These formative assessment practices by the science teachers was determined through using a researcher-made formative assessment practices checklist (FAPC).

Least mastered competencies are those competencies where learners get 74% and below (DepEd, 2015).

In this study, “least mastered competencies” are those top five learning competencies in physics derived from the DepEd K to 12 curriculum guide in science with the highest percentage of incorrect answers obtained from the 60-item learning progression test in physics.

Module is a unit of work and a course of instruction that is virtually self-contained and a method of teaching that is based on the concept of building up skills and knowledge in discrete units (Taneja,1989).

In this study, “module” refers to the instructional material in physics which would be developed on the basis of the identified least mastered topics in physics and on the result of formative assessment practices of the science teachers.

Physics is the science of matter and its motion that deals with concepts such as force, energy, mass, and charge (ScienceDaily, 2017).

In this study, “physics” refers to one of the domains/strands in the K to 12 Science Curriculum from Grades 7 to 10 which include the topics such as force, motion, and energy wherein concepts and skills are presented in an increasing level of complexity from one grade level to another in spiral progression.

Scope and Delimitation of the Study

This study aimed at developing an instructional material in physics based on the assessment of the learning progression of Grade 11 students in physics who were officially enrolled for SY 2019-2020 at Maasin National Comprehensive High School and science teachers' formative assessment practices. The identified least mastered competencies in physics from Grades 7 to Grade 10 and formative assessment practices of the science teachers served as bases in developing a teaching module in physics. The study utilized the ADDIE Model. Three (3) intact groups from the Academic track comprising one section in the Accountancy, Business, and Management (ABM) strand and two sections in the Humanities and Social Sciences (HUMSS) strand for a total of 128 students served as the participants in the study. Moreover, eight junior high school science teachers participated in the assessment of the formative assessment practices in the science classroom. The instruments used were the researcher-made learning progression test in physics and the formative assessment practices checklist. The learning progression test included the learning competencies in the K to 12 Curriculum Guide in Science covering the topics in physics from Grades 7 to Grade 10 with increasing levels of complexity. On the other hand, the researcher-made formative assessment practices checklist that listed the different formative assessment practices practiced by the science teachers in the classroom to promote developmental learning was employed and incorporated in the development of a teaching module in physics.

The researcher utilized fifteen (15) science teachers teaching physics subjects at the secondary and tertiary level who attended the seminar-workshop on the development of a teaching module in physics. Their comments and suggestions were properly noted and included in the enhanced module. For the try-out of the teaching module, four (4) junior high school science teachers delivered the lessons to 128 Grade 11 Academic track students who also participated and evaluated the module. Lastly, the enhanced module was evaluated by 16 physics teachers and 1 curriculum and development expert.

Chapter 2

Review of Related Literature

This chapter presents literature and researches relevant to the present study. It consists of six parts: (1) Classroom Assessment, (2) Learning Progression, (3) Learning Progression and Formative Assessment, (4) Instructional Material, (5) Importance and Selection of Instructional Material, and (6) Summary.

Part One, Classroom Assessment, discusses the nature, type and importance of classroom assessment in assessing learner's current and developing abilities on the different learning areas.

Part Two, Learning Progression, expounds on learning progression as a new tool for improvement as well as its importance and applicability to various educational settings.

Part Three, Learning Progression and Formative Assessment, provides studies and findings about learning progression and the use of formative assessment as part of instructional planning.

Part Four, Instructional Material, elucidates the concepts, types, and uses of different instructional materials.

Part Five, Importance and Selection of Instructional Material, delineates the importance and selection of instructional materials in the teaching-learning process.

Part Six, Summary, recapitulates on the concepts and studies used in the conceptualization of the study.

Classroom Assessment

Assessment plays a central role in process of effective instruction. A number of assessment techniques are associated with the quality of instruction and evaluation learning outcomes (Saeed, Tahir, Latif, 2018). Classroom assessment is an ongoing process of identifying, gathering, organizing, and interpreting quantitative and qualitative information about what learners know and can. It can also measure the achievement of competencies by the learners do (DepEd, 2015).

The Department of Education released the policy guidelines on the K to 12 Basic Education classroom assessment as part of the implementation of the curriculum. This classroom assessment informs the learners of their progress on the different learning areas. With such, teachers should provide appropriate assessment when they aim to holistically measure learners' current and developing abilities while enabling them to take responsibility in the process (DepEd Order No. 8 s. 2015). The framework of assessment should consider deliberately the learner's zone of proximal development (Vygostsky, 1978) that is committed to ensure learner's success in moving from guided to independent display of knowledge, understanding, and skills, and to enable them to transfer this successfully in future situations. From this point of view, assessment facilitates the development of learners' higher-order thinking and 21st- century skills.

Various kinds of assessment consistent with curriculum standards can be used appropriately for different learners. Through such, teachers can inform learners about the objectives of the lesson so that the latter will aim to meet or even exceed the standards. There are two type of classroom assessment, namely: formative and summative. According to the UNESCO Program on Teaching and Learning for a Sustainable Future (UNESCO-TLSF), formative assessment refers to ongoing forms of assessment that are closely linked to the learning process. It is characteristically informal and is intended to help students identify strengths and weaknesses in order to learn from assessment experience. On the other hand, summative assessment may be seen as assessment of learning which occurs at the end of a particular unit. This form of assessment usually occurs toward the end of a period of learning in order to describe the standard reached by the learner. Judgments derived from summative assessment are usually for the benefit of people rather than of the learner (UNESCO-TLSF).

Assessment as a major part of educational institutions provides comprehensive information about the overall learning development of the teacher and students' performance in educational settings. It is the responsibility of teachers to use different classroom assessment techniques for assessing students' performance or focus on quality assessment. Literature provides adequate information that a teacher needs to focus on self-development and for this he/she should have ample knowledge and skills in classroom assessment. Dhindsa, Omar, and Waldrip (2007) found that students are developing authentic and a realistic approach which is being related to their real learning that is done instead of measuring luck. Present research results show that teachers use different classroom assessment techniques in their classroom without knowing their purpose. The main reason is that teachers are not fully aware of the purpose of different classroom assessment techniques for students' learning (Stiggins & Conklin, 1992). Pellegrino and Goldman (2008) recommended a way that learning of students can be improved by classroom assessment.

Saeed, Tahir, & Latif (2018) disclosed that most public and private school teachers use summative assessment. They believe that formative and summative assessment can play a pivotal role in promoting students' learning in the classroom.

Teachers may also use other alternative assessment techniques, such as peer assessment, and portfolio assessment which will result in more effective and holistic development of elementary and secondary grade students both in public and private schools.

Struyven, Dochy and Janssens (2005) reveal that there are three important objectives for assessment in the educational context. The first one is to plan effective learning strategies for developing accountability habits among students, second is issue degree and result card after pass or fail the examination, and the third is to provide feedback of school and teachers' efforts or abilities and make them accountable for their performances or duties which they serve for the improvement of students' learning and found the observable significant influence on the performances of students. Formative assessment, also known as assessment for learning, is a major source for improvement of students' learning (Clark, 2010; Eyal, 2012; Johannesen, 2013).

Formative assessment theory (FAT) was initiated by Scriven, in the year 1967. Found at the basis of the theory's development, it stresses that formative assessment practices influence student learning when teachers apply them instructionally (Black & Wiliam, 1998). As specified by Scriven, formative methods for evaluation replaced those used in the past. In place of the older criteria and the dependent procedures, new concepts of educational readiness, strengths on which to build, deficiencies to be attacked, and the likes were needed. These new concepts must be based on the assumption of dynamic potential in all or almost all human beings. The evaluation task is to describe or measure phases of this potential and difficulties to be surmounted that can help the individual and the educational institution in improving student learning. Formative assessment theory upholds that teachers should regularly diagnose and assess student learning for mastery within the classroom (Bailey & Jakicic, 2012). Moreover, teachers' diagnosis and assessment of students' learning must encompass the professional setting through collegial conversations and reflective learning experiences (Black & Wiliam, 2009). When formative assessment is practiced with fidelity, it would have a positive effect on student achievement and typically contrast with summative assessment in purpose and placement in relationship to the delivery of instruction. Proponents of formative assessment theory view the connection between cognition and the social aspect of the learning environment as an interaction that "blends cognition and social interaction into a functional theoretical framework by situating individual cognitive development in a context of collective classroom activity" (Clark, 2010, p. 347). As a result, the interplay between formative assessment theory and the tenets of cognitive theory and social constructivism enhances the overall validity of formative assessment theory (Clark, 2010).

William and Thompson (2008) stated that many terms are used for formative assessment and discussed about some other type of assessing students' learning like monitoring assessment, diagnostic assessment, and formative assessment. In monitoring assessment, different activities or actions are monitored which are related to the educational learning process, like for example, teacher strategies for assessing students' skills and knowledge, students learning abilities which teacher promotes in classroom, or all those activities which are designed and planned in classroom for effective teaching learning process. It facilitates the effectiveness of the whole education system and provides guidelines or instructions where the mistakes be found in effective teaching learning process and how to overcome these learning difficulties during sessions. On the other hand, assessment provides detailed information about learning difficulties of learners and provides remedies on how to solve their learning difficulties which they face in the learning process. The students in formative assessment are actively engaged, because of the reason that collecting students' data step by step improves their learning progress (William, 2011).

Formative assessment drives classroom instruction and provides learners opportunity to self-evaluate their strengths and weaknesses regarding a particular concept (Amoako, 2018). Studies have shown that formative assessment practices have a positive impact or play a crucial role in the improvement of teaching and learning in the classroom (Amoako, 2018; Bahati, Tedre, Fors & Mukama, 2016; Kline, 2013; Magno & Lizada, 2015;Mayosore, 2015; Mehmood, Hussain, Khalid & Azam, 2012;Oduro, 2015;OECD, 2011;Wei, 2010). However, it is reported that teachers have lackadaisical attitude towards its practice or even some teachers do not even practice it at all (APERA Conference, 2006;Gashaw, 2014;Hingins, Grant, Thompson & Montarzino, 2010; McMillan, Cohen, Abrams, Cauley, Pannozzo, & Hearn, 2010).

Formative assessment is a part of the instructional process. When incorporated into classroom practice, it provides the information needed to adjust teaching and learning while they are happening. In this sense, formative assessment informs both teachers and students about student understanding at a point when timely adjustments can be made. These adjustments help to ensure students achieve targeted standards-based learning goals within a set time frame. Although formative assessment strategies appear in a variety of formats, there are some distinct ways to distinguish them from summative assessments.

Formative assessment helps teachers determine next steps during the learning process as the instruction approaches the summative assessment of student learning.

Another distinction that underpins formative assessment is student involvement. If students are not involved in the assessment process, formative assessment is not practiced or implemented to its full effectiveness. Students need to be involved both as assessors of their own learning and as resources to other students. There are numerous strategies teachers can implement to engage students. In fact, research shows that the involvement in and ownership of their work increases students' motivation to learn. This does not mean the absence of teacher involvement. On the contrary, teachers are critical in identifying learning goals, setting clear criteria for success, and designing assessment tasks that provide evidence of student learning.

One of the key components of engaging students in the assessment of their own learning is providing them with descriptive feedback as they learn. Research shows descriptive feedback to be the most significant instructional strategy to move students forward in their learning. Descriptive feedback provides students with an understanding of what they are doing well, links to classroom learning, and gives specific input on how to reach the next step in the learning progression (Garrison, n.d).

There are many classroom instructional strategies that are parts of the repertoire of good teaching. When teachers use sound instructional practice for the purpose of gathering information on student learning, they are applying this information in a formative way. In this sense, formative assessment is pedagogy and clearly cannot be separated from instruction.

Some of the instructional strategies that can be used formatively include the following: (1) Criteria and goal setting with students engage them in instruction and the learning process by creating clear expectations. In order to be successful, students need to understand and know the learning target/goal and the criteria for reaching it.

Establishing and defining quality work together, asking students to participate in establishing norm behaviors for classroom culture, and determining what should be included in criteria for success are all examples of this strategy. Using student work, classroom tests, or exemplars of what is expected helps students understand where they are, where they need to be, and an effective process for getting there; (2) Observations go beyond walking around the room to see if students are on task or need clarification. Observations assist teachers in gathering evidence of student learning to inform instructional planning. This evidence can be recorded and used as feedback for students about their learning or as anecdotal data shared with them during conferences; (3) Questioning strategies should be embedded in lesson/unit planning. Asking better questions allows an opportunity for deeper thinking and provides teachers with significant insight into the degree and depth of understanding. Questions of this nature engage students in classroom dialogue that both uncovers and expands learning. An "exit slip" at the end of a class period to determine students' understanding of the day's lesson or quick checks during instruction such as "thumbs up/down" or "red/green" (stop/go) cards are also examples of questioning strategies that elicit immediate information about student learning. Helping students ask better questions is another aspect of this formative assessment strategy; (4) Self- and peer assessment helps to create a learning community within a classroom. Students who can reflect while engaged in metacognitive thinking are involved in their learning. When students have been involved in criteria and goal setting, self-evaluation is a logical step in the learning process. With peer evaluation, students see each other as resources for understanding and checking for quality work against previously established criteria; (4) Student record keeping helps students better understand their own learning as evidenced by their classroom work. This process of students keeping ongoing records of their work not only engages students; it also helps them, beyond a "grade," to see where they started and the progress they are making toward the learning goal.

States and Keyworth (2018) provided an overview of the summative assessment gleaned from multiple studies conducted over more than 40 years. Summative assessment is a commonplace tool used by teachers and school administrators. It ranges from a simple teacher-constructed end-of-lesson examination to standardized tests that determine graduation from high school and entry into college. If used for the purposes for which it was designed, summative assessment plays an important role in education. When used appropriately, it can deliver objective data to support a teacher's professional judgment, to make high-stakes decisions, and as a tool for acquiring the needed information for adjustments in curriculum and instruction that will ultimately improve the education process. When used incorrectly or for accountability purposes, summative assessments can take valuable instruction time away from students and increase teacher and student stress without producing notable results (States & Keyworth , 2018).

The use of formative assessment in keeping track of learner's progression in a specific domain of learning has been one the concerns of teachers in determining where student learning lies on a continuum, and knowing what to do to close the gap between current learning and desired goals. When teachers understand the continuum of learning in a domain and have information about current status relative to learning goals (rather than to the activity they have designed to help students meet the goal), they are better to make decisions about what next steps in learning should be (Heritage, 2008).

Summative assessment is taken at the end of session and it is used for decision-making process because it provides comprehensive information about whole session what teacher have taught and what students have learned during whole session (Wojtczak, 2002). Summative assessment is to provide detailed information about student or teacher learning activities after the completion of session or study period (Anthony & Susan, 2005). Summative assessment facilitates to decision makers and policy makers about the current performance of the teaching-learning process. American researchers (Bloom, Hastings, & Madaus, 1971) discussed that summative assessment is not only concerned with the grade position of the students but it also deals with the whole educational system performance like institutions, teacher, students and all those educational activities which are arranged for making effective teaching learning system. Summative assessment helps teachers to evaluate their students' performance on what they have learned during whole session from their teacher, classmates, or learning activities designed to promote critical thinking among their students. Some researchers discussed that diagnostic assessment is different from formative assessment but many researchers agree that diagnostic assessments are used to make formative assessment effective.

Diagnostic assessments are used to identify learners' difficulties and provide information about learners' weak areas so that remediation can be possible through well-planned instruction and acknowledging learners' needs. Wiggins and McTighe (2007) assert that pre-assessments include "checks of prior knowledge and skill levels and surveys of interests or learning-style preferences" (p. 101). After formative and diagnostic assessment, the most commonly used classroom assessment technique is portfolio assessment which is not a new term in education.

Herrera, Murry, and Cabral (2007) stated that the purpose of portfolio is to integrate students' work on one places; as they state "Portfolio is an effective tool which enables a student to collect his work and assess his performance according to set criteria and improve his performance or products to meet the established criteria" (p. 29). Some researchers focus on the development of portfolio for effective teaching- learning process. In portfolio assessment, teachers decide on the nature of students' collective and their efforts and set the criteria for assessment of student work (Wiggins & McTighe, 2007). Teacher gives them task or work on daily basis which includes reading, writing, sketching, short assignment, etc. According to Herrera (2007), in portfolio assessment, students' work is displayed to show students' learning and their achievement. Portfolio is considered as the best choice for collection of student work rather than traditional assessment because in portfolio assessment, students' work is integrated in one document and all records are kept safely for improvement of students' work. One of the most effective aspects of portfolio assessment is that it provides information about students' performance on the basis of longitudinal observation and assesses students' progress or their proficiency level which cannot easily be examined through traditional paper- and- pencil test. In paper- and- pencil test, students' performance is assessed more or less on the basis of rote memorization and decision is taken on the basis of final written test, rather than portfolio assessment (Herrera, 2007). It is an instrument that helps the students to develop higher-order skills (Kotsopoulos, Lee, Cordy, & Bruyns, 2014).

Like self-assessment, educators consider peer-assessment beneficial, as it provides opportunities to the students to recognize targeted learning goals (Chappuis & Stiggins, 2004). In peer-assessment, students assess their peer performance and compare it with some pre-determined criteria. Another most important element of peer assessment is to involve students in classroom discussion and provide them opportunity to give their critical reflection on each other's work instead of just signal teacher's comments on students' work (Saeed, Hafsa, & Iqra, 2009). In this way, peer assessment will be the most effective tool to develop confidence and competitive skills among the peers. Black and Wiliam (1998) recommend that students must be well-trained on and fully aware of the importance of peer assessment. As students criticize their peers' work, they and use informal language which is easy and comprehensive to them. Herrera, et al. (2007) stated that "the idea of peer-assessment is in the context that students evaluate other students' work to the established criteria, which "enable them to discern outstanding elements of both their own classmates' performances and products" (p. 34). Self-assessment is an important instrument in the teaching-learning process as it helps student to evaluate their own performance according to predetermined criteria. Self-assessment provides opportunity to students to improve their weak learning areas and improve their performance according to set criteria. Black and Wiliam (1998) discussed that students are interested and show willingness in assessing their own performance.

Self-assessment provides a clear picture to learners about their learning. After self-assessment, students are aware of their weak learning areas and they make their extra efforts to improve their learning through their own assessment. Through self-assessment students are able to make their extra efforts for the improvement of their learning weaknesses and compare themselves with their peers or classmates. Once they will be able to know their weaknesses and strengths, they become more committed and more effective as learners; their own assessment becomes an object discussion with their teachers and with one another. Self- and peer assessments help students to control their learning and put extra efforts for enhancing their performance in the teaching-learning process. Various teachers provide instruction about self-assessment and provide rubrics for their students to assess their performance. The rubrics integrate the criteria that provide the opportunity students to reflect on the extent to which they have made progress. Atkin, Black, and Coffey (2001) stated that quality of alternative assessment provides opportunity to learner to ask questions by their own self (in Chappuis & Stiggins, 2004, p. 43).

Heritage and Vindlinski (2008) enumerated three key elements of formative assessment which serve as bases of learning progressions and these are: (1) eliciting evidence about learning to close the gap between current and desired performance; (2) providing feedback to students; and (3) involving students in the assessment and learning process. To be effective, formative assessment cannot be treated as a series of ad hoc events; rather, evidence of learning needs to be elicited in systematic ways so that teachers have a constant stream of information about how student learning is evolving toward the desired goal. With clear learning goals outlined in a progression, teachers can match formative assessment opportunities to them, and can make plans in advance of and during instruction about when, what, how, and who to assess.

Feedback to students is critical to formative assessment. A considerable body of literature documents the nature and benefits of quality feedback for student learning, motivation, and self-regulation (eg., Bangert-Drowns, et al., 1991;Butler, 1986,;Butler & Nisan, 1986; Kluger & DeNisi, 1996,; Pintrich & De Groot, 1990). Quality teacher feedback needs to be timely, specific, and linked to explicit criteria (that are known to the student) and provide suggestions for how to improve (OECD, 2005). Feedback is given in relatively frequent and manageable chunks so that requirements for improvement are both understandable and doable (Brookhart, 2007). Quality feedback does not involve comparison with peers, but instead helps students to understand their own performance in relation to the learning goal. Thus, the learning process is transparent and also provides students with models of " learning how to learn" (OECD, 2005).

In the context of formative assessment, metacognition involves students in monitoring and evaluating their own learning process to determine what they know and understand, and to develop a variety of learning strategies so that they can adapt their learning to the task at hand. Sharing the criteria for success with the students at the outset of the instructional segment not only provides transparency on the learning process; it also means that the students can monitor their learning while engaged in the learning task (Heritage, 2008).

Formative assessment conducted in different parts of the lesson serves different purposes. Before the lesson, it helps teachers understand where the students are in terms of conceptual understanding and application and provides bases for making instructional decision, such as moving on to a new lesson or clarifying prerequisite understanding. During the lesson, it informs teachers of the progress of the students in relation to the development of the learning competencies. It also helps the teacher determine whether instructional strategies are effective. The results of formative assessment given may be compared with the results of the formative assessments given before the lesson to establish if conceptual understanding and application have improved. On this basis, the teacher can make decisions on whether to review, re-teach, remediate, or enrich lessons and subsequently, when to move on to the next lesson. After the lesson, formative assessment assesses whether learning objectives were achieved. It also allows the teacher to evaluate the effectiveness of instruction (DepEd Order No. 8 s. 2015).

Learning Progression

Learning involves progression. To assist in its emergence, teachers need to understand the pathways along which students are expected to progress. These pathways or progressions ground both instruction and assessment. Despite a plethora of standards and curricula, many teachers are unclear about how learning progresses in specific learning domains. Learning is envisioned as a development of progressive sophistication in understanding and skills within a domain.

According to Masters and Forster (1997), learning progression is a description of skills, understanding, and knowledge in the sequence in which they typically develop; a picture of what it means to "improve" in an area of learning. Stevens, et al. (2007) describe that learning progression represents not only how knowledge and understanding develop, but also predicts how knowledge builds over time. Another idea presented in these definitions of learning progression is that progression, is a sequence along which students can move incrementally from novice to more expert performance (Heritage, 2008). This is supported by Vygotsky's concept of the zone of proximal development (ZPD). Teachers activate this zone when they teach students concepts that are just above their current skills and knowledge level, which motivate them to excel beyond their current skills level (Jaramillo, 1996). With clear connections between what comes before and after a particular point in the progression, teachers can calibrate their teaching to any missing precursor understanding or skills revealed by assessment, and determine what the next steps are to move the students forward from that point.

According to the US National Research Council (2007), learning progressions have five essential components: (1) Learning targets or clear end points that are defined by social aspirations and analysis of the central concepts and themes in a discipline; (2)

Progress variables that identify the critical dimensions of understanding and skills that are being developed over time; (3) Levels of achievement or stages of progress that define significant intermediate steps in conceptual skill development that most children might be expected to pass through on the path to attaining the desired proficiency; (4) Learning performances which are the operational definitions of what children's understanding and skills would look like at each of these stages of progress, and which provide the specifications for the development of assessments and activities which would locate where students are in their progress; and, (5) Assessments that measure student understanding of the key concepts or practices and can track their developmental progress over time.

Learning progressions are hypothesized descriptions of the successively more sophisticated ways of student thinking about how an important domain of knowledge or practice develops as children learn about and investigate that domain over an appropriate span of time. They must contain at least the following elements: (1) Target performances or learning goals which are the end points of a learning progression and are defined by societal expectations, analysis of the discipline, and/or requirements for entry into the next level of education; (2) Progress variables which are the dimensions of understanding, application, and practice that are being developed and tracked over time. These may be core concepts in the discipline or practices central to scientific work; (3) Levels of achievement that are intermediate steps in the developmental pathway(s) traced by a learning progression. These levels may reflect levels of integration or common stages that characterize the development of student thinking. There may be intermediate steps that are non-canonical but are stepping stones to canonical ideas; (4) Learning performances which are the kinds of tasks students at a particular level of achievement would be capable of performing. They provide specifications for the development of assessments by which students would demonstrate their knowledge and understanding; and, (5) Assessments, which are the specific measures used to track student development along the hypothesized progression. Learning progressions include an approach to assessment, as assessments are integral to their development, validation, and use.

Science education researchers, learning scientists, assessment developers, teacher educators, and curriculum developers are interested in the development of learning progressions, and many believe that learning progressions can lead to the development of more focused standards, better designed curricula, better assessments, and ultimately more effective instruction and improved student learning of science. They believe that standards and curricula based on learning progressions would be more parsimonious and better aligned vertically because learning progressions would provide clear pathways for development over time of more sophisticated understanding of the core concepts and practices in science (Corcoran, Mosher, & Rogat, 2009).

When it comes to curriculum, learning progressions could provide much more useful frameworks for devising specific curricula than are provided by most current standards documents. Because they would be grounded and tested in real teaching and learning situations, they also hold the promise of providing more realistic pictures of the kinds of progress or growth students are likely to be able to show within the time and particular resource constraints available to schools and teachers. They could support realistic and parsimonious planning for what would be required to meet the needs of a given student population, and help to guide the development of fairer and more realistic accountability provisions for schools, teachers, and students. If learning progressions were derived from and tested against evidence of the association between the kinds of progress students make and the kinds of instruction they have experienced, then they could provide a basis for specifying "curriculum frameworks" for determining what, and in what order and intensity, specific content and skills should be taught; it could also provide a basis for designing "instructional regimes" that would specify ways of responding pedagogically to individual students' or groups of students' particular stages of progress and learning problems (Corcoran, Mosher, & Rogat, 2009).

Having a clear conception of the likely stages of students' progress ought in itself to be useful in guiding teachers on their instructional goals and choices, particularly as those would be reinforced by curricula and assessments informed by progressions. But the evidence generated during the development and testing of the hypothetical learning progressions concerning how they are influenced by instructional choices and experiences should provide even more direct support for teachers' choices about what to do when they see evidence of how their students are progressing and what particular difficulties they are facing. The empirical investigations that are required to inform the development of progressions and to conform their usefulness also should provide the grounding for the pedagogical content knowledge that teachers need to guide their instructional choices. Teachers' acquisition of that knowledge could of course be facilitated through participation in pre-service education or professional development experiences that would be informed by, and designed in accordance with, the research that supports the development and ongoing validation of the progressions (Corcoran, Mosher, & Rogat, 2009).

A learning progression approach can respond to this need by presenting an explicit path in which student abilities can be mapped and charted. For example, the

Consortium for Policy in Research in Education recently identified the following benefits to using learning progressions (Corcoran, et al., 2009): (1) Provide a more understandable basis for setting standards, with tighter and clearer ties to the instruction that would enable students to meet them; (2) Provide reference points for assessments that report in terms of levels of progress (and problems) and signal to teachers where their students are, when they need intervention, and what kinds of intervention or ongoing support they need; (3) Inform the design of curricula that are efficiently aligned with what students need to progress; (4) Provide a more stable conception of the goals and required sequences of instruction as a basis for designing both pre- and in- service teacher education; (5) Form the basis for a fairer set of expectations for what students and teachers should be able to accomplish, and thus a fairer basis for designing accountability systems and requirements." (pp.9---10)

Similarly, learning progressions have the potential to organize standards, assessments, and instruction in a way that promotes scientific literacy. Current standards and curricula prioritize the structure of the scientific disciplines, using a top-down approach that creates logical (from scientists' perspective) sequences of ideas. Learning progressions, which use both top-down and bottom-up design approaches, can combine ideas about scientific domains with understandings of how students learn. Thus learning progressions provide a significantly different perspective from that of other currently available frameworks for organizing standards, assessments, and instruction. Learning progressions prioritize big ideas that are generative and merit extended periods of study. As part of the top-down design approach to learning progressions, scientists and science educators select these big ideas from the core knowledge needed for understanding socio-scientific issues and achieving scientific literacy. However, this logical decomposition of big ideas may not necessarily reveal the paths students take as they learn scientific content. Therefore, the bottom-up design approach to learning progressions promotes the organization of content based on students' thinking as they develop more sophisticated understandings. Students' progression from naïve to more sophisticated understandings may not be linear or easily described. An investigation of the "messy middle" (Gotwals & Songer, 2010, p. 277) of students' learning may thus provide powerful information for formative assessments (e.g., Alonzo, 2011), curriculum development (e.g., Wiser, Smith, & Doubler, this volume), and standards (e.g., Foster & Wiser, this volume). The top-down and bottom-up processes of developing learning progressions require varied expertise. Learning progressions draw on existing work that has not before been brought together in a coherent and systematic manner. In addition, learning progressions require collaborations to generate new knowledge needed to advance the field even further. In the past, scientists and science educators have articulated core ideas in science that are generative and allow students to integrate knowledge that produces powerful explanations of socio-scientific phenomena (e.g., AAAS, 1990; NRC, 1996, 2007). However, while they have identified goals for scientifically literate citizens, they have not taken the bottom-up design approach described above; thus, they have failed to identify and/or prioritize the ways students achieve these goals.

Cognitive and learning scientists have conducted research on how children learn in specific domains and have studied the ideas students bring to school. However, much of this research has been conducted outside the classroom, with limited success in transferring the knowledge acquired to learning environments. In addition, assessment experts have researched ways of ascertaining what students know, and psychometricians have developed sophisticated models of students' responses to assessments. Yet, since there has been little communication between science educators and these measurement experts, new techniques have not been systematically applied to science education (NRC, 2001). Hence the research on learning progressions represents a systematic effort to synthesize the ideas from multiple strands of research into frameworks for scaffolding students in the deep understandings required for scientific literacy. Learning progressions hold great promise for the science education community. They can harmonize and coalesce multiple aspects of the educational system by their focus on a common framework that is informed by core socio-scientific ideas and by knowledge of how students learn. Standards and large-scale assessments have identified which science topics to teach and curricula have outlined how to teach these topics. However, while students' misconceptions have informed curricula and standards documents (e.g., AAAS, 1990, Davis & Krajcik, 2005), learning progressions go further in that they focus on how students learn these topics (Alonzo, 2011).

Because learning progressions appear to "re-visit" student understanding of the core concepts that form their spine at multiple points, they are sometimes said to spiral. This leads to some confusion between progressions and spiraling curricula. While learning progressions might be used to develop a spiraling curriculum, spiraling is not their essential feature. It is the developmental pathway, the continua of development of understanding of the concepts covered by the progression that is their key feature. Spiraling curricula do focus on the mastery of concepts over time, but they may lack a clear pattern of development, are seldom based on strong empirical foundations, and typically lack the validation evidence characterizing progressions.

Learning Progression and Formative Assessment

Formative assessment has three key elements: (1) eliciting evidence about learning to close the gap between current and desired performance; (2) providing feedback to students; and (3) involving students in the assessment and learning process. Learning progressions are foundational to these elements.

To be effective, formative assessment cannot be treated as a series of ad hoc events. Instead, evidence of learning needs to be elicited in systematic ways so that teachers have a constant stream of information about how student learning is evolving toward a desired goal. A constant stream is necessary because, if assessment is used effectively to inform instructional action, then that action will render previous assessment information out of date: student learning will have progressed and will need to be assessed again so that instruction can be adjusted to keep learning moving forward. With clear learning goals outlined in a progression, teachers can match formative assessment opportunities to them, and can make plans in advance of and during instruction about when, what, how, and who to assess. Even when formative assessments arise spontaneously in the course of a lesson, interpretations of how learning is evolving can be made on the basis of the trajectory of learning represented in the progression. The information from the assessments maps back onto the progression and assists teachers to identify where students are in their learning and to decide what they need to do next.

Feedback to students is critical to formative assessment. A considerable body of literature documents the nature and benefits of quality feedback for student learning, motivation, and self-regulation (e.g., Bangert-Drowns, et al., 1991; Butler, 1986; Butler & Nisan, 1986; Kluger & DeNisi, 1996; Pintrich & De Groot, 1990.) Quality teacher feedback needs to be timely, specific, and linked to explicit criteria (that are known to the student) and provide suggestions for how to improve (OECD, 2005). The explicit criteria, or "what a good performance looks like," Sadler (1989:120), have also been termed "success criteria" (e.g., Clarke, 2005; Wiliam, 2007). These criteria serve as sign-posts for students about where they are going in their learning, as a means for teachers to assess the current state of students' learning, and for students themselves to reflect on their performance. Returning to the science goals described earlier, if teachers are clear that their learning goal is to develop understanding that "objects have properties that can be explained and measured", they have a basis for determining what a good performance looks like. For example, in a classification task the students should accurately sort objects according to weight, length, and area; be able to explain their classification system; and describe reasons for why they have put specific objects in one category rather than another. The task would provide the teacher with information about students' understanding of the goal and enable her to provide specific feedback to the students; for example, "there are three objects that belong in this category and one that doesn't. Look again, think about your explanations, and see if you can figure out which one does not belong and why." The teacher is able to analyze how student performance differs from the criteria and provides feedback that requires the student to think more about the classification she has made. The teacher also knows that these criteria connect with an earlier learning goal of understanding that "objects are constituted of matter" (which she may need to return to depending on the information from the assessment task) and to the subsequent goal of understanding that "objects are made of matter that takes up space and has weight" (which she may move to more quickly than she anticipated as a result of the assessment). The feedback is given in relatively frequent and manageable chunks so that the requirements for improvement are both understandable and doable (Brookhart, 2007). Quality feedback does not involve comparison with peers, but instead helps students to understand their own performance in relation to the learning goal. Thus, the learning process is transparent and also provides students with models of "learning how to learn" (OECD, 2005).

Cognitive theories note a central role for metacognition (i.e., thinking about thinking) in students' learning. In the context of formative assessment, metacognition involves students in monitoring and evaluating their own learning process to determine what they know and understand, and to develop a variety of learning strategies so that they can adapt their learning to the task at hand. Sharing the criteria for success with the students at the outset of the instructional segment not only provides transparency on the learning process; it also means that the students can monitor their learning while engaged in the learning task. "But how can students monitor their learning while they are learning? Won't they need to have learned what they need to learn to be able to know if they have learned it?" To answer these questions, more on success criteria and the tension between summative and formative assessment is in order here. Teachers have traditionally been trained to write learning goals as "by the end of… students will…". Clarke (2005) refers to these as product criteria that describe a longer-term learning goal. These product criteria are often accompanied by rubrics, usually on a one to four-point scale, that specify what performance for each score point looks like. Rubrics are provided to students (or are developed by students and teachers together) at the beginning of the learning sequence. Students know what they are aiming for and, using the rubric, they are able to evaluate their product. Teachers might use the rubric as part of the students' grade. Students and teachers evaluate learning expected at the end of a longer-term objective, which stands in contrast to the notion of a steady stream of information to guide "minute-by-minute, day-by-day" instruction and learning (Leahy, et al., 2006). Without a doubt, it is desirable for students to know what the longer-term goal is or what the final product of the learning will be. Increased involvement in learning occurs when teachers share with the students what their longer- term goals are and enable them to participate in evaluating the degree to which they have met the goals. However, long-term goals represent too much of a stretch for students (and for teachers) to be able to profitably monitor their learning and to respond to feedback from teachers and peers. Needed for formative assessment are short-term objectives (for one or two lessons) and process criteria for students to help them while they are engaged in the task; in other words, the key steps or ingredients students need to meet the learning goal of the lesson or lessons (Clarke, 2005). What does this look like in practice? Take, for example, the long-term writing goal: students will use conditionals in past and future to speculate about possible causes (past) and review a range of options (future). A short-term goal or objective toward meeting this goal could be to have students use some connectives in their writing to show causality. The process criteria for the students might be: "in your writing today, remember to use words like *because*, *so*, as, *however*, therefore to express the reasons why things did or should happen." These criteria become the means for students to be reflective while they are learning to use the connectives to show causality, as well as being the basis for teachers' assessment while the students are writing. Further reflection and the opportunity to be actively involved in learning could come at the end of the lesson when students respond to the question "how well do you think that you used connectives to show causality – why do you think this?" and leave their responses on cards for the teacher to read as they leave class. Alternatively, she could ask them to review their writing against the success criteria, identify where they have used the connectives well and note a place where they could improve their writing the following day. Through this process, students have a manageable way to be self-reflective about their learning while they are learning. Furthermore, the teachers' observations from the lesson, analysis of the writing samples against the criteria, and the students' end of the lesson reflection give her the means to make decisions about how well learning is progressing and the kind of feedback she will give to the class as a whole or to individual students. Not only does she have the criteria on which to provide specific feedback to the students about their learning; she also has information to guide her lesson the next day. At the same time, process criteria enable students to be involved in peer- as well as self-assessment. Peers can review each other's work against the criteria and provide feedback on areas for improvement. Ultimately, the teachers and the students will likely want to evaluate how well they have met the longer-term goal of "using conditionals in past and future to speculate about possible causes (past) and review a range of options (future)," which could involve evaluating with a rubric a piece of writing intended to display this competence. Critically, though, prior to this, the students will have had many opportunities to reflect on the short-term goals during the course of learning, with corollary opportunities to adjust their learning in response to their own reflection and to teacher and peer feedback.

A well- constructed learning progression presents a number of opportunities to teachers for assessment and instructional planning. In instruction planning, it enables the teachers to focus on important learning goals in the domain, centering their attention on what the student will learn rather than what the student will do (i.e, learning activity) (Heritage, 2008). A progression also helps teachers see connections between what comes before and after a specific learning goal, both in short and long term. In the

Smith, Wiser, Anderson, and Krajcik (2006) progression of Molecular- Atomic Theory, for example, teachers have the opportunity to build explicit connections between ideas for students that thread the development of increasingly complex forms of a concept or skill together.

Designing and validating assessment instruments focused on the identified levels of progress is part of the process of developing a learning progression. Developers of learning progressions specify learning performance indicators that exemplify how students are likely to think and what they are likely to know, understand, and be able to do at particular points along the progression (Corcoran, et al., 2009). The learning performances defined in the progressions typically would require students to engage to more complex tasks and provide teachers with richer insights into student thinking than the assessment items typically used in national assessments. The assessments derived from learning progressions are likely to provide information that is more easily interpreted by teachers and potentially allow them to make better informed and more precise decisions about students' needs and how to respond to them instructionally (Corcoran, et.al., 2009).

Information from formative assessment can be used to pinpoint where students' learning lies on the continuum. With clear learning goals outlined in a progression, teachers can match formative assessment opportunities to them, and can make plans in advance of and during instruction about when, what, how, and who to assess (OECD, 2005). The information from the assessments maps back onto the progression and assists teachers to identify where students are in their learning and to decide what they need to do next. Teachers who are responsible for a particular range of the progression could have the detail they need for planning and for formative assessment. They would be able to see how the focus of their instruction connects to a larger picture of learning, and in the case when assessment information shows that one or more of their students are performing outside the range, they would know what precursor understanding or skill need to be developed for students to move forward (Shepard, 2007).

The U.K National Curriculum presents a program of study that focuses on the core ideas of the domain provided for each of the attainment levels. The program of study outlines in some, but not overwhelming detail what the core ideas of each attainment levels look like. The way the core ideas develop progressively through the attainment levels is reminiscent of Jerome Bruner's notion of the "spiral curriculum". He expressed the hypothesis that any subject can be taught effectively in some intellectually honest form to any child at any stage of development (Bruner, 1960:33). Consequently he proposed that as any curriculum develops teachers should revisit these ideas and build on them in successive ways.

Clarity about core ideas developed from their earliest to more sophisticated forms presents a number of advantages for teaching and learning. First, the description of the ideas at each of the attainment levels helps teachers keep the big picture in mind, and enables them to see where their focus of learning fits in a larger trajectory. Thus, they expand their knowledge of the domain and can connect prior successive learning to the students' current learning focus. Knowing that at a later stage students will be learning that representations and interpretations could prompt teachers of an earlier stage to not only help children understand there are different sources of evidence about the past, but to also lay the ground work for the future by connecting the idea of who provided the source of evidence and what that person's role was or is (Heritage, 2008).

The descriptions of attainment at each level provide sufficient detail for instructional planning and help teachers to map formative assessment opportunities on to the key elements of learning in the description. There are several components of formative assessment and teachers have sufficient detail from which to derive criteria for success, which can be shared with students. They are able to decide on appropriate pedagogical strategies that will assist students to meet the criteria and use these strategies as formative assessments to elicit evidence of how learning is evolving toward the criteria. The criteria become the focus for determining how learning is progressing and enable teachers to provide descriptive, criterion-based feedback that can help students understand their current status in learning and provide pointers so they know what to do to move forward. For instance, the teacher feedback could let the students know that they are able to extract information beyond the observation but that they are not yet combining information form sources, which is the ultimate goal. The feedback is in manageable chunks and learning is transparent – students know where they are going. Additionally, sharing criteria with the students at the beginning of the instructional sequence establishes the expectations that students will be involved in the learning process and helps them monitor and adjust their own learning (Heritage, 2008).

Most importantly for the development of better assessments, learning progressions characterize how student performances change over time and describe how thinking will develop over time relative to specific starting and ending points. Thus, the assessments based on a progression should provide more useful information than conventional standardized norm-referenced tests do about student progress toward specific learning goals. The assessments derived from learning progressions are likely to provide information that is more easily interpreted by teachers and potentially allow them make better informed and more precise decisions about student needs and how to respond to them instructionally (Corcoran, Mosher, & Rogat, 2009).

Instructional Material

All students deserve access to worthwhile, rigorous, and meaningful educational experiences and all teachers deserve the supports to help them create classroom environments where students can thrive. Quality instructional materials allow teachers to better help students master the skills, knowledge, and experience that will support them in school and in life especially when they are implemented effectively in schools that address the students' need.

Teaching in this modern period is increasingly becoming more complex and technical to be effectively actualized with traditional tools alone (Anyanwu, 2003). The development in modern technology has made available a wide range of instructional materials to supplement teachers' efforts in the teaching-learning process. More importantly, the curricula of the modern subjects call for extensively and frequently combined use of traditional with convectional materials in the teaching-learning process (Abolade, 2001). Effective teaching and pedagogical delivery depends majorly on cordial relationship and free flow of communication between the teachers and the students. Verbal instruction, which is seen as the easiest form of instructional and teaching delivery system apart from real experience, is always very abstract (Adeyanju, 2003). Since students in schools are from varied cultural and socio-cultural backgrounds and training, teachers thus need instructional materials or teaching aids to help them communicate and mix effectively and hence cope with students' needs based on their abilities and potentialities (Edward, 2002).

Instructional material (IM) refers to those alternative channels of communication, which a classroom teacher can use to concretize a concept during the teaching and learning process; traditionally, classroom teachers have relied heavily on the "talk-chalk" method during which messages are sent across. In using instructional materials, teachers and students extend not only the range of sense organs they use but also the range of materials used for convening the same message through the same organ (Amadioha, 2010). Instructional materials, therefore, constitute the media exchange through which a message transaction is facilitated between a source and a receiver. Additionally, it also facilitates the "process" nature of communication. In this way, the process nature of communication implies that both the source and the receiver of a message are actively involved in a communication encounter. In fact, it means that both the receiver and the source share and exchange ideas and feelings in any communication (Tyler, 1987, Dike, 1989). Instructional materials do so because they constitute tangible products, which can be used by learners. During such use, a learner interacts with the material. Such interaction may entail that a learner manipulates the instructional material and expresses his/her views about the problem and idea encapsulated in the material. Then, any feedback obtained from such use informs the teacher (which is the source) the extent to which a learner has attained an instructional objective.

Teaching in secondary schools can only be effective through the use of some instructional materials that guide the teacher in explaining topics to students effectively and efficiently (Ofune, 2001). However, instructional aids are not ends in themselves but they are means intended to serve a specific instructional purpose or function (Meduabum, 2004). Teachers at various Age, right from the Stone Age and Dark Ages down to the Knowledge Age or Information Age, had felt the need to make use of instructional materials/aids to produce better results in the teaching-learning process (Olumorin, 2001). However, many of these instructional materials and equipment are still foreign and rarely used in the school system today.

Teaching aids both in print and those of audio and visual types are of fundamental importance to the success of teacher education programs. Modern teaching-learning demands that necessary facilities, well-qualified teachers, suitable texts, and instructional materials are needed to achieve the aims and objectives of teaching at all levels. Provision or presence of these facilities and materials is of great importance to enhance better and effective learning in schools (Ralph, 1999).

Despite this, however, it is interesting to note that teachers are almost ignorant of the availability and the relevance of instructional materials in schools. Teachers find it difficult to use instructional aids effectively in imparting knowledge to the students. The immediate effect of this is that it leads to poor performance of students in both internal and external examinations (Ololube, 2006; 2008).

The use of instructional materials does not only encourage teachers and students to work collaboratively but also results in more cooperative learning activities among the students. The use of instructional materials provides teachers with interesting and compelling platforms for conveying information since they motivate learners to learn more. Going through the description of instruction materials, teachers would find that the understanding behind the use of instructional material is to aid learners in their learning.

Piaget (2009) states that merely using instructional material does not guarantee effective teaching; to make teaching and participation effective, the IM must be appropriately selected and used. Therefore, teachers should be familiar with the types of

IM, and the greater value to be derived from their use. He further states that the primary function of IM as a communication device is to serve as a more concrete reference to meaning than the spoken or written word.

Anyanwu (2003) identified three ways by which a teacher should prepare for the use of IM; these are: By previewing it before bringing to the class, the teacher has to have a first knowledge by using it before the class; teacher should have full knowledge of the parts, names, operational level of the intended instructional materials, and actual presentation. This is the period when the teacher operates and uses these materials in instructing the learners. The following, however, are the basic guidelines and requirements for utilization and use of instructional materials in effective instructional delivery: Specification-of objectives: clear objectives which are behaviorally stated are user ring guides in IM using process; they direct the sequence, methods, content, and techniques of instructional processes. They provide scientific basis of valid evaluation instrument construction and administration. Maximal fit with instructional tasks: Teaching aids must be appropriate to situationally determined and individually responsive. Preparation and preview: For effective and successful use of teaching for proper teaching-learning situation, the teacher must in advance prepare himself, the learners, and the environment, the materials, as a matter of fact , must should be previewed by the teacher in order to follow its process of presentation sequentially. Multi-dimensional presentation: Proper and creative use of a variety of instructional materials or teaching aids at different levels of lesson planning can be adequate in achieving various instructional objectives, because it will enrich a variety of learners' minds as they attain better goals more easily than with the use of a single medium Environmental situation: The environmental variables such as physical, cultural, and social in which the teaching aids are utilized for learning have significant effect on their effectiveness. Sound-motion films for instance, with their attention complexity properties can be successfully presented in less quiet environment. Measure for outcomes teaching aids should be evaluated in terms of their suitability, practicability to the instructional objectives, appeal to the cost effectiveness, learner achievement level, and consistency with content call for improvement in utilization techniques.

There are many teaching aids from various sources. It is therefore very important of professional teachers to note and bear in mind that every instructional material has its definite unique strength in teaching-learning situations that properly cannot be replicated by the use of another. It is necessary to note that through effective communication, better teaching and faster learning can only be facilitated or guaranteed by careful selection and skillful utilization of appropriate instructional materials by the users. However, availability of the instructional materials, teacher’s experience, terms of preference, and the volume of instructions should constitute intrinsic consideration in their selection decision. Despite that fact, the following principles should guide an effective teacher in the selection of instructional materials: Instructional tasks; the behavioral objectives, contents, learning activities, evaluation instruments, and techniques as element of instructional tasks should be taken into consideration by an effective teacher in the selection and development of instructional materials. Target audience attributes: these consist the learners’ features and their level of understanding, their developmental stages such as age, sex, physical skills, attitude towards self and others, the learners experiences, socio-economic background should be considered. The economy: the available resources, financial factors, technological advancement, economic climate of society where the materials should be operated, the socio-cultural level of the materials, users, degree of urbanization, feasibility, and acceptability of the selected instructional materials are equally considered in the selection and development decision. Dynamic variables: these variables constitute the concentration and size of the target audience, the desired level of learners' response and participation, the classroom social climate, seating, viewing, and listening arrangement, available time, space, teacher competence among others, are to be seriously considered in the selection decision and development. The environmental factors: these consist of the educational community and the available educational infrastructure such as people, facilities, equipped library, workshops, laboratories, electricity, water supply, and personnel should equally be considered in the selection and development.

Bozimo (2002) posited the following criteria in the selection of instructional materials: Appropriateness of the materials to instructional objectives; freedom of the content from bias; degree of the quality variety of the materials, quality of the format, print, sound, or photography; availability of the materials; to clarify objectives of and how to operate the materials; how reasonable the time, effort, and expenses are for both the learners and the teachers.

Importance and Selection of Instructional Materials

According to Mwangi (2010), in the teaching learning process, IM serves the function of enhancing retention which makes learning more permanent. Equally, they stimulate and sustain interest in learning by providing firsthand experience with opportunities for private study and reference, the learner's interest and curiosity are increasingly stimulated. Further, the teacher is assisted in overcoming physical difficulties that could have hindered his effective presentation of a given topic. They generally make teaching and learning easier and less stressful. They are equally indispensable catalysts of social and intellectual development of the learners. Bolick (2003) pointed to a good relationship between effective teachings and using of instructional materials. He argued that "… while some educators have been fascinated by the potential of instructional materials to enhance teaching and learning, teachers lagged behind in using instructional materials during teaching and learning. Others expressed doubts that instructional materials will ever incite teaching reform on participation". Instructional materials are integral components of teaching-learning situations; they are not just to supplement learning but to complement its process. It then shows that, if there must be an effective teaching-learning activity, utilization of instructional materials will be necessary (Kibe, 2011).

Ema (2004) asserted that, "teaching equipment and materials have changed over the years, not only to facilitate the teaching-learning situation but also to address the instructional needs of individuals and groups". Instructional materials are made up of objects such as printed, audio and visual that aid in the successful delivery of lesson (Chuba,2000). To this end, instructional materials are said to be objects or things the teacher can use in the classroom while teaching in order to ease off his teaching activities. However, although instructional materials cannot address all the teaching-learning problems, they can go a long way in solving them, simply because they are additional apparatuses that can influence the reality of teaching and learning activities.

Joof (2005) explained that "the concept of teaching aids has gone through several evolutionary stages – from the simple aids, instructional technology, and media to communication and educational technology". This however, tells that instructional materials are not just objects or equipment used during the teaching and learning process but there those objects improvised by the teacher to make conceptual abstraction more concrete and practical to the learners. Instructional materials are the relevant materials utilized by a teacher during the instructional process for the purpose of making the contents of the instructions more practical and less vague (Chuba, 2000).

Ajayi (2006) opined that "without the teacher who is knowledgeable, instructional materials cannot create change and progress; the only time they begins to make impact is when the teacher begins to make use of them and allows them to take over their values". This portrays the professional attributes of the teacher and general knowledge or his creativity selecting, developing and using instructional materials effectively (Esther, 2009). Teaching and learning materials design, production, and their use facilitate the teaching and learning outcomes. However, the success of using IMs to meet the teaching objectives demands, the effective use and communication skills of the teacher to satisfy instructional delivery.

Furthermore, Amadioha (2010) cited the importance of instructional materials as follows: (a) the essence of producing instructional materials is to facilitate the teaching learning process. The essence is not to use such instructional materials as objects of decoration in classrooms or as objects to be presented during award-winning national exhibitions on winning improved IMs. If the essence of producing instructional materials is to use such materials to facilitate teaching-learning, it therefore seems logical that the best approach to adopt any production exercise is to predict out production on research findings on how individuals learn. Besides, there are, for instance, many factors that affect the attention of human beings. These are also ideas about how people we perceive objects. Hence, for a classroom teacher, who wants to produce IMs, his production has to be on sound principles; (1) while presenting various learning theories, one has to be sure that a classroom teacher is guided by expert ideas during his production and utilization of IMs; (2) they supply a concrete basis for conceptual thinking and reduce meaningless work responses for pupils as it makes learning more permanent; (3) instructional materials have a high degree of interest for the learner; for they offer a reality of experience, which stimulates self-activity on the part of pupils;(4) instructional materials develop continuity of thought; this is especially true of motion pictures, as they provide experience not easily obtained through other materials and contribute to the efficiency and variety of learning. Therefore the use of IMs in the teaching/learning process exposes the learner to primary experiences and this exposure enriches learning.

Ramadevi (2002:186) in her article talked on the importance of materials for learners as they act as concrete exposure to the language to be learned and instruct the learners to do specific things in specific ways so that they practice and use language and learn it in the process.

Candlin and Edelhoff (1982) given the purposes of materials which offer information and data about the language being studied, and in particular context, the culture within which communication takes place and derives much of its meanings and value. They need to be authentic to communication and the world outside. At the same time, materials have a role to promote learning and language in particular.

Utilization judges the value of instructional materials, process, or personnel by the degree they singly or collectively satisfy the derived instructional needs, the foresight instructional behavior controls and, to a large extent, the means for achieving them. IMs are not ends in themselves but means of attaining specific instructional functions. Teachers' ability to effectively utilize the available IMs and this optimizes the attainment of instructional situation that varies with their level of utilization. However, once materials have been selected, careful preparation comes first by the user and other subsequent preparation.

Summary

The foregoing review of related literature focuses on learning progression as new tools for improvement in the teaching-learning process. The utilization of different assessment tools as part of the instructional process aimed to establish and target measurable achievement goals and assesses students' growth at the outset of an instructional period. Also, it encapsulates the concepts, importance, and selection of instructional materials as integral components of teaching-learning situations to complement the process.

Assessment provides comprehensive information about the learning development of the teacher and students' performance in educational settings. Different assessment techniques have been used for assessing students' performance in keeping track of students' progress in learning. It has been noted that the use of assessment should consider deliberately the learner's zone of proximal development that would ensure learner's success in moving from guided to independent display of knowledge, understanding, and skills (Vygotsky, 1978).

Formative assessment is a major source for improvement of students' learning (Clark, 2010; Eyal, 2012; Johannesen, 2013). Williams (2011) supports this idea that students in formative assessment are actively engaged, thus, their learning progress. Heritage (2008) described that the purpose of formative assessment is to provide feedback to teachers and students during the course of learning about the gap between students' current and desired performance so that actions can be taken to bridge the gap. In doing so, teachers need to have in mind a continuum of how learning develops in any particular knowledge domain so that they are able to locate students' current learning status and decide on pedagogical action to move students' learning forward.

Williams (2007) envisioned learning as development of progressive sophistication in understanding and skills within a domain. According to Heritage (2008), with clear connections between what comes before and after a particular point in the progression, teachers can calibrate their teaching to any missing precursor understanding or skills revealed by assessment, and determine what the next steps are to move the student forward from that point. This is supported by the findings of Smith, Wiser, Anderson, & Krajcik (2006) that progression helps teachers see connections between what comes before and after a specific learning goal, both in short and long term. The way the core ideas develop progressively through the attainment levels is reminiscent of Jerome Bruner's notion of spiral progression. He expressed that any subject can be taught effectively in some intellectually honest form to any child at any stage of development. Corcoran, Mosher, and Rogat (2009) provided potential benefits of learning progressions in science which include improved standards and curriculum, improved assessments, and instruction. Simultaneously, learning scientists within the core subject areas of mathematics, science, and English language arts (ELA/ literacy) have been studying and mapping the ways students learn key concepts. The resulting learning progressions have the potential to strengthen teachers' ability to analyze and respond to the individual learning needs of students (Achieves Competency-based Pathways State Partnership, 2015).

Quality instructional materials influence students' learning outcomes in school. They allow teachers to help students master the skills, knowledge, and experience that will support them in school and in life especially when they are implemented effectively in schools that address the students' need. According to Tyler (1987) and Dike (1989), instructional materials facilitate the process nature of communication as a more concrete reference to meaning than the spoken or written word. Piaget explained that using instructional materials does not guarantee effective teaching; thus, instructional materials must be appropriately selected and used. This is supported by Kibe (2011) that instructional materials are not just to supplement learning but to complement its process. On the other hand, Bolick (2003), Esther (2009), and Amadioha (2010) pointed a good relationship between effective teaching and using instructional materials. To this end, instructional materials are said to be objects or things teachers can use in classrooms. However, Ema (2004) pointed out that instructional materials cannot address all the teaching-learning problems but can go a long way in solving them, simply because they are additional apparatuses that can influence the reality of teaching and learning activities.

With the abovementioned views and discussions in the review of literature, this study on learning progression and formative assessment practices could be of help to learners and to other educational players in building a stronger knowledge base for teaching and for the development of instructional tools and supports. With this, investing in learning progressions would not solve all educational problems but would put teachers on the right path toward finding solutions.

Chapter 3

Research Design and Methodology

This chapter includes the following parts: (1) Research Design and (2) Methodology.

Part One, Research Design, discusses the collection, measurement, and analysis of data.

Part Two, Methodology I, describes the participants of the study, data-gathering instruments, data collection procedure, and data analysis procedure.

Research Design

This study utilized the developmental research design. Developmental research has been defined as the systematic study of designing, developing, and evaluating instructional programs, processes, and products that must meet the criteria of internal consistency and effectiveness (Seels & Richey, 1994). The most common types of developmental research involve situations in which the product-development process is analyzed and described, and the final product is evaluated. It is a way to establish new procedures, techniques, and tools based upon a methodical analysis of cases. Specifically, design research utilizes the ADDIE (analysis, design, development, implementation, and evaluation) model in instructional development. The phases of ADDIE Model were used in this study. Analysis was done by assessing the least mastered competencies of learners in their learning progression in physics through a 60-item researcher-made learning progression test. Also, a formative assessment practices checklist was given to the science teachers to identify their formative assessment practices in the classroom to promote developmental learning. Thereafter, Design and

Development through crafting of the enhanced instructional material in physics based on the least mastered competencies and science teachers' formative assessment practices followed. The fourth phase, is Implementation, in which the pilot testing of the instructional material was conducted, followed by Evaluation through assessment of the enhanced instructional material in physics conducted as the last phase.

Figure 2 shows the flow of the process of the study.

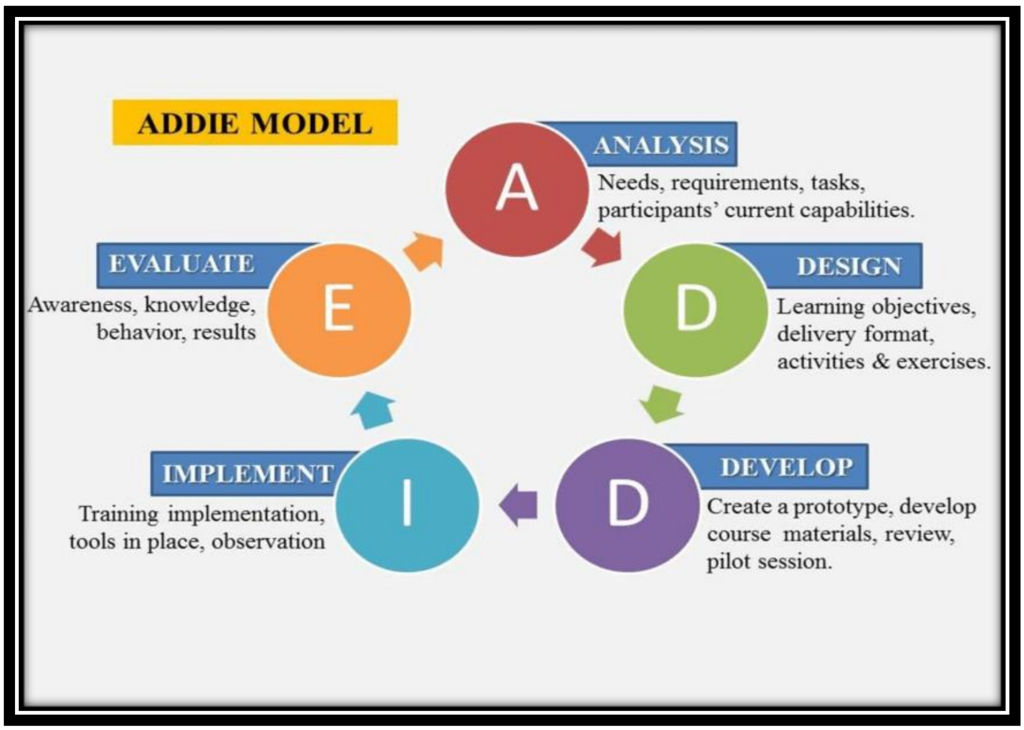


Figure 2. The ADDIE Model of Instructional Material Development Design (Source: *http-eclipsemuacin-mod-forum-discussphpd1783).*

Methodology

Participants. The participants in this study were the 60 selected Grade 11 students of the Academic strand in the Province of Guimaras for the pilot testing of the learning progression test in physics. Meanwhile, three (3) intact groups of students in

Grade 11 senior high school of Maasin National Comprehensive High School of school year 2019-2020 under the Academic Track composed of the two strand,s namely: 1 section under the Accountancy, Business, and Management (ABM) strand and 2 sections under the Humanities and Social Sciences (HUMSS) strand served as the participants in the data gathering and implementation of the module. During the Analysis stage, the researcher utilized three intact groups in Grade 11 under the Academic Track composed of one section under the Accountancy, Business, and Management (ABM) strand and 2 sections under the Humanities and Social Sciences (HUMSS) strand for a total of 128 learners who participated in answering the learning progression test in physics. Meanwhile, eight (8) science teachers from Grades 7 to 10 who were teaching physics participated in answering the formative assessment practices checklist in order to determine the assessment practices in their classrooms. A focused group discussion on the formative assessment practices of the science teachers in their science classroom to promote developmental approach to learning was undertaken. In the Design and Development stage, the researcher utilized fifteen (15) doctoral students major in physical science of West Visayas State University preferably teaching physics and physical science subjects in secondary and tertiary levels who participated in the seminar-workshop for the design and development of the teaching module in physics. Their comments and suggestions were properly documented and incorporated towards the enhancement of the teaching module. In the Implementation stage, the try-out of the module was participated in by 128 Grade 11 students and 4 (four) science teachers who evaluated the module based on their experiences with its use. Lastly, in the Evaluation stage, the enhanced module was evaluated by 16 science teachers teaching physics and 1 education teacher expert with concentration in curriculum and development.

Table 1 shows the participants and their corresponding nature of participation.

Table 1

Participants and Corresponding Nature of Participation in the Study

Participants	*Nature of Participation*
60 Grade 11 learners • 20 ABM • 20 HUMSS • 20 GA	Pilot testing of learning progression test in physics (LPTP)
128 Grade 11 learners • 40 ABM • 44 HUMSS A • 44 HUMSS B	Assessment of learning progression test in physics (LPTP)
8 science teachers	Assessment of formative assessment practices
15 science teachers	Seminar-workshop on module development
4 science experts	Try-out of the module
128 Grade 11 learners	Try-out of the module
16 science teachers	Evaluation of the module
1 education expert	Evaluation of the module

Instruments. The data-gathering instruments used in this study were the researcher-made Learning Progression Test in Physics (LPTP) and Formative Assessment Practices Checklist (FAPC). These instruments underwent content validation by experts in physics and were reliability tested. A table of specifications was prepared to ensure the distribution of the test items. The learning progression test was pilot tested to 60 selected Grade 11 students under the Science, Technology, Engineering, and Mathematics (STEM) strand students of San Lorenzo National High School- Suclaran Annex who were not the actual participants in this study who had gone through these topics from Grades 7 to 10. On the other hand, the formative assessment checklist was administered to the doctoral students major in physical science of West Visayas State University to preliminarily assess the formative assessment strategies they practiced in their science classroom classes and supported by the description of each formative assessment practice. The results were tallied and analyzed and were used as bases in the final listing of formative assessment practices. The final list of formative assessment practices was given to 8 science teachers teaching physics at Maasin National Comprehensive High School.

Learning Progression Test in Physics (LPTP). The researcher-made multiple-choice test in physics consisted of 30 learning competencies in physics from Grades 7 to 10 as reflected in the K to 12 Science Curriculum Guide with increasing levels of complexity of the concepts and skills (see Appendix B). A table of specifications was prepared to ensure the distribution of the test items. The final instrument was composed of 60 items, with 2 (two) questions allotted to each learning competency was constructed for Grade 11; it was originally composed of 75 items with 2-4 questions allotted to each learning competency in physics from Grades 7-10. The instrument was content validated and reliability tested using Kuder-Richardson (KR20) with reliability coefficient of .881 which was interpreted as reliable. Each correct answer from the 60- item learning progression test was credited with 1 point.

Formative Assessment Practices Checklist (FAPC). This researcher-made checklist contained the different types of formative assessment strategies or practices employed by the science teachers in their science classroom classes. The checklist was validated by a panel of experts and was pre-assessed by doctoral students major in physical science of West Visayas State University. Each formative assessment practice was supported by its corresponding description. The results were tallied and analyzed and were used as bases in the final listing of formative assessment checklist. The final list of formative assessment practices composed of items about the different formative assessment employed in teaching physics was given to 8 (eight) science teachers from Grades 7 to 10. The result obtained from the checklist of formative assessment practices was the basis in determining the formative assessment practice of the science teachers and was incorporated in the crafting of the module (see Appendix C).

Focused group discussion guide. A validated researcher-made interview guide consisting of 5 (five) questions aimed at investigating how the results of formative assessment utilized by the teachers in the classroom to promote developmental learning (see Appendix D).

Document analysis. A secondary source to further extract information on formative assessment practices of science teachers in the lesson plan, was a copy of the assessment tool used and other instructional materials utilized in the classroom.

Evaluation of the Module. Structured questions were prepared by the researcher to determine how science teachers and students evaluated the module in terms of (a) learning objectives, (b) content and activities, and (c) assessment (see Appendices E and F). The students were asked to answer the following questions: (1) Is the module easy and enjoyable? (2) Did the module enhance your knowledge, understanding, and skills? How? (3) Is the module of good quality? Why? (4) What is/are the best feature(s) of this module? (5) What difficulties did you encounter in using this module? The researcher discussed the questions with the students and instructed them to write their responses for interpretation. Similarly, teachers were asked to evaluate the module in terms of the following: (A) objectives, (B) content and activities, and (C) assessment. Their responses were tallied, analyzed, and interpreted. Meanwhile, students' responses were analyzed and interpreted through thematic analysis.

On the evaluation of the enhanced module in physics, 1 education expert and 16 science teachers were asked to evaluate the module by means of the instructional material evaluation form adopted from Tellermo (2019). The material evaluation form was content validated and reliability tested using Kuder-Richardson (KR20) with reliability coefficient of .831 which was interpreted as reliable. The module was evaluated in terms of: (a) learning objectives, (b) content and activities, (c) assessment, and (d) design and presentation. Their ratings of the quality of the module based on their personal opinion were interpreted on the basis of the mean score as: poor (1.00-1.50), fair (1.51-2.50), very good (2.51-3.50), or excellent (3.51-4.00).

Table 2 shows the scale for determining the quality of the module adapted from Tellermo (2019).

Table 2

Scale for Determining the Quality of the Module

Mean	Descriptive Rating	Description
3.51 -4.00	Excellent	Always shows accurate, complete, clear, coherent ideas; appropriate and related to topic; clearly articulate information and ideas; information and evidences are accurate and focus is clear and consistent; appealing and presentable.
2.51 – 3.50	Very Good	Most of the times shows accurate, complete, clear, coherent ideas; appropriate and related to topic; clearly articulates information and ideas; information and evidences are accurate and focus is clear and consistent; appealing and presentable.
1.51 – 2.50	Fair	Sometimes shows accurate, complete, clear, coherent ideas; appropriate and related to topic; clearly articulates information and ideas; information and evidences are accurate and focus is clear and consistent; appealing and presentable.
1.00 – 1.50	Poor	Inaccurate, incomplete, lacks a clear point of view and logical sequence of information; in-appropriate and not related to the topic; information and ideas are not clear; purpose and focus are not clear and inconsistent; not appealing and presentable.

Data Collection Procedure. This study utilized the ADDIE model in the development of the module. It underwent analysis, design, development, implementation, and evaluation stages.

Phase 1

Analysis. Before the assessment of the least mastered competencies, a letter asking permission from the Schools Division Superintendent of the Schools Division of Iloilo was sent on the first week of June 2019, asking for a time/ schedule to administer the 60-item learning progression test, give the formative assessment practices checklist to science teachers and implement the module to the identified Grade 11 students and teachers.

In the assessment of the least mastered competencies, the researcher administered the 60-item learning progression test in physics to the three intact groups of Grade 11 students under the Academic track composed of one section of Accountancy, Business, and Management (ABM) strand and 2 sections of Humanities and Social Sciences (HUMSS) strand of Maasin National Comprehensive High School. On the other hand, 8 science teachers teaching physics from Grades 7 to 10 were given the formative assessment practices checklist to identify their formative assessment practices employed in teaching physics. Based on the result of the learning progression test in physics, the items in which the students committed many mistakes or had low scores were their least learned. This was done by ranking the least learned competencies and the bottom 5 least mastered competencies served as the topics for the development of a module in physics.

Before the administration of the formative assessment practices to the identified science teachers, a draft of the formative assessment practices checklist was given to the doctoral students major in physical science of West Visayas State University to preliminarily assess the formative assessment strategies they practices in their own science classes supported by the description of each formative assessment practice. The results were tallied and analyzed and were used as bases in the final listing of formative assessment practices. The final list of formative assessment practices in the checklist was given to 8 science teachers of Maasin National Comprehensive High School teaching physics in Grades 7 to 10. The results obtained from the checklist served as bases in determining the formative assessment practice by science teachers in the classroom to promote developmental learning. This was done by counting the number of times each assessment tool was employed by the teacher, and the formative assessment practices that gained many responses were considered and integrated in designing the module. The results were further reinforced through a focused group discussion as to how these formative assessments were utilized by the teachers in the classroom to promote developmental approach to learning. To further extract information on formative assessment practices of science teachers, the researcher utilized a document analysis guide of lesson plans, test banks, portfolios and other instructional materials used by the science teachers to determine further how these formative assessment practices happened in the science classes to promote developmental learning.

Phase 2

Design. The top 5 least mastered competencies in the learning progression test in physics administered to the Grade 11 students and the top 5 formative assessment practices of the science teachers were the bases for the proposed instructional material in physics.

One way of making the teaching and learning process successful in every classroom is through the use of quality instructional material like a module to help students acquire knowledge, conceptual understanding, skills, and experience they need in moving from the basic to more complex levels of learning. As a type of learning resource, a module provides the basis for close instruction between the learner and the subject matter (Hughes, 1992). In this study, a module was chosen as an instructional material to encourage mastery of concepts and skills rather than partial knowledge of the students by helping them build their skills and knowledge of the topics in physics and incorporating the use of the different formative assessment practices of the science teachers in the lesson to monitor students' progress in learning. Further, it can help science teachers by preparing instructional materials to support their lessons.

The proposed teaching module had the following parts: Grade Level, Content Standard, Competency Code, Learning Competency, Learning Objectives, and Material, and the utilization of the 7Es approach which included: Elicit, Explore, Explain, Elaborate, Extend, and Evaluate. The objectives of the lessons were aligned with the set of competencies in physics from Grades 7-10 in the K to 12 Science Curriculum Guide of the Department of Education suited to the topics with increasing levels of complexity from one grade level to the next. To further enrich the content of the module, the researcher consulted other reference materials. The activities provided were contextually developed and some were adapted from other reference materials that would suit the needs and level of the students. The formative assessments were also incorporated in the lesson for the teacher to monitor and assess students' learning of the topic.

Development. The identified least mastered competencies from the learning progression test in physics and the formative assessment practices of science teachers served as bases in drafting the teaching module in physics. The module followed the 7Es learning cycle – Elicit, Engage, Explore, Explain, Elaborate, Extend, and Evaluation Phases (NRC 2006; Mackenzie 2006; Bybee & Landes 1990). A seminar-workshop was conducted to assess the module being developed with the assistance of the doctoral students major in physical science of West Visayas State University and the panel members. Their comments and suggestions for the improvement of the instructional material were noted and incorporated in the refinement of the module.

Implementation. During this phase, the try-out of the module which focused on the identified least mastered competencies in physics and formative assessment practices of science teachers started. This was done through the assistance of four (4) physics teacher demonstrators who implemented the lesson to the identified group of Grade 11 senior high school students in the Province of Iloilo for effectiveness and usefulness. For the researcher's convenience, the school where he is presently teaching was selected for the implementation of the teaching module. The teachers' teaching experiences and students' learning experiences were also considered in the enhancement of the module.

Evaluation. The module was evaluated by fifteen (15) science teachers who had been teaching physics in public and some private secondary schools in the Schools Division of Iloilo for at least three years. Also, one (1) curriculum development expert and another one (1) science education expert in college evaluated the module. Their responses were tallied and interpreted on the basis of the scale.

Figure 3 presents the summary of the data collection procedure undertaken by the researcher in the conduct of this study using the ADDIE model.

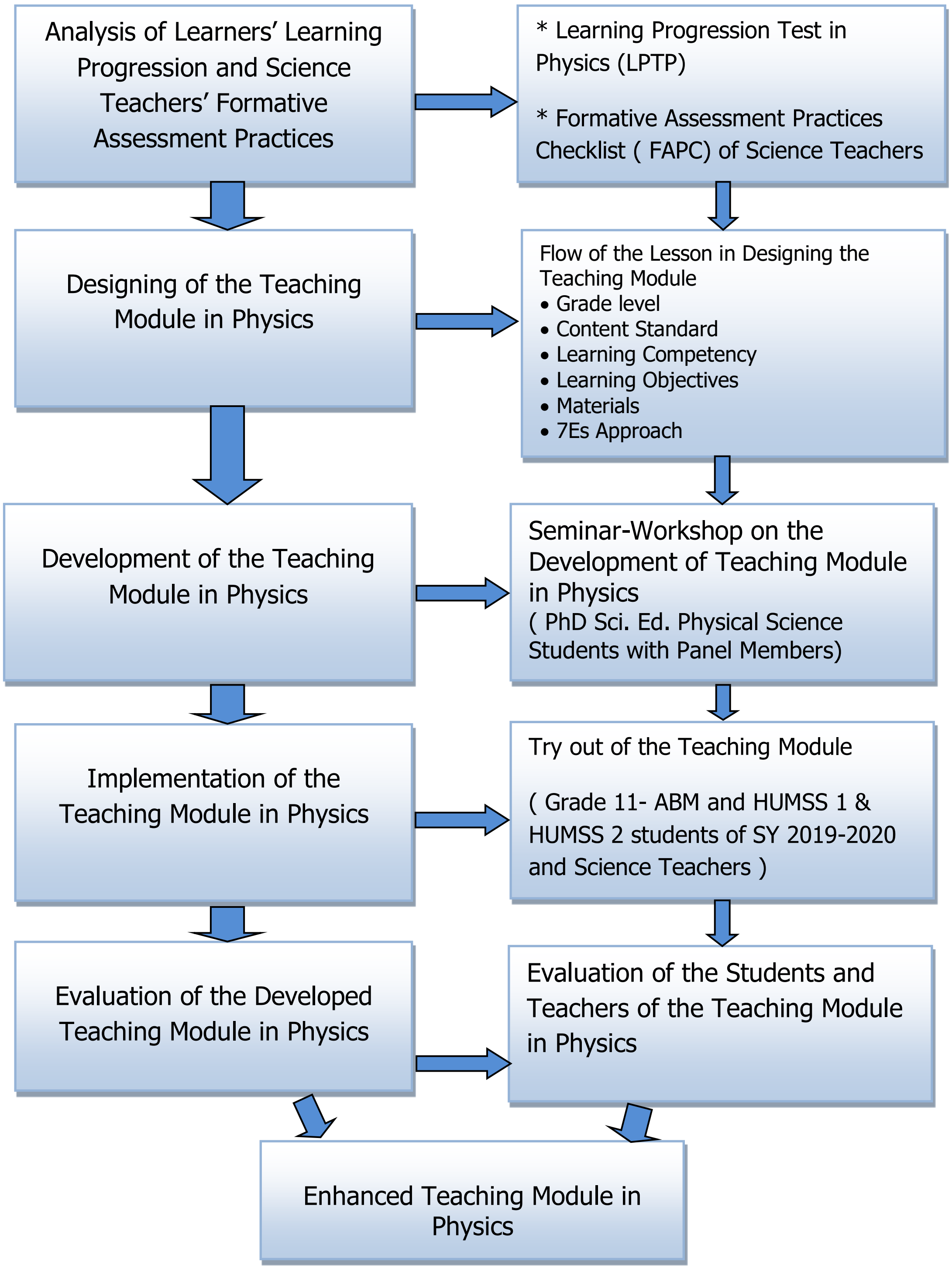


Figure 3. Summary of the Data Collection Procedure Using the ADDIE model.

Data Analysis Procedure. The following statistical tools were employed in the description and analysis of the data gathered. For descriptive analyses, mean, standard deviation, frequency count, and percentage count were employed. Mean and standard deviation were used to determine the acceptability level of the module in physics in terms of learning objectives, content and activities, assessment, and design and presentation. Frequency count was used to determine the top five least mastered competencies of the learners in their learning progression in physics and was used to determine the frequency of each different formative assessment practices employed by the science teachers in teaching physics.

To further interpret the results of the focused group discussion on the utilization of the formative assessment practices of the science teachers in the classroom to promote developmental learning and the evaluation of students on the quality of the module, the researcher utilized thematic analysis.

The researcher was guided by the six phases approach involved in thematic analysis adapted from Braun & Clarke (2012): (1) Familiarizing with the data, (2) Generating Initial Codes, (3) Searching for themes, (4) Reviewing Potential Themes , (5) Defining and naming Themes, and (6) Producing the Report.

Phase 1: Familiarizing with the Data. In this phase, the researcher familiarized himself with the data contents through reading at least once the transcripts and taking down notes that might be relevant to the study.

Phase 2: Generating Initial Codes. This phase was the start of systematic analysis of the data through coding. Codes are used to provide interpretation of data contents. These interpretations or codes identify the depth of the contents.

Phase 3: Searching for Themes. In this phase, the codes were transformed into themes. A theme "captures something important about the data in relation to the research question, and represents some leveled of patterned response or meaning within the data set "(Braun and Clarke, 2006).

Phase 4: Reviewing Potential Themes. This phase involved two levels of reviewing and refining themes. Level One involved reviewing the themes at the level of the coded data extracts. In this level, the data gathered for each theme were considered to find out whether a pattern was formed. Level Two involved the same process as in Level One but was in relation to the entire data set. This level involved the final rereading of all data to determine whether the themes captured the entire data set.

Phase 5: Defining and Naming Themes. This part involved defining and further redefining the themes that presented the analyzed data within them. Defining themes, should clearly state what is unique and specific about each theme or summarizing the essence of each theme in a few sentences.

Phase 6: Producing the Report. This phase involved the final analysis and write-up of the report. The significance of this report is to provide a compelling story about the data gathered based on the analysis.

Figure 4 illustrates the phases/steps used in doing thematic analysis.

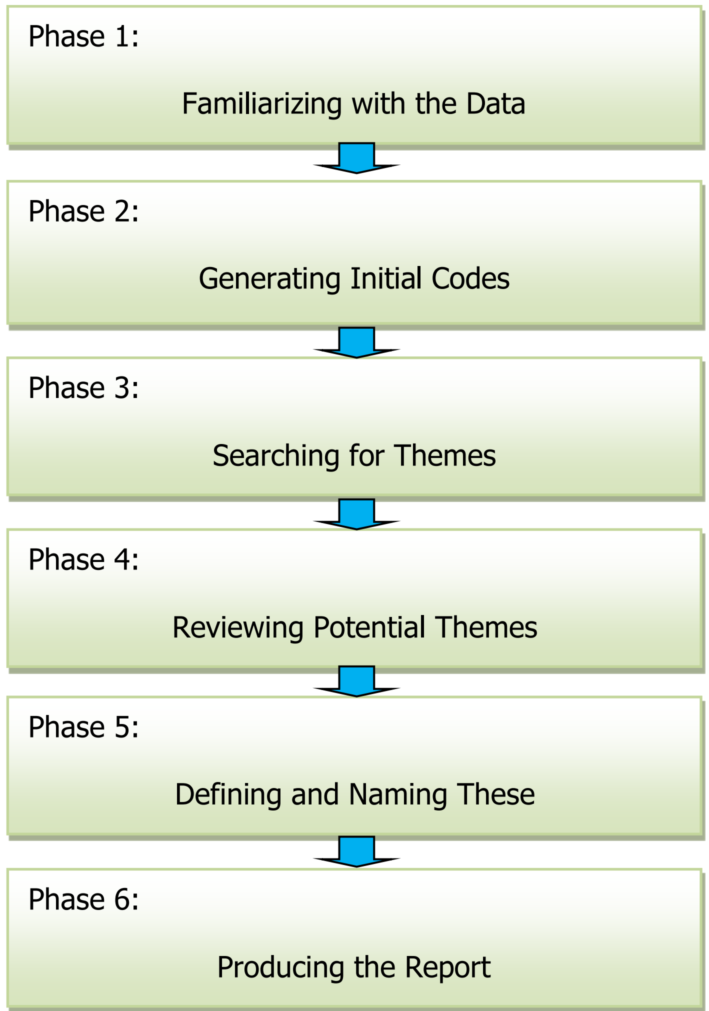


Figure 4. Flow Chart in Doing Thematic Analysis.

Chapter 4

Results and Discussion

This chapter includes two parts: Part (1) Descriptive Data Analysis and Part (2) Development of the Module.

Part One, Descriptive Data Analysis, presents the least mastered competencies in physics and formative assessment practices of the science teachers.

Part Two, Development of the Module, discusses the analysis, design, development, implementation, and evaluation of the module.

Phase I: Descriptive Analysis

Least-mastered Competencies of Learners in Their Learning Progression Test in Physics

To determine the least mastered competencies of the Grade 11 learners in their learning progression test in physics, the researcher used frequency, percentage, and ranking.

The learning progression test results in physics of the learners in thirty (30) learning competencies from Grades 7 to 10 are shown graphically in Figure 5, where the most number of least mastered learning competencies and with the lowest mean average in the learning progression test in physics in physics were found in Grades 8 and 9; namely: learning competency numbers 16 and 21, respectively. On the other hand, two learning competencies in Grades 7 and 10 which corresponded to learning competencies 5 and 30, respectively, were identified to have the highest mean average among other competencies. It can be inferred from the graph that most of the learning competencies in physics from Grades 7 to 10 that Grade 11 students should acquire were below 75%

level of mastery. This would mean that students had not fully mastered and acquired the knowledge, understanding, and skills in their physics lesson which they would typically develop.

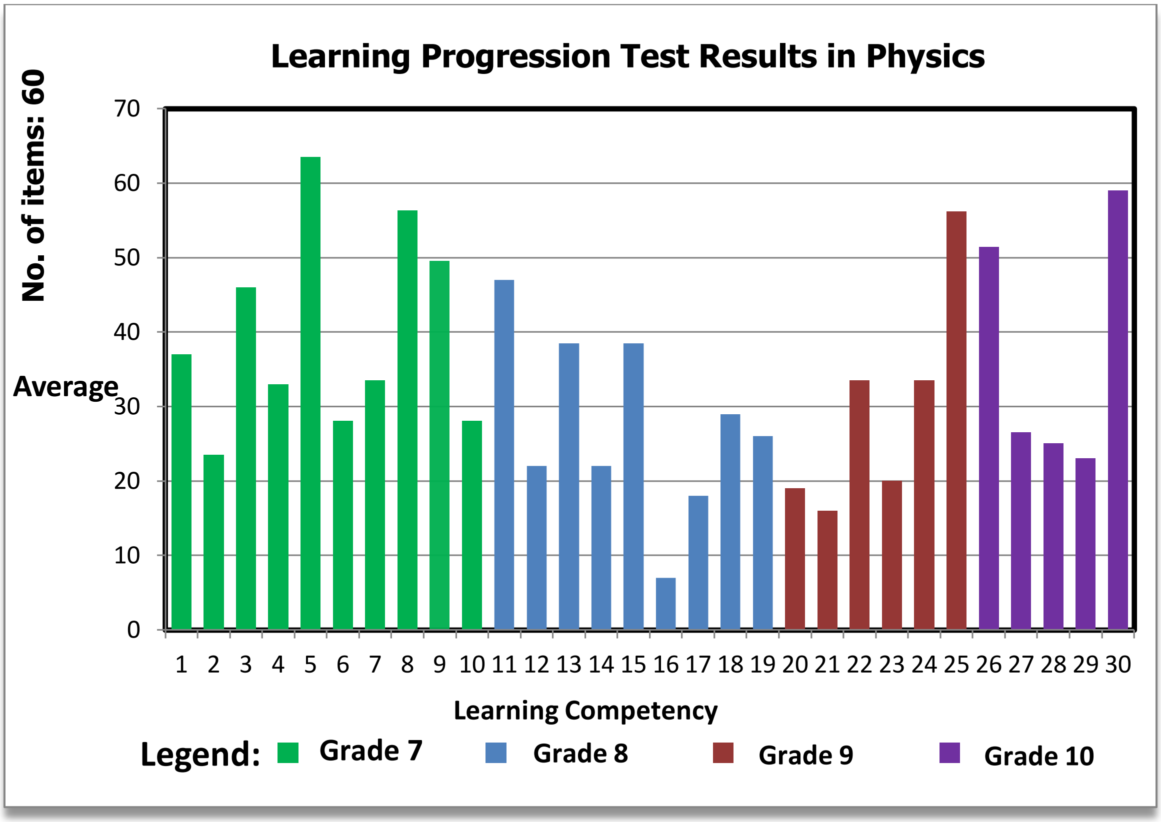


Figure 5. Learning progression test results in physics.

Table 3 shows the percentage of students who got incorrect answers in their learning progression test in different learning competencies in physics from Grades 7 to 10. The top five (5) least mastered competencies of Grade 11 learners in their learning progression in physics were: infer how the movement of the particles of an object affects the speed of sound through it (119 or 93%) for the learning competency in Grade 8, investigate relationship between the angle of release and the height and range of the projectile (108 or 84%) for Grade 9 learning competency, infer the relationship between current and charge (105 or 82%) for Grade 8 learning competency, describe the horizontal and vertical motions of a projectile (104 or 81%) for Grade 9 learning competency, and infer that the total momentum of the system before and after collision is equal (102 or 80%) for Grade 9 learning competency.

The results further showed that students had not mastered concepts and skills learned from their previous physics lessons which hindered their learning of science from moving to basic to more complex learning tasks. Also, most students failed to make connections and apply the concept learned from past lessons with new ones. Perhaps, as in this study, one reason could be the number of physics teachers who are not physics majors but teaching physics subject from Grades 7 to 10 and, as a result, non-physics majors opted to teach the physics subject, thus resulting in limited transfer of knowledge, understanding, and skills to students .This is supported by the study of Ince (2018) that a student's success in solving physics problems depends not only on the student's knowing the concepts of physics but also on establishing relations between the information and concepts in the problem. In this regard, it has been observed that expert problem solvers take more time to understand the problem and the concepts involved in the problem and to explore the relationship between these information and concepts whereas novice problem solvers cannot establish these connections, especially in complex and difficult problems.

In addition, lack of emphasis on these topics due to time constraints, inherent difficulty of the topics which involve both conceptual understanding and problem- solving skills, application of equations in word problems, students poor foundation in mathematics, and limited instructional material to provide activities to support students' learning contributed to non-mastery of the competencies. The results are also in agreement with the study of Nava (2017) that sources of difficulty in physics included content of the subject matter and learning materials. Topics such as mechanics, optics, electromagnetism, and thermodynamics are considered by students as difficult for they do not know how to apply knowledge in novel and real-life situations highlighting problem solving problem as a major source of the difficulty.

Learning involves progression. Learning progression not only represents how knowledge and understanding develop, but also predicts how knowledge builds over time (Stevens, et al., 2007). Jaramillo (1996) emphasized that with clear connections between what comes before and after a particular point in the progression, teachers can calibrate their teaching to any missing precursor understanding or skills revealed by assessment, and determine the next steps to move the students forward from that point. Moreover, appropriate assessments given derived from learning progression are likely to provide information that is more easily interpreted by teachers and potentially allow them to make better informed and more precise decisions about students' needs and how to respond to them instructionally (Corcoran, et al., 2009).

Table 3

Least-mastered Competencies of Learners in the Progression Test in Physics

Least mastered Competencies *(n=128)*	% of incorrect answers	Rank
Infer how the movement of the particles of an object affects the speed of sound through it.	93.00	1
Investigate the relationship between the angle of release and the height and the range of the projectile.	84.00	2
Infer the relationship between current and charge.	82.00	3
Describe the horizontal and vertical motions of a projectile.	81.00	4
Infer that the total momentum of the system before and after the collision is equal.	80.00	5
Relate laws of motion to bodies in a uniform circular motion.	78.00	6.5
Identify ways in which the properties of mirrors and lenses determine their use in optical instruments (e.g., cameras and binoculars).	78.00	6.5
Differentiate quantities in terms of magnitude and direction.	77.00	8
Apply ray diagramming techniques in describing the characteristics and positions of images formed by lenses.	76.50	9
Explain the advantages and disadvantages of series and parallel connections in homes	75.00	10
Predict the qualitative characteristics (orientation, type, and magnification and positions of images formed by plane and curved mirrors and lenses).	74.00	11
Describe the characteristics of a sound using the concepts of wavelength, velocity and amplitude	73.50	12
Explain the importance of grounding	72.00	13.5
Explain the functions of circuit breakers, fuses, earthing, double insulation, and other safety devices in home	72.00	13.5
Differentiate transverse from longitudinal waves and mechanical waves from electromagnetic waves	71.00	15
Explain sound production in human voice box, and how pitch, loudness, and quality of sound vary from one person to another.	67.00	16
Relate impulse and momentum before and after collision is equal.	66.50	17.5
Examine effects and predict cause of collision-related damage/injuries	66.50	17.5
Describe the motion of an object in terms of distance or displacement, speed or velocity and acceleration.	66.50	17.5
Infer that circular motion requires the application of constant force directed toward the center of the circle.	63.00	20
Create and interpret visual representation of the motion of objects such as tape charts and motion graphs.	61.50	21.5
Infer that when body exerts a force on another, an equal amount of force is exerted back on it.	61.50	21.5
Describe the different types of charging process.	54.00	23
Cite examples of practical applications of the different regions of EM waves, such as the use of radio waves in telecommunications.	53.00	24
Demonstrate how a body responds to changes in motion.	50.50	25
Investigate the relationship between the amount of force applied and the mass of the object to the amount of change in the object's motion.	48.57	26
Infer that light travels in a straight line.	43.83	27
Compare the relative wavelengths of different forms of electromagnetic waves	43.67	28
Demonstrate the generation of electricity by movement of a magnet through coil.	41.00	29
Relate the characteristics of waves.	34.50	30

Formative Assessment Practices and Utilization of Its Results by the Science Teachers in the Classroom to Promote Developmental Learning

To determine the formative assessment practices used by the science teachers in their science classroom classes, the researcher used frequency count. Following the identification of formative assessment practices of the science teachers was a focused group discussion to obtain answers on how the results of their formative assessment were utilized in the classroom to promote developmental learning.

Table 4 presents the different formative assessment practices employed by the science teachers from the results of the formative assessment practices checklist (FAPC). Results show that the top 5 formative assessment practices of science teachers were: classroom discussion, problem solving, observation, rubrics, Venn diagram, multiple-choice, and self/peer assessments when ranked in order according to most frequently used formative assessment.

The results showed that science teachers use varied formative assessment practices in their science classes. These formative assessment strategies are useful for teachers as they serve as evidence on what learners know and can do to inform their teaching. The research results of Voinea (2018) showed that formative assessment plays a powerful role in order that students become lifelong learners possessing learning to learn (L2L) competencies; they need to become, gradually, owners, producers and assessors of their learning. Formative assessment plays a powerful role in this direction, by making possible a continuous development of students' learning, including knowledge and skills of learning assessment and improvement through feedback incorporation. Studies have shown that the use of formative assessment practices/strategies has a positive impact or plays a crucial role in the improvement of teaching-learning in the classroom (Amoako, 2018; Bahati, Tedre, Fors & Mukama, 2016; Kline, 2013; Magno &

Lizada, 2015; Mayosore, 2015; Mehmood, Hussain, Khalid, & Azam, 2012). Additionally, Amoako (2018) emphasized that formative assessment drives classroom instruction and provides learners the opportunity to self-evaluate their strengths and weaknesses regarding particular concepts.

It is the responsibility of teachers to use different classroom assessment techniques for assessing students' performance or focus on quality assessment. Pellegrino and Goldman (2008) recommended that learning of students can be improved by classroom assessment.

Table 4

Science Teachers' Formative Assessment Practices

Science teachers' formative assessment strategies /practices (*n*= 8)	Frequency of responses	Rank
Class discussions	8	1.5
Problem-solving	8	1.5
Observation	7	3.5
Rubrics	7	3.5
Venn diagram	6	5.5
Multiple-choice answers	6	5.5
Self/peer assessment	6	5.5
Simulations	5	8.5
Oral questioning and interviews	5	8.5
Questionnaires	4	10.5
Graphic organizers	4	10.5
Demonstration	3	12.5
Checklists	3	12.5
Self-evaluation	3	12.5
Visual representations	3	12.5
Oral questioning	3	12.5
K-W-L (Know-What-Learn)	3	12.5
Learning portfolios	3	12.5
Think-pair-share	2	12.5
What did we learn today	2	20.5
Learning logs	2	20.5
Concept mapping sticky notes	1	20.5
Self-assessment	1	23.5
Web/concept map	1	23.5
Teach a friend	1	23.5
Index card summaries/ questions	1	23.5
Journal entry	1	23.5
Talk to each other	1	23.5
Raised hand	1	23.5

Meanwhile, to obtain information on the utilization of the results of formative assessment by the science teachers in the classroom to promote developmental learning, the researcher conducted a focused group discussion with the identified physics teachers. To further extract information on the formative assessment practices of the physics teachers, the researcher undertook a document analysis of their lesson plans, the assessment tools used, and other instructional materials utilized in the classroom. Thematic analysis was utilized for the science teachers' responses. The researcher generated two themes from the result of focused group discussion with the science teachers, namely: (1) to elicit evidence about students' learning; and (2) to modify or adjust teaching and learning instruction.

Elicit Evidence about Students' Learning

Science teachers handling physics classes were asked how the results of their formative assessment were utilized in the classroom to promote developmental learning. The majority of the physics teachers answered that it is for eliciting evidence about students' learning. Science teacher A, teaching for almost 22 years, said that "*by using that assessment, I can assess and then, of course, I can evaluate if they learn something from my lesson and then from that, I can identify those students that have some enrichment, if there is a need of some enrichment".* Teacher B added, "*by using that (formative assessment results), we can determine if we are effective or not and then if our students learn in our lesson or if there is a need for us to give some enrichment to improve students' learning".* Similarly, teacher C added, "*we will know if the student really learned something about our topic".* Teacher D also added*, "I utilize the results as a basis if they master the subject or a particular competency or if the objectives have been met or to correct students' misconception of the or skills that need to develop further they learn in the lesson".*

These results were supported by Heritage and Vindlinski (2008), that the key elements of formative assessment which serve as bases of learning progression involve eliciting evidence about learning to bridge the gap between current and desired performance. To be effective, formative assessment cannot be treated as a series of ad hoc events, rather, as evidence of learning needs to be elicited in systematic ways so that teachers have a stream of information about how student learning is evolving toward the desired goal. With clear goals outlines in a progression, teachers can match formative assessment opportunities to them, and can make plans in advance of and during instruction about when, what, how, and who to assess (OECD, 2005). Moreover, Shepard (2007) noted that teachers who are responsible for a particular range of the progression could have the detail they need for planning and for formative assessment. They would be able to see how the focus of their instruction connects to a larger picture of learning, and when assessment information shows that one or more of their students are performing outside the range they would know what precursor understanding or skill needs to be developed for students to move forward.

Modify or Adjust Teaching and Learning Instruction

Furthermore, the collected responses from the science teachers about their utilization of the results of formative assessment revealed that it served as the basis for them to modify or adjust their teaching and learning instruction. Teacher C quoted; *"if the result of the formative assessment shows that all my students are able to understand my lesson, then it simply tells me that I have been delivering the lesson well and I'm on the right approach and strategy. Meanwhile, if a significant number of my students' formative assessment show otherwise, I decide to modify the strategy and look for other strategies that could facilitate better understanding among my students".* Teachers A and C answered, "*It also made me decide if I am going to reteach or to proceed to the next lesson and in the summative test I can decide if that learner needs remediation or removal test. "For me as a teacher I will know if I need to reteach the lesson or not and going to proceed to the next lesson or not"* and *yes, we can determine if we (teachers) are effective or not*.

These results are parallel to those of Corcoran, Mosher, and Rogat (2009) that assessments derived from learning progressions are likely to provide information that is more easily interpreted by teachers and potentially allows them to make better informed and more precise decisions about students' needs and how to respond to them instructionally. Likewise, Heritage (2008) added that there are several components of formative assessment and teachers have sufficient detail from which to derive criteria for success, which can be shared with students. They are able to decide on appropriate pedagogical strategies that will assist students to meet the criteria and use these strategies as formative assessments to elicit evidence of how learning is evolving toward the criteria.

Phase 2. Module Development

This part discusses in detail the development of the module using the ADDIE (analysis, design, development, implementation, and evaluation) model based on the least mastered competencies identified in the learning progression test results in physics and science teachers' formative assessment practices. The first stage, analysis, discussed the rationale of the development of the module based on the least mastered competencies identified in the learning progression test results in physics and science teachers' formative assessment practices. The second stage was the designing of the teaching module in physics for Grades 8 and 9. The third stage was the development of the module through a seminar-workshop participated in by the science teachers teaching physics in the secondary and tertiary levels. The fourth stage was the try-out of the module and, lastly, the evaluation of the module by the science teachers.

Analysis. The researcher's bases for the development of the teaching module were the results of the learning progression test in physics in Part I, that the top 5 least mastered competencies of Grade 11 learners were the following: infer how the movement of the particles of an object affects the speed of sound through it for the learning competency in Grade 8, investigate relationship between the angle of release and the height and range of the projectile for Grade 9 learning competency, infer the relationship between current and charge for Grade 8 learning competency, describe the horizontal and vertical motions of a projectile for Grade 9 learning competency, and infer that the total momentum before and after collision is equal for Grade 9 learning competency. Hence, there were 2 least mastered competencies identified in Grade 8 physics and 3 least mastered competencies in Grade 9 which need to be enhanced. Meanwhile, as a follow-through of the results of the learning progression test, the researcher administered the formative assessment checklist to the science teachers and determined the common formative assessment practices employed by the science teachers in their science classes, and these were: classroom discussion, problem solving, observation, rubrics, Venn diagram, and multiple-choice answers. Others also used in their science classroom classes the following formative assessment practices: self/peer assessments, simulations, oral questioning and interviews, questionnaires, and graphic organizers. These formative assessment practices, together with the description of how the results of these formative assessment practices are utilized in the classroom, were incorporated and served as bases in the designing and development of a teaching module. Since some of the considerations of the researcher to conduct this study were to enhance the retention and grasp of the concepts and skills learned by the students from their previous physics lessons and capacitate teachers to teach physics subjects with confidence especially to the difficult topics in physics, the teaching module was developed.

Designing the Module. All students deserve access to worthwhile, rigorous, and meaningful educational experiences and all teachers deserve the supports to help them create classroom environments where students' learning can thrive. One way of making teaching and learning processes successful in every classroom is through the use of quality instructional material like a module to help students acquire knowledge, conceptual understanding, skills and experience they need in moving from the basic to the more complex levels of learning.

The main purposes in developing the module were as follows: (1) encourage mastery of concepts and skills rather than partial knowledge of the students particularly on the top five least mastered competencies, (2) incorporate the most frequently used formative assessment practices in the lesson to monitor students' progress in learning, (3) help Grade 8 and 9 science teachers in eliciting evidence about students' learning, modify or adjust teaching and learning instruction by preparing instructional materials to support their lesson.

In designing the module, the researcher included the following parts: (1) Grade Level, (2) Content Standard, (3) Competency Code, (4) Learning Competency, (5) Learning Objectives, (6) Materials, and the utilization of the 7E approach which includes: elicit, engage, explore, explain, elaborate, extend, and evaluate. Grade level specifies which grade level each lesson in the module will be taught. Content standard includes statements of what students should be able to do, should know, and should care about. It also describes specific content areas that students should learn at each grade level. Competency code consists of letters and numbers that specify the learning area and subject, grade level, domain/content/topic, quarter, week, and competency. Learning objectives include statements on what students should accomplish after each lesson.

Materials list the things to be prepared and needed in the lesson. *Elicit* presents preliminary activities that assess the prior knowledge of the students. *Engage* provides activities that arouse and capture students' interest by using a discrepant event; by giving a demonstration; or by showing an object, picture, or video that motivates and captures students' interests. *Explore* gives activities that students work with to make observations, investigate a question or phenomenon, make predictions, develop hypotheses, design experiments, collect data, draw conclusions, and so forth. Teachers' role is to provide support and scaffolding. *Explain* introduces and clarifies the concept and terms and summarizes the results of the findings of the activity in the Explore phase. Students report findings and discoveries to the class leading, to the generation of ideas and concepts of the lesson. *Elaborate* includes additional concepts that would deepen and enrich students' understanding of the concepts and principles. *Extend* leads students to connect and apply the concepts learned through practical and real-life situations to transfer new learning. *Evaluate* provides the evaluation of students' learning progress about the lesson through the use of formative assessment. Figure 6 displays the module design template.

Title of the Lesson

Grade Level

Content Standard

Competency Code

Learning Competency

Learning Objectives

Materials

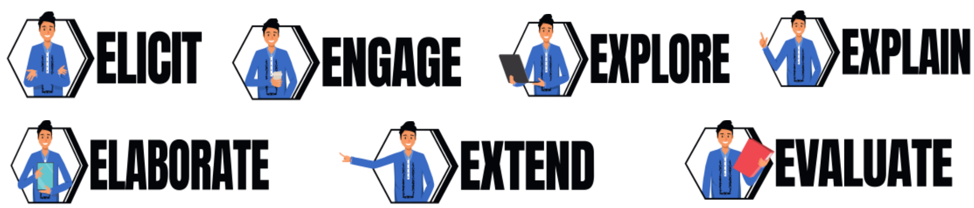


Figure 6. Module Design Template.

Development of the Module. The teaching module designed by the researcher underwent development through a seminar-workshop participated in by the doctoral students major in physical science at West Visayas State University. The seminar-workshop was observed by the members of the research panel.

Photograph 1 shows the panel and the participants during the seminar-workshop.

Photograph 1. The members of the panel and the participants during the seminar-workshop on the development of the teaching module in physics.

The seminar-workshop was entitled "Seminar-Workshop on the Development of Teaching Module in Physics". The activity started with registration and was followed by a short program. The main objective of the seminar-workshop was to develop the designed Teaching Module in Physics for Grades 8 and 9 focusing on the least mastered competencies, as follows: (1) infer the movement of the particles of an object affects the speed of sound through it, (2) investigate the relationship between the angle of release and the height and range of the projectile, (3) infer the relationship between current and charge, (4) describe the horizontal and vertical motions of a projectile, and (5) infer that the total momentum before and after collision is equal.

The main purposes of developing this module were as follows: (1) encourage mastery of concepts and skills rather than partial knowledge of the students particularly on the top five least mastered competencies, (2) incorporate the use of the different formative assessment practices in the lesson to monitor students' progress in learning, (3) help Grade 8 and 9 science teachers by preparing instructional materials to support their lesson.

The researcher invited a resource speaker who was knowledgeable and experienced in module making. After the talk, the statement of purpose to module making was presented. Then, participants were paired to critique the module; two lessons were provided per pair of participants for their comments and suggestions for the improvement of the material. A copy of the module was also given to the members of the research panel. The participants' and panel members' comments and suggestions were noted and incorporated in the refinement of the module.

Implementation of the Module. This stage involved consistent content design and product evaluation. Redesigning and editing were done to enhance the quality and effectiveness of the module. The module underwent pilot implementation in one of the schools in the Schools Division of Iloilo to test its effectiveness and usefulness. The researcher asked assistance from a Grade 9 physics teacher to implement the module to the 40 Grade 11 students of Maasin National Comprehensive High School taking up Accountancy, Business, and Management strand in Senior High School. This group of students was considered for they had taken up physics lessons from Grades 7 to 10. The first implementation was on November 13, 2019 in the presence of the researchers' adviser, four panel members, and the researcher himself.

Photograph 2 shows the first implementation of the first lesson in the module with the students performing the activities and being observed by the panel members.

Photograph 2. The members of the panel and the participants during the first try-out of the module.

After the first try-out of the lesson, the remaining 7 lessons in the module were implemented by four science teachers teaching physics in Junior High School. Table 5 shows the schedule of the implementation of the instructional material.

Table 5

Schedule of Implementation of the Instructional Material

Lesson	Date of Implementation
Lesson 1	November 13, 2019
Lesson 2	November 25, 2019
Lesson 3	December 3, 2019
Lesson 4	November 26, 2019
Lesson 5	November 27, 2019
Lesson 6	December 4, 2019
Lesson 7	November 28, 2019
Lesson 8	November 29, 2019

Photograph 3 shows the implementation of the remaining lessons in the module with the teacher implementer and students performing the activities being observed by the science teachers.

Photograph 3. Implementation of the remaining lessons of the module.

The try-out or implementation of the module was done with the assistance of the science teacher observer. After each implementation of the lesson, the students were asked to write down their personal experiences with its use. They answered the following questions:

1. Is the module easy to understand and enjoyable?
2. Did the module enhance your knowledge, understanding, and skills?
3. What is/are the best feature(s) of this module?

4. Is the module of good quality?

Table 5 shows the results of students' responses to questions 1, 2, and 4. The results revealed that most of the students found that the module was easy to understand and enjoyable. Student A said, *"yes, the module is easy to understand because I have background knowledge about the topic and it was also enjoyable because we worked as a group sharing knowledge to one another*". Student B also added "*yes, it is easy to understand. I find it enjoyable because I was able to experience the things needed to learn in every lab station*".

The results also revealed that the majority of the students found the module to have enhanced their knowledge, understanding, and skills. As mentioned by Student C, "*yes, in the way that we did the activity, the knowledge that we apply in answering the question, understanding in following the direction or procedure, and skills in doing the task in every activity"*. Further, Student E said, "*yes, through doing activities by the group, I learned something that I can use in my future life*. *This enhances my understanding and skills because as we do the activities we understand and observe how things will affect*". Student F added, *"yes, by adding information that I can use in my studies. It enhances my understanding in a way that I observed during the activity and my skills in public speaking increased".* Student D also replied, "*yes, because of more explanation and real-life situation examples, activities, and guide questions prepared and that enhance our critical thinking skills"*. This confirms the study of the US National Research Council (2007) that one of the key elements of learning progression is the learning performances which are the kinds of tasks students at a particular level of achievement would be capable of performing. They provide specifications for the development of assessments by which students would demonstrate their knowledge and understanding.

Further, the results revealed that the majority of the students found that the module was of good quality. Students' reasons for these were analyzed through thematic analysis. The common reasons for students' responses revealed that the ideas are well-presented and easy to understand and that the activities provided were enjoyable.

Table 6 shows the students' responses on their experience with the module during the pilot implementation.

Table 6

Students' Responses on Their Experience with the Module During the Pilot Implementation

Items (*n= 128*)	Yes		No	
	f	*%*	*f*	*%*
The module is easy to understand and enjoyable.	125	97.66	3	2.34
The module enhances my knowledge, Understanding, and skills.	120	93.75	8	6.25
The module is of good quality.	123	96.09	5	3.91

Meanwhile, when students were asked about "What is/are the best feature(s) of this module?", the researcher consolidated the common answers of the students. The results showed that the best feature of the module was the activities provided in the lesson. This feature helped them to understand better the lesson and the concepts and ideas they wanted to develop in them. Student A said, "*when we do the group activity it is fun and we develop the teamwork to answer the questions".* Also, student B said "*the activities in the lesson that are enjoyable and informative. It expands the learnings of the* *students and encourages them to think and give their own idea about the topic*. This result conforms to the findings of Shi-Yin Lin (2012) that small-group instruction, cooperative learning, and activity-based instruction are effective in teaching science to diverse groups of students. In the same manner, cooperative learning has been proven to be one of the effective strategies in acquiring and constructing a robust understanding of physics concepts and develop good problem-solving skills. Thus, it is important for teachers to constantly developing and select instructional methods or strategies and design scaffolding support to better bridge the performance gap among students (Kohl, 2006).

Evaluation of the Module. Seventeen evaluators who were secondary school science teachers in public and private schools, college professor, and curriculum development expert evaluated the developed instructional material. They evaluated the quality of the module in terms of learning objectives, content activities, assessment, and design and presentation. A checklist was provided to the teachers. To interpret their responses, the researcher utilized mean and standard deviation. Results shown in Table 7 show that evaluation of the teachers in terms of learning objectives was excellent because the module was accompanied by a list of specific objectives (M= 3.88, SD=.33), suit a particular topic (M= 3.94, SD=.24), clear and simple (M= 3.88, SD=.33), fitted to the level and needs of the learners (M= 3.76, SD=.44), and attainable (M= 3.88, SD=.33). The overall rating of the teachers for the objective of the module was excellent (M= 3.87, SD=.33). It can be said that the teachers found the objectives of the module excellent as shown by the overall mean score.

Table 7

Evaluation of Teachers in Terms of Objectives of the Module

Objectives (*n*=17)	*SD*	*M*	Description
1. Module is accompanied by a list of specific objectives.	0.33	3.88	Excellent
2. The objectives suit particular topic.	0.24	3.94	Excellent
3. The objectives are clear and simple.	0.33	3.88	Excellent
4. The objectives are fitted to the level and needs of the learners.	0.44	3.76	Excellent
5. The objectives are attainable.	0.33	3.88	Excellent
Overall Mean	0.33	3.87	Excellent

Note: Scale of Means: 3.51-4.00 Excellent, 2.51-3.5 Very Good, 1.51-2.5 Fair; 1.0-1.5 Poor

Table 8 shows the result of the teachers' evaluation of the module in terms of content. The results revealed that the module was excellent because it is easily understood (*M*= 3.88, *SD*=.33), adequate to attain the objectives (*M*= 3.88, *SD*=.33), clear and well-organized (*M*= 3.88, *SD*=.33), up-to-date (*M*= 3.82, *SD*=.39), and reliable (*M*= 3.88, *SD*=.33). The overall rating of the teachers for the content of the module was excellent (*M*= 3.87, *SD*=.34). It can be said that the teachers found the content of the module are excellent as shown by the overall mean score.

Table 8

Evaluation of Teachers in Terms of Contents of the Module

Contents (*n*=17)	*SD*	*M*	Description
1. Content is easily understood.	0.33	3.88	Excellent
2. Content is adequate to attain the objectives.	0.33	3.88	Excellent
3. Content is clear and well-organized.	0.33	3.88	Excellent
4. Content is up-to-date.	0.33	3.88	Excellent
5. Content is reliable.	0.39	3.82	Excellent
Overall Mean	0.34	3.87	Excellent

Note: Scale of Means: 3.51-4.00 Excellent, 2.51-3.5 Very Good, 1.51-2.5 Fair; 1.0-1.5 Poor

Table 9 shows the result of the teachers' evaluation of the module in terms of activities. The results revealed that the module was excellent because the activities in the module are congruent to the objectives of the lesson (*M*= 3.82, *SD*=.39), contextualized (*M*= 3.82, *SD*=.39), interesting, self-motivating, and within the context of the learners (*M*= 3.94, *SD*=.24), enhance the knowledge and skills of the students (*M*= 3.76, *SD*=.44), and help students improve their understanding of the lesson (*M*= 3.76, *SD*=.44). The overall rating of the teachers for the activities in the module was excellent (*M*= 3.82, *SD*=.38). It can be said that the teachers found the activities in the module excellent as shown by the overall mean score.

Table 9

Evaluation of Teachers in Terms of Activities of the Module

Activities (*n*=17)	*SD*	*M*	Description
1. Activities are congruent to the objectives of the lesson.	0.39	3.82	Excellent
2. Activities are contextualized. .	0.39	3.82	Excellent
3. Activities are interesting, self-motivating, and within the context of the learners.	0.24	3.94	Excellent
4. The activities enhanced the knowledge and skills of the students.	0.44	3.76	Excellent
5. Enrichment activities can help students improved their understanding of the lesson.	0.44	3.76	Excellent
Overall Mean	0.38	3.82	Excellent

Note: Scale of Means: 3.51-4.00 Excellent, 2.51-3.5 Very Good, 1.51-2.5 Fair; 1.0-1.5 Poor

Table 10 shows the result of the teachers' evaluation of the module in terms of assessment. The results revealed that the module was excellent because the module provides formative assessment for learners (*M*= 3.88, *SD*=.33), enhances the knowledge, understanding, and skills of the learners (*M*= 3.82, *SD*=.39), is congruent to the objective of the lesson (*M*= 3.76, *SD*=.44), challenges students to think critically (*M*= 3.82, *SD*=.39), and is adequate to measure students' learning (*M*= 3.76, *SD*=.44). The overall rating of the teachers for the assessment of the module was excellent (*M*= 3.81, *SD*=.40). It can be said that the teachers found the module excellent in terms of assessment as shown by the overall mean score.

Table 10

Evaluation of Teachers in Terms of Assessment of the Module

Assessment (*n*=17)	*SD*	*M*	Description
1. Module provides formative assessment for learners.	0.33	3.88	Excellent
2. Assessment enhances the knowledge, Understanding, and skills of the learners.	0.39	3.82	Excellent
3. Assessment is congruent to the objective of the lesson.	0.44	3.76	Excellent
4. Assessment challenges students to think critically.	0.39	3.82	Excellent
5. Assessments are adequate to measure students' learning.	0.44	3.76	Excellent
Overall Mean	0.40	3.81	Excellent

Note: Scale of Means: 3.51-4.00 Excellent, 2.51-3.5 Very Good, 1.51-2.5 Fair; 1.0-1.5 Poor

Table 11 shows the result of the teachers' evaluation of the module in terms of design and presentation. The results revealed that the module was excellent in terms of design and presentation for the module presentation is clear by observing correct grammar (*M*= 3.82, *SD*=.39), lay-out is appealing (*M*= 3.76, *SD*=.44), illustrations are clearly presented and properly labeled (*M*= 3.76, *SD*=.44), font style, font size, and spacing are appropriate to teachers regardless of age (*M*= 3.76, *SD*=.44), and language is clear and appropriate to teachers of all ages (*M*= 3.88, *SD*=.33). The overall rating of the teachers for the design and presentation of the module was excellent (*M*= 3.80, *SD*=.41). It is presumed that the teachers found the module excellent in terms of design and presentation as shown by the overall mean score.

Table 11

Evaluation of Teachers in Terms of Design and Presentation of the Module

Design and Presentation (*n*=17)	*SD*	*M*	Description
1. Presentation is clear by observing correct grammar.	0.39	3.82	Excellent
2. The lay-out of the module is appealing.	0.44	3.76	Excellent
3. The illustrations are clearly presented and properly labeled.	0.44	3.76	Excellent
4. Font style, font size, and spacing are appropriate to teachers regardless of age.	0.44	3.76	Excellent
5. Language is clear and appropriate to teachers of all ages.	0.33	3.88	Excellent
Overall Mean	0.41	3.80	Excellent

Note: Scale of Means: 3.51-4.00 Excellent, 2.51-3.5 Very Good, 1.51-2.5 Fair; 1.0-1.5 Poor

Table 12 shows the summary of teachers' evaluation in terms of objectives, content, activities, assessment, and design and presentation. The results showed that the teachers' overall rating of the module was excellent (*M*= 3.84, *SD*=.37) with a reliability coefficient of 0.960 interpreted as reliable. This means that the teachers found the overall components of the module to be of excellent quality.

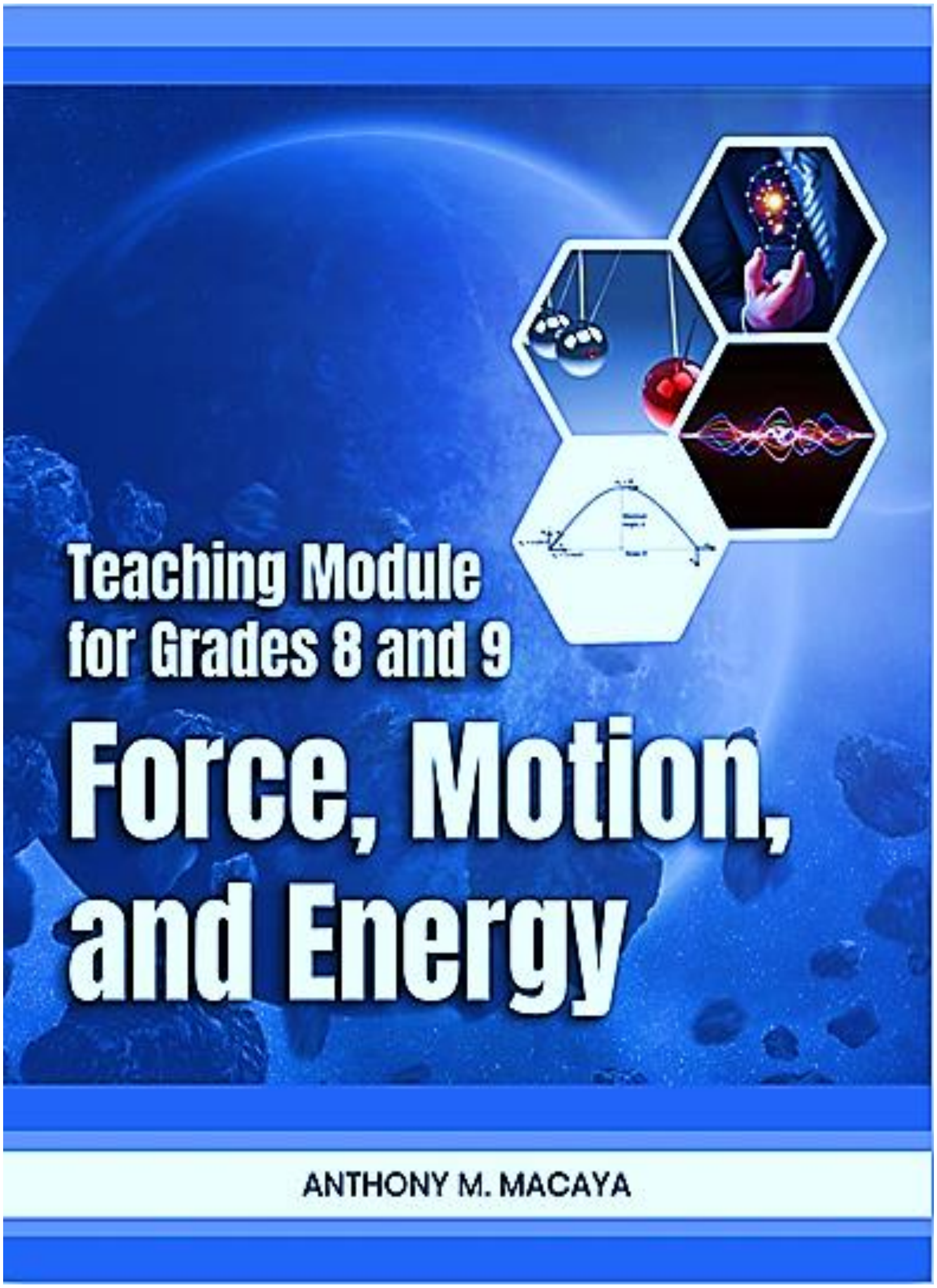
Table 12

Summary of Teachers' Evaluation of the Module

Areas (*n*=17)	*SD*	*M*	Description
1. Objectives	0.34	3.87	Excellent
2. Content	0.38	3.82	Excellent
3. Activities	0.38	3.82	Excellent
4. Assessment	0.40	3.81	Excellent
5. Design and Presentation	0.33	3.88	Excellent
Overall	0.37	3.84	Excellent

Note: Scale of Means: 3.51-4.00 Excellent, 2.51-3.5 Very Good, 1.51-2.5 Fair; 1.0-1.5 Poor

SAMPLE TEACHING MODULE



Preface

The K to 12 science curriculum aims to develop scientific literacy among learners to prepare them to be informed and participative citizens capable of making judgments and decisions on the application of scientific knowledge and its impact on human lives. In order to attain the objective of the basic education science program, teachers should work together in uplifting scientific literacy and bringing science education a higher perspective. It is thus expected that students in science classes acquire knowledge, conceptual understanding and skills to solve problems and make informed decisions in scientific and other contexts. To keep track of the students' progress in learning, appropriate assessment shall be given to provide immediate feedback on how well learning happens throughout the teaching-learning process. Thus, this Teaching Module for Grades 8 and 9 in Physics was made.

The topics included in this module were taken from the least-mastered competencies in Grades 8 and 9 based on the K to 12 Curriculum Guide in Science. It is learner-centered and inquiry-based, emphasizing the use of illustrations, models, diagrams, activities, pictures, and real-life situations and examples to concretize mastery of knowledge, concepts, and skills in science.

Each lesson in this module has the following parts:

Grade Level	Specifies which grade level each lesson in the module to be taught.
Content Standard	Statements of what students should be able to do, should know, and should care about. It also describes specific content areas that students should learn at each grade level.
Competency Code	Consists of letters and numbers that specify the learning area and subject, grade level, domain/ content/topic, quarter, week and competency.
Learning Competency	Includes the statement of the specific competency that students should master for the day.
Learning Objectives	Statements of what students should accomplish after each lesson.
Materials	Lists the kinds of materials to be prepared and needed in the lesson.
ELICIT	Presents preliminary activities that assess the prior knowledge of the students.

ENGAGE

Activities that arouse and capture students' interest by using a discrepant event, giving a demonstration, or showing an object, picture, or brief video to motivate and capture students' interest.

EXPLORE

Activities that students work on to make observations, investigate a question or phenomenon, predictions, develop hypotheses, design experiments, collect data, draw conclusions, and so forth. Teacher's role is to provide support and scaffolding.

EXPLAIN

Introduces and clarifies the concepts and terms and summarizes the results of the findings of the activity in the Explore phase. Students report findings and discoveries to the class, leading to the generation of ideas and concepts of the lesson

ELABORATE

Additional concepts that would deepen and enrich students' understanding of the concepts and principles.

EXTEND

Leads students to connect and apply the concepts learned through practical and real-life situations to transfer new learning.

EVALUATE

Evaluates students' learning progress about the lesson through the use of formative assessment.

Rationale

All students deserve access to worthwhile, rigorous, and meaningful educational experiences and all teachers deserve the supports to help them create classroom environments where learning can thrive. One way of making the teaching and learning process successful in every classroom is through the use of quality instructional material like a module to help students acquire knowledge, conceptual understanding, skills, and experience they need in moving from the basic to more complex levels of learning.

Through the identification of the least mastered competencies from Grades 7 to 10 science lessons particularly in Force, Motion, and Energy topics, the researcher developed a module in Physics that incorporates the use of the different formative assessment strategies/practices of science teachers to address the gaps in science learning. The identified least-mastered competencies were the results of the Learning Progression Test which covered the 30 competencies in science from Grades 7-10. The top 5 least-mastered competencies all came from Grades 8 and 9 learning competencies which included the following: (1) infer the movement of the particles of an object affects the speed of sound through it, (2) investigate the relationship between the angle of release and the height and range of the projectile, (3) infer the relationship between current and charge, (4) describe the horizontal and vertical motions of a projectile, and (5) infer that the total momentum before and after collision is equal.

This module has eight lessons. Lessons 1 to 4 are for Grade 8, namely: (1) Sound wave; Carriers of Energy; (2) Transverse and Longitudinal Waves; (3) Propagation of Sound; and (4) Electric Current and Charge. On the other hand, lessons 5-8 for Grade 9 include: (5) Projectile Motion I ;(6) Projectile Motion II; (7) Impulse and Momentum; and (8) Conservation of Momentum. Each lesson is given a time allotment of 1 hour.

On the other hand, the formative assessment checklist given to the science teachers revealed that the top 5 prevalent formative assessment strategies/ practices used in teaching physics were class discussions, raised hand, multiple choice answer, problem solving, and observation. Thus, through the results of the learning progression test given to learners and formative assessment practices checklist of science teachers, this module was materialized.

The main purposes for developing this module are as follows: (1) encourage mastery of concepts and skills rather than partial knowledge of the students particularly on the top five least mastered competencies, (2) incorporate the use of the different formative assessment practices in the lessons to monitor students' progress in learning, and (3) help Grade 8 and 9 science teachers by preparing instructional materials to support their lesson.

1 Sound Wave: Carriers of Energy

Grade Level: 8
Content Standard: The propagation of sound through solid, liquid, and gas
Competency Code: S8FE-I-e-24
Learning Competency: Infer how the movement of particles of an object affects the speed of sound through it.

Learning Objectives:

At the end of the lesson, the learners should be able to:

a. prove that sound is produced by a vibrating source; and
b. infer that sound waves are carriers of energy.

Materials:

projector	activity sheets
laptop	blindfold

ELICIT

"All people can talk.
Ben can talk because he has vocal cords.
Dogs, birds, and frogs have vocal cords, too.
Insects, however, do not have vocal cords.
They rub their legs against their abdomen to communicate with their mates."

Teacher's Note

Let the students recite in unison a short reading paragraph in the box while they are placing their fingers lightly on their throat. Ask students to answer the questions.

Time Frame: 5 minutes

a. What do you feel when you touch your throat while speaking?
b. What is produced when you read aloud the paragraph?
c. How are sound waves produced when you talk?

ENGAGE

Guide Questions:

a. What form/s of energy carry the message in a face-to-face actual conversation?

b. What form of energy carries/carry the message in a distance communication where the persons talk using a telephone? How about in the improvised telephone?

Teacher's Note

The teacher can use the suggested activities provided below:

* Show to students the pictures how sound relates to communication (see page 6). Ask them to read and answer the guide questions.

(continue to next page)

For (a.)

For (b.)

Teacher's Note

* The teacher may provide an improvised telephone (from junk metallic cans and string) and let the students simulate the process of communication out of it.

Time Frame: 5 minutes

EXPLORE

The learners will perform the Activity 1.A on **Sound Waves** in small groups of about equal size. A small group activity will be assigned for each group on a round robin basis (ex. Group 1 will work on Laboratory Station 1, Group 2 on Laboratory Station 2 and so on). Learners will be given 5 minutes to perform each activity; after 5 minutes, they will proceed to the next laboratory station. All groups should go to the different laboratory stations (3 rounds). Students will be asked to answer the guide questions in their activity sheets.

Teacher's Note

Let each group perform the assigned activity. Go around and check if each group follows the procedures properly. The teacher may use a bell to signal the end of each activity.

Time Frame: 20 minutes

An optional activity, Activity 1.B about Sound Waves can be performed by the students by dividing themselves into four groups of about equal number. Assign the first two groups to set-up and perform Part A of the activity while the second group will set-up and perform part B of the activity. Thereafter, the two groups will swap places and do the task of the other group. Ask students to answer the guide questions in their activity sheets.

Activity 1.A: Sound Waves

What to accomplish

At the end of the activity, the learners should be able to

a. describe how sound waves are produced;
b. describe the movement of the medium through which sound waves pass; and
c. infer that sound waves transfer energy.

What to prepare

guitar or any string instrument	thread
10-cm straw ribbon	small styrofoam/ light pingpong ball
a short reading paragraph	scotch tape
speaker	fine salt/ face powder

What to Do

Laboratory Station 1 (Materials: guitar, 10-cm straw ribbon)

* Tie a piece of short straw ribbon to one guitar string (see illustration).
* Pull up and let go this guitar string. Observe closely how the ribbon moves.
* While there is still sound, touch the string lightly at first with your thumb and then press it hard.

Guide Questions:

1. What did you hear when you released the guitar string?
2. Describe the motion of the ribbon as sound waves are produced.
3. What causes the movement of the ribbon?
4. What produces sound waves? Explain.
5. What is the detector of sound?
6. How did the sound wave reach you?

Laboratory Station 2 (Materials: speaker, styroball, thread)

* Tie a styroball or pingpong ball with a thread and placed it steady over the speaker. If possible, the set-up should be free from air disturbance (see illustration).
* Turn on the speaker and control its volume through-out the activity
* Answer the guide questions.

Guide Questions:

1. What happens to the movement of the styroball/ ping pong ball as the speaker produces sound?

2. What causes the movement of the styroball/ ping pong ball?
3. Why did the styrofoam/ping pong ball? move that way?

Laboratory Station 3 (Materials: guitar/ stringed instrument, salt grains)

* Lay the string instrument on the table.
Place a thin sheet of paper over its opening (see illustration). Sprinkle a little amount of fine salt on the paper.


Photo credit to the Researcher

* Gently pull up and let go each string of the instrument one after the other, starting from the direction at about 1.5 cm from the sheet of paper (see illustration).

* Observe what happens to the salt particles or powder.

Guide Questions:

1. What happens to the salt grains as each string of the instrument is pulled?

2. Compare the movement of the salt grains as each string of the instrument is being pulled from the thinnest to the thickest string.

3. What do you observe of the patterns formed by the salt grains?

4. What caused the salt grains to move?


Photo credit to the Researcher

Activity 1.B: Sound Waves

What to accomplish

At the end of the activity, the learners should be able to:

a. describe that sound consists of vibrations that travel through air; and
b. describe that sound is transmitted in air through vibrations of air particles.

What to prepare

1 rubber band
1 piece of plastic sheet
1 empty large can of powdered milk– 800 g
1 wooden ruler
1 empty can of evaporated milk– 400 mL
2 large books
5 pieces of string
slinky spring
rock salt
1 dowel or wooden stick
1 blue bead
4 colored beads
3 inches of tape
scissors
paper
transistor radio

What to Do

Part A: Vibrations produce sound

1. Prepare all the materials needed for the activity. Make sure that you find a work area far enough from the other groups.
2. Put the plastic sheet tightly over the open end of the large can and hold it while your partner puts the rubber band over it.
3. Sprinkle some rock salt on top of the plastic sheet.
4. Hold the small can close to the salt and tap the side of the small can with the ruler.
5. Try tapping the small can at different spots or holding it in different directions. Find out how you should hold and tap the can to get the salt to move and dance the most.
6. Switch on the transistor radio and position the speaker near the large can. Observe the rock salt.
7. Increase the volume of the radio while it is positioned near the large can. Observe the rock salt again.

Guide Questions:

1. What happened to the salt when the small can was tapped on the side?
2. How were you able to make the salt move and dance the most?
3. What was produced when you tapped the small can? Did you observe the salt bounce or dance on top of the plastic sheet while you tapped the small can?
4. What made the salt bounce up and down?
5. From your observations, how would you define sound?
6. What happened to the rock salt as the loudness is increased in the transistor radio?
7. Which wave characteristic is affected by the loudness or intensity of sound as the volume of the radio is increased?

Part B: Transmitting sound

1. Let 2 books stand up. Place a wooden dowel on top of the 2 books.
2. Cut out an image of a human ear from a magazine and tape it to one of the books.
3. Start with the blue bead. Tape the string to the mark on the dowel that is farthest from the ear.
4. Then tape the 4 colored beads to the other 4 marks. Make sure that all the

beads hang in a straight line.

5. The colored bead represent air particles. Create vibrations (sound) in the air by tapping the blue beads toward the colored beads.
6. Create more vibrations by continuously tapping the blue bead and observe the other beads.
7. Connect one end of the slinky to a fixed point. Hold the other end, then push and pull the slinky continuously. Record you observations.
8. This time, shake the other end of the slinky while the other end is still connected to the fixed point. Record your observations.

Guide Questions:

1. What happens to the other colored beads when the blue bead is tapped?
2. Are there occasions when the beads converge then expand?
3. Are there converging and expanding parts of the slinky?
4. How then sound is classified as a wave?

EXPLAIN

CONCEPT CHECK:

What is sound? Sound is a longitudinal wave that is produced by vibrating objects. It travels through a medium from one point to another point. For the most part, the medium through which sound travels is air, although it can just as readily travel through liquids and solids.

There must be a source of the wave, some type of vibrating object that is capable of setting into motion the entire chain of events for the disturbance. The source is some object that causes a vibration, such as a ringing telephone, or a person's vocal chords, a stereo speaker, or a tree falling in the forest. The vibration disturbs the particles in the forest. The vibration disturbs the particles in the surrounding medium; those particles disturb those next to them, and so on. The pattern of the disturbance creates outward movement in a wave pattern, like waves of seawater on the ocean. The wave carries the sound energy through the medium, usually in all directions and less intensely as it moves farther from the source.

Sound waves are energy carriers. In sound waves, energy is transferred through vibration of air particles or particles of a solid, liquid or gas through which the sound travels. This energy is in turn converted to mechanical energy and other forms of

Teacher's Note

* Ask each group to discuss and explain their observations/answers from the activity. Encourage students to evaluate others' output / observation particularly on the similarities and differences of their observations.

* Let the students provide facts, ideas and concepts they have learned from the activity by writing their answers on the board. After which, ask a student volunteer to synthesized the concepts of the lesson.

Time Frame: 10 mins.

energy.

ELABORATE

Introduce the idea that sound is a wave, a mechanical wave. Like other waves, it is described in terms of its frequency, wavelength, and speed.

A summary of the description of each wave characteristic is presented on a table next page.

Teacher's Note

Show to students the table about the characteristics of a wave in relation to vibration. Allow them to read and ask them to connect these characteristics from the activity they performed.

Time Frame: 10 mins.

Summary of the Description of Wave Characteristics

	Description	Frequency	Speed
Vibration	To and fro motion of the particles of the medium	Number of vibrations per unit time	Speed of a particle varies with time. Different particles have different speeds at a given time.
Wave	Disturbance produced in the medium Carrier of the energy transferred from one place to another in the medium.	Same as the frequency of the vibration which produced it.	Speed is constant in a uniform medium. Speed is different in different media.

EXTEND

A. Show to students pictures of the following:

a. A "Fiesta Disco or "*Binayle*" in their barangay/ town.
b. A static discharge (lightning) that produces thunder.

1. What do you feel when you go near a sound system?
2. Why is that happening?
3. How do static discharges produce a thunder?
4. Why is sound a carrier of energy?
5. How do sounds affect our lives?

B. Imagine yourself floating in outer space which is considered as a vacuum (empty space). Can you produce sound? Can you talk to you peers? Why or why not?

Teacher's Note

Pair students up with partners. Ask them to describe each illustration. Give them a few minutes to think and discuss their answers as guided by the questions.

Randomly call on students to share their ideas and circulate throughout the class as students are sharing to assess the overall depth of understanding.

Time Frame: 5 minutes

EVALUATE

DIRECTIONS. Read and analyze the questions carefully and choose the letter of the correct answer.

1. Sound waves are produced by
   A. linear motion B. vibrating bodies
   C. circular motion D. transitional motion

2. Which produce/s sound waves?
   I. A body vibrating in water
   II. A body at rest in air
   III. A vibrating object in vacuum
   A. I only B. I and II
   C. II and III only D. I and III only

3. Which describes the motion of particles when a sound wave passes through the medium?
   A. The particles do not move.
   B. The particles move in all directions.
   C. The particles move in one direction.
   D. The particles move back and forth.

4. Human sounds are produced by the
   A. vibration of the vocal chords.
   B. vibration of the box-like part called larynx.
   C. back and forth movement of the tongue.
   D. back and forth movement of the air along the pharynx.

5. Sound waves are considered as carriers of energy because they can
   A. cause objects to vibrate
   B. transport particles from one place to another
   C. travel in different materials, thus losing energy
   D. all of these

Teacher's Note

Answer Key

1. B
2. A
3. D
4. A
5. A

Time Frame: 5 minutes

References:

* National Institute for Science and Mathematics Education Development (2008). *Practical work in high school physics: A sourcebook for teachers.* Quezon City: UP NISMED. Department of Education Resource Materials.
* National Institute for Science and Mathematics Education Development (2009). *Physics: Science and Technology textbook for fourth year.* Quezon City. Book Media Press and Printwell Inc.
* Ocampo P.C., et. al. (2013). *Science 8 learner's module.* Pasig City, Philippines. Department of Education– Instructional Materials Council Secretariat and Vibal Publishing House, Inc.
* Virginia Department of Education, 2012.

Summary of Key Concepts:

- Sound waves are produced by vibrating objects. They are propagated through a medium from the source.
- Sound waves are mechanical waves that need a medium to propagate. Vibrations of the medium create series of compression and rarefaction which result in longitudinal waves.
- Sound ,just like other waves, does have characteristics such as frequency, wave-length, and speed.
- The frequency of a wave is the number of waves that pass a particular point for every one second while the wavelength is the distance between adjacent crests or troughs.
- Sound waves are carriers of energy. In sound waves, energy is transferred through vibration of air particles or particles of a solid, liquid, or gas through which the sound travels. This energy is in turn converted to mechanical energy and other forms of energy.

Answers to the Guide Questions

Activity 1.A

Laboratory 1

1. There is sound produced when a guitar string is released.
2. The ribbon vibrates up and down as sound waves are produced.
3. The movement of the ribbon is caused by the vibration of the string of the guitar.
4. Sound waves are produced the objects that are vibrating.
5. Ear is the sound's detector.
6. Sound reaches the ear through the vibration of air particles of gas through which sound waves travel.

Laboratory 2

1. The styroball/ ping pong ball moves up and down as the speaker produces sound.
2. The movement of the styroball / ping pong is caused by the vibration of the Japanese paper it receives from the sound produced in the speaker.
3. The styroball responds to the vibration of the air particles which causes it to move up and down.

Laboratory 3

1. The salt grains move up and down as the string vibrates.
2. The salt grains move up and down more frequently and higher in the thickest string than in the thinnest one.
3. The pattern formed by the salt grains follows the vibration (up and down) of the guitar string.
4. The grains move due to the vibration of the guitar string as it is released.

Activity 1.B

Part A

1. The salt grains bounced up and down.
2. When the small can is tapped loudly or forcefully.
3. Sound was produced when the small can was tapped. Yes, the salt bounced up and down the plastic top while tapping the small can.
4. The sound produced in the small can made the plastic top of the large can vibrate, making the salt bounce up and down.
5. Sound waves are vibrations of air particles.
6. As the rock salt bounced higher, the loudness of the sound is increased.
7. The amplitude of the wave.

Part B

1. The other colored beads collided with the blue bead.
2. Yes.
3. Yes.
4. Sound wave is classified as a longitudinal wave.

Teachers' and Students' Evaluation of the Module in Terms of Learning Objectives, Content, Activities, and Assessment

The results of the teachers' and students' evaluation of the module should serve as bases for the research question "How do teachers and students evaluate the module in terms of (a) learning objectives; content and activities; and assessment? The responses of the teachers and students in their evaluation of the module were compared. Using thematic analysis, the researcher generated themes on how teachers and students evaluate the module in terms of learning objectives, content, activities, and assessment.

Teachers' Evaluation of The Module in Terms of Learning Objectives, Content, Activities, and Assessment

Teachers were asked to evaluate the module and to provide their responses about their experience with the module. The science teachers evaluated the learning objectives, content, activities, and assessment of the module excellent. In terms of objectives, the majority of the science teachers agreed that the objectives were suited to the particular topic and were clear and simple. In addition, they found the content to be easily understood, clear, and well-organized. Moreover, the module's activities were relevant, interesting and self-motivating, and within the context of the learners. The formative assessment provided to the students challenged them to think critically. Significant comments of the science teachers were also noted, such as the alignment or congruence of objectives to activities, improving the cover page, and design suited for slow learners as areas for improvement of the module.

Students' Evaluation Of The Module in Terms of Learning Objectives, Content, Activities, and Assessment

After the implementation of the module, students were also asked to evaluate the module in terms of learning objectives, content, activities, and assessment. Students' responses were analyzed through themes that revealed that the objectives, are fitted to the level and needs of the learners, clear, and simple. As mentioned by Student A, "y*es, the module is easy to learn and has a good content"*. Also, Student B added, *"the module has a good quality in a way of its words that every student will understand it easily, a simple word, yet so informative*". Kibe (2011) posited that instructional materials are integral components of teaching-learning situations; they are not just to supplement learning but to complement its process. It then follows that, if there must be an effective teaching-learning activity, utilization of instructional material will be necessary. Meanwhile, the content is good and easily understood. As narrated by Student C, " *yes the module was very easy to understand because the teacher teach it so well and I find it enjoyable because the activity were able to do the task and experience the things needed to learn".* Student D also added, *"yes, the module has good quality because the concepts and lessons are understandable and it gives a lot of information".* According to Bozimo (2002), in the selection of instructional material, appropriateness of the material to instructional objectives, availability of the materials to clarify objectives, and how to operate the materials, freedom of content from bias and reasonable time, effort and expenses for both learners and teachers are some of the qualities of a good instructional material. In terms of activities, majority of the students responded that the activities were enjoyable and helped enhance their knowledge, skills, and understanding of the lesson. Student E mentioned, "*yes* (the module) *because it enhances our skill and* *knowledge about this kind of activity".* In the same manner, Student F, replied "yes*, the module enhanced my knowledge, understanding, and skills about our lesson in the sense that I was able to recall our past lessons and connect them to present one. It gives me more ideas that I acquired knowledge, seek understanding and enhance my skills.* Kibe (2011) asserted that instructional materials are integral components of teaching-learning situations; they are not just to supplement learning but to complement its process. It then follows that, if there must be an effective teaching-learning activity, utilization of instructional materials will be necessary. Meanwhile, the assessments in the module challenged the students to think critically. As Student G replied, "the *questions provided in the evaluation of the lesson build and challenge the mind of the students to use their critical thinking skills*". There are many teaching aids from various sources. It is therefore important to note that provision for these facilities and materials is of great importance to enhance better and effective learning in schools (Ralph, 1999). Other significant comments of the students were noted down, such as answering guide questions in the activity and solving problems were some difficulties they encountered using the module.

These comments helped the researcher to further improve the content of the module, specifically the activities and problem solving segments. With the help of more experienced physics teachers, the researcher revised and simplified the guide functions, taking into consideration students' level of learning and giving more practical and contextualized problem solving situations where students can easily relate, connect, and apply what they learn from their lessons.

Chapter 5

Summary, Conclusions, Implications, and Recommendations

This chapter has four parts: (1) Summary of the Problem, Method, and Findings, (2) Conclusions, (3) Implications, and (5) Recommendations.

Part One, Summary of the Problem, Method, and Findings, presents the significant point and findings of the study.

Part Two, Conclusions, presents the important inferences drawn from the results of the study.

Part Three, Implications, presents various concepts that demonstrate how the present findings would relate to previously cited literature and their implications to theory and practice.

Part Four, Recommendations, offers suggestions based on the findings and conclusions of this study.

Summary of the Problem and Method

This study sought to develop a module in physics based on the assessment of students' learning progression in physics and science teachers' formative assessment practices.

Specifically, it sought answers to the following questions:

1. What are the least-mastered competencies of Grade 11 learners in their learning progression in Physics?

2. What are the formative assessment practices and how are the results of formative assessment utilized by the teachers in the classroom to promote developmental learning?

3. What instructional material in physics can be developed on the basis of the least-mastered competencies and formative practices used by the teachers?

4. How do the teachers and students evaluate the module in terms of (a) learning objectives; (b) content and activities; and (c) assessment?

This study utilized the ADDIE model. During the Analysis stage, the researcher administered the learning progression test in physics to the three intact groups of Grade 11 students. A total of 128 Grade 11 students in the three academic strands in Senior High School took the learning progression test in physics. On the other hand, 8 science teachers participated in and answered the formative assessment practices checklist and were interviewed through focused group discussion. In the Design and Development stage, the top 5 least-mastered competencies from the results of the learning progression test given to the Grade 11 students and the top 5 formative assessment practices utilized by the science teachers reinforced by the focused group discussion as to how these formative assessments results were utilized in the classroom were considered in the design and development of a teaching module. Fifteen (15) science teachers preferably teaching physics in the secondary and tertiary schools attended the seminar-workshop for the design and development of the teaching module. Their comments and suggestions were noted and incorporated in the refinement of the module. In the Implementation stage, pilot implementation of the module to the 128 Grade 11 academic strand students and to four science teachers who implemented or delivered the module was conducted. Teachers evaluated the module based on their experiences its use. In the evaluation stage, the enhanced module was evaluated by 16 science teachers teaching physics and 1 curriculum development expert.

The main sources of data in this study were the researcher-made learning progression test in physics which underwent content validation by experts in physics and reliability testing, the formative assessment practices checklist and the focused group discussion guide were also validated. These instruments assessed the learning progression of students in physics, identified the type of formative assessment practices employed by science teachers, and investigated how these formative assessment practices happened in science classroom, respectively.

Mean, standard deviation, frequency count, and percentage were used in interpreting the data. Moreover, thematic analysis was utilized to answer the qualitative questions.

Findings

Following is a summary of the findings of the present study:

1. The top five (5) least-mastered competencies of Grade 11 learners in their learning progression in physics were: infer how the movement of the particles of an object affects the speed of sound through it for the learning competency in Grade 8; investigate relationship between the angle of release and the height and range of the projectile for Grade 9 learning competency; infer the relationship between current and charge for Grade 8 learning competency; describe the horizontal and vertical motions of a projectile for Grade 9 learning competency; and infer that the total momentum of the system before and after collision is equal for Grade 9 learning competency.

2. The formative assessment practices were classroom discussion, problem-solving, observation, rubrics, Venn diagram, multiple-choice, and self/peer assessments. Science teachers utilized the results of these formative assessments in promoting

developmental learning to elicit evidence on students' learning and to modify or adjust their teaching and learning instruction.

3. The teaching module was developed on the basis of the five least-mastered competencies in physics and formative assessment practices used by the science teachers. This module was designed for the utilization of Grade 8 and 9 teachers. The developed module was rated excellent by the teachers in terms of objectives, content, activities, assessment, and design and presentation. The overall rating of the teachers of the module was excellent.

4. Teachers' evaluation of the module in terms of objectives revealed that the module objectives were suited to the particular topic and they were clear and simple. The content of the module was easily understood, clear, and well-organized. The activities were interesting and self-motivating and within the context of the learners. The assessments challenged the students to think critically. Meanwhile, students' evaluation of the module in terms of learning objectives revealed that the objectives were fitted to the level and needs of the learners and were clear and simple. For the content, it was good and easily understood. In terms of activities, they were enjoyable and helped enhance students' knowledge, skills, and understanding of the lesson. The assessments challenged the students to think critically.

Conclusions

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

Students' had not mastered the concepts and skills in physics since there were identified gaps in their learning progression. This can be attributed to the incapability of the students to proceed from lower to higher competency level. Students' limited knowledge and conceptual understanding, poor acquisition and transfer of science process skills, and insufficiency of instructional material that requires specific activities that progressively target the competencies seem to have contributed to the learners' lack of mastery of the competency.

Science teachers use varied formative assessment practices in their science classroom classes which are useful for them as they serve as evidence on what their learners know and can do to inform their teaching and to cater to multiple intelligences of learners.

The teaching module thus developed aims to help address the gaps in students' learning, particularly in their mastery and understanding of physics concepts and skills rather than their partial acquisition of knowledge incorporating the use of formative assessment strategies in the lesson to monitor students' progress in learning.

The teaching module developed was suited to particular topics in physics. It is a contextualized module with interesting and self-motivating activities that help enhance students' knowledge, skills, and understanding of the lesson and challenge the students to think critically based on the evaluation of teachers and students with the use of the material.

Implications

The findings and conclusions of this study pose some implications for theory and practice:

For Theory. The constructivist theory of learning states that learning is a dynamic and social process in which learners actively construct meaning from their experience in connection with their prior understanding and the social setting (Driver, Asoko, Leach, Mortimer, & Scoot, 1994). Through this, learners continuously reflect on their experiences while developing the needed abilities and skills to achieve this learning (Slavin, Stofflett, & Stoddart, 1994). From this perspective, learners gradually build their knowledge over time with proper support in their zone of proximal development (ZPD). Teachers can activate this zone when they teach students concepts that are just above the latter's current skills and knowledge level which motivates them to excel beyond their current skills level. Through the learning activities provided in the developed module–that is guided and involves group collaboration–better high-level reasoning, critical thinking skills, a deeper understanding of learned material and more positive attitudes toward subject areas would be developed among the learners.

Learning involves progression. Progressive learning is envisioned as the development of progressive sophistication in understanding and skills within a domain. It aims to develop learners who are armed with sufficient competencies which could be achieved by actively applying and utilizing them in the real-world, actively testing ideas or concepts learned. To assist in their emergence, teachers need to understand the pathways along which students are expected to progress and this is grounded in both instruction and assessment. In this study, the use of appropriate formative assessment to keep track of students' progress in learning is one of the important considerations to keep in mind. Since formative assessment practices influence students' learning when teachers apply them instructionally, teachers should regularly diagnose and assess students' learning for mastery within the classroom. With clear learning goals outlined in progression, teachers can match formative assessment opportunities to them, and can make plans in advance of and during instruction about when, what, how, and who to assess (OECD, 2005).

The Instructional Design Theory which involves five basic phases such as Analysis, Design, Development, Implementation, and Evaluation is conceptually helpful to the researcher to serve as a guide to integrate and develop an instructional material in physics.

For Practice. The results of this study showed that students had not mastered the concepts and skills learned from their previous physics lessons. It is sad to note that many Grade 11 Senior High School students still lacked mastery of the competencies which they were supposed to have developed during their lower grade levels. This insufficiency hinders students' learning of science as the K to 12 Science curriculum is in spiral progression wherein concepts and skills are presented with increasing levels of complexity from one grade level to the next. Thus, there is a need for science teachers to be knowledgeable of learning progression to examine and map ways in which students learn to inform them of the needed intervention based on their experience of teaching students and to use assessment data to analyze student learning and determine strategic next subsequent for instruction. Moreover, teachers can design activities that promote learning progression by examining and understanding what the students learned before and what they will need to engage in after—in order to ensure deep learning, including the use of formative assessment practices. These activities should be within the zone of proximal development of students so that teachers could provide support to students' learning.

Another contributing factor to students' poor mastery of the basic and prerequisite learning competencies is the limited number of physics teachers who teach physics from Grades 7 to 10 as a result of which non-physics majors opt to teach physics that results in the limited transfer of knowledge, understanding, and skills to students.

Lacking in confidence to teach science subjects, teachers tend to focus or linger on topics they are familiar with and leave out the difficult ones. Hence, teaching physics in Junior High School needs to be further enhanced and enriched.

There are varied formative assessment strategies to monitor students' progress in learning. It is the responsibility of teachers to use different classroom assessment techniques to assess students' performance or to focus on quality assessment. However, it was found that most science teachers have limited use or practice of these varied formative assessments. Since formative assessments have a positive impact on or play a crucial role in the improvement of teaching and learning process in the classroom, they should be included in the learning progression to allow teachers to make better informed and more precise decisions about students' needs and how to respond to them instructionally (Corcoran, et al., 2009).

One way of making the teaching and learning process successful is through the use of quality instructional material. The teaching module thus developed addresses the least-mastered competencies in physics incorporating the use of the different formative assessment practices of science teachers. The developed instructional material includes activities that may help enhance students' knowledge, conceptual understanding, skills, and experience in physics. Moreover, the developed instructional material could be of big help as a review material of science teachers in the National Achievement Test (NAT) and for the basic exit assessment of Grades 10 and 12 students, respectively, a laboratory manual for teachers and students as well as supplementary materials for underachieving students towards mastery of ideas and concepts in their physics lessons.

Recommendation

Based on the findings and conclusions of the study, the following recommendations are advanced:

Learners should be involved in monitoring and evaluating their own learning process to determine what they know and understand and to develop a variety of learning strategies so that they can adapt their learning to the task at hand. It is desirable that students set and reflect on their learning goals during the course of learning with the response of teacher and peer feedback.

Science and non-science teachers should take extra effort to continuously monitor students' progress in learning and employ appropriate assessment strategies to track students' understanding to gain a better understanding of how students' ideas develop. Science teachers teaching physics in Grades 8 and 9 are encountered to use the developed teaching module to help improve students' knowledge, understanding, and skills, thus making science more engaging and enjoyable to students. Corollary to, teachers can utilize appropriate formative assessment practices to make strategic decisions about the ways students are grouped, assigned tasks, and given support individual needs in relation to their learning progression.

School administrators should include instructional material development as one of the priority improvement areas for teachers in consideration of students' learning progression. Likewise, they may support, provide assistance, and continuously encourage teachers to discover and innovate some points towards a productive and effective teaching and learning process.

The Department of Education should provide instructional support and integrate module-making linking assessment to students' learning progression in training and workshops to help teachers develop a deeper understanding and diagnose students' progress and instructional needs.

Textbook writers may include learning progression and employ appropriate formative assessment strategies in the content of the instructional material that affect learning in the classroom, thus advancing and guiding students to excel beyond their current skill level.

Curriculum designers may consider rethinking or reviewing the curriculum to be consistent with learning progressions and their key features should be incorporated into instructional materials (e.g. appropriate assessments that align with learning standards and performances). Policymakers as well may formulate educational policies to improve physics education.

Other researchers may conduct similar or related studies on progression that highlight other areas or topics that lack progressions to build a stronger knowledge base for teaching and for the development of instructional tools and supports.

REFERENCES

References

Amadioha, S.W. (2009). The importance of instructional materials in our schools; An overview. *New Era Research Journal of Human, Educational and Sustainable Development, 2*(2), 3-4. Retrieved from https://www.researchgate.net/publication/322368912_THE_IMPORTANCE_OF_INSTRUCTIONAL_MATERIALS_IN_OUR_SCHOOLS_AN_OVERVIEW

Amoako, I. (2018). Formative assessment practices among distance education tutors in Ghana. *African Journal of Teacher Education*, *7(3*), 22-36. doi: 10.21083/ajote.v7i3.4325

Amoako, I.et al (2018). Knowledge of Formative Assessment Practices among Senior High School Mathematics Teachers in Ghana. *American Journal of Humanities and Social Sciences Research (AJHSSR)*, *3*(3), 08-13. Retrieved from https://www.researchgate.net/publication/331452849_Knowledge_of_Formative_Assessment_Practices_among_Senior_High_School_Mathematics_Teachers_in_Ghana

Anderson, C.W., Cobb, P., Barton, A.C., Confrey, J., Penuel, W.R.,& Schauble, L. (2012). *Learning progressions footprint conference: Final report* (Vol. 28) East Lansing, MI.

Armellin,iA., & Aiyegbayo, O. (2010). Learning design and assessment with e-tivities. *British Journal of Educational Technology, 41*(6),922-935.

Armah, B.D. (2013). Mathematics teachers' perception on classroom assessment and practice of junior high school in Ghana. A case study at Awutu Senya District. (Master's dissertation). Retrieved from http://www/uew.gh.com.

Bandura, A. (1988). Social foundations of thought and action. Englewood Cliffs. NJ: Prentice Hall. Retrieved on December 8, 2014 from http://www.uky.edu/_eushe2/Bandura/Pubs.pdf.

Beebe, R., Vonderwell, S., & Boboc, M. (2010). Emerging patterns in transferring assessment practices from f2f to online environments. *Electronic Journal of E-Learning, 8*(1),1-12.

Black, P. & William, D. (2004). The formative purpose: Assessment must first promote learning. In M. Wilson (ed.), *Towards Coherence Between Classroom assessment and Accountability. 103rd Yearbook of the National Society for the Study of Education, Part 2.* Chicago, IL: National Society for the Study of Education, 20-50.

Black, P., & William, D. (1998). Assessment and classroom learning. *Assessment in Education, 5*(1), 7-74. Retrieved from https://www.gla.ac.uk/t4/learningandteaching/files/PGCTHE/BlackandWiliam1998.pdf

Briggs, D., Billelo, E.D., Peck, F.,Alzen, J.,Chattergoon, R., & Johnson, R. (2015). *Using a learning progression framework to assess and evaluate student growth* (NCIEA Report 3-025). Retrieved from University of Colorado, Boulder, Center Design Research and Evaluation website:https://www.colorado.edu/education/sites /default/files/attached-files/CADRE.CFA-StudentGrowthReport-Final_0.pdf .

Brooks, S., Dobbins, K., Scott, J. A., Rawlinson, M., Norman, R. I. (2014). *Learning about learning outcomes: The student perspective.* Retrieved from https://eric.ed.gov/?q=learning+outcome&id=EJ1029578 .

Brookhart, S.M. (2011). Educational assessment knowledge and skills for teachers. Educational Measurement: Issues and Practice, *30*(1), 3-12

Cagasan, L; Griffin, P; Nava, FJ; Vista, A; Care, E (2016). Formative Assessment Project Phase 1 Research Report, 2016, pp. 1 – 13. Retrieved from https://minerva-access.unimelb.edu.au/bitstream/handle/11343/129790/2016+Care+et+al+-+Formative+assessment+project+-+Phase+1+research+report.pdf;jsessionid=F65B8E641F47EF596C1FAA24237F08EC?sequence=1 .

Catley, K., Lehrer, R., &Reiser, B. (2005). Tracign a proposed learning progression for developing understanding of evolution. Paper commissioned for the Committeee on Test Design for K-12 Science Achievement. Center for Education, National Research Council.

Corcoran, T., Mosher, F., & Rogat, A. (2009). *Learning progressions in science*. Consortium for Policy Research in Education. Paper presented to the Center on Continuous Instructional Improvement Teachers College- Columbia University. Retrieved from https://repository.upenn.edu/cgi/viewcontent.cgi?article=1026&context=cpre_researchreports .

Creswell, J.W. (4th). (2012). *Educational research: Planning, conducting, and evaluating.quantitative and qualitative research*. Boston: Pearson.

Datu, N. (2016, June 24). The philosophical bases of the K-12 curriculum. Retrieved from https://www.pressreader.com/ .

Department of Education Order No.8, s. 2015. Policy Guidelines on Classroom Assessment for the K to 12 Basic Education Program. Retrieved from https://www.deped.gov.ph/wp-content/uploads/2015/04/DO_s2015_08.pdf .

Department of Education (2016). K to 12 Curriculum Guide in Science. Retrieved from https://www.deped.gov.ph/wp-content/uploads/2019/01/Science-CG_with-tagged-sci-equipment_revised.pdf .

DiCarlo, K.,& Cooper, L. (2014). Classroom assessment techniques: a literature review. *Journal of Instructional Research, 3*, 15-29.

Doherty, K.M., & Jacobs, S. (2013). State of states 2013: Connect the dots: Using evaluations of teacher effectiveness to inform policy and practice. *National Council on Teacher Quality.* Retrieved from *http://www.nctq.org/dmsView/State_of_the_States_2013_Using_Teacher_Evaluations_NCTQ_Report.*

Garrison, C., & Ehringhaus, M. (n.d.). Formative and summative assessments in the classroom. Association for Middle Level Education. Retrieved on https://www.amle.org/portals/0/pdf/articles/Formative_Assessment_Article_Aug2013.pdf .

Gonzales, P., Williams, T., Jocelyn, L.,Roey, S.,Kastberg, D., & Brenwald, S. (2008). *Highlights form TIMSS 2007: Mathematics and science achievement of U.S. fourth-and eighth-grade students in an international context* (NCES 2009-001). Washington, D.C: National Center for Education Statistics: Institute of Education Sciences, U.S. Department of Education.

Gotwals, A.W. (2012). Learning progressions for multiple purposes. In *Learning progressions in science* (pp 461-472). SensePublishers.

Heritage, M. (2008). *Learning progression: Supporting instruction and formative assessments*. Paper prepared for the Formative Assessment for Teachers and Students Collaborative on Assessment for State Standards of the Council of Chief State School Officers. Retrieved from https://www.csai-online.org/sites/default/files/Learning_Progressions_Supporting_2008.pdf.

Herman, J.L. (2006). Challenges in Integrating Standards and Assessment with Student Learning. *Measurement: Interdisciplinary research perspectives, 4*(1&2) Mahwah, NJ:Lawrence Erlbaum. 119-124.

Johnson, D., Johnson R. (1999). Learning together and alone: *Cooperative, competitive, and individualistic learning.* Boston. Alyn and Con Publishers.

Kalchman, M & Koedinger, K.R. (2005). Teaching and learning functions. In National Research Council (Ed.), How Students Learn. Washington DC.: National Academies Press. 351-393.

Kibe,J (2011). Cyber Psychology, Behavior and Social Networking. Retrieved from https://pdfs.semanticscholar.org/bfa5/24c66e1120cfca74ecf6bb7066b988a41209.pdf .

Kim, H. & Care, E. (2018). Learning progressions: Pathways for 21st- century teaching and learning. Brookings. Education Plus Development. Retrieved from https://www.brookings.edu/blog/education-plus-development/2018/03/27/learning-progressions-pathways-for-21st-century-teaching-and-learning/.

Kohl, H. (2006). "*I won't learn from you and other thoughts on creative adjustments"*. New York: The Press.

Krajcik, J. S., Blumenfeld, P. C., Marx, R. W., Soloway, E. (2000). A collaborative model for helping middle grade science teachers learn project-based instruction: *The Elementary School Journal, 94* (5), 483–497.

Kuhn, D., & Dean, D. (2005). A bridge between cognitive psychology and educational practice. *Theory into Practice*, 43(4), 268–273.

Kumpas-Lenk, K. (2013). Learning outcomes in higher education: The factors which help or hinder student achievement - Students and teachers views. *Journal of International Scientific Publications*: Educational Alternatives,*11*, 263-274.

Ince, E. (2018). An overview of problem-solving studies in physics education. Journal of Education and Learning.7(4),191-200.doi::10.5539/jel.v7n4p191 .

Lawton, D.,Vye, N., Bransford, J., Sanders, E., Richey, M., French, D., & Stephens, R. (2012). Online learning based on essential concepts and formative assessment. *Journal of Engineering Education, 101*(2), 244-287.

Lee, P., & Ashby, R. (2001). Progression in historical understanding among students ages 7-14. In P. Stearns, P. Seixas, & S. Wineburg (Eds.), *Knowing, teaching and learning history: National and international perspectives.* New York, NY: University Press.

Lin, S.Y. (2012). Problem solving, scaffolding, and learning. Published dissertation. University of Pittsburgh. Pittsburgh, Pennsylvania, U.S.

Marabe, J.J. (2018, October). *Learning Progressions*. Paper presented at the ACTRC Regional Conference Cebu, Philippines.

Melmer, R., Burmaster, E., & James, T. K. (2008). *Attributes of effective formative assessment.* Washington, DC: Council of Chief State School Officers. Retrieved January 16, 2008, from http://www.ccsso.org/publications/details/cfm?PublicationsID=362) .

Merriam-Webster Dictionary. (2006). https://www.merriam-webster.com .

National Research Council (2000). National science education standards. Washington DC: National Academies Press.

National Research Council (2001). *Knowing what students know: The science and design of educational assessment.* J. Pellegrino, N. Chudowsky, & R. Glase (Eds.). Committee on the Foundations of Assessment. Washington DC: National Academies Press.

Nava, J.F.G. (2017). High school students' difficulties in physics. Paper presented to the National Conference on Research in Teacher Education- University of the Philipines. Retrieved from https://www.researchgate.net/publication/320980117_HIGH_SCHOOL_STUDENTS'_DIFFICULTIES_IN_PHYSICS .

Ocampo, D. (2015). K to 12 Program Updates. Retrieved from http://www.cfo.pso.org.ph/pdf .

Odhiambo, G., (2008). Elusive search for quality education: The case of quality assurance and teacher accountability. *International Journal of Educational Management, 22*(1), 417-431.

OECD (2003), Learners for Life: Student Approaches to Learning: Results from PISA 2000, OECD, Paris. Retrieved from https://www.oecd.org/site/educeri21st/40600533.pdf .

Ogbaji, D.I. (2017). Teachers' perception of the utilization of instructional materials in teaching social studies in junior secondary schools in Calabar Municipality, Cross River State, Nigeria. *Global Journal of Educational Research.(*16), 2017: 95-100. Retrieved from file:///C:/Users/asus-pc/Downloads/162435-420628-1-SM.pdf .

Pallon, R. (2003). *Science process skills, attitudes, and science and technology achievement of high school students.* (Unpublished master's thesis). Wes Visayas State University, Iloilo City, Philippines.

Patel, M.M. (2004). *Instructional Materials for Educational and Technology,* Noirobi, Kenya, Kenyatta University.

Pellegrino, J. W., & Goldman, S. R. (2008). Beyond rhetoric: Realities and complexities of integrating assessment into classroom teaching and learning. In C. A. Dwyer (Ed.). *The future of assessment: Shaping teaching and learning* (pp. 53-82). New York: Lawrence Erlbaum Associates.

Plomp, T. and Pelgrum, J., (2003). *Implementation of innovation in 21 Education Systems.* New York: Pergamon Press.

Reference News. *Science Daily* (2017, November). Retrieved from https://www.sciencedaily.com/terms/physics.htm.

Reigeluth, C. & Chellman, A.A. (2009). *Instructional-design theories and models volume III: Building a common knowledge base*. 270 Madison Ave. New York, NY 10016. Routledge.

Robles, M., & Braathen, S. (2002). Online assessment techniques. *Delta Pi Epsilon Journal, 44*(1) 39-49.

Seels, B.A & Richey, R.C. (1994). Developmental research methods: Creating knowledge from instructional design and development practice. *Journal of Computing Higher Education. 16*(2), 23-38. Retrieved from http://myweb.fsu.edu/jklein/articles/Richey_Klein_2005.pdf .

Shepard, L. A .(2018). Classroom assessment to support teaching and learning. *The ANNALS of the American Academy of Political and Social Science , 683*(1),183-200. Retrieved from https://journals.sagepub.com/doi/10.1177/0002716219843818 .

Stevens S.Y. et al. (2010). Developing a Hypothetical Multi-dimensional Learning Progression for the Nature of matter. *Journal of Research in Science Teaching, 47* (6) (2010), pp. 687-715.

Stiggins, R. J., & Conklin, N. F. (1992). *In teachers' hands: Investigating the practices of classroom assessment*. Albany: State University of New York Press. Retrieved from https://files.eric.ed.gov/fulltext/EJ1209818.pdf .

Tellermo, F.S. (2018). Students' problem-solving and critical thinking skills: Bases for the development of contextualized module in geometry. (Unpublished doctoral dissertation). West Visayas State University, La Paz, Iloilo City.

Tyler, R.W. (1986). Basic principles of curriculum and instruction. 7th Edition.

The Glossary of Education Reform by Great Schools Partnership. Retrieved from http://greatschoolspartnership.org/ .

Sadler, D.R. (1989). Formative assessment: Revisiting the territory. *Assessment in Education: Principles, policy, and practice, 5(*1), 77-84.

Saeed, M. Tahir, H. & Latif, I. (2018). Teachers' perception about the use of classroom assessment technique in elementary and secondary school. *Bulletin of Education and Research.* 40, 115-130.

SEI-DOST & UP NISMED, (2011). Framework for Philippine science teacher education. Manila: SEI-DOST & UP NISMED.

Taneja, R. (1989). *Dictionary of education*. Murare, New Delhi, India. Anmol Publication.

United Nations Educational, Scientific and Cultural Organization.(2017). Education for Sustainable Development Goals. Retrieved from https://unesdoc.unesco.org/in/documentViewer.xhtml?v=2.1.196&id=p::usmarcdef_0000247444&file=/in/rest/annotationSVC/DownloadWatermarkedAttachment/attach_import_82603519-4d73-431c-9324 8e0dcc1b6b1e%3F_%3D247444eng.pdf&locale=en&multi=true&ark=/ark:/48223/pf0000247444/PDF/247444eng.pdf#815_18_Learning%20Objectives_int_En.indd%3A.121515%3A381 .

Van Gog, T., Sluijsmans, D.A., Joosten-ten Brinke, D., & Prins, F.J. (2010). Formative assessment in an online learning environment to support flexible on-the-job learning in complex professional domains. *Educational domains. Educational Technology Research and Development, 58(*3), 311-324.

Vaughan, W. (2002). Effects of cooperative learning on achievement and attitude among students of color. *The Journal of Education Research*. *87* (2), 105–110.

Vonderwell, S., & Boboc, M. (2013). Promoting formative assessment in online teaching and learning. Techtrends: *Linking Research and Practice to Improve Learning, 57*(4), 22-27.

Vygotsky, L.S.(1978). Mind in society. In M. Cole, V. John Steiner, S. Scribner, & E. Souberman (Eds.), *The development of higher psychological processes*. Cambridge: Harvard University Press.

Wisconsin Department of Instruction (2017). Formative Assessment 10 Key Questions. Retrieved from https://dpi.wi.gov/sites/default/files/imce/strategic-assessment/Formative%20Assessment%20FAQ%20FINAL%201_19_17.pdf .

William, D. (2007). Content *then* process: teacher learning communities in the service of formative assessment. In D.B. Reeves (Ed.), *Ahead of the curve: The power of assessment to transform teaching and learning.* Bloomington, IN: Solution Tree .

Wison, M. & Draney, D. (2004). Some Links Between Large-Scale and Classroom assessments: The case of the BEAR Assessment System In M. (ed.), Towards Coherence Between Classroom assessment and Accountability. 1033rd Yearbook of the National society for the Study of Education, Part 2. Chicago, IL: National Society for the Study of Education. 20-25.

Zellmer, L.(2017*). Identifying effective formative assessment practices.* Retrieved from Wisconsin Department of Education website http://wi.gov/strategic-assessment.pdf .

APPENDICES

Appendix A

Table of Specifications

Learning Progression Test in Physics (Grade 7-10)

GRADE 7		GRADE 8	
Learning Competency	**Item No.**	**Learning Competency**	**Item No.**
describe the motion of an object in terms of distance or displacement, speed or velocity, and acceleration	1K 2An 3 E		
differentiate quantities in terms of magnitude and direction	4K 5An 6C		
create and interpret visual representation of the motion of objects such as tape charts and motion graphs	7C 8Ap 9-10S	demonstrates how a body responds to changes in motion	34C
		investigate the relationship between the amount of force applied and the mass of the object to the amount of change in the objects motion	29C 30An 31C
		infer that when body exerts a force on another, an equal amount of force is exerted back on it	32-33An
		relate the laws of motion to bodies in uniform circular motion	35An
		infer that circular motion requires the application of constant force directed toward the center of the circle	36C 37An 38S
differentiate transverse from longitudinal waves and mechanical from electromagnetic waves	11C 12-13C		
relate the characteristics of waves	14K 15K		
describe the characteristics of sound using the concepts of wavelength, velocity, and amplitude	16K 17C	infer how the movement of the particles of an object affects the speed of sound through it	39-40C
explain sound production in the human voice box, and how pitch, loudness, and quality of sound vary from one person to another	18C 19Ap		
infer that light travels in a straight line	20-21K 22-23C 24An		
describe the different types of charging process	25K 26K 27An	infer the relationship between current and charge	41C
		explain the functions of circuit breakers, fuses, earthing, double insulation, and other safety devices in the home	43- 44Ap
explain the importance of earthing or grounding	28Ap	explain the advantages and disadvantages of series and parallel connections in homes	42Ap

K- Knowledge; **C**- Comprehension; **Ap**- Application; **An**- Analysis; **S**- Synthesis; **E**- Evaluation

GRADE 9		GRADE 10	
Learning Competency	**Item No.**	**Learning Competency**	**Item No.**
describe the horizontal and vertical motions of a projectile	45-46S		
investigate the relationship between the angle release and the height and range of the projectile	47E 48E		
relate impulse and momentum before and after collision is equal	49C 50S		
infer that the total momentum before and after collision is equal	51An		
examine effects and predict cause of collision-related damage/injuries	52AN 53Ap		
		compare the relative wavelengths of different forms of electromagnetic waves	54-55C 56C-57C 58An, 59S 60S
		cite examples of practical applications of the different regions of EM waves, such as the use of radio waves in telecommunications	61K 62Ap 63Ap 64K 65-67Ap
		predict the qualitative characteristics (orientation, type, and magnification and positions of images formed by plane and curved mirrors and lenses)	68C 69E
		apply ray diagramming techniques in describing the characteristics and positions of images formed by lenses	70-71Ap
		identify ways in which the properties of mirrors and lenses determine their use in optical instruments (e.g., cameras and binoculars)	72Ap 73C
		demonstrate the generation of electricity by movement of a magnet through a coil	74An 75S

K- Knowledge; **C**- Comprehension; **Ap**- Application; **An**- Analysis; **S**- Synthesis; **E**- Evaluation

Appendix B

Learning Progression Test in Physics (LPTP)

Learning Progression Test in Physics (LPTP)

Name (Optional):____Date:_______________
Grade Level & Section: ______________________________________Score:_______________

Directions: Read and understand each question carefully. Choose the correct answer and shade the letter corresponding to it on your answer sheet. In general, if you have some knowledge about a question, it is better to try to answer it.

1. With respect to a point of reference, when is an object considered to be in motion?
   I. When its position changes
   II. When its distance changes
   III. When its direction changes
   IV. When its speed changes
   A. I , II, and III   B. I, II, and IV
   C. I, III, and IV   D. II, III, and IV

For questions 2 and 3, refer to the table below. Data were obtained from a 200-meter dash competition.

Athlete	Gender	Time (seconds)
1	Female	26.5
2	Female	26.1
3	Female	25.3
4	Female	26.7
5	Male	22.4
6	Male	21.9
7	Male	23.0
8	Male	22.6

2. Which of the following statements is/are true?
   I. The male athletes are faster than the female athletes.
   II. The fastest male athlete is greater than the average speed of the female athlete.
   A. I only   B. Both I and II
   C. II only   D. Neither I nor II

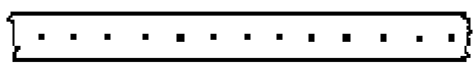
3. How do you compute for the speed of each athlete?
   A. Divide 200 meters by the recorded time of travel.
   B. Divide the recorded time of travel by 200 meters.
   C. Multiply 200 meters by the recorded time of travel.
   D. Divide 200 meters by twice the recorded time of travel.

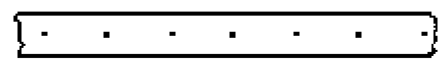
4. What vector quantity represents a speed in an applied direction?
   A. displacement   B. distance   C. velocity   D. weight

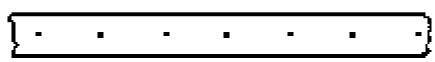
5. Which of the following is true about an object that travels 5 meters to the left, then 2 meters up, then another 5 meters to the right?
   A. The displacement of the object is equal to 2 meters up.
   B. The displacement of the object is equal to 2 meters down.
   C. The total distance travelled by the object is equal to 12 meters.
   D. The total distance travelled by the object is equal to 12 meters down.

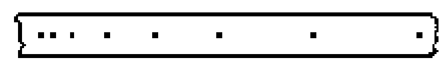
6. Which of the following statements is TRUE?
   A. Both displacement and distance are vectors.
   B. Displacement and distance are always equal in magnitude.
   C. Displacement is a scalar quantity and distance is a vector quantity.
   D. Displacement is a vector quantity and distance is a scalar quantity.

7. Which of the following pieces of ticker tape represent an object that is speeding up? (Assuming the ticker tape was pulled to the LEFT, through the device.)

A. 

B. 

C. 

D. 

8. What does it tell if the dots on the piece of ticker tape are close together? The object is
   A. moving (relatively) slowly.
   B. moving (relatively) fast.
   C. not moving at all.
   D. speeding up.

Appendix C

Formative Assessment Practices Checklist

FORMATIVE ASSESSMENT PRACTICES CHECKLIST (FAPC)

Name (optional): ________________________ Sex: ( ) Male ( ) Female
Major:___________________________________ No. of year/s teaching Physics: ______________
Grade level/s being taught: ____________________
Subject/s taught other than Physics: ____

DIRECTIONS. Below is the list of science teachers' formative assessment strategies/practices. Please put a check (√) on the box the type of formative assessment you practice in science classroom classes. You may check as many practices you use in your science classroom classes.

- ☐ Class discussions
- ☐ Problem Solving
- ☐ Observation
- ☐ Rubrics
- ☐ Venn diagram
- ☐ Multiple Choice answers
- ☐ Self/peer assessment
- ☐ Simulations
- ☐ Oral questioning and interviews
- ☐ Questionnaires
- ☐ Graphic organizers
- ☐ Demonstration
- ☐ Checklists
- ☐ Self-evaluation
- ☐ Visual representations
- ☐ Oral Questioning
- ☐ K-W-L (Know-What – Learn)
- ☐ Learning portfolios
- ☐ Think-pair-share
- ☐ What did we learn today
- ☐ Learning logs
- ☐ Concept mapping sticky notes
- ☐ Self-assessment
- ☐ Web/concept map
- ☐ Teach a Friend
- ☐ Index card summaries/ questions
- ☐ Journal entry
- ☐ Talk to each other
- ☐ Raised hand
- ☐ Likert Scale
- ☐ Drawings
- ☐ Constructive quizzes
- ☐ Create something
- ☐ Kinesthetic assessments
- ☐ One sentence summary
- ☐ Practice presentations
- ☐ Hand signals
- ☐ Write it down
- ☐ Find errors and fix them
- ☐ Partner quizzes
- ☐ Jigsaw group
- ☐ Analogies
- ☐ Demonstration Stations
- ☐ Mini white boards
- ☐ Venn Diagram
- ☐ Hot-seat questioning
- ☐ Extension projects
- ☐ Metacognition
- ☐ Misconception check
- ☐ One minute essay
- ☐ Socratic seminar
- ☐ Round robin charts
- ☐ Examples/Non- examples
- ☐ List Ten Things

Others, if not found on the list:

____

Appendix D

Focused Group Discussion Guide on Formative Assessment Practices of Science Teachers

Interview Questions on Formative Assessment Practices

of Science Teachers

1. What is your idea about formative assessment?
2. Can you give examples of formative assessments you use in teaching physics?
3. What is/are the common formative assessment practices/strategies that you use in teaching physics?
4. Why are these formative assessments useful to you in teaching physics?
5. How do you utilize the results of formative assessment in your classroom in promoting developmental approach to learning?

Appendix E

Module Evaluation Sheet for Teachers

Module Evaluation Sheet for Teachers

Name (optional): ____
School:____

Directions: **The following items ask your personal opinion about your experiences with the module**. Please check the appropriate box that corresponds to your personal opinion. Your cooperation and honest answer will be highly appreciated.

	Excellent	**Very Good**	**Fair**	**Poor**
A. OBJECTIVES				
1. Module is accompanied by a list of specific objectives.	16	1	0	0
2. The objectives suit the particular topic.	16	1	0	0
3. The objectives are clear and simple.	15	2	0	0
4. The objectives are fitted to the level and needs of the learners.	14	3	0	0
5. The objectives are attainable.	15	2	0	0
B. CONTENTS				
1. Content is easily understood.	15	2	0	0
2. Content is adequate to attain the objectives.	15	2	0	0
3. Content is clear and well-organized.	15	2	0	0
4. Content is up-to-date.	15	2	0	0
5. Content is reliable.	15	2	0	0
C. ACTIVITIES				
1. Activities are congruent to the objectives of the lesson.	15	2	0	0
2. Activities are contextualized.	14	3	0	0
3. Activities are interesting, self-motivating, and within the context of the learners.	16	1	0	0
4. The activities enhanced the knowledge and skills of the students.	13	4	0	0
5. Enrichment activities can help students improve their understanding of the lesson.	15	2	0	0
D. ASSESSMENT				
1. Module provides formative assessment for learners.	16	1	0	0

2. Assessment enhances the knowledge, understanding and skills of the learners.	14	3	0	0
3. Assessment is congruent to the objectives of the lesson.	14	3	0	0
4. Assessment challenge students to think critically.	14	3	0	0
5. Assessments are adequate to measure students' learning.	13	4	0	0
E. DESIGN AND PRESENTATION				
1. Presentation is clear by observing correct grammar.	14	3	0	0
2. The lay-out of the module is appealing.	13	4	0	0
3. The illustrations are clearly presented and properly labeled.	13	4	0	0
4. Font style, font size, and spacing are appropriate to teachers regardless of age.	13	4	0	0
5. Language is clear and appropriate to teachers of all ages.	15	2	0	0

Difficulties encountered in the delivery of this module.

____
____
____
____

The best feature(s) of this module is/are:

____
____
____
____

The priority area (s) for improvement of this module is/are:

____
____
____
____

Thank you for your time and God bless!

Appendix F

Module Evaluation Sheet for Students

Module Evaluation for Students

Name (optional): ____

School: ____

Directions: **The following items ask your personal opinion about your experiences with the module**. Please answer the questions based on your personal opinion about the module. Your cooperation and honest answer will be highly appreciated.

1. Is the module easy to understand and enjoyable? Why?

____

____

____

2. Did the module enhance your knowledge, understanding, and skills? How?

____

____

____

3. Is the module of good quality? Why?

____

____

____

4. What is/are the best feature(s) of this module?

____

____

____

5. What are the difficulties you encountered in using this module?

____

____

____

Thank you for your time and God bless!

Appendix G

Communications

Letter to the Validators

Sir/Madam:

Greetings!

The undersigned is a student of the College of Education- Graduate School of this university who is presently conducting a study on "LEARNERS' LEARNING PROGRESSION AND SCIENCE TEACHERS' FORMATIVE ASSESSMENT PRACTICES: BASES FOR THE DEVELOPMENT OF INSTRUCTIONAL MATERIALS IN PHYSICS". This is in partial fulfillment of the requirements for the degree Doctor of Philosophy in Science Education (Physical Science).

In this connection, I would like to request for your expertise and wholehearted assistance in validating the attached instruments. I shall be grateful if you could indicate you suggestions/ recommendations for the improvement of each item. Your expertise would be of great help for the completion of the aforementioned study.

I am hoping for your positive response to this request.

Thank you very much and may God bless you!

Respectfully yours,

(sgd) ANTHONY M. MACAYA
Ph.D. in Science Education (Physical Science), Candidate

Noted:

(sgd) CHIVE G. GABASA, PhD
Adviser

Letter to the Schools Division Superintendent

July 4, 2019

MIGUEL MAC D. APOSIN, EdD, CESO V
Schools Division Superintendent
Schools Division of Iloilo
La Paz, Iloilo City

Sir:

Greetings!

The undersigned is a student of the College of Education- Graduate School of West Visayas State University who is presently conducting a study on "LEARNERS' LEARNING PROGRESSION AND SCIENCE TEACHERS' FORMATIVE ASSESSMENT PRACTICES: BASES FOR THE DEVELOPMENT OF A MODULE IN PHYSICS". The study seeks to develop an instructional material in physics based on the assessment of learning the progression of students in physics and science teacher's formative assessment practices. This is in partial fulfillment of the requirements for the degree Doctor of Philosophy in Science Education (Physical Science).

In this connection, I am humbly asking permission from your good office to be allowed to conduct my study in Maasin National Comprehensive High School from July 22, 2019 to October 31, 2019 for the data gathering of my research study which will include the administration of the assessment of learning progression in physics to Grade 11 students and the assessment of science teacher's formative assessment practices.

Rest assured that in no way will this study affect my classes as I have made necessary adjustments to this end.

Thank you very much for your positive action to this request.

Very truly yours,

(sgd) ANTHONY M. MACAYA
Ph.D. in Science Education (Physical Science), Candidate

Noted:

(sgd) CHIVE G. GABASA, PhD
Adviser

Action taken: (   ) Approved
(   ) Disapproved

(sgd) MIGUEL MAC D. APOSIN, EdD, CESO V
Schools Division Superintendent
Schools Division of Iloilo
La Paz, Iloilo City

Letter to the Principal for the Conduct the Study

July 4, 2019

DELIA C. BOMBITA, PhD
Principal II
Maasin National Comprehensive High School
Delgado St., Maasin, Iloilo

Madam:

Greetings!

The undersigned is a student of the College of Education- Graduate School of West Visayas State University who is presently conducting a study on "LEARNERS' LEARNING PROGRESSION AND SCIENCE TEACHERS' FORMATIVE ASSESSMENT PRACTICES: BASES FOR THE DEVELOPMENT OF A MODULE IN PHYSICS". The study seeks to develop an instructional material in physics based on the assessment of learning the progression of students in physics and science teacher's formative assessment practices. This is in partial fulfillment of the requirements for the degree Doctor of Philosophy in Science Education (Physical Science).

In this connection, I am humbly asking permission from your good office to be allowed to conduct my study in your institution- Maasin National Comprehensive High School from July 22, 2019 to October 31, 2019 for the data gathering of my research study which will include the administration of the assessment of learning progression in physics to Grade 11 students and the assessment of science teacher's formative assessment practices.

Rest assured that in no way will this study affect my classes as I have made necessary adjustments to this end.

Thank you very much for your positive action on this request.

Very truly yours,

(sgd) ANTHONY M. MACAYA
Ph.D. in Science Education (Physical Science), Candidate

Action taken: ( ) Approved
( ) Disapproved

Noted:

(sgd) CHIVE G. GABASA, PhD
Adviser

(sgd) DELIA C. BOMBITA, PhD
Principal II
Maasin National Comprehensive High School
Delgado St., Maasin, Iloilo

Letter to the Principal for Pilot Testing of the Instrument

July 4, 2019

SARAH D. GANANCIAL
Principal I
Remedios E. Vilches- San Lorenzo National High School
Suclaran, San Lorenzo, Guimaras

Madam:

Greetings!

The undersigned is a student of the College of Education- Graduate School of this university who is presently conducting a study on "LEARNERS' LEARNING PROGRESSION AND SCIENCE TEACHERS' FORMATIVE ASSESSMENT PRACTICES: BASES FOR THE DEVELOPMENT OF A MODULE IN PHYSICS". The study seeks to develop an instructional material in physics based on the assessment of learning the progression of students in physics and science teacher's formative assessment practices. This is in partial fulfillment of the requirements for the degree Doctor of Philosophy in Science Education (Physical Science).

In this connection, I am humbly asking permission from your good office to conduct a pilot test of my research instrument in your institution, Remedios E. Vilches- San Lorenzo National High School on July 10, 2019. The pilot testing will include the Learning Progression Test in Physics (LPTP) which is a 75-item multiple choice designed to assess the learners' learning progression in physics.

If you would request for additional information about the said pilot testing, I am more than willing to enlighten you further.

I am hoping for you positive response to this request. Thank you very much and may God bless you!

Respectfully yours,

(sgd) ANTHONY M. MACAYA
Ph.D. in Science Education (Physical Science), Candidate

Noted:

(sgd) CHIVE G. GABASA, PhD
Adviser

Letter to the Dean for the Conduct of Seminar-Workshop

September 13, 2019

MA. ASUNCION CHRISTINE V. DEQUILLA, PhD
Dean
College of Education- Graduate School
West Visayas State University
La Paz, Iloilo City

Madam:

Greetings!

The undersigned is a student of the College of Education- Graduate School of this university who is presently conducting a study on "LEARNERS' LEARNING PROGRESSION AND SCIENCE TEACHERS' FORMATIVE ASSESSMENT PRACTICES: BASES FOR THE DEVELOPMENT OF A MODULE IN PHYSICS". The study seeks to develop an instructional material in physics based on the assessment of learning the progression of students in physics and science teacher's formative assessment practices. This is in partial fulfillment of the requirements for the degree Doctor of Philosophy in Science Education (Physical Science).

In this connection, I am humbly asking permission from your good office to be allowed to conduct my seminar- workshop to the identified PhD in Physical Science students in your college on September 21, 2019 from 1:30 to 4:30 in the afternoon. The inputs to be given by the teacher-participants during the workshop would be of big help in the development of my module.

Thank you very much for your positive action on this request.

Very truly yours,

(sgd) ANTHONY M. MACAYA
Ph.D. in Science Education (Physical Science), Candidate

Noted:

(sgd) CHIVE G. GABASA, PhD
Adviser

Letter to the Principal for the Implementation of the Module

October 28, 2019

DELIA C. BOMBITA, PhD
Principal II
Maasin National Comprehensive High School
Delgado St., Maasin, Iloilo

Madam:

Greetings!

The undersigned is a student of the College of Education- Graduate School of West Visayas State University who is presently conducting a study on "LEARNERS' LEARNING PROGRESSION AND SCIENCE TEACHERS' FORMATIVE ASSESSMENT PRACTICES: BASES FOR THE DEVELOPMENT OF A MODULE IN PHYSICS". The study seeks to develop an instructional material in physics based on the assessment of learning the progression of students in physics and science teacher's formative assessment practices. This is in partial fulfillment of the requirements for the degree Doctor of Philosophy in Science Education (Physical Science).

In this connection, I am humbly asking permission from your good office to allow my panel members to observe the pilot implementation of my teaching module in physics to the Grade 11 students of Maasin National Comprehensive High School on November 13, 2019 from 9:30 to 10:30 in the morning. The inputs to be given by the panel members during the pilot implementation would be of big help in the refinement of my module.

Thank you very much for your positive action on this request.

Very truly yours,

(sgd) ANTHONY M. MACAYA
Ph.D. in Science Education (Physical Science), Candidate

Noted:

(sgd) CHIVE G. GABASA, PhD
Adviser

Letter to the Teachers for Implementation of the Module

____

____
____
____
____

Dear Sir/Madam:

Greetings!

The undersigned is a student of the College of Education- Graduate School of West Visayas State University who is presently conducting a study on “LEARNERS’ LEARNING PROGRESSION AND SCIENCE TEACHERS’ FORMATIVE ASSESSMENT PRACTICES: BASES FOR THE DEVELOPMENT OF A MODULE IN PHYSICS”. The study seeks to develop an instructional material in physics based on the assessment of learning the progression of students in physics and science teacher’s formative assessment practices. This is in partial fulfillment of the requirements for the degree Doctor of Philosophy in Science Education (Physical Science).

In this connection, I would like to ask you to be my implementer in the tryout of my teaching module in physics to the Grade 11 students of Maasin National Comprehensive High School on November 18, 2019 to December 6, 2019. Please be guided of your schedule and the section you will handle (see attached schedule in this letter). Your participation in this activity will be of big help in the refinement of my module.

Thank you very much for your positive action on this request.

Very truly yours,

(sgd) ANTHONY M. MACAYA
Ph.D. in Science Education (Physical Science), Candidate

Noted:

(sgd) CHIVE G. GABASA, PhD
Adviser

Approved:

MARY ARLENE R. MEMORANDO
Head Teacher I
OIC- Office of the Principal

Appendix H

Consent Form

Consent Form

I am a faculty member of Maasin National Comprehensive High School teaching Physical Science in Senior High School Department and presently working on my dissertation study entitled: LEARNERS' LEARNING PROGRESSION AND SCIENCE TEACHERS' FORMATIVE ASSESSMENT PRACTICES: BASES FOR THE DEVELOPMENT OF A MODULE IN PHYSICS. This study seeks to develop an instructional material in physics based on the assessment of learning the progression of students in physics and science teacher's formative assessment practices. The output of this study can be used to improve the teachers' instructional strategies in the enhancement of teaching physics subject in Junior and High School.

This study will be conducted from _______________ to __________________. The duration of the study will include the administration of the learning progression test in physics and the pilot implementation of the module to Grade 11 students.

All information derived in this study will be kept confidential. Likewise, the results of this study will be presented as a group and no individual participant will be identified without his/her permission.

If you allow your child to participate in this learning endeavor, please affix your signature below.

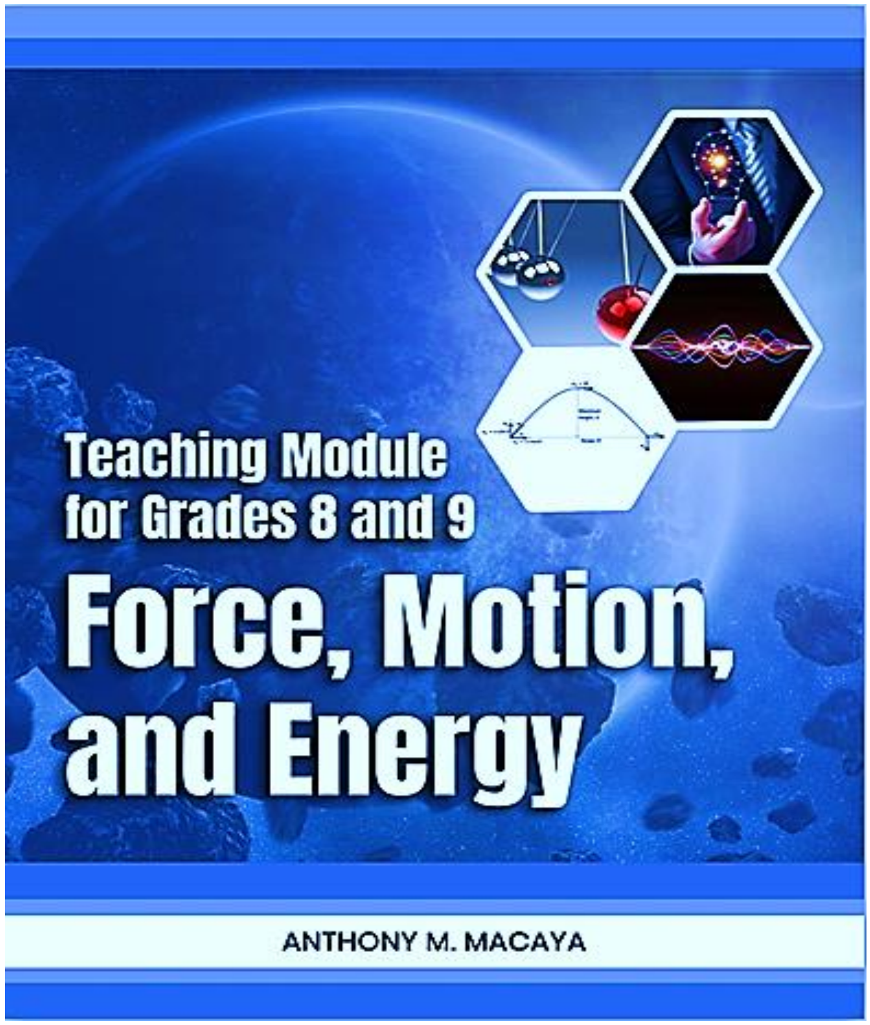
Student's name:_________________________ Parent's name: _______________________

Signature over printed name *Signature over printed name*

If you have any questions about this study, please feel free to contact the researcher at this number: #09093885817 or email him at *antmacaya7@gmail.com*.

Appendix H

Teaching Module in Force, Motion, and Energy for Grades 8 and 9



For a complete copy of this module, please contact the author at:

Mobile Number: 09093885817

E- mail address: *antmacaya7@gmail.com*

Appendix I

Photographs

Photographs Taken during the Implementation of the Module