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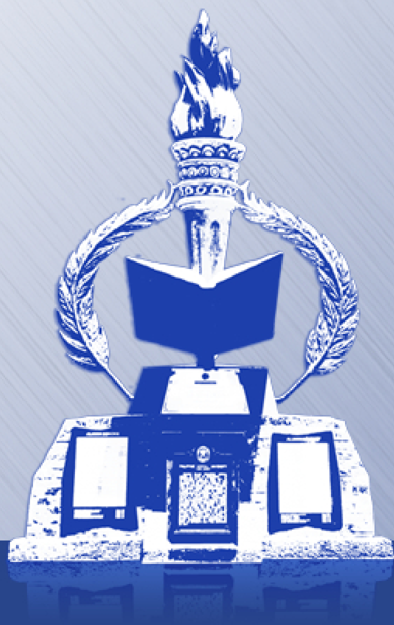
Curriculum Alignment and Efficacy Beliefs of STEM Teachers

Zaldy Jose M. Lazara Jr.
Philippine Normal University



CURRICULUM ALIGNMENT AND EFFICACY BELIEFS OF STEM TEACHERS

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ZALDY JOSE M. LAZARA JR.

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APPROVAL SHEET

This thesis entitled **"CURRICULUM ALIGNMENT AND EFFICACY BELIEFS OF STEM TEACHERS"** prepared and submitted by **ZALDY JOSE M. LAZARA JR.** in partial fulfillment of the requirements for the degree of Master of Arts in Science Education with Specialization in Physics, is hereby recommended for approval and acceptance.

MARIE PAZ E. MORALES, Ph.D.
Adviser

Approved in partial fulfilment of the requirements for the degree of Master of Arts in Science Education with Specialization in Physics by the Oral Examination Committee.

ADONIS P. DAVID, Ph.D.
Chairperson

LEVI E. ELIPANE, Ph.D.
Member

PROF. BENILDA R. BUTRON
Member

PROF. RUEL A. AVILLA
Member

Accepted in partial fulfillment of the requirements for the degree Master of Arts in Science Education with Specialization in Physics.

March 2018

ANTRIMAN V. ORLEANS, Ph.D.
Officer in-Charge
College of Graduate Studies and
Teacher Education Research

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ABSTRACT

Name: **Zaldy Jose M. Lazara Jr**

Title: **CURRICULUM ALIGNMENT AND EFFICACY BELIEFS OF STEM TEACHERS**

Key Concepts: STEM Curriculum (Intended, Enacted and Received), Teaching Efficacy Beliefs, Social Cognitive Theory

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Adviser: Marie Paz E. Morales, Ph.D.

This study was undertaken as an attempt to determine the efficacy beliefs of selected STEM teachers and their role in the alignment of the intended, enacted and received Grade 11 science curriculum. To thoroughly examine the STEM curriculum and teaching efficacy beliefs, a descriptive case study utilizing both qualitative and quantitative strategies was used. Qualitative strategies used were observation, interview and document analysis while quantitative strategy was used in the analysis of the responses of the participant to the questionnaire checklist. Three STEM teachers from Angono National High School – Senior High School Department were selected purposively. Convenience sampling was used to identify the class of each STEM teacher participant for observation. Based on the data gathered and analyzed there is high degree of alignment between the enacted and

intended curriculum, and received and intended curriculum from the three STEM teaching cases. These alignments from the three STEM teaching cases were all possible because of the appropriate enacted curriculum of the STEM teachers. There was a high degree of personal teaching efficacy beliefs and outcome expectancy beliefs identified from the three STEM teaching cases. The teachers who hold high efficacy beliefs provide more congruent alignment of the intended, enacted and received curriculum.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Chapter 1

The Problem and Literature Review

Background of the Study

Technological and scientific innovations have become increasingly significant as we face the challenges and benefits of both knowledge-based economy and globalization in the 21st century. Connections between economic growth and technological innovations are well-recognized. More than half of economic growth since World War II has come from technological innovations as what economists broadly agree (Thomasian, 2011). One of the most prevalent things in every aspect of life is technology and as we encounter changes in the workplace, STEM skills and knowledge grow in extreme importance for workers. Science, technology, engineering and mathematics education and professional practice is abbreviated as STEM. STEM practitioners and workers are important contributors to the country's and the world's innovations on which modern life depends and have become an international initiative which plays an important role in the future advancement of human race. According to Hynek (2010), an innovation pipeline is important for a region because it plays an essential role in commercialization, competitiveness, industrial development and capacity to sustain long-term growth. A powerful factor of this innovation pipeline is STEM workforce. Individuals who create ideas and applications that become commercialized resulting to job creation is employed in STEM occupation. Rothwell (2013) even stated that workers in the STEM fields play a direct role in driving economic growth. STEM contributes to sustainable technologies and new knowledge which benefit social welfare and national wealth which makes it important in the society (Albion & Ting, 2014). To have a powerful STEM workforce that would contribute to the economic growth of the country, there is a need for improvement in the quality of STEM education.

According to Albion and Ting (2014), STEM education is very essential for those who pursue STEM professions and also for every 21st century citizen because it stimulates creativity, productivity, and economic growth. STEM education is important for the development and security of the quality of human life, which give it a serious role in modern civilization (Petroski, 2010). Meyrick (2011) even claimed that the benefit of incorporating STEM education to every content area in every grade levels is it informally train students in solving problems creatively until such time that they decide to take a course of study in college. Engaging and motivating lessons should be offered by schools to encourage students to continue STEM learning throughout their education and convince them to pursue STEM careers. An enhancement on the quality of each STEM subject such as science is needed to achieve a strong STEM education. Future technological advances that will continue to drive forward social welfare and economic engines of each country that people should have. Hence, it is important to support quality science education and research in order to produce globally competitive citizens in terms of technology and engineering. In addition, Obama (2009) stated that scientific movement should grow and above all develop the quality of science education at all levels as a method to overcome financial crisis and its outcome in the country.

Quality science education is strongly connected to the 21st century skills (National Science Teachers Association, 2009). According to Windschitl (2009), the goals of science education and the 21st-century skills are interrelated. These skills concentrate on broadly enhancing applicable capacities, habits of mind, and preparing knowledge workers for new economy while quality science education concentrates on nurturing learning competencies by engaging students in intellectual activities while using different pedagogies (Windschitl, 2009). Apparently, the improvement in the preparation of workers of the future and the development of individuals' lifelong skills that will help them prosper are some of the contributions of quality science education. Moreover, a major factor that affects and contributes to the quality of science education are the teachers and their pedagogical skills. Hence, quality science education will be achieved through quality science teaching.

Accordingly, the National Academy of Sciences, Engineering and Medicine of the United States of America (2016), referred to science teaching as a multifaceted activity which follows certain standards that lie at the heart of the vision of science education. The standards of quality science teaching argue that teachers of science: 1) design and facilitate learning environments that provide students with the resource, space, and time needed for learning science; 2) develop communities of science learners that show the intellectual rigor of scientific inquiry and the attitudes and social values beneficial to science learning; 3) direct and facilitate learning; 4) are involved in the ongoing assessment of their students' learning; and 5) plot an inquiry-based science program for their students. These standards of quality science teaching must be implemented to the educational reforms initiated by the Department of Education.

The K to 12 Program implemented by the Department of Education will have nationwide batch of Senior High School (SHS) students' during the school year 2016-2017 in which one of the strands in the academic track in this program is Science, Technology, Engineering and Mathematics (STEM). Outcomes for both students and teachers are attained from the STEM teaching and learning processes. Similarly, Crismond and Adams (2012) identified six significant outcomes for students and two outcomes for STEM teachers. Some of these outcomes are observable, measurable, and can be identified while students and teachers are in the teaching and learning process (Crismond & Adams, 2012). However, much of the teaching processes and instruction are driven by the teachers, hence, the success of the process highly lies in the hands of the teachers. STEM teachers should deliver learning that is intended for the curriculum and should be properly received by the students no matter what STEM subject it is (Fairweather, 2008).

Apparently, in order to achieve STEM outcome for learners and improve science teaching, STEM teachers must learn to teach in an engaging way. The teachers' actions inside the classroom to achieve a positive learning outcome can be evaluated based on the lesson design and implementation, content and classroom culture (Calingacion, 2008). But certain aspects of the teacher such as efficacy beliefs may be taken into consideration. Bandura's (1997) Social Cognitive Theory highlights the idea that the most powerful mediator of human activity are self-efficacy beliefs which help individuals evaluate their control of environment and activities. Self-efficacy beliefs help individuals in planning activities to attain the required product or outcome which is a result of strong beliefs in their abilities. Significantly, the whole teaching and learning process is both affected by the teachers' actions and the learners' outcomes, hence, personal or self-efficacy in teaching or teacher efficacy should be considered inside the learning environment. Thus, this study intended to explore how teacher's efficacy is developed and if this trait/characteristic influence how STEM teachers enacts the intended curriculum.

This study will help STEM teachers unlock connections between their instructional practices and efficacy beliefs that could help enhance science teaching in the STEM strand. The students' daily activities that are based on the curriculum could be a starting point in making connections between STEM instructional practices and efficacy beliefs that will make STEM learning more relevant and meaningful resulting to student success and achievement. Moreover, this study will serve as a guide in; the design and assessment of teacher-training and in-service programs for science instruction in the STEM strand; the improvement of instructional processes; consideration in hiring STEM teachers; and in providing for their professional growth. It could also result to polishing administrative policies and supervisory strategies that would serve as bases for appropriate actions with regard to STEM instruction. Hence, findings from this study can help organize professional development, serve as baseline in providing the needed support for knowledge of teachers and learning of students, and in nurturing reflections for involving teachers in the significant parts concerning the preparation and application of STEM literacy and instruction and teacher personality development programs.

Literature Review

Quality Science Education

There are four broad purposes of science education: develop students' capacity to think scientifically, equip them with basic concepts and processes about things, make them literate in science, and prepare students for their science profession. When educational institutions attain these purposes, the quality of science education is uplifted (Gluckman, 2011). An effort in combining science, technology, engineering, and mathematics into a single course leading to an integrated STEM education based on the link between each subject and real life situations and problems, does not need to include all four disciplines because it involves different courses and teachers (Stohlmann, 2012). Accordingly, the method of instruction or pedagogy is a crucial factor in making the students engage in science and mathematics. In fact, excellent classroom teaching is the most important factor for the students to become engaged and learn. Hence, teachers in STEM education are very important assets with esteemed value. STEM teachers considerably vary on a wide range of characteristics and behaviors since they come from different disciplines. However, instructional methods and strategies for enhancing students' performance and learning outcomes do not entirely depend on discipline (Fairweather, 2008). Furthermore, dynamic and combined teaching instruction, together with several ways to boost student participation and engagement, consistently results to enhanced outcomes for learners regardless of the academic discipline. Educators of the STEM strand should deliver learning that is intended for the curriculum and that should be properly received by the students no matter what STEM subject it is (Fairweather, 2008). The teaching and learning of each STEM subject, like science, inside a classroom greatly depends on the performance of the teacher.

According to Xanthoudaki (2010), the National Science Education Standards (NSES) set standards on the basis of four principles regarding science learning which result to quality science education. These principles include: 1) active process is needed to learn science; 2) all students should learn science; 3) systematic educational reform should be done to enhance science education; and 4) science content standards in schools must comprise contemporary science which should reflect the intellectual traditions of culture.

K to 12 Educational Reform

Restructuring the Philippine's basic educational system, through the K to 12 program, to improve the quality of education is challenging. However, the government's devised strategic way guaranteed the development of capable individuals that can become the future skilled employees and professionals.

Yap (2011) gave four reasons why there is a need for educational reforms through the K to 12 curriculum: 1) to decongest the curriculum; 2) to prepare the students for higher education; 3) to prepare the students for the labor market; and 4) to comply with global standards. Thus, the Department of Education (DepEd) introduced the K to 12 program in 2011 that required basic education to include kindergarten as a prerequisite to elementary level. It offers a senior high school program that offers vocational and technical courses for students who are not planning to go to college but want to get employed as soon as possible. The said program prolongs high school education by two years but it integrates the fundamental lessons comprised of basic accountancy, business management, humanities and social sciences, science and technology, engineering, mathematics and general academic courses such as technical-vocational-livelihood, arts and design, and sports.

The K to 12 curriculum stimulates and challenges students' interest and encourages them to acquire concepts and appreciate science as an important and helpful subject because the subject matter and the processes involved are interrelated and arranged to deal with daily life situations and problems (Cabansag, 2014). Collectively termed as spiral curriculum, in the K to 10 the method is to make students learn various concepts and information by continuously studying it with expanding difficulty for them to master the four areas of Physics, Chemistry, Biology, and Earth Science in four years. In the grades 11 and 12, the STEM strand focuses in one content area of science and on a per semester basis which still follows spiral progression (Sanchez, 2014).

Accordingly, Martin (2008) stated that spiral curriculum is designed to help science teachers to create lessons, activities, and projects that will focus on enhancing the character and thinking skills of students. It involves continuity and progression in learning science. The framework of spiral curriculum will help the teachers target the progress of critical thinking and characters of students from comprehension of concepts up to real-life application that is why engaging activities and projects are involved in each lesson. Learning science in this framework involves continuity and progression of concepts and information. The procedure in which the education system constructs knowledge and delivers enough progress and challenge for students in a recognizable framework of the curriculum is the concept of continuity. Progression is the description of students' personal journeys through education and ways in which they acquire, develop and apply their skills, knowledge and understanding in challenging situations. The process in which they obtain, advance and use their skills, and their character development are the depiction of progression in education. Hence, spiral progression method is a way or approach on how to implement the spiral curriculum which can be done through the efforts of quality science teachers.

Quality Science Teaching

STEM Integration and Teaching Practices

A connection between and among the Science, Technology, Engineering, and Mathematics (STEM) subjects was established by the National Academy of Engineering and National Research Council (2014). In fact, instead of a single definite experience, integrated STEM education dwells in a multidimensional area in the bigger K to 12 education framework. A level of connection between wide ranges of experiences is included in integrated STEM education. Improving student learning in STEM is the goal of the National Academies of Science (NAS) and the National Science Foundation (NSF) (Fairweather, 2008). Furthermore, Fairweather (2008) stated that the goal is divided into three reform objectives that have varied effects on students and teachers. The first objective is improving the traditional teaching-learning process that is focused on teachers. The second objective focuses on improving student learning which is based on a learner-centered paradigm. This reform focuses on increasing learning outcomes and student achievement through some changes in the instructional approach. The last goal is improving learning productivity which focuses on aggregate student learning relative to cost. This objective wants to find out the minimum amount and easiest procedure to achieve the biggest development in the students' performance within a given group. The improvement of the investment and not the enhancement of the classroom performance is the concentration of this objective. The improvement in STEM learning of each student lies not on the implementation of the best strategies in teaching but on the removal of the poorest teaching strategies inside the classroom. The outcomes that we measure are a great factor in the accomplishment of any STEM reform inside the classroom (Fairweather, 2008).

In fact, to achieve quality science teaching the constructivist theoretical framework could be used as a basis in the selection of approaches and strategies. Constructivist theoretical framework is learner-centered which transpires when the teacher offers an appropriate environment for learning to enable activities that are student-centered (Woolfolk, 2010). Woolfolk (2010) even stated that in the Constructivist Learning Theory, the focus is learning for the sake of learning because previous knowledge is very much important for the students to learn. Approaches such as reflections from journals, portfolio, projects, writings and other strategies that support constructivist learning is important and all are STEM outcomes or products of learners, such as, the capacity to transfer understanding from all STEM disciplines, competencies of the 21st century, interest in STEM, and STEM learning and achievement.

A learning practice done in a constructivist classroom is cooperative learning. According to Dotson (2001), cooperative learning structure affects student achievement. Furthermore, curriculum, teacher, and students are the important variables to be considered in the teaching and learning process. However, it is naturally expected that instruction plays an important role in the process of learning and achievement of students (Igwebuike & Ikponmwosa, 2013). Active learning by students can also result in academic achievement of students. Quality science teaching engage students in asking questions, acquire knowledge, construct and test explanations, and communicate ideas with others (National Research Council, 1996). This active learning is also known as inquiry approach which also uses cooperative learning.

Efficacy Beliefs of Teachers

Teaching Efficacy

The quality of science teaching can be determined by the way the teacher plans and delivers the lesson. An aspect of the teacher that can be taken into consideration are his/her efficacy beliefs. Efficacy modifies the teacher's teaching methods and strategies and also reconstruct the objectives he/she sets to achieve his/her target. Teachers that possesses a strong sense of efficacy tend to be more open to new ideas. They show more willingness to experiment with new methods and also exhibit better planning and organizational skills (Woolfolk, 2005). Furthermore, Protheroe (2008) even stated that in comparison, teachers with high efficacy are well organized in terms of planning, organizing and trying out new teaching practices and strategies. Having higher efficacy directly affects student learning and is also significant in teaching science to students with different levels of comprehension. Accordingly, Joseph (2010) even stated that teaching efficacy is observed in the modern classroom whenever the teacher directs learning and this is considered important in the teaching-learning process. Moreover, a research finding suggests that factors influencing classroom management were affected by teaching efficacy (Hicks, 2012). Therefore, both strategies and classroom management are affected and influenced by teachers' efficacy that is why an understanding of efficacy beliefs is important to be able to improve the teaching-learning process.

Tschannen-Moral and Woolfolk (2001) describe teachers' beliefs in his/her competency to plan and implement lessons that will help achieve a certain objective in a given situation or setting as teaching efficacy. It is also defined as confidence in encouraging students to learn (Protheroe, 2008). Historically, teacher efficacy was conceptualized as having two elements, general teaching efficacy and personal teaching efficacy. General teaching efficacy is the belief that teaching, as a profession, can impact the learning of all students regardless of background. This is also known as the outcome expectancy belief. Personal teaching efficacy is the belief of an individual teacher that he or she has the ability to reach all students (Tschannen-Moran & Woolfolk, 2001).

From the definition of teaching efficacy, it cannot be denied that the teachers' state of conviction influences the attitude and learning of students under his/her supervision and custody, and determines whether the student outcomes are positive or negative. This conviction would motivate the teacher to look for different avenues in order to improve the delivery of instruction or teaching. When teachers are concerned with teaching efficacy, they tend to maneuver learning in a very fruitful manner. They would have a complete and thorough analysis of the components of lesson planning from the objectives down to the giving of assignments. Weaknesses and strengths of the elements in learning would always be re-assessed after every discussion.

However, assessing teachers' efficacy beliefs needs clear standards and has to be backed up by strong qualitative approach (Wyatt, 2010). Moreover, careful analysis of outcome expectancies and their relation to teacher's self-efficacy beliefs should be taken into consideration. Confusion among agent-means, means-ends and the agent-ends beliefs arises when it comes to teacher-self efficacy beliefs. Agents-means is centered on the belief that a person can successfully perform the behavior necessary to yield the results while means-end is more centered on a conviction that a given behavior will lead to certain outcomes. Agent-ends is all about the ability of a teacher to successfully improve student outcome in learning and engagement. The self-efficacy beliefs of teachers are their “beliefs in their abilities to support learning in various task- and context-specific cognitive, metacognitive, affective and social ways” (Wyatt, 2010). That is why although the researcher focused on the agent-means perspective, this study still reflects the teachers’ concern for learning outcomes, how these outcomes are achieved and if the students achieved the expected outcome.

A study done by Tangen (2010) traced the source of teachers’ efficacy beliefs by observing teachers’ strategies and methods in teaching. Four factors were included in her model; they are personal efficacy, teaching efficacy, classroom management efficacy and outcome efficacy, together with four contextual considerations such as culture load, learning load, language load, and cognitive load relating it to students with English as a Second Language (ESL). Results of her research showed that teacher efficacy can be represented using a two-factor model which are personal efficacy and teaching efficacy. Personal efficacy refers to the teachers’ general abilities while teaching efficacy refers to the capacity of teachers to deal with environmental factors. Important circumstantial considerations were given to culture and language load of students with ESL. Familiarization of the curriculum and specific use of teaching strategies to attain the needs of various group of students should be the focus in trainings of teachers (Tangen, 2010). With this, two constructs of efficacy beliefs that affect teaching and learning processes are considered-teaching outcome expectancy beliefs and personal teaching efficacy beliefs. Self-efficacy beliefs help individuals in planning activities to attain the required product or outcome which is a result of strong beliefs of their abilities. Verbal encouragement, enactive achievement, vicarious experience and emotional as well as psychological factors are the most influential foundations in constructing self-efficacy beliefs. Self-efficacy is a cognitively controlling motivation because people control the level and distribution of the energy they will use according to the outcome they are expecting from their actions.

Teachers Efficacy and Student Achievement

Researches on teachers' self-efficacy level and students' academic achievement have revealed substantive results in the pursuit of important academic outcomes. The effect of teacher efficacy on the achievement students has attracted the educational field in the past two decades. Studies have found strong correlations between teacher efficacy and student achievement in the classroom (Woolfolk, 2005). A previous research by Czubaj (1996) supported this finding, suggesting a strong correlation between teacher efficacy and student performance. Furthermore, he stressed that when teachers feel they could produce the desired student outcome, their student produce positive achievements.

Guerrero (2005) identified determinants of student achievement in science as a function of teacher characteristics. Findings of his study revealed that about nineteen percent of the student's level of achievement in Science is due to the combined effects of all the teacher characteristics. More concrete evidences are shown by studies related to this phenomenon. Newman (1993) for example cited in his research that student achievement was assessed using teacher-assigned grades, and the result suggested that the teacher with high efficacy have students with higher grades in class. Furthermore, White (2009) found out in her study that the teachers' level of self-efficacy has an effect on students' achievement in math. The result of her study showed that high level of teacher efficacy results in providing better strategies to reach the students, which in turn, leads to an increase in students' achievement.

Mojavezi and Tamiz (2012) did a study to find out the impact of teacher efficacy on student achievement and motivation towards learning using eighty senior high school teachers and one hundred fifty students in four cities in Iran. The findings of their study backed up by earlier researches suggests that teachers' self-efficacy and increased students' achievement are correlated and this can be achieved by influencing teachers' instructional practices, enthusiasm, commitment, and teaching behavior.

Teachers Efficacy and Learning Environment

Aside from having an influence on student achievement, teaching efficacy strongly affects learning environment and students' motivation towards learning. Mojavezi and Tamiz (2012) found out that teaching efficacy is positively correlated with students' motivation towards learning. Furthermore, Ashton (1996) determined how teachers' sense of efficacy could affect student learning. He based his framework from previous research literature which is about a comparison of two different middle schools and the teaching strategies of their 48 high school teachers. He found out that teachers with high efficacy attitudes monitor students' on-task behavior, and develop a warm supportive learning environment. In addition, Santos (2003) used a quasi- experimental method of research and investigated the effect of teacher efficacy on student performance in oral and written discourse in business communication courses. Data gathered from triangulated measures of teacher efficacy and evaluation of students' written and oral performance provided evidence that teacher efficacy could be positively related to student performance in oral and written discourse.

A study done by Pan (2012) showed that teacher's self-efficacy could positively influence learning motivation, learning atmosphere, and learning satisfaction of students which all play a key role in the students' learning process and environment. According to Thompson (2016), teachers that have a strong sense of self-efficacy beliefs provide and implement strategies and interventions that contribute to a positive classroom environment. Furthermore, Teaching and Learning International Survey (2013) proved that a key factor in developing an effective learning environment is teachers' self-efficacy.

Intended, Enacted and Received Curriculum

Curriculum according to Morisson (1993) can be defined in two different ways. The difference lies on the way we think about the curriculum and the way we plan about it. Some researchers and practitioners define it according to different educational programs and materials used inside the classroom while others define it based on the students' experiences received inside the school. While variations exist in defining curriculum, it is clearly agreed that curriculum is something multidimensional that shows plans and actions that give assistance to students and guide them to attain certain objectives. Based on this agreement, the three components of curriculum are: 1) intended curriculum, 2) enacted curriculum, and 3) received curriculum.

Nolet and McLaughlin (2000) stated that intended curriculum, also known as written curriculum is the officially implemented curriculum often contained in a state or government policy and represents what students are expected to learn. The implementation of the written curriculum is known as enacted curriculum and shows the decisions a teacher makes during execution (Nolet & McLaughlin, 2000). In addition, Cuban (1992) emphasized that enacted curriculum covers the informal and formal instructions and activities, as well as the teachers' performances, management approaches and principles. The received curriculum is the learned curriculum which is the consequence of being in the classroom and interacting with the intended and enacted curriculum (Nolet & McLaughlin, 2000).

Teachers have an important role in attaining the education goals whenever there is a curricular reform. Therefore, no matter what the curriculum recommends, it is the teacher who makes the final decision about what will happen inside the classroom. However, competencies intended for the curriculum should be delivered and enacted by the teacher. According to Cohen and Hill (2001), the teachers are considered the central part of curricular reform movements because they are the implementers and their ability to easily adapt and innovate that leads to better student learning. . Hence the competencies intended for the curriculum can be enacted by the teacher and received by the students. Thus, any changes in the curriculum must give attention to what teachers know and believe. Several factors such as efficacy, contribute to teacher's knowledge, beliefs and performance, as demonstrated and seen from several studies (Goddar & Woolfolk, 2010). Accordingly, Bandura (2006) stated that the belief in one's abilities to plan and arrange, and do the necessary things to deal with incoming situations is called self-efficacy Hence, implementation of the curricular reform by the teachers is greatly affected by their self-efficacy beliefs. Hall (1992) conducted a study about perception of teacher efficacy (PTE) and was able to observe and identify that students' achievement and learning outcomes have a relationship with the teacher acknowledgements for students, teaching level and PTE. Results of his study showed that teachers with high level and strong PTE give emphasis to the teachers' role in students' achievement and consider themselves responsible for students' success and failure and vice versa. This means that the attribution of teachers to their students varies with the efficacy level of students. Thus, from the competencies in the curriculum implemented by the teachers and received by the students there are efficacy beliefs that transpire and somehow affect and influence the teaching and learning process.

Synthesis of Literature

The purpose of quality science education is to equip students with practical knowledge that can be used throughout their lives and prepare students to the world of work locally and internationally to contribute to the innovations and economic growth. Because of this, much effort is being exerted by the Department of Education to ensure that quality science education is achieved. Reforms like the K to 12 curriculum program resulted to different strands like STEM which is composed of four areas known as science, technology, engineering, and mathematics. Science teaching in this educational reform is anchored on spiral progression curriculum. In this type of curriculum, the approach is student-centered and is driven and directed by the teacher. Hence, quality teaching and the importance of teachers in the education process is immeasurable. Quality science teaching can be observed by identifying the instructional practices of the teachers which follow the constructivist philosophy and inquiry approach. However, the belief that teachers hold about themselves regarding their ability to perform task must be given attention because the teachers’ beliefs are more powerful than their knowledge. Teachers’ efficacy beliefs do not only influence their decisions and actions but also affect their classroom instructional practices and student achievement. This is based on the social cognitive theory. Thus, in the process of teaching and instruction, both STEM practices and enacted curriculum and efficacy beliefs should be explored. Alignment between what is intended for the curriculum and enacted by teachers is important for the students to receive proper science education. Efficacy beliefs should transpire in order to have quality science teaching.

Research Problems

The main purpose of this study is to describe the role of teachers' efficacy beliefs on the alignment of the K to 12 Grade 11 STEM intended, enacted and received curriculum of three STEM teachers in a government-owned school.

Specifically, it will try to answer the following questions:

1. To what extent are the enacted and received curriculum are aligned with the intended curriculum in the three Grade 11 STEM teaching cases?
2. What teaching efficacy beliefs were identified from the STEM teachers in the three Grade 11 STEM teaching cases?
3. How do the teaching efficacy beliefs of the three Grade 11 STEM teachers contribute to the alignment of the intended, enacted and received curriculum?

Conceptual Framework of the Study

Bandura's Social Cognitive Theory (1997) focuses on the idea of efficacy beliefs wherein individuals practice their control of activities, emotions, and views using self-system. The most powerful mediator of human activity is self-efficacy beliefs which help individuals evaluate their control of environment and activities. There is a high percentage that individuals will do the task given to them if they believe they can accomplish it. Moreover, the main point of the social cognitive theory lies on self-efficacy which gives importance to the role of learning through observations, and personality development through social experience. The social cognitive theory's main concept lies in actions and reactions of individuals, together with their behavior towards others. The intellectual processes in all scenarios are affected by what an individual observes from others. Self-efficacy is indeed an essential feature of the social cognitive theory because it can be developed from everyday experiences and observations. People with high level of efficacy view challenging tasks as something to be overcome and not something to be avoided (Bruner, 1997).

In the context of learning, teaching efficacy beliefs are referred to as teachers' expectations that they bring about in student learning. Harrison (1997) found this idea to be consistent by showing the relationship between teaching efficacy and responsiveness to instructional reforms. Accordingly, teachers who explore new teaching strategies, specifically methods that are difficult to implement like those that share control with the students, have high teaching efficacy. Variations in teaching strategies are frequently employed to suit peculiarities in teaching as well as to achieve the goals because the teachers have the strong belief to influence the learning of the students. Moreover, challenges inside the classroom motivate teachers to experiment and use different strategies. Teaching efficacy level can be observed from the teachers' instructional practices and students outcome. Efficacy beliefs affect the teaching and learning process and are identified based on outcome expectancies and from personal teaching efficacy.

During the teaching and learning process, teachers are considered to have a significant part in the actualization of ideas. No matter what the curriculum recommends, it is the teacher who makes the final decision about what will happen inside the classroom. Hence, the well and proper delivery of the content and competencies embedded in the curriculum lies in the hands of the teacher. The intended curriculum is the written curriculum that represents what students are supposed to learn. This curriculum contains the specific objectives, the target content, and the performance standards for a certain amount of time. These content and competencies embedded in the curriculum serves as a standard concepts needed to be attained and skill goals needed to be achieved by the students from the education department. Over the years, efforts in improving the high school intended curriculum was done by the Department of Education, leading to the spiral progression of the science curricula of the K to 12 educational reform. The K to 12 curriculum showcases an integrated science curriculum in which progression of content occurs as the learner advances to the next grade level. This scheme gives the student an opportunity to learn the science concepts and competencies in an increasing level of complexity with continuity. However, the content and competencies will be properly received by the students if the teachers know how to structure their lessons consistent with the framework and progression of the intended curriculum with respect to their students. Intended curriculum should be seen on the teachers' daily plan which serves as guidelines of what concepts they need to deliver to the students. Furthermore, it guides the teachers on how they will build the learning environment and motivate the students which could lead to students' achievement. Student achievement is considered as the measure of the received curriculum which should be aligned with the intended curriculum. The alignment of the intended and enacted curriculum is reflected from the students' mastery level and is measured by the teachers using various assessment methods. Accordingly, the alignment of the intended and received curriculum lies on the teachers' enactment of the curriculum. Enacted curriculum refers to the strategies, procedures and practices used by the teacher or how the teacher structure and implements the lesson delivery.

Different instructional practices affect the learning environment and student achievement in the three cases that will be observed by the researcher. The teachers' enacted curriculum which encompasses both their lesson design and procedure implementation plays a significant role for the students to receive the intended curriculum. Enacting the curriculum means designing and implanting the lesson consistent with consideration for the students' prior knowledge. Furthermore, enacting of the curriculum should be more on building a proper learning environment that would stimulate the students leading to properly received curriculum. Received curriculum can be measured by knowing the quantity and quality of concepts the student learns in a given amount of time which utilizes different assessment and evaluation designed and a part of the teachers instruction. According to Igwebuike and Ikponmwosa (2013), instruction which is part of the enacted curriculum plays an important role in the learning process and achievement of the student.

Whenever teacher gives instruction and direct learning, teaching efficacy is observed which is considered important in the teaching-learning process (Joseph, 2010). Teacher efficacy is a simple idea with significant implications. A teacher's efficacy belief is a judgment of his or her capabilities to bring about desired outcomes of student engagement and learning. Thus, this study explores the role of the efficacy beliefs of three STEM teachers on the alignment of the intended, enacted and received curriculum.

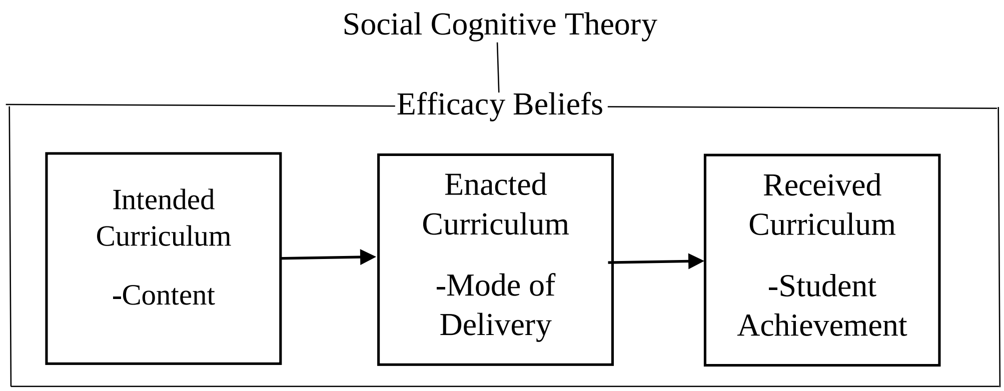

Figure 1. The Conceptual Framework of the Study

Figure 1 presents the conceptual framework of the study. Social cognitive theory suggests that efficacy beliefs of teachers' increases through interactions with students and colleagues, teaching and training experiences and observing others. These efficacy beliefs help the teachers to accomplish their task. Teachers with higher efficacy beliefs are more likely to design and come up with more reliable lesson plans for the delivery of the intended curriculum. Woolfolk (2005) even stated that teachers with high self-efficacy show more willingness to experiment with new methods and also exhibit better planning and organizational skills. Furthermore, teachers with higher efficacy beliefs are more competent in delivering the lesson enacting the curriculum. Teachers' who are more knowledgeable and skilled have higher efficacy beliefs which in turns allow them to structure and implement their lessons better (Aquino, 2000) and provide better strategies to reach the students (White, 2009). Accordingly, this high efficacy enables the teacher to stimulate the learning environment, which could lead to higher student achievement or receive curriculum. Pan (2012) found out that efficacy beliefs could positively influence learning motivation, learning atmosphere, and learning satisfactory of the students which all play a key role in the students' learning process and environment. Hence, teachers with higher efficacy beliefs could provide better learning environment that would stimulate the received curriculum which is consistent with the intended curriculum.

Scope and Delimitation

This study focuses mainly on identifying a match among intended curriculum, enacted curriculum, received curriculum and efficacy beliefs. The research will reveal if appropriate teaching practices are done and competencies are properly acquired by the students and if efficacy beliefs transpire in the teaching-learning process. The researcher will observe three cases having one teacher participant in each case. Confidentiality of the results shall be assured. A validated observation tool and a questionnaire checklist for both teachers and students will be used by the researcher. This will be done in a public school in Angono Rizal for a period of 10 weeks, from June to August 2017 which is also equivalent to one quarter. The researcher assures that the school in Angono is a safe place to conduct a research.

Definition of Terms

The following terms are defined either conceptually or operationally to fully understand the study.

Enacted Curriculum. In this study, it is referred to as the strategies, procedures and practices used by the teacher or how the teacher structure and implements the lesson delivery.

Inquiry Approach. It is an instructional approach, which helps students learn through discovery and exploration.

Intended Curriculum. It consists of the concept and skill goals for the enacted curriculum, often found in curriculum guides or related files.

Outcome expectancy beliefs. They refer to the level to which an individual believes that learning of students in a certain subject can be influenced by the teachers' actions.

Personal teaching efficacy beliefs. They refer to the self-efficacy and confidence related to teaching a certain subject.

Received Curriculum. In this study, it is referred to the students' achievement and mastery level.

STEM track. The Science, Technology, Engineering, and Mathematics track, refers to a track in the General Academic Strand of the K to 12 program which deals mainly on science, mathematics, and technology concepts and applications.

Student Achievement. In this study, it is referred to as the students' quarterly grade.

Chapter 2

Method

Research Design

The main goal of this research is to determine the role of efficacy beliefs on the alignment of the intended, enacted and received STEM curriculum in three STEM teaching cases. Questionnaire with scales was used to determine the teachers' level of efficacy beliefs and the students' motivation towards learning science in three STEM teaching cases which is a technique used in quantitative research. Observation, document analysis and interview was done to determine the alignment of the intended, enacted, and received curriculum of three STEM teaching cases which are all techniques used in the qualitative research. These use of qualitative and quantitative techniques leads to the descriptive case study design of the research. According to Gulsecen and Kubat (2006), many education based researches uses case study method. This method let the researcher thoroughly observe a data within its boundaries. Yin (1994) defined the case study research method as an empirical inquiry that explores a current phenomenon within its actual context; when the limitations between the phenomenon and context are not obvious; and in which several sources of evidence are used was used to provide reliable evidence to help the researcher.

Utilizing the qualitative research in this study required the researcher to get close to the data sources through fieldwork, interviews, and observations so that more detailed descriptions of the participants' perspectives, and experiences would be fully presented (Kawulich, 2005). While the use of quantitative research allowed the researcher to gather data that are in need of measureable interpretations and objective measurements (Given, 2008).

Research Locale

This study was conducted in a government-owned school in Angono Rizal. The school was selected by the researcher since it is the school near the researchers' area that offers grade 11 senior high school STEM track. The school is situated at Kalayaan Angono, Rizal. The total land area of the school is approximately 36,000 square meters. The school is a few kilometers from Laguna Bay. It is beside the Barangay Hall of Barangay Kalayaan.

The school at present consists of 23 buildings mostly of the Ynares type. During school year 2017-2018, there are 16 sections of Grade 11 compose of 614 students and 15 sections of Grade 12 compose of 587 students with a total of 1,201 senior high school students. The senior high school teachers belongs to four department: ABM, HUMMS, STEM and TVL. There are 47 senior high school teachers compose of 10 ABM teachers, 12 HUMMS teachers, 10 STEM teachers and 15 TVL teachers.

Selection Criteria and Participants

The primary participants of the study were three purposively chosen STEM teachers. They were selected based on the judgement of the researcher that they were qualified to provide the information needed to achieve the objective of the study. The following criteria were used in choosing the participants: at least three years teaching in the school, with master's degree, under the STEM department, female and currently teaching Grade 11 science. Consequently, all the three STEM teachers complied with the criteria. Secondary participants of the study were the students from the selected class of each teacher-participant, which the researcher observed. The sampling technique used to select the class that to be observed and the student participants was convenience and purposive sampling. The class of each teacher participant was chosen by the researcher based on the time the researcher and his co-observers were both available for observation.

The participants of the study are three senior high school teachers who are teaching Grade 11 Physical Science or Earth and Life Science belonging to the STEM department. They were observed in one of the classes they handled. All the students from the observed classes was asked to answer a questionnaire checklist about learning environment stimulation. Confidentiality of the responses and results of the observation was assured by the researcher.

Instrument

Reformed Teaching Observation Protocol (RTOP)

RTOP was created by the Arizona Collaborative for Excellence in the Preparation of Teachers as an assessment tool for a specific instructional segment. Specifically, it focuses on measuring the reformed teaching established upon the constructivist framework. The researcher asked permission to the developer through the use of email and the developer replied that the researcher is free to use RTOP but in its original form. It was validated by three science professors and one psychology professor. The results of the validation showed that RTOP was very acceptable in terms of purpose, content, and organization and presentation. Additionally, this instrument was utilized locally by Morales (2017) in her study "Transitions and transformations in Philippine physics education curriculum: A case research." The researcher will use RTOP as an observation tool that will identify the characteristic of teachers in terms of: lesson design and implementation, propositional and procedural knowledge, and classroom culture.

The following are item number 1 and 2 section 3 of RTOP which focuses on the teachers' lesson design and implantation:

1. The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.

4	The students write or draw a diagram of their hypothesis, estimation or prediction and discuss it in a small group or large group setting, prior to exploration and teacher instruction.
3	The students write, draw or discuss their hypothesis, estimation or prediction prior to exploration and teacher instruction.

2	The teacher solicits information from students concerning prior knowledge of phenomenon.
1	The teacher refers to previous student experiences or relates previous learning. (no respect aspect)
0	The teacher makes no reference to prior knowledge.

2. The lesson was designed to engage students as members of a learning community.

4	All students in the small group contribute to the construction of ideas and theory building.
3	Some students in the small group contribute to the construction of ideas and theory building.
2	There is some student-to-student interaction and discussion but little or no construction of ideas or theory building.
1	The lesson employs only large group discussion with little evidence of community. Primarily the teacher addresses the class and some students
0	This lesson is completely teacher-centered, lecture only.

Science Teaching Efficacy Beliefs Instrument (STEBI)

The STEBI was developed from the extensive research on the effects of efficacy on science teaching and learning by Riggs and Enochs (1990) and was based from the Gibson and Dembo (1984) approach. The researcher asked permission to the developer through the use of email and the developer replied that the researcher can use STEBI since it has no copyright. It was also validated by three science professors and one psychology professor. The results of the validation showed that STEBI was very acceptable in terms of purpose and content while it is only acceptable in terms of organization and presentation.

STEBI was given to the teacher participants as a questionnaire checklist to measure their level of efficacy in teaching science. Two efficacy factors were identified using this questionnaire namely: personal teaching efficacy and science teaching outcome expectancy. The following are items number 1 and 2 of STEBI:

Statements	**Strongly Agree**	**Agree**	**Uncertain**	**Disagree**	**Strongly Disagree**
1. When a student does better than usual in science, it is often because the teacher exerted extra effort.					
2. I will continually find better ways to teach science.					

The following numerical values and verbal interpretation were used for the level of agreement of the responses for STEBI:

Numerical Values		Verbal Interpretation
4.50 – 5.00	-	Outstanding
3.50 - 4.49	-	High
2.50 - 3.49	-	Medium
1.50 - 2.49	-	Low
1.0 - 1.49	-	Very Low

Students Motivation towards Science Learning (SMTSL)

Tuan, Chin, and Shieh (2005) developed SMTSL to identify students' willingness to participate in their science class. The researcher asked permission to the developer through the use of email and the developer replied that the researcher is welcome to use any part of the instrument. It was also validated by three science professors and one psychology professor. The results of the validation showed that SMTSL was very acceptable in terms of purpose, content, and organization and presentation.

The researcher used the last part of STMSL as a questionnaire to identify learning environment stimulation of students. The last part of SMTSL has two domains which can measure students' willingness to participate based on physical space or how the teachers manages and prepares the classroom, and cognitive space or how the teacher sets up the students in the classroom and makes the climate motivational. Learning environment should be envisioned by the teacher in both physical and cognitive space (Evertson, 1999). The following are items number 1 and 2 found in SMTSL:

Statements	**Strongly Agree**	**Agree**	**Uncertain**	**Disagree**	**Strongly Disagree**
1. I am willing to participate in this science subject because the content is exciting and changeable.					
2. I am willing to participate in this					

science subject because the teacher uses a variety of teaching methods.					

The following numerical values and verbal interpretation were used for the level of agreement for the responses for SMTSL:

Numerical Values		Verbal Interpretation
4.50 – 5.00	-	Outstanding
3.50 - 4.49	-	High
2.50 - 3.49	-	Medium
1.50 - 2.49	-	Low
1.0 - 1.49	-	Very Low

Semi-Structured Interview

Semi-structured interview questions was based on the post conference questionnaire of the Department of Education Division of Rizal. The researcher asked permission to his department chairperson in modifying the questions to become aligned with his research. The results of the validation showed that RTOP was very acceptable in terms of content while acceptable in terms of purpose, and organization and presentation. Part 1 of the interview focused on the recently delivered lesson delivery of the teachers while part 2 of the interview focused on gathering the perceptions of the teachers about the intended, enacted and received curriculum and their beliefs about how they deliver the intended curriculum. Interview was done to strengthen the data gathered from the observation and questionnaires.

The following are items number 1 and 2 of part 2 of the interview questions:

Part 2. Focusing with the curriculum and efficacy.

1. How do you know that learning occurs in a science class?
2. What do you think are your characteristics that help students learn?

Document from the Department Education – Science Curriculum Guide

Grade 3 to 11 K to 12 Science curriculum guide from the Department of Education was used by the teacher to identify the intended curriculum content and content standards. These curriculum guides was also used to determine the spiraling of the curriculum content and content standards. Curriculum guides contains the standard learning competencies set by the education department.

Document from the Teacher Participants – Test Mean Profile and Students Grade

The researcher asked the department chairperson and teacher participants for permission to hand over their mean profile and observes class students' grades.

Mean profile contains the result of the final examination done per quarter and measures the students' mastery level while the students' grade are the measure of each students achievement in terms of written works, performance tasks and final examination.

Data Collection

The researcher asked permission from the research supervisor of the division of Rizal, school principal and the senior high school coordinator of the government-owned school in Angono to conduct the study, specifically to do classroom observations, interviews, and administer the questionnaire to the participants. The researcher used three classes assigned to the teacher participants for observation with 35 to 50 students per class. The objective of the study was explained to the teacher-participants, and the confidentiality of their responses and results of the observations was assured within the boundaries of the research process. The researcher underwent three steps in gathering data: teacher and student participant observation and documentation; guided interview with teacher participants; and administration of questionnaire checklist to the teacher participants and their students.

Before doing the observation, the researcher asked a copy of the science curriculum guides of Grade 3 to 12 from a master teacher in the senior high school STEM department. These curriculum guides were analyzed to identify the spiral progression of the curriculum from each grade level. Furthermore, these guides served as a tool in identifying the alignment of the teachers' daily lesson objectives with the competencies set by the education department.

Observations were done for a period of 10 weeks by the researcher in the selected classes of each teacher-participant. The teacher-participants were observed once a week for one hour in one of their classes. Reformed Teaching Observation Protocol was used an observation tool by the researcher in observing the teacher-participants. Observation documentation was done using smartphones to document and recheck everything that the researcher did during the ten-week period for coding and transcription. For validation purposes, two more teachers were asked to observe the teacher participants in their selected classes.

Teachers mean profile, which reflects the student mastery level and students grades were collected after the final examination of the quarter. These data were used to identify the students' achievement and was collected after seventh observation for stem teacher 1and ninth observation for stem teachers 2 and 3.

Interviews were also conducted with the teacher participants after the last week of observations following the structure of the guide questions from the Department of Education. The interviews were conducted for 30 minutes to one hour per teacher after their class. Recording of interview proceedings was also done using smartphones to document and recheck everything that the participants said during the interview for coding and transcription.

The administration of the questionnaire checklist to the teacher participants to measure their efficacy beliefs and student participants to measure their motivation towards learning science was also done during the last week of observations. These instruments were given to the teacher and students simultaneously and were answered during their class period. The researcher borrowed 15 to 30 minutes from the science class of each teacher participant for administration and answering of the questionnaire.

The data that were gathered were transferred and saved in the researcher's laptop to make sure that the files were organized. Cloud back up of all files was also secured. Answer to the interview questions and questionnaire checklist will be evaluated and analyzed by the researcher. Printed copies of questionnaires answered by the teacher and student participants were kept in a secured place. The interrelatedness of the curriculum competencies (intended curriculum), teacher planning and implementation (enacted curriculum), and student achievement and learning environment (received curriculum) was determined together with the efficacy beliefs of the teacher-participants. The sample STEBI, SMTSL, RTOP and interview questions are found in Appendices A, B, C and D.

Data Analysis

Document analysis was done with the curriculum guide and teacher participants' daily lesson plan. Alignment of the lesson objectives with the standard learning competencies from the education department was analyzed using the said documents. Furthermore, these documents were used to determine if the teacher participants' was able to deliver their lesson according to their design and consistent with the intended curriculum based on content analysis and observation.

The result from each section of the observation tool (RTOP) was used to identify the most frequently observed characteristics of STEM teachers in terms of lesson design and implementation, and propositional and procedural knowledge. Transcription and coding was done with the responses from the interview. The average mean from results from the SMTSL which was used to gather reasons of students' motivation and willingness to learn from their teachers' science class was obtained. Similarly, results of STEBI which gathered the level of personal teaching efficacy beliefs and outcome expectancy beliefs was obtained.

The result of the RTOP lesson design section was analyzed to check it alignment with the curriculum guide. This alignment of the enacted and intended curriculum was further strengthened by the results of the interview and analysis of their lesson plans. The results of RTOP implementation and propositional and content knowledge section was analyzed to check it alignment with the received curriculum. These alignment was further strengthened by the results of the interview and average scores from SMTSL. The mean profile of the teachers and students grades that were analyzed to identify the alignment of the intended and received curriculum. After identifying the alignment of the intended, enacted and received curriculum using triangulation. The level of efficacy beliefs of STEM teachers were identified by getting the average scores from the results of STEBI. The results of STEBI was used to identify the role of teachers' efficacy beliefs on the alignment of the curriculum and was strengthen by the results of the interview.

Role of the Researcher

The researcher in this study identified the standard learning competencies in Grade 11 science subject, the biases in the environment and the participants at the onset of the study. Although the researcher belongs to the STEM department of the public school where the research was conducted and has been teaching in the school for six years, he did not teach Grade 11 science subjects and did not handle grade 11 students for the school year 2017-2018 to lessen researcher's bias. The researcher also attended some teacher trainings and seminars over the past few years. His consciousness and understanding improved because of these experiences and allowed him to address the problems that he encountered during the conduct of the study. With these previous knowledge and experiences, he was able to conduct the study properly and efficiently. To ensure that full impartiality is exhibited during the course of the study, the researcher was careful when collecting data from the participants, which were gathered through questionnaires, observation and interviews. While doing the observation, he also asked two other teachers that were not participants of the study to observe and help him in the collection of data through observation of their peer to validate and avoid personal biases. The observations and interviews were also recorded and were interpreted and content analyzed by the researcher and co-observers. The researcher put aside personal feelings and opinions different from other participants, which assisted him to achieve neutrality to truly understand the participants of the study.

Ethical Considerations

While conducting the research, the researcher considered the ethical dilemmas that he might encounter. It is the researchers responsibility to take in consideration the rights and values of the participants since he utilized interview as his tool to gather data. Furthermore, the results of the study could be made as reference for future researches by others. Hence, the succeeding ethical considerations were followed:

a. The researcher asked permission from the division research supervisor, the school principal and the senior high school coordinator to do the research.

b. The researcher explained to the teacher participants through a letter of consent signed by the Principal and the Senior High School Coordinator about the on-going research. The letter of consent assured that the topics and learning competencies that the school offered were not sacrificed during the research implementation. Also discussed in the letter are the activities that would be done during the implementation process and how their specific class section was chosen.

Confidentiality of their performance during and after the research implementation was guaranteed unless the results are requested by the Principal.

c. The researcher also explained thoroughly to the teacher participants that their performance evaluation, rating, and ranking would not be affected by the research implementation and that the data collected would be kept with utmost confidentiality by the researcher, the Principal of the public school in Angono and the Philippine Normal University.

d. The researcher guaranteed through an informed consent form signed by the selected students in each section handled by the teacher participants that their answers to the questionnaire will be kept with confidentiality and will not affect their grades.

e. The researcher also guaranteed through the letter of consent and informed consent form to both the parents and the student participants that the data collected would be kept with utmost confidentiality by the researcher, the Principal of the public school in Angono and the Philippine Normal University and their grades will not be affected.

f. The researcher also explained to the participants that their full participation in the research would contribute to the enhancement of the teaching and learning process not only in the government-owned school in Angono but in many educational institutions.

g. The result of the study would also be shared and discussed with the school community during in service trainings where the teachers meet together every semester. In this way, teaching strategy and teacher efficacy will be given importance and emphasis for the enhancement of the teaching and learning process.

Chapter 3

Findings and Discussion

Alignment of the three STEM Teachers Intended, Enacted and Received Curriculum

Intended curriculum consists of the content standards and learning competencies found in the curriculum guide set by the education department. These content standards and learning competencies are the basis of the teachers for their daily lesson objectives. Table 1 shows the content standards and the aligned lesson objectives of ST1, which also reflects the consideration for prerequisite knowledge of the students, and some strategies used by ST1.

STEM Teacher 1 (ST1)

Intended Curriculum

Table 1

List of Lesson Plan Objectives Based on Content Standards of the Grade 11 Earth and Life Science Curriculum Guide of ST1

Date and content	Content standards	Lesson objectives	Linking prerequisite knowledge of the lesson and planned strategy
	The learners demonstrate an understanding of:	At the end of the lesson, the learners are expected to:	
June 27, 2017 - Origin and Structure of the Earth - Universe and the Solar System	The formation of the universe and the solar system	1. Recognize the uniqueness of the Earth, being the only planet in the solar system with properties necessary to support life, 2. Identify similarities and differences among the three planets, Venus, Mars and Earth, 3. Explain the	• Used lecture and discussion with the aid of computer and television • Multiple choice type of test

		impact of planet size to gravity, internal heat and atmosphere of the planet	
July 4, 2017 - Origin and Structure of the Earth - Earth Subsystems	The subsystems	1. Explain that the Earth consists of four subsystems, 2. Define the concept of system and recognize that the Earth as a system is composed of subsystems, 3. Show the contribution of personalities/ people in understanding the Earth system	• The teacher asked questions like: what is the term used to describe the solid layers of the Earth such as crust, mantle and core? • Group activity • Group presentation
July 11, 2017 - Earth Materials and Processes - Rocks and Minerals	The origin and environment of common minerals and rocks	Identify the common rock forming minerals using their physical and chemical properties	• The teacher asked questions like: What are the layers of the Earth? • Used collaborative learning
July 12, 2017 - Earth Materials and Processes - Rocks and Minerals	The origin and environment of common minerals and rocks	Identify the common rock forming minerals using their physical and chemical properties	• Used lecture and discussion • Pen and paper type of test
July 21, 2017 - Earth Materials and Processes - Rocks and Minerals	The origin and environment of common minerals and rocks	The three main categories of rocks	• The teacher asked questions like: what is erosion? What is weathering? • Inquiry approach and discussion

August 4, 2017 - Earth Materials and Processes - Rocks and Minerals	The folding and faulting of rocks	Describe how rocks behave under different types of stress such as compression, tensile and shearing	• The teacher asked questions like: What are the different types of boundaries? • Collaborative learning and group activity
September 5, 2017 - Introduction to Life Science	Historical development of the concept of life	1. Explain the evolving concept of life based on emerging pieces of evidence, 2. Describe how the unifying themes in the study of life show the connections among living things and how they interact with one another and the environment	• The teacher asked questions like: What is a cell? • Group dynamics
September 7, 2017 - Introduction to Life Science	Historical development of the concept of life	1. Explain the evolving concept of life based on emerging pieces of evidence, 2. Describe how the unifying themes in the study of life show the connections among living things and how they interact with one another and the environment	• Lecture and discussion with the aid of computer and television
September 8, 2017 - Introduction to Life Science	Historical development of the concept of life	1. Explain the evolving concept of life based on emerging pieces of evidence, 2. describe how the unifying themes in the study of life show the connections among living things and how they interact with one another and the environment	• Lecture and discussion with the aid of computer and television
September 22, 2017 – Bioenergetics	How photosynthetic organisms capture light energy to form sugar molecules	1. Explain how cells carry out functions required for life, 2. Explain how photosynthetic organisms use light energy to combine carbon dioxide and water to form energy	• The teacher asked questions like: What are needed in order for photosynthesis to occur? • Group activity

Note. 10 observations

Table 1 shows that the teacher was following the curriculum guide given by the Education Department. The set lesson objectives or learning competencies for each day are aligned with the content standards and ST1 was able to specify the planned strategy to teach the content. However, the teacher was not able to complete some lessons and attain the learning competencies in one meeting (50 minutes). The teacher took three meetings to complete the lesson objectives such as the lesson on identifying the common rock forming minerals using their physical and chemical properties. Also, it took the teacher two meetings to achieve the objectives on explaining the evolving concept of life based on emerging pieces of evidence, and describing how the unifying themes in the study of life show the connections among living things and how they interact with one another. She emphasized *that "time is a hindrance in completing the lesson and attaining the lesson objectives."* Although the curriculum guide from the Department of Education provides time duration for each content standard, difficulties emerge within the school and in relation to school facilities. Since the school lacks buildings for senior high school grades 11 and 12 students, the school decided that these levels take shifting schedules. The grade 12 students had their classes in the morning and the grade 11 students in the afternoon with a 50-minute per subject schedule. This was decided within the division level. Furthermore, Table 1 shows that the teacher tries to link prerequisite knowledge in his/her lessons, hence, showing respect to students' prior knowledge. This process, which could help in concept building and attaining lesson objectives is part of a student-centered classroom environment which is reflected in the teacher's lesson design and implementation or procedures undertaken.

Enacted Curriculum

Enacted curriculum reflects how teachers structure and deliver their lessons to be consistent with the intended curriculum and aligned with the level of the received curriculum. Tables 2 and 3 show the enacted curriculum of teachers in terms of lesson design and implementation, and their propositional and procedural knowledge.

Lesson Design and Implementation

Table 2

Lesson Design and Implementation, and Classroom Culture of ST1

Items for Lesson Design and Implementation, and Classroom Culture	Frequency of observation					Weighted average
	4	3	2	1	0	
The instructional strategies and activities considered the students' prior knowledge and the preconceptions inherent therein.	0	1	9	0	0	2.1
The lesson was designed to engage students as members of a learning community.	1	1	4	4	0	1.9
In this lesson, student exploration preceded formal presentation.	0	3	4	1	2	1.8
This lesson encouraged students to seek and value alternative modes of investigation or of problem solving.	0	0	3	5	2	1.1
The focus and direction of the lesson was often determined by ideas originating from the students.	0	3	3	4	0	1.9
There was communicative interaction.	0	6	3	1	0	2.5
There was a close student-teacher relationship.	3	3	3	1	0	2.8

Note. 10 observations

Apparently, the most frequently observed characteristics of ST1 on lesson design and implementation are consideration for students' prior knowledge and preconceptions; efforts in engaging the students as members of the learning community; and letting the ideas originating from the students direct the lesson. These characteristics describe a student-centered paradigm. In fact, the teacher even mentioned, "*I usually use group dynamics during group activities and inquiry approach.*" These student-centered strategies allow communicative interactions among students to occur and engage them to share their ideas and information. Quality science teaching (National Research Council, 1996) and good student-teacher relationship promote high student engagement, intellectual growth and improve academic achievement (Calingacion, 2008; Dotson, 2001).

However, due to the practice of guided inquiry in junior high school, engaging student exploration before formal presentation of the lesson and letting students seek alternative modes of investigation and problem solving are seldom observed in the teaching and learning process exhibited by ST1 (Arslan, 2014; Sadeh & Zion, 2009). The teacher even stated, *"I give instructions and objectives to motivate the students and guide the direction of the lesson and I also give the definition of terms that were new to the students or complex words."* Accordingly, efforts of ST1 in engaging the students as part of the learning community still reflect a student-centered classroom.

Content Knowledge

Table 3

Propositional and Procedural Knowledge of ST1

Items for Propositional Knowledge	Frequency of occurrence					Weighted average
	4	3	2	1	0	
The lesson involved fundamental concepts of the subject.	2	5	2	1	0	2.8
The lesson promoted strongly coherent conceptual understanding.	5	5	0	0	0	3.5
The teacher had a solid grasp of the subject matter content inherent in the lesson.	3	6	1	0	0	3.2
Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so.	1	3	4	5	1	2.6
Connections with other content disciplines and/or real world phenomena were explored and valued.	0	1	8	1	0	2
Items for Procedural Knowledge						
Students used a variety of means (models, drawings, graphs, symbols, concrete materials, manipulatives, etc.) to represent phenomena.	1	0	7	1	1	1.9
Students made predictions, estimations and/or hypotheses and devised means for testing them.	2	1	2	5	0	2
Students were actively engaged in thought-provoking activities that often involved the critical assessment of procedures.	0	2	4	4	0	2
Students were reflective about their learning.	1	2	3	3	1	1.9
Intellectual rigor, constructive criticism, and the challenging of ideas were valued.	0	3	4	2	1	1.9

Note. 10 observations

The most frequently observed characteristic in terms of propositional knowledge of ST 1 is his/her ability to provide lessons that promote strongly coherent conceptual understanding and solid grasp of the subject matter content inherent in the lesson. This characteristic leads to providing the students with fundamental concepts of the lesson and allowing them to use elements of abstraction and connect the lesson with other disciplines and real world phenomena although at an intermediate level. Teachers who exhibit and are able to deliver propositional knowledge can provide students with new concepts and knowledge which they could connect with their previous knowledge resulting to optimal learning (Aquino, 2000; Etkina, 2009). In terms of procedural knowledge, ST1 is at an intermediate level, which can be attributed to the intermediate and low level domains of lesson design and implementation. Lesson design and procedural knowledge are essential components in structuring the classroom (Piburn, 2002). Hence, it may be that ST1 is still transitioning from junior high school to senior high school science curriculum. The teacher even claimed that she needs to improve in some aspects, *"I need to improve the way I give abstraction and in dividing the lessons that will be delivered or observe time management for the lesson and also in the use of computer or technology"*. Nevertheless, ST1 continuously delivers the intended curriculum utilizing different strategies, integrating technology and using some assessment methods that she stated in the plan (see table 1).

Received Curriculum

Received curriculum can be measured using different assessment practices and it is also reflected in the students' grades and mastery level. Table 4 shows the mastery level ST1's students based on the final examination test results and the students grades.

Students' Achievement

Table 4

Test Results and Grades of ST1 Class

Score percentage	No. of students	Percentage of students	Interpretation
Final examination results			
0-49%	7	20.00%	Non-Mastery
50-74%	18	51.43%	Nearing Mastery
75-100%	10	28.57%	Mastery
Total No. of Students	35		
Grades			
65-74%	7	20.00%	Failed
75-100%	28	80.00%	Passed
Total No. of Students	35		

Note. Data from the first quarter of the first semester.

Table 4 shows that there is a large percentage (80%) of students who passed the test compared to those who failed (20%). The 20 percent of students who failed belong to the non-mastery level which could also be attributed to the 20 percent of the students who attained failing grades during the first quarter of the first semester. Although there is a large number of students who passed the first quarter examination, the number of students who failed should be considered and made a target for improvement by the teacher. These students could improve with the help of the teacher. The use of more appropriate strategies that would build a better learning environment for these students could be done to increase their mastery level and motivate them to learn since passing rate and mastery level can be associated with improvement of knowledge and strategies of the teacher (Caprara, Barbaranelli, Steca, & Malone, 2006). ST1 even stated, *"STEM teachers should* *study and deepen their knowledge which can be done through trainings and seminars to improve science teaching and student achievement."*

Furthermore, as mentioned in the forgoing discussion, technology integration should also be done in the grade 11 science class. ST1 further stated, "*Technology is a factor that can be considered when teaching in the senior high school. Students in the senior high school are more exposed to technology so I need to improve greatly in using technology."* Thus, technology integration enhances and supports the learning environment which could lead to students' motivation and increased participation (Dockstader, 2008).

Consequently, students' motivation should also be taken into consideration as part of the received curriculum. Providing positive learning environment is part of teachers' classroom management and instructional practices which promote student motivation in learning and influence student achievement (Mojavezin & Tamiz, 2012). Table 5 shows the consolidated responses on students' motivation towards learning science of ST1 class.

Students Motivation towards Learning Science

Table 5

Students Motivation towards Science Learning of ST1 Class

Items	Frequency of response					Weighted average
	SA(5)	A(4)	U(3)	D(2)	SD(1)	
I am willing to participate in this science subject because the content is exciting and changeable.	9	18	5	0	0	4.13

I am willing to participate in this science subject because the teacher uses a variety of teaching methods.	4	22	5	1	0	3.91
I am willing to participate in this science subject because the teacher does not put a lot of pressure on me.	5	18	7	1	1	3.78
I am willing to participate in this science subject because the teacher pays attention to me.	2	19	11	0	0	3.72
I am willing to participate in this science subject because it is challenging.	14	13	4	1	0	4.25
I am willing to participate in this science subject because students are involved in discussions.	7	20	5	0	0	4.06
I am willing to participate in this science subject because I am motivated by the teacher.	1	23	7	0	1	3.72
I am willing to participate in this science subject because the learning activities are relevant to daily life situations.	9	17	5	1	0	4.06
Average						3.95

Note. 32 respondents

As gleaned from Table 5, the students were willing to participate in the science class of ST1 because they appreciate the excitement and challenges brought about by the subject. These students value how ST1 designs her activities for the students to be able to see the relevance of the topic to daily life and how the students are involved in the discussion. These factors affect the students' willingness to participate in classroom discussion. ST1 even claimed, *"Students' interest is enhanced during inquiry while sharing of experiences and thoughts happen during group dynamics"*. Hence, the way a teacher enacts the intended curriculum influences the received curriculum by the students. The average mean is 3.95, which means that the willingness or motivation of the students in ST1 class is high

Alignment of the Intended, Enacted and Received Curriculum of ST1

Table 6

Alignment of the Intended, Enacted and Received Curriculum of ST1

Intended Curriculum	Enacted Curriculum	Received Curriculum
Content standards	Structuring the lesson and mode of delivery	Student achievement
The learners demonstrate an understanding of: • The formation of the universe and the solar system • The subsystems • The origin and environment of common minerals and rocks • The folding and faulting of rocks • How photosynthetic organisms capture light energy to form sugar molecules	Lesson Design and Implementation: • Consideration for students' prior knowledge and preconceptions • Efforts in engaging the students as members of the learning community • Letting the ideas originating from the students direct the lesson • Good communicative interaction and relationship Propositional and Procedural Knowledge: • Ability to provide lessons that promote strongly coherent conceptual understanding • Solid grasp of the subject matter content inherent in the lesson • Providing students with fundamental concepts of the lesson and allowing them to use elements of abstraction and connecting the lesson with other disciplines	Test Results from the Teachers' Mean Profile: • 7 students attained 0 to 49 percent correct answers on the first quarter examination which means that 20 percent are non-mastery students. • 18 students attained 50 to 74 percent correct answers on the first quarter examination which means that 51.43 percent are nearing mastery students. • 10 students attained 75 to 100 percent correct answers on the first quarter examination which means that 28.57 percent are nearing-mastery students. Students First Quarter Grades: • 7 students received a grade ranging from 65 to 74 which is equivalent to the 20 percent of the students who failed in the first quarter of the first semester.

	and real world phenomena • Students were actively engaged in thought-provoking activities that often involved the critical assessment of procedures • Students made predictions, estimations and/or hypotheses and devised means for testing them Observed strategies: • Lecture and Discussion • Use of Inquiry Approach • Group Dynamics • Group Activities and Collaborative Learning • Use of power point presentations with the aid of computer and television • Use of different assessment methods	• 28 students received a grade ranging from 75 to 100 which is equivalent to the 80 percent of students who passed in the first quarter of the first semester. Main Reasons why students are motivated to learn science: • The science subject is challenging. • The content of the subject is exciting and changeable. • The students are involved in the discussions • The learning activities are relevant to daily life situations.

As seen on Table 6, the content standards specified in the intended curriculum were found in the lessons designed by ST1. Her identification of content standards was also guided by her researches on Grade 11 STEM learning competencies. According to ST1, "*Based on the researches I've done for my lesson plan, the concepts in the senior high school were much higher in level compared with the junior high school.*" This progression of the intended curriculum emphasizing continuity with increasing level of complexity convinced ST1 to structure lessons that give consideration for students' prior knowledge and preconceptions. Consideration for students' prior knowledge was observed as she used strategies such as inquiry approach, which in turn, allows her to provide lessons that promote strongly coherent conceptual understanding. The use of inquiry approach allowed ST1 to deduce ideas originating from the students to direct the lesson, which also provided the students with fundamental concepts of the lesson and allowed them to use the elements of abstraction and connect the lesson with other disciplines and real world phenomena. This procedure was highly appreciated by the students (see Table 6) because the learning activities were relevant to their daily life situations. In fact, even ST1 sees the relevance of her lesson as she stated, *"Lessons in the senior high school science can be seen and used in real life situations."*

Furthermore, the content standards in ST1 lesson plans were designed in such a way that the students were engaged as members of the learning community resulting to procedures that actively engaged the students in thought-provoking activities that allow them to make predictions, estimations and/or hypotheses and devise means for testing them such as group dynamics and collaborative learning (Woolfolk, 2005), which are within the paradigm of constructivism. These lesson design and procedures the lessons exciting and challenging, which in turn motivate the students and increase their willingness to learn about science concepts. Accordingly, majority of ST1's students passed the test and are at the nearing mastery and mastery levels. This could be the result of the students' motivation towards learning science which is in congruence with the intended curriculum as enacted by ST1.

ST1 lesson design, implementation, procedures and strategies resulted to majority of students who attained nearing mastery and mastery levels, and passing grades during the first quarter of the first semester. Thus, congruency of the intended, enacted and received curriculum is achieved with proper implantation of the enacted curriculum.

STEM Teacher 2 (ST2)

Intended Curriculum

Table 7 shows the content standards and the aligned lesson objectives of ST2 which also reflect the consideration for prerequisite knowledge of students and some strategies used by ST2.

Table 7

List of Lesson Plan Objectives Based on Content Standards of the Grade 11 Earth and Life Science Curriculum Guide of ST2

Date and content	Content standards	Lesson objectives	Linking prerequisite knowledge of the lesson and planned strategy
	The learners demonstrate an understanding of:	At the end of the lesson, the learners are expected to:	
June 28, 2017 - Origin and Structure of the Earth - Universe and the Solar System	The subsystems that make up the Earth and the Earth's internal structure	1. Identify the layers of the Earth, 2. Demonstrate the different layers of the Earth through a model, 3. Describe the layers of the Earth	• The teacher asked questions like: what are the things found inside the

			Earth? What is geosphere? • Group activity and discovery approach
June 30, 2017 - Earth Materials and Processes - Rocks and Minerals	The origin and environment of common minerals and rocks	1. Describe the physical properties of rocks and minerals, 2. Identify the common rock forming minerals using their physical properties	• The teacher asked questions like: What are the different types of rocks? • Discovery approach
July 4, 2017 - Earth Materials and Processes - Rocks and Minerals	The origin and environment of common minerals and rocks	1. Describe the physical properties of rocks and minerals, 2. Identify the common rock forming minerals using their physical properties	• Used PowerPoint presentation in her lecture and discussion • Fill in the blank and identification type of test
July 18, 2017 - Earth Materials and Processes - Exogenic Processes	Geologic process on the surface of the Earth	Differentiate physical, chemical and biological weathering	• Teacher asked questions like: What is weathering? • Collaborative learning and discovery approach • Used of group presentation
July 19, 2017 - Earth Materials and Processes - Exogenic Processes	Geologic process on the surface of the Earth	Differentiate physical, chemical and biological weathering	• Lecture and discussion
August 1, 2017 - Earth Materials and Processes - Deformation of the Crust	Plate tectonics	1. Explain the continental drift theory, 2. Place together a puzzle of the supercontinent Pangea, 3. cite evidences of the continental drift theory	• The teacher asked questions like: What is Pangea? • Group activities
August 8, 2017 - History of the Earth	History of the Earth	Describe how the Earth's history can be interpreted from the geologic time scale	• Used PowerPoint presentation in her lecture and discussion

September 6, 2017 – Bioenergetics	The cell as the basic unit of life	1. Identify the parts of the cell, 2. Differentiate plant cell from animal cell, 3. explain how cells carry out functions required for life	• The teacher asked questions like: What is a cell? • Discovery approach
September 7, 2017 – Bioenergetics	The cell as the basic unit of life	1. Identify the parts of the cell, 2. Differentiate plant cell from animal cell, 3. Explain how cells carry out functions required for life	• The teacher asked questions like: What is a cell? • Discovery approach
September 28, 2017 - Perpetuation of Life	How genes work	1. Create and decode a DNA recipe, 2. Explain how variations in DNA lead to the inheritance of different traits, 3. Explain how the information on DNA allows the transfer of genetic information	• The teacher asked questions like: What is a DNA? • Group activities and performance based assessment

Note. 10 observations

ST2 followed the curriculum guide given by the Department of Education when it comes to content and content standards. The lesson objectives or learning competencies set to be attained for the day were also aligned with the content standards. ST2 was not able to complete lessons such as the origin and environment of common minerals and rocks; geologic process on the surface of the Earth and the cell as the basic unit of life. He/she said that the time allotted for 1 session is not enough to finish the lesson. Surprisingly, ST2 stated, *"Enhancement of techniques, creativeness and resourcefulness should be practiced to be able to adapt to the different situations in the senior high school."* *S*T2 further claimed, "*I'll try to create new strategies and find other resources to become more efficient* *in managing time to finish all the topics in a lesson."* Hence, delivery of the intended curriculum is influenced by how a teacher designs and implements his/her lesson (Nolet and McLaughlin, 2000).

Enacted Curriculum

Tables 8 and 9 show the enacted curriculum of ST2 in terms of lesson design and implementation, and her propositional and procedural knowledge.

Lesson Design and Implementation

Table 8

Lesson Design and Implementation, and Classroom Culture of ST2

Items for Lesson Design and Implementation, and Classroom Culture	Frequency of observation					Weighted average
	4	3	2	1	0	
The instructional strategies and activities considered the students' prior knowledge and the preconceptions inherent therein.	0	4	6	0	0	2.4
The lesson was designed to engage students as members of a learning community.	3	7	0	0	0	3.3
In this lesson, student exploration preceded formal presentation.	0	10	0	0	0	3
This lesson encouraged students to seek and value alternative modes of investigation or of problem solving.	1	4	5	0	0	2.6
The focus and direction of the lesson was often determined by ideas originating from the students.	0	6	4	0	0	2.6
There was a communicative interaction.	1	9	0	0	0	3.1
There was a student-teacher relationship.	6	4	0	0	0	3.6

Note. 10 observations

Table 8 shows that ST2 frequently designed, as observed, lessons for more enjoyable communicative interaction and positive student-teacher relationship. This characteristic of ST 2 led to good communicative interaction and positive student-teacher relationship. ST 2 even claimed, "*I used learning-by-doing, collaborative strategy and discovery approach".* Hence his/her observed characteristic, of letting the students explore while engaging them as part of the learning community might be attributed to the teaching strategies she used. Furthermore, this characteristic might also be the reason for her intermediate, yet developing characteristics, which are; encouraging students to seek and value alternative modes of investigation or of problem solving, and designing lessons that are directed by ideas originating from the students and sensitivity to prior knowledge. ST2 further stated, *"I inquire, motivate and encourage students to participate in the classroom activities and discussions".* Hence, ST2 promotes a student-centered classroom that utilizes inquiry and discovery approach wherein the teachers let their students search, ask questions and find out new concepts and learnings (Houtz, 2010).

Content Knowledge

Table 9

Propositional and Procedural Knowledge of ST2

Items for Propositional Knowledge	Frequency of occurrence					Weighted average
	4	3	2	1	0	
The lesson involved fundamental concepts of the subject.	4	6	0	0	0	3.4
The lesson promoted strongly coherent conceptual understanding.	4	6	0	0	0	3.4
The teacher had a solid grasp of the subject matter content inherent in the lesson.	4	6	0	0	0	3.4
Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so.	3	5	2	0	0	3.1

Connections with other content disciplines and/or real world phenomena were explored and valued.	5	1	4	0	0	3.1
Items for Procedural Knowledge						
Students used a variety of means (models, drawings, graphs, symbols, concrete materials, manipulatives, etc.) to represent phenomena.	1	4	5	0	0	2.6
Students made predictions, estimate and/or hypotheses and devised means for testing them.	0	7	3	0	0	2.7
Students were actively engaged in thought-provoking activities that often involved the critical assessment of procedures.	1	3	6	0	0	2.5
Students were reflective about their learning.	1	4	5	0	0	2.6
Intellectual rigor, constructive criticism, and the challenging of ideas were valued.	1	7	2	0	0	2.9

Note. 10 observations

The most observed characteristic in terms of propositional knowledge occurring in ST2's class included a solid grasp of the concept which includes knowledge of the fundamental concepts of the subject, and a better concept understanding for the students. This characteristic was evident when ST2 showed capabilities for using elements of abstraction and connecting lessons with other disciplines and real life situations. Accordingly, propositional knowledge helped the students to learn new concepts which they can apply in real life situations. ST2 even stated, "*Learning occurs in a science class when students can apply what they have learned in real life situations or they can solve problems or answer questions easily".* Quality science teaching engages students to ask questions, acquire knowledge, construct and test explanations, and communicate ideas with others (National Research Council, 1996). In addition, the most observed characteristics of ST2 in terms of procedural knowledge highlighted constructive criticism and testing of devised hypothesis. These characteristics might be attributed to the aforementioned strategies used by ST2 and might be associated with the intermediate, yet developing level of procedural outcomes such as: students representing phenomena in different ways, students' reflection on their learning and active engagement of students in thought-provoking activities. In fact, ST2 even emphasized during the last observation, "*I have seen everyone participating and enjoying their activity".* Furthermore, ST2 delivers the intended curriculum using different strategies that enable students to properly receive the intended curriculum.

Received Curriculum

Students' Achievement.

Table 10 shows the mastery level of ST2's students based on the final examination test results and the students' grades.

Table 10

Test Results and Grades of ST2 Class

Final examination results			
Score percentage	No. of students	Percentage of students	Interpretation
0-49%	6	12.24%	Non-Mastery
50-74%	29	59.18%	Nearing Mastery
75-100%	14	28.57%	Mastery
Total No. of Students	49		
Grades			
65-74%	6	12.24%	Failed
75-100%	43	87.76%	Passed
Total No. of Students	49		

Note. Data from the first quarter of the first semester.

Table 10 shows that there is a large percentage (87.76%) of the students who passed the test compared to those who failed (12.24%). The percentage of students who passed is higher compared to the percentage of those who failed. The students who failed in the test belong to the group of non-mastery level. The percentage of students who got failing grades during the first quarter of the first semester is the same as the percentage of the students who failed in the test. The number of students without mastery should be taken into consideration in improving the teaching and learning process. Improvement in the way the teachers builds the students learning environment could help these students to get passing grades and increase their motivation to be able to pass the second quarter of the first semester. Passing rate and mastery level can be associated with the level of interest of the students in learning motivated by the teachers' strategy (Mojavezi & Tamiz 2012). ST2 even stated during the last observation, *"I see and feel the interest of the class to learn"* Table 11 shows the consolidated responses on students' motivation towards learning science of ST2 class.

Students Motivation towards Learning Science

Table 11

Students Motivation towards Science Learning of ST2 Class

Items	Frequency of response					Weighted average
	SA(5)	A(4)	U(3)	D(2)	SD(1)	
I am willing to participate in this science subject because the content is exciting and changeable.	9	22	0	0	0	4.29

I am willing to participate in this science subject because the teacher uses a variety of teaching methods.	8	20	3	0	0	4.16
I am willing to participate in this science subject because the teacher does not put a lot of pressure on me.	15	10	6	0	0	4.29
I am willing to participate in this science subject because the teacher pays attention to me.	15	12	4	0	0	4.35
I am willing to participate in this science subject because it is challenging.	10	21	0	0	0	4.32
I am willing to participate in this science subject because students are involved in discussions.	5	21	5	0	0	4.00
I am willing to participate in this science subject because I am motivated by the teacher.	4	25	1	1	0	4.03
I am willing to participate in this science subject because the learning activities are relevant to daily life situations.	15	10	6	0	0	4.29
Average						4.22

Note. 31 respondents

As gleaned from Table 11, ST2 got the highest rating for the item that the student is willing to participate in the science subject because the teacher pays attention to them. This might also be the reason why ST2 got a high rating for the item which states that students are willing to participate in the science subject because the teacher does not put a lot of pressure on them. These responses from the students might be attributed to the ST2 lesson design. This refers to the item in the scale which states that the lesson was designed to engage students as members of a learning community. Engaging students' active participation with patience results to good student-teacher relationship and creates a more positive learning environment. ST2 even stated, "*I am patient and I always try to involve the students in activities and discussions.*" The average mean is 4.22 which means that the willingness or motivation of the students in ST2 class is high.

Alignment of the Intended, Enacted and Received Curriculum

Table 12

Alignment of the Intended, Enacted and Received Curriculum of ST2

Intended Curriculum	Enacted Curriculum	Received Curriculum
Content standards	Structuring the lesson and mode of delivery	Student achievement
The learners demonstrate an understanding of: • The subsystems that make up the Earth and the Earth's internal structure • The origin and environment of common minerals and rocks • Geologic process on the surface of the Earth • Plate tectonics • History of the Earth • The cell as the basic unit of life • How genes work	Lesson Design and Implementation: • Letting the students explore while engaging them as part of the learning community • Encouraging students to seek and value alternative modes of investigation or of problem solving • Designing lessons that are directed by ideas originating from the students and sensitivity to prior knowledge • Good communicative interaction and relationship Propositional and Procedural Knowledge: • Solid grasp of the subject matter. • Lesson involved fundamental concepts and promoted strongly coherent conceptual understanding	Test Results from the Teachers' Mean Profile: • 6 students attained 0 to 49 percent correct answers on the first quarter examination which means that 12.24 percent are non-mastery students. • 29 students attained 50 to 74 percent correct answers on the first quarter examination which means that 59.18 percent are nearing mastery students. • 14 students attained 75 to 100 percent correct answers on the first quarter examination which means that 28.57 percent are nearing-mastery students. Students First Quarter Grades: • 6 students received a grade ranging from 65 to 74 which is equivalent to the

	• Values intellectual rigor, constructive criticism, and the challenging of ideas. • Students made predictions, estimate and/or hypotheses and devised means for testing them • Students were allowed to reflect about their learning • Students used a variety of means (models, drawings, graphs, symbols, concrete materials, manipulatives, etc.) to represent phenomena Observed strategies: • Lecture and Discussion • Discovery approach • Use of Inquiry Approach • Group Dynamics • Group Activities and Collaborative Learning • Use of power point presentations with the aid of computer and television • Use of different assessment methods (rubric-based)	12.24 percent of the students who failed in the first quarter of the first semester. • 43 students received a grade ranging from 75 to 100 which is equivalent to the 87.76 percent of students who passed in the first quarter of the first semester. Main Reasons why students are motivated to learn science: • The teacher pays attention to them. • The science subject is challenging. • The learning activities are relevant to daily life situations. • The content is exciting and changeable. • The teacher does not put a lot of pressure on them.

The concepts and lesson objectives included in the lesson plans of ST2 were relevant and were based on the content standards of the Education Department. She was aware that these content standards follow the spiraling of the curriculum. This is the reason why she structured her lessons in a way that respected prior knowledge of the students. She even stated, "*The lessons in the senior high school are continuation of lessons from the junior high school".* Furthermore, her lesson structure allowed her students to explore while engaging them as part of the learning community and encouraged them to seek and value alternative modes of investigation or of problem solving. These lesson design and implementation bring excitement and challenge to the students which, in turn, motivate them to learn about science concepts.

ST2 used the discovery approach, which allowed the students to explore even before the lesson was formally presented to them, and this style encouraged them to formulate their hypothesis and devise their own means of testing the concepts of the lessons. These characteristics further engaged the students as members of the learning community that extracted their feelings that they are members of the learning community, by involving them in activities and discussion. ST2 doesn't put any pressure on them, creating a positive learning environment which enable a majority of the students to pass the subject and attain nearing mastery and mastery levels. Utilizing rubrics in performance-based assessment and evaluation makes the students aware of their performance, leading to better achievement.

ST2 allowed her students to be reflective about their learning and to give constructive criticisms during group activities and discussions, which made the students recognize the relevance of their lessons to daily life situations. This design of the curriculum that is delivered by ST2 develop students' awareness. ST2 even claimed, "*The curriculum helps the growth and development of the learners especially in their chosen field of work and this is a big contribution to the progress of education.*"

ST2 lessons appreciated by the students' who saw their relevance. This means that the intended curriculum was operationalized. This successful operationalization of the intended curriculum was possible because of the proper lesson design and implementation of procedures done by ST2.

STEM Teacher 3 (ST3)

Intended Curriculum

Table 13 shows the content standards and the aligned lesson objectives of ST3 which also reflect the consideration for prerequisite knowledge of students and some strategies used by ST3.

Table 13

List of Lesson Plan Objectives Based on Content Standards of the Grade 11 Earth and Life Science Curriculum Guide of ST3

Date and Content	Content Standards	Lesson Objectives	Linking prerequisite knowledge of the lesson and planned strategy
	The learners demonstrate an understanding of:	At the end of the lesson, the learners are expected to:	
June 23, 2017 - Origin and Structure of the Earth - Universe and the Solar System	The formation of the universe and the solar system	1. Recognize the difference in the physical and chemical properties between the Earth and its neighboring planets, 2. Identify factors that allow a planet to support life	• Lecture and discussion with the aid of computer and television • True or false type of question
June 30, 2017 - Origin and Structure of the Earth - Earth Subsystems	The subsystems that make up the Earth and the Earth's internal structure	1. Define the concept of a system, 2. Recognize the Earth as a system composed of subsystems	• The teacher asked questions like: Can you give example of an Earth system? • Inquiry approach
July 3, 2017 - Origin and Structure of the Earth - Earth Subsystems	The subsystems that make up the Earth and the Earth's internal structure	1. Define the concept of a system, 2. Recognize the Earth as a system composed of subsystems	• The teacher asked questions like: What are the different spheres of the Earth? • Group activity
July 17, 2017 - Origin and Structure of the Earth and Earth Materials and Processes - Earth Subsystems, and Rocks and Minerals	The subsystems that make up the Earth, The three main categories of rock and the origin and environment of common minerals and rocks	Identify the common rock forming minerals using their physical and chemical properties and answer the test	• Used lecture and discussion with the aid of computer and television

July 19, 2017 - Earth Materials and Processes - Exogenic Processes	Geologic processes that occur on the surface of the Earth such as weathering, erosion, mass wasting and sedimentation	Describe how rocks undergo weathering	• The teacher ask questions like: What is weathering? Used group activity and performance-based assessment
July 25, 2017 - Earth Materials and Processes - Endogenic Processes	Geologic processes that occur within the Earth and the folding and faulting of rocks	Describe how rocks behave under different types of stress such as compression, pulling apart and shearing	• Lecture and discussion using power point presentation
August 1, 2017 - Earth Materials and Processes - Deformation of the Crust	Plate tectonics	1. Explain how continents drift, 2. Cite evidences that support continental drift	• The teacher asked questions like: What is a plate boundary? • Group dynamics, and pen and paper type of test
August 3, 2017 - Earth Materials and Processes - Deformation of the Crust	Plate tectonics	Explain how the seafloor spreads and describe the structure and evolution of the ocean basins	• Discussion with the aid of computer and video clips and presentations • Identification type of test
August 30, 2017 - Introduction to Life Science	Historical development of the concept of life, the origin of first life forms and unifying themes in the study of life	Describe how the unifying themes in the study of life show the connection among living things and how they interact with their environment	• The teacher asked questions like: What are needed in order for photosynthesis to occur? • Group activity, recitation and group presentation

September 18, 2017 - Bioenergetics	How photosynthetic organisms capture light energy to form sugar molecules	1. Identify the raw materials and products of light-dependent and light-independent reactions of photosynthesis, 2. Locate the part in the chloroplast where light-dependent and light-independent reactions take place, 3. Explain how photosynthetic organisms use light energy to combine carbon dioxide and water to form energy	• The teacher asked questions like: What is photosynthesis ? • Role playing and collaborative activity

Note. 10 observations

Based on Table 13, ST3 followed the curriculum guide given by the Department of Education in terms of content and content standards. The lesson objectives or learning competencies set to be attained for the day were also aligned with the content standards. However, some of the lessons in the class of ST3 were not finished within one meeting because of the limited time. These are the lessons on the subsystems that make up the Earth, the Earth's internal structure, the origin and environment of common minerals and rocks, the subsystems of the Earth, geologic process on the surface of the Earth and plate tectonics. Internal agreement within the division for the allotment of 50-minutes per subject was done to accommodate all the students. This resulted to two shifts of classes. This allotted time period of 50 minutes results to lessons that could not be finished in one meeting. ST3 said during the last observation, *"If there was more time, the students would be asked to fill out the table individually or do a picture analysis for the* *students to be able to discover concepts."* She further stated, *"I was not able to explain the Calvin cycle because of the lack of time. It is much better if the lesson is intended for two meetings".* Hence, time is a factor that affects how much intended curriculum could be delivered by the teacher.

Enacted Curriculum

Tables 14 and 15 show the enacted curriculum of ST3 in terms of lesson design and implementation, and their propositional and procedural knowledge.

Lesson Design and Implementation

Table 14

Lesson Design and Implementation, and Classroom Culture of ST3

Items for Lesson Design and Implementation, and Classroom Culture	Frequency of observation					Weighted average
	4	3	2	1	0	
The instructional strategies and activities considered the students' prior knowledge and the preconceptions inherent therein.	1	4	5	0	0	2.6
The lesson was designed to engage students as members of a learning community.	5	5	0	0	0	3.5
In this lesson, student exploration preceded formal presentation.	2	7	1	0	0	3.1
This lesson encouraged students to seek and value alternative modes of investigation or of problem solving.	3	5	2	0	0	3.1
The focus and direction of the lesson was often determined by ideas originating from the students.	1	6	3	0	0	2.8
There was a communicative interaction.	5	4	1	0	0	3.4
There was a student-teacher relationship.	6	1	3	0	0	3.3

Note. 10 observations

The most frequently observed characteristic of ST3 in terms of lesson design and implementation is the provision to engage the students as members of a learning community which leads to good communicative interaction and better student-teacher relationship. This also allows the students to explore before the formal presentation of the lesson and encourages them to seek and value alternative modes of investigation. ST3 claimed*, "Teachers are facilitators, I assure that each lesson is activity based, what I do with or without observer is the same."*

Content Knowledge

Table 15

Propositional and Procedural Knowledge of ST3

Items Propositional Knowledge	Frequency of occurrence					Weighted average
	4	3	2	1	0	
The lesson involved fundamental concepts of the subject.	4	5	1	0	0	3.3
The lesson promoted strongly coherent conceptual understanding.	5	5	0	0	0	3.5
The teacher had a solid grasp of the subject matter content inherent in the lesson.	6	2	2	0	0	3.4
Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so.	1	8	1	0	0	3
Connections with other content disciplines and/or real world phenomena were explored and valued.	3	3	4	0	0	2.9
Items for Procedural Knowledge						
Students used a variety of means (models, drawings, graphs, symbols, concrete materials, manipulatives, etc.) to represent phenomena.	1	5	4	0	0	2.7
Students made predictions, estimates and/or hypotheses and devised means for testing them.	3	5	2	0	0	3.1
Students were actively engaged in thought-provoking activities that often involved the critical assessment of procedures.	2	5	3	0	0	2.9
Students were reflective about their learning.	3	4	3	0	0	3
Intellectual rigor, constructive criticism, and the challenging of ideas were valued.	2	5	3	0	0	2.9

Note. 10 observations

The most observed characteristics in terms of propositional knowledge occurring in the ST 3 class include a solid grasp of the concept, which involves knowledge of the fundamental concepts of the subject, and coherence of concept understanding. These characteristics consequently provided a means for ST3 to show his/her capabilities in using abstraction where students are able to connect lessons with other concepts and real life situations. Accordingly, ST3's propositional knowledge provides students with new learning. ST3 stated, *"Generally we can say that there is learning when the students can apply what they learn in daily life situations, while inside the classroom there are many types of assessment to know if they learn."* However, ST3 suggested, *"mastery of the lesson should be improved because we cannot teach what we don't know. For example, I am a physics major and quite having some difficulties in teaching deeper concepts in biology."* Hence, improvement in content pedagogical knowledge should also be done by teachers.

Additionally, the most observed characteristics of ST3 in terms of procedural knowledge are: allowing students to make predictions, estimates and/or hypotheses and devise means for testing them, encouraging reflective learning, valuing Intellectual constructive criticism, and challenging ideas, and engagement in thought provoking activities. However, observed occurrences of students using a variety of means such as models, drawings and graphs to represent phenomena ranked lowest which may be attributed to some factors such as time constraints as mentioned in the forgoing discussion.

Received Curriculum

Table 16 shows the mastery level of ST3's students based on the final examination test results and the students' grades.

Students' Achievement

Table 16

Test Results and Grades of ST3 Class

Score percentage	No. of students	Percentage of students	Interpretation
Final examination results			
0-49%	5	10.00%	Non-Mastery
50-74%	38	76.00%	Nearing Mastery
75-100%	7	14.00%	Mastery
Total No. of Students	50		
Grades			
65-74%	3	6.00%	Failed
75-100%	47	94.00%	Passed
Total No. of Students	50		

Note. Data from the first quarter of the first semester.

Table 16 shows that there are 47 (94%) students who attained a passing mark compared to the very low number of students who attained a failing mark. The percentage of passing students is 94 % which is high. The five students who failed are classified under non-mastery level. This is almost equal to the number of failed students. Student achievement in terms of grades and test results can be associated with the effective teaching strategies the teacher used (Dotson, 2001), ST3 stated during the last observation, *"the strategies I used were effective because* *so far their test answers were correct".* Table 17 shows the consolidated responses on students' motivation towards learning science of ST3 class.

Students Motivation towards Learning Science

Table 17

Students Motivation towards Science Learning of ST3 Class

Items	Frequency of response					Weighted average
	SA(5)	A(4)	U(3)	D(2)	SD(1)	
I am willing to participate in this science subject because the content is exciting and changeable.	12	28	3	0	0	4.21
I am willing to participate in this science subject because the teacher uses a variety of teaching methods.	15	23	5	0	0	4.23
I am willing to participate in this science subject because the teacher does not put a lot of pressure on me.	17	24	2	0	0	4.35
I am willing to participate in this science subject because the teacher pays attention to me.	15	25	3	0	0	4.28
I am willing to participate in this science subject because it is challenging.	15	25	3	0	0	4.28
I am willing to participate in this science subject because students are involved in discussions.	17	24	2	0	0	4.35
I am willing to participate in this science subject because I am motivated by the teacher.	9	32	2	0	0	4.16
I am willing to participate in this science subject because the learning activities are relevant to daily life situations.	11	30	2	0	0	4.21
Average						4.26

Note. 43 respondents

Most of the responses of the students about their willingness to participate point to the fact that ST3 involved them in the discussions without putting any pressure on them. This style may be attributed to ST3 lesson design that engages students as part of the learning community and the procedural knowledge of engaging students in thought-provoking activities. ST3 claimed, *"I don't want that I am the only one who speaks, I want to hear the voice of my students."* These characteristics of ST3 might also be associated with the students' high ratings for the following items: the teacher pays attention to them and the subject is challenging. These are the reasons why they are willing to participate. ST3 stated, *"I roam around the classroom during the activity to make sure that everyone is cooperating."* The students' high rating on their willingness to participate in their science class can further be associated with the teacher's use of a variety of methods, making the lessons exciting and challenging, and the application of the activities in real world situations. ST3 even claimed during the last observation, *"aside from (SINEMOTO) the activity and abstraction, application was also a high light of the lesson since the students were able to answer the last question".* The average mean is 4.26 which means that the willingness or motivation of the students in ST3 class is high

Alignment of the Intended, Enacted and Received Curriculum

Table 16

Alignment of the Intended, Enacted and Received Curriculum of ST3

Intended Curriculum	Enacted Curriculum	Received Curriculum
Content Standards	Structuring the Lesson and Mode of Delivery	Student Achievement
The learners demonstrate an understanding of: • The formation of the universe and the solar system • The subsystems that make up the Earth and the Earth's internal structure • The three main categories of rock and the origin and environment of common minerals and rocks • Geologic process on the surface of the Earth • Plate tectonics • Historical development of the concept of life, the origin of first life forms and unifying themes in the study of life • How photosynthetic organisms capture light energy to form sugar molecules	Lesson Design and Implementation: • Lesson was designed to engage students as members of a learning community • Lesson encouraged students to seek and value alternative modes of investigation or of problem solving • Lesson, student exploration preceded formal presentation • Good communicative interaction and student-teacher relationship Propositional and Procedural Knowledge: • Lesson promoted strongly coherent conceptual understanding. • Teacher had a solid grasp of the subject matter content inherent in the lesson • Lesson involved fundamental concepts of the subject • Students made predictions, estimates and/or hypotheses and devised means for testing them	Test Results from Teachers Mean Profile: • 5 students attained 0 to 49 percent correct answers on the first quarter examination which means that 10 percent are non-mastery students. • 38 students attained 50 to 74 percent correct answers on the first quarter examination which means that 76 percent are nearing mastery students. • 7 students attained 75 to 100 percent correct answers on the first quarter examination which means that 14percent are nearing-mastery students. Students First Quarter Grades: • 3 students received a grade ranging from 65 to 74 which is equivalent to the 6 percent of the students who failed in the first quarter of the first semester. • 47 students received a grade ranging from 75 to 100

	• Students were reflective about their learning . Observed strategies: • Lecture and Discussion • Role Playing • Use of Inquiry Approach • Group Dynamics • Group Activities and Collaborative Learning • Use of power point presentations with the aid of computer and television • Use of different assessment methods	which is equivalent to the 94 percent of students who passed in the first quarter of the first semester. Main Reasons why students are motivated to learn science: • The students are involved in discussions. • The teacher does not put a lot of pressure on them. • The teacher pays attention to them. • The science subject is challenging. • The teacher uses a variety of teaching methods.

The content standards found in ST3 lesson plans were relevant and based on the content and standards prescribed by the Department of Education. These content standards were properly transitioned in her lesson plan because of his solid grasp of the subject matter. This characteristic enabled ST3 to adapt to the lessons embedded in the senior high school science curriculum. ST3 stated, "*The level of the senior high school science curriculum is deeper and the concepts STEM e more complex and there were many topics in the junior high school curriculum that were not explained well because the topics were limited to certain objectives. These topics and concepts are now included in the senior high school curriculum and it's our task to deliver them to our students with the best of our knowledge and abilities."* Furthermore, ST3's solid grasp of the subject matter is also shown in his ability to design the lessons in such a way that it would involve fundamental concepts, and ensure strongly coherent student conceptual understanding with respect to the students' prior knowledge. Accordingly, lesson design that involves students in the discussion utilize the inquiry approach which also considers the students' prior knowledge.

Furthermore, as gleaned from Table 16, ST3 designed and implemented her lesson in such a way that the students were engaged as part of the learning community, exploration was promoted, the students' devised means to test hypothesis, and give constructive criticisms. These characteristics were reflected in her use of different strategies such as collaborative learning, group activities, role playing, technology integration and performance based assessment. These strategies are highly appreciated by the students as it is seen in the table that they are motivated and willing to learn science because the teacher uses a variety of teaching methods. Moreover, these strategies which reflects constructivism further involve the students and challenge them to create a positive learning environment that would influence their willingness to participate and enhance their science achievement and mastery level. Dotson (2001) stated that constructivist learning environment could enhance students' achievement.

ST3 enacted curriculum resulted to the congruent alignment of the intended and received curriculum. This is proven by the fact that majority of the students who nearing mastery and mastery levels, and majority of the students received a passing grade during the first quarter of first semester.

Synthesis of the Alignment of the three STEM Teachers Intended, Enacted and Received Curriculum

The progression of the intended curriculum allows the learners to demonstrate scientific inquiry skills, understand and apply scientific knowledge, and develop and demonstrate scientific values and attitudes as seen in the content and the content standards from one grade level to another hence, reflecting the core objectives of the K to 12 science curriculum. Additionally, the intended K to 12 science curriculum competencies can be delivered using various pedagogical approaches, unlike in the previous curriculum that featured more teacher-centered activities, and the use of lecture and discussion approaches, and pen and paper evaluation. These were mentioned by one of the senior high school science teachers, who said, *"The curriculum now is more on collaboration and integration of subjects, and most competencies are high-level and lessons are tasks-oriented" (STEM Teacher 2),* hence, operationalizing what the K to 12 science curriculum envisions. In fact, the science teachers in senior high school appreciate the framework of the new science curriculum and believe that it will produce individuals who are equipped with knowledge to compete in a knowledge-based society.

ST2 frequently designed lessons for more enjoyable communicative interaction and positive student-teacher relationship. This characteristic of ST 2 is different from ST 1 but they both lead their lessons to a good communicative interaction and student-teacher relationship. ST 2 even claimed, "*I used learning-by-doing, collaborative strategy and discovery approach".* Hence his/her observed characteristic, of letting the students explore while engaging them as part of the learning community might be attributed to his/her teaching strategies.

Just like ST1, ST2 also promotes a student-centered classroom as seen in Table 15. Their difference is that ST2 uses the discovery approach and performance-based assessment. However, these teaching strategies and assessment practices still fall on the constructivist framework, just like in the case of ST1. This enacted curriculum wherein constructivist environment occurs can be divided into three major parts, namely; enacted curriculum for content, enacted curriculum for practices and enacted curriculum for assessment. Classroom activities that reflect constructivism can be identified from the teachers' curricular, instructional, and assessment practices (Paek, Braun, Trapani, Ponte, & Powers, 2005).

This is reflected in the ratings given for the scale item which states that the lesson was designed to engage students as members of a learning community. Engaging students' active participation with patience results to good student-teacher relationship and creates a more positive learning environment. ST2 even stated, "*I am patient and always try to involve the students in activities and* *discussion."* These characteristics of ST2 might also be the reason why his/her students' passing percentage and nearing/mastery and mastery level percentages are a little higher compared with ST1. The difference is in the use of discovery approach by ST2. This strategy allows the students to explore even before the lesson is formally presented to them, and this encourages them to formulate their hypothesis and devise their own means of testing the concepts of the lessons. These characteristics further engage the students as members of the learning community. The students' feelings that they are members of the learning community means that the teacher pays attention to them by involving them in activities and discussions. ST2 doesn't put any pressure on them, creating a positive learning environment. Utilizing rubrics in performance-based assessment and evaluation gives the students awareness of their performance which results to better achievement.

Similar with ST2, the most observed characteristics in terms of propositional knowledge occurring in the ST 3 class include a solid grasp of the concept, which involves knowledge of the fundamental concepts of the subject, and coherence of concept understanding. These characteristics consequently provided a means for ST3 to show his/her capabilities in using abstraction where students are able to connect lessons with other concepts and real life situations. Accordingly, ST3's propositional knowledge provides students with new learning

Role playing is the distinctive teaching strategy used by ST3, which is evidenced by the high frequency of occurrence of the lessons that engage students as members of a learning community. Similarly, ST3 integrates technology in his/her lessons and uses different assessment methods.

STEM Teachers Efficacy Beliefs

STEM Teacher 1 (ST1)

Personal Teaching Efficacy Beliefs

Table 19

Personal Teaching Efficacy Beliefs of ST1

Items	Score	Level of agreement
2. I will continually find better ways to teach science.	2(4)*	Agree
3. Even when I try very hard, I don’t teach science as well as I do most subjects.	5	Strongly Disagree
5. I know the steps necessary to teach science concepts effectively.	2(4)*	Agree
6. I am not very effective in monitoring science experiments.	2	Agree
8. I generally teach science ineffectively.	4	Disagree
12. I understand science concepts well enough to be effective in teaching it.	3	Uncertain
17. I find it difficult to explain why science experiments work to my students.	4	Disagree
18. I am typically able to answer students' science questions.	3	Uncertain
19. I am curious if I have the necessary skills to teach science.	4	Disagree
21. Given a choice, I will not invite the principal to evaluate my science teaching.	4	Disagree
22. When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand it better.	4	Disagree
23. When teaching science, I will usually welcome student questions.	2(4)*	Agree

24. I do not know what to do to turn students on to science.	3	Uncertain
Average	3.69	Agree

Note. Some items have reverse scoring. They are enclosed in parenthesis to achieve consistency in scoring.

Based on Table 19, ST1 believes that he teaches science better than he does other subjects which means that the teacher is confident in teaching science. Teachers that possess a strong sense of efficacy tend to be more open to new ideas, show more willingness to experiment with new methods and also exhibit greater levels of planning and organization (Woolfolk 2005). ST1 perceives that he knows the necessary steps to teach science. ST 1 knows that he/she is an effective science teacher and will continue to find better ways to teach science to attain the next highest rating (strongly agree level). Furthermore, ST1 believes that he/she is able to explain how science experiment works, guide students when they find difficulty in understanding science concepts and welcome students' questions. These items fall in the agreeing level which gives ST1 the confidence in inviting the principal to evaluate his/her science teaching. These beliefs of teachers influence the general teaching efficacy, which is the belief that teaching, as a profession, can impact the learning of all students regardless of background which is also known as outcome expectancy beliefs (Tschannen-Moran & Woolfolk 2001). The average weighted mean of 3.69 reflects a high level of personal efficacy beliefs of ST1.

Outcome Expectancy Beliefs

Table 20

Outcome Expectancy Beliefs of ST1

Items	Score	Level of agreement
1. When a student does better than usual in science, it is often because the teacher exerted extra effort.	2(4)*	Agree
4. When students' grades in science improve, it is often due to their teacher having found a more effective teaching approach.	2(4)*	Agree
7. If students are underachieving in science, it is most likely due to ineffective science teaching.	4(2)*	Disagree
9. The inadequacy of a student's science background can be overcome by good teaching.	4(2)*	Disagree
10. The low science achievement of some students cannot generally be blamed to their teachers.	2	Agree
11. When a low-achieving child progresses in science, it is usually due to the extra attention given by the teacher.	4	Agree
13. Enhanced effort in science teaching produces little change in some students' science achievement.	4	Disagree
14. The teacher is generally responsible for the achievement of students in science.	2(4)*	Agree
15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	2(4)*	Agree
16. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.	2(4)*	Agree
20. Effectiveness in science teaching has a little influence on the achievement of students.	4	Disagree
25. Even teachers with good science teaching abilities cannot help some kids learn science.	4	Disagree

Average	3.83	Agree

Note. Some items have reverse scoring. They are enclosed in parenthesis to achieve consistency in scoring.

As gleaned in Table 20, items 1, 10, 13, 15, and 16, are the most frequently observed beliefs of ST1. ST1 believes that the teacher's effort and strategies may bring about student learning which may also be further enhanced with parents' commitment and engagement. However, she also considers that low student achievement may be due to factors other than the teacher. Excellent instructional strategies and knowledge of the subject matter lead to effective science teaching and have an important role in the outlook of efficacy (Usher & Pajares, 2006). Studies have found strong correlations between teacher efficacy and student achievement in the classroom (Woolfolk, 2005). Some studies found out that when teachers feel that they could produce the desired outcomes, their students produce positive achievements (Czubaj, 1996), that student achievement in science is a function of teacher characteristics (Guerrero, 2005), that level of self-efficacy has an effect on students' achievement in math (White, 2009), and that teacher efficacy has an impact on students' achievement and motivation towards learning (Mojavezi & Tamiz, 2012). The average weighted mean of 3.87 reflects a high level of outcome expectancy beliefs of ST1.

STEM Teacher 2 (ST2)

Personal Teaching Efficacy Beliefs

Table 21

Personal Teaching Efficacy Beliefs of ST2

Items	Score	Level of agreement
2. I will continually find better ways to teach science.	1 (5)*	Strongly Agree
3. Even when I try very hard, I don't teach science as well as I do most subjects.	5	Strongly Disagree
5. I know the steps necessary to teach science concepts effectively.	1 (5)*	Strongly Agree
6. I am not very effective in monitoring science experiments.	5	Strongly Disagree
8. I generally teach science ineffectively.	5	Strongly Disagree
12. I understand science concepts well enough to be effective in teaching it.	1 (5)*	Strongly Agree
17. I find it difficult to explain why science experiments work to my students.	4	Disagree
18. I am typically able to answer students' science questions.	1 (5)*	Strongly Agree
19. I am curious if I have the necessary skills to teach science.	3	Uncertain
21. Given a choice, I will not invite the principal to evaluate my science teaching.	5	Strongly Disagree
22. When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand it better.	5	Strongly Disagree
23. When teaching science, I will usually welcome student questions.	1 (5)*	Strongly Agree
24. I do not know what to do to turn students on to science.	5	Strongly Disagree
Average	4.85	Strongly Agree

Note. Some items have reverse scoring. They are enclosed in parenthesis to achieve consistency in scoring.

Based on Table 21, the domains that are related to quality science teaching and the attainment of high ratings by ST2 include her belief that she will continually find better ways to teach science, which got high rating and it reflects the teacher's strong sense of efficacy. Consequently, based on the forgoing discussion, teachers with a strong sense of efficacy are confident and are more open to new ideas and are more willing to experiment with new methods to better meet the needs of their students (Woolfolk, 2005). These characteristics of ST2 gives her confidence in inviting the principal to evaluate his/her science teaching, to monitor his/her students' experiments and to answer their questions, to better engage the students in science activities and to guide students having difficulties in understanding science concepts. These characteristics also influence the teachers' outcome expectancy beliefs. In Table 20, ST2 strongly agrees that student achievement in science and improvement of grades are influenced by the teachers' effectiveness in teaching. This implies that the teacher's effectiveness in teaching is directly related with student achievement and improvement of grades in science. The average weighted mean of 4.85 reflects an outstanding level of personal efficacy beliefs of ST2.

Outcome Expectancy Beliefs

Table 22

Outcome Expectancy Beliefs of ST2

Items	Score	Level of agreement
1. When a student does better than usual in science, it is often because the teacher exerted extra effort.	2 (4)*	Agree

4. When students' grades in science improve, it is often due to their teacher having found a more effective teaching approach.	1 (5)*	Strongly Agree
7. If students are underachieving in science, it is most likely due to ineffective science teaching.	4(2)*	Disagree
9. The inadequacy of a student's science background can be overcome by good teaching.	2 (5)*	Agree
10. The low science achievement of some students cannot generally be blamed to their teachers.	1	Strongly Agree
11. When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher.	1 (5)*	Strongly Agree
13. Enhanced effort in science teaching produces little change in some students' science achievement.	4	Disagree
14. The teacher is generally responsible for the achievement of students in science.	1 (5)*	Strongly Agree
15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	1 (5)*	Strongly Agree
16. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.	2 (4)*	Agree
20. Effectiveness in science teaching has a little influence on the achievement of students.	5	Strongly Disagree
25. Even teachers with good science teaching abilities cannot help some kids learn science.	5	Strongly Disagree
Average	4.17	Agree

Note. Some items have reverse scoring. They are enclosed in parenthesis to achieve consistency in scoring.

As seen in Table 22, ST2 strongly agrees that good science teaching can compensate for the students' inadequacy of science background and help them learn science. When a low-achieving child shows progress in science, it is usually due to the extra attention given by the teacher. ST2 also expresses her strong agreement to items that show beliefs that effective teaching improves students' science achievement and good science teaching can improve students' background in science. The average weighted mean of 4.17 reflects a high level of outcome expectancy beliefs of ST1.

STEM Teacher 3 (ST3)

Personal Teaching Efficacy Beliefs

Table 23

Personal Teaching Efficacy Beliefs of ST3

Items	Score	Level of agreement
2. I will continually find better ways to teach science.	1 (5)*	Strongly Agree
3. Even when I try very hard, I don't teach science as well as I do most subjects.	4	Disagree
5. I know the steps necessary to teach science concepts effectively.	2 (4)*	Agree
6. I am not very effective in monitoring science experiments.	4	Disagree
8. I generally teach science ineffectively.	4	Disagree
12. I understand science concepts well enough to be effective in teaching it.	2 (4)*	Agree
17. I find it difficult to explain why science experiments work to my students.	4	Disagree
18. I am typically able to answer students' science questions.	2 (4)*	Agree
19. I am curious if I have the necessary skills to teach science.	5	Strongly Disagree
21. Given a choice, I will not invite the principal to evaluate my science teaching.	5	Strongly Disagree
22. When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand it better.	5	Strongly Disagree

23. When teaching science, I will usually welcome student questions.	1 (5)*	Strongly Agree
24. I do not know what to do to turn students on to science.	5	Strongly Disagree
Average	4.46	Agree

Note. Some items have reverse scoring. They are enclosed in parenthesis to achieve consistency in scoring.

As observed in Table 29, responses of ST3 to items such as, I know the necessary skills to teach science effectively, I am very effective in monitoring science experiments, I understand science well enough to teach it and I generally teach science effectively, fall under the agreeing level only. These responses might be attributed to his/her strong agreement that he/she will continuously find better ways to teach science because she doubts that he/she has the necessary skills to teach science. As mentioned in the forgoing discussion, to increase the teachers' level of efficacy, they need to continuously improve their teaching skills (Aquino, 2000). Furthermore, ST3 strongly agrees that he/she knows how to engage students to learn science, that she welcomes students' questions and knows what to do when students cannot understand science concepts which give him/her confidence to invite the principal to evaluate his/her science teaching. Knowledge, background and mastery of the subject matter, teacher's above-average intelligence, and willingness to learn more by gathering new information with an analytical mind, are indicators of a teacher's personal efficacy (Aquino, 2000; Lardizabal 1997). The average weighted mean of 4.46 of ST3 reflect a high level of personal efficacy beliefs of ST3.

Outcome Expectancy Beliefs

Table 24

Outcome Expectancy Beliefs of ST3

Items	Score	Level of agreement
1. When a student does better than usual in science, it is often because the teacher exerted extra effort.	2 (4)*	Agree
4. When students' grades in science improve, it is often due to their teacher having found a more effective teaching approach.	1 (5)*	Strongly Agree
7. If students are underachieving in science, it is most likely due to ineffective science teaching.	2 (4)*	Agree
9. The inadequacy of a student's science background can be compensated by good teaching.	1 (5)*	Strongly Agree
10. The low science achievement of some students cannot generally be blamed on their teachers.	2	Agree
11. When a low-achieving student progresses in science, it is usually due to extra attention given by the teacher.	1 (5)*	Strongly Agree
13. Enhanced effort in science teaching produces little change in some students' science achievement.	4	Disagree
14. The teacher is generally responsible for the achievement of students in science.	3	Uncertain
15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	3	Uncertain
16. If parents comment that their child is showing more interest in science in school, it is probably due to the performance of the child's teacher.	2 (4)*	Agree
20. Effectiveness in science teaching has a little influence on the achievement of students.	4	Disagree
25. Even teachers with good science teaching abilities cannot help some kids learn science.	1	Strongly Agree
Average	3.67	Agree

Note. Some items have reverse scoring. They are enclosed in parenthesis to achieve consistency in scoring.

Based on Table 30, particularly in items 4, 9, 11, 25, the teacher shows strong agreement in terms of improvement in the students' grades. It is due to the teacher having found a more effective teaching approach which could also be associated with their strong belief that the inadequacy of a student's science background can be compensated by good teaching. This belief can be attributed to their personal teaching efficacy beliefs that they will continue to find better ways to teach science. Furthermore, the teacher believes that when a low-achieving child progresses in science, it is usually due to the extra attention given by the teacher. This is very much aligned with the students' high level of participation in science activities. As mentioned in the foregoing discussions, students' motivation towards learning (Mojavezi & Tamiz, 2012; Ashton 1996), classroom performance (Santos, 2003) and learning satisfaction (Pan, 2012) can be influenced and are positively related with teaching efficacy. The average weighted mean of 3.67 of ST3 reflect a high level of outcome expectancy beliefs.

Synthesis of the Efficacy Beliefs of the Three STEM Teachers

It can be gleaned from table 19 that ST1's level of personal teaching efficacy beliefs is high. She believes that she knows the necessary steps to teach science, knows how to monitor science experiments, welcomes students' questions and teaches science well and effectively. However, she was uncertain if she understands science concepts well but is typically able to answer students' science questions. These uncertainties can be attributed to the fact that she is a physical science major while science subjects in the senior high school are composed of physical and biological sciences. ST1 even stated, *"I had difficulties in teaching deep biology related subjects that is why I try to find time to study and research."*

ST2 personal teaching efficacy beliefs are outstanding based from the results in table 21 ST2 believes that she knows the necessary steps in teaching science and understands science concepts well to be able to teach effectively. She is only uncertain if she has enough skills in teaching science. This uncertainty can be attributed to the fact that there are different strands and tracks in the senior high school. Earth and life science, and physical science are two core subjects for the different strands and tracks in the senior high school. These different strands and tracks are composed of different groups of learners who learn in different ways. The teachers' skills in structuring the lesson in such a way that students will receive the content is very much important. According to ST2, *"changes in the strategies were done because of the different strands, for example, students in the GAS strand do more activities since they were able to explain the lesson while in SMAW , it is more on discussion on how to apply the concepts."*

The level of personal teaching efficacy beliefs of ST3 is high as can be seen in table 23. Her beliefs that she understands science concepts well enough, knows the necessary steps in teaching science and possess skills to teach science make her believe that she teaches science well and effective. These beliefs further transpire as she also believes that she can monitor science experiments and answer students' questions about science concepts and experiments. ST3 even stated, *"I feel confident in teaching when I know the lesson".* The teachers' confidence in teaching a certain subject refers to personal teaching efficacy. Personal teaching efficacy is the belief of an individual teacher that he or she has the ability to reach all students (Tschannen-Moran & Woolfolk, 2000).

Outcome expectancy belief refers to the level to which an individual believes that learning of students in a certain subject can be influenced by teachers' actions (Wyatt, 2010). The level of outcome expectancy beliefs of ST1 is as high as the level of her personal teaching efficacy beliefs based from the results shown in Table 20. She believes that extra attention, enhanced effort in teaching and improved strategies could lead to students doing better in science, and increases their achievement. Furthermore, she also believes that good and effective science teaching could enhance students' achievement. However, ST1 agrees that the low science achievement of some students cannot generally be blamed to their teachers but could be attributed to other factors that might influence students learning. ST2 supports this attribution as she strongly agrees that low science achievement of some students cannot generally be blamed to their teachers. Conversely, ST2 strongly agrees that students' improvement in science achievement is due to teachers' practices and effectiveness. She strongly believes that students' achievement in science is directly related to their teacher's effectiveness in science teaching. ST3 strongly believes that low-achieving students can progress by giving them extra attention. Inadequacy of students' background in science can be compensated by good teaching and students' grades in science can improve because of the teacher finding better ways to teach science. These beliefs are evidences that ST3 has a high level of outcome expectancy beliefs. However, she is uncertain that students' achievement in science is directly related to teacher's effectiveness in teaching and agrees that the low science achievement of some students cannot generally be blamed on their teachers. It seems that for ST3, students' underachievement and low performance is not because of teachers' performance but can be overcome by effective teaching, and extra effort and attention from teachers.

The personal teaching efficacy beliefs of the three STEM teachers lead to their belief that their content and pedagogical knowledge could bring about positive effect in the teaching and learning process while their outcome expectancy beliefs make them believe that their content and pedagogical knowledge are effective enough to increase students' achievement.

Teachers Efficacy Beliefs and the Alignment of the Intended, Enacted and Received Curriculum

From the aforementioned discussions, efficacy beliefs, both personal teaching efficacy beliefs and outcome expectancy beliefs play a significant role in the lesson design and implementation of procedures of the teacher, which also affects students' achievement and its consistency with the intended curriculum. Table 25 shows the efficacy beliefs of ST1 and the alignment of the intended, enacted and received curriculum.

STEM Teacher 1 (ST1)

Table 25

Efficacy Beliefs and the Alignment of the Intended, Enacted and Received Curriculum of ST1

Intended Curriculum	Personal Teaching Efficacy Beliefs	Enacted Curriculum	Outcome Expectancy Beliefs	Received Curriculum
Content standards	The teacher believes that:	Structuring the lesson and mode of delivery	The teacher believes that:	Student achievement
The learners demonstrate an understanding of: • The formation of the universe and the solar system • The subsystems • The origin and	• She knows the necessary steps to teach science. • She knows how to monitor science	Lesson design and implementation: • Consideration for students' prior knowledge and preconceptions. • Efforts in engaging the students as members	• Extra attention given to students and extra effort given by teachers could increase students'	Test results from the teachers mean profile: • 7 students attained 0 to 49 percent correct answers on the

environment of common minerals and rocks • The folding and faulting of rocks • How photosynthetic organisms capture light energy to form sugar molecules	experiments. • Teaches science well and effectively • Continues to find better ways to teach science. • Welcomes students' questions.	of the learning community. • Letting the ideas originating from the students to direct the lesson. • Good communicative interaction and relationship. Propositional and procedural knowledge: • Ability to provide lessons that promote strongly coherent conceptual understanding. • Solid grasp of the subject matter content inherent in the lesson. • Providing students with fundame	achievement and to do better in science. • Good science teaching can improve science background of students. • Effective teaching can enhance students' achievement. • Teacher are responsible for students' achievement.	first quarter examination which means that 20 percent are non-mastery students. • 18 students attained 50 to 74 percent correct answers on the first quarter examination which means that 51.43 percent are nearing mastery students. • 10 students attained 75 to

	ntal concepts of the lesson and allowing them to use elements of abstraction and connecting the lesson with other disciplines and real world phenomena. • Students were actively engaged in thought-provoking activities that often involved the critical assessment of procedures. • Students made predictions, estimations and/or hypotheses and devised		100 percent correct answers on the first quarter examination which means that 28.57 percent are nearing-mastery students. Students first quarter grades: • 7 students received a grade ranging from 65 to 74 which is equivalent to the 20 percent of the students who failed in the first

	means for testing them. Observed strategies: • Lecture and Discussion • Use of Inquiry Approach • Group Dynamics • Group Activities and Collaborative Learning • Use of power point presentations with the aid of computer and television • Use of different assessment methods	quarter of the first semester. • 28 students received a grade ranging from 75 to 100 which is equivalent to the 80 percent of students who passed in the first quarter of the first semester. Main reasons why students were motivated to learn science: • The science subject is challenging. • The content of the subject is

	exciting and changeable. • Students are involved in discussions. • The learning activities are relevant to daily life situations.

As gleaned from Table 25, ST1 shows a high level of efficacy beliefs (personal teaching and outcome expectancy beliefs) and also exhibits good alignment of the intended curriculum (content standard, lesson plan), enacted curriculum (lesson delivery) and enacted curriculum (student achievement and motivation). Congruent transitioning of the intended curriculum from the content standards to the teachers' lesson objectives and design may be brought about by what the teacher believes that she knows the necessary steps in teaching science. The belief of successfully accomplishing a certain objective for a particular lesson through a person's ability to plan and implement sequences of activities is known as teacher efficacy (Tschannen-Moran & Woolfolk, 2001), which may also affect classroom management (Hicks, 2012). Teachers who prepare the lesson well have a higher sense of efficacy (Pajares, 2006). Moreover, as the teaching-learning process progresses, the teacher believes that she becomes more efficient when she delivers the intended curriculum using different strategies and assessment methods while integrating technology. In effect, a solid grasp of the subject matter, which promote strongly coherent conceptual understanding was observed in the lesson delivery of ST1. This motivated his students to engage in different activities which enabled them to formulate new concepts using their prior knowledge. This also further improved the students' answers to questions and explanations to experiments. This also guide students with difficulties. Hence, an environment where students' willingness to participate due to the excitement, challenge and relevance of activities done is developed through the teachers' belief that student achievement is due to teachers' performance, effort, and effective science teaching. Consequently, high passing percentage, high nearing mastery, and mastery percentages for ST1 students were obtained.

Below is a section of ST1 lesson last July 11, 2017 which shows teachers efficacy beliefs and her lesson design and implementation.

Table 26

Role of efficacy Beliefs on the Lesson Design and Implementation of ST1

Efficacy Beliefs	Teacher Delivery	Students Response
• She knows the necessary steps to	• She started the lesson by reviewing the previous lesson and asking: What are the layers of the	• Majority of the students raised their hands and the students who were called were able to

teach science.	Earth? Kindy describe one. • She presented the new lesson by doing a board activity. The activity required a representative from each group to recall and write as many properties of salt as he/she can.	answer and describe a layer. • Each representative of the group enjoyed and actively participated. The members who were not involved in writing on the board cheered for their members.

Her lesson objectives for the day are for the students to be able to identify the common rock forming minerals according to their physical and chemical properties and classify rocks. Her beliefs that she knows the necessary steps to teach science transpired as she designed her lesson that reviewed a previous topic related to the objective for the day, which is also a sign of consideration for the students' prior knowledge. This lesson design was operationalized in her implementation when she asked the review questions and majority of the students raised their hands. Those who were called were able to answer proving that they are willing to participate in ST1's class because they were involved in the discussion. Further consideration of the students' prior knowledge and the use of inquiry was observed as she presented the lesson that engages students as part of the learning community, further involving the students, which in turn motivated them. As the lesson progressed her beliefs that she teaches science well and effectively was observed when she continued her lesson last July 11, 2017. This lesson about classification of rocks based on mineral content utilized collaborative learning and group activity as seen in Table 27.

Table 27

Role of efficacy Beliefs on Propositional and Procedural Knowledge of ST1

Efficacy Beliefs	Teacher Delivery	Students Response
• She teaches science well and effectively • Extra attention given to students and extra effort given by teachers could increase students' achievement and motivate them to do better in science.	• She used collaborative learning and group activity. Each group was given rocks and they classified the rock into igneous, sedimentary or metamorphic based on the minerals present.	• Members of each group actively participated and majority was able to get the correct classifications. • Each group devised different ways of presenting their classifications. Some used process presentation while others used tabular presentation.

Her belief that she teaches science well was actualized during the student group activity and presentation of results. The students were actively engaged in the activity while critically assessing their procedure. This assessment was observed when the students presented the results of their activity in different ways. This use of different presentations is also a sign that the students were able to use elements of abstraction (process presentation, tabular presentation). Furthermore, members of each group were actively participating and it can be inferred that the activity given by ST1 were exciting and challenging. The result of the activity showed that majority of the students was able to properly classify the rocks which actualized her belief that she is effective in teaching science. Providing her students with such activity showed her effort in teaching science and this manifested her belief that extra effort given by teachers could lead to students' better achievement.

STEM Teacher 2 (ST2)

Table 28 shows the efficacy beliefs of ST1 and the alignment of the intended, enacted and received curriculum.

Table 28

Efficacy Beliefs and the Alignment of the Intended, Enacted and Received Curriculum of ST2

Intended Curriculum	Personal Teaching Efficacy Beliefs	Enacted Curriculum	Outcome Expectancy Beliefs	Received Curriculum
Content standards	The teacher believes that:	Structuring the lesson and mode of delivery	The teacher believes that:	Student achievement
The learners demonstrate an understanding of: • The subsystem that make up the Earth and the Earth's internal structure • The origin and environment of common minerals and rocks • Geologic process on the surface	• She knows the necessary steps to teach science. • She knows how to monitor science experiments. • Teaches science well and effectively. • Continues to find better ways to teach science. • Welcomes	Lesson design and implementation: • Letting the students explore while engaging them as part of the learning community. • Encouraging students to seek and value alternative modes of investigation or of problem solving, • Designing lessons that are directed by ideas originati	• Extra attention given to students and extra effort given by teachers could increase students' achievement and motivate them to do better in science. • Good science teaching can improve science backgro	Test Results from the teachers mean profile: • 6 students attained 0 to 49 percent correct answers on the first quarter examination which means that 12.24 percent are non-mastery students. • 29 students

of the Earth • Plate tectonics • History of the Earth • The cell as the basic unit of life • How genes work	students' question. • Can answer students question and explain why science experiments work.	ng from the students, and sensitivity to students' prior knowledge • Good communicative interaction and relationship. Propositional and procedural knowledge: • Solid grasp of the subject matter. • Lessons involved fundamental concepts and promoted strongly coherent conceptual understanding. • The teacher values intellectual rigor, constructive criticism, and the challengi	und of students. • Effective teaching can enhance students' achievement. • Teachers are responsible for students' achievement. • Teachers with good science teaching can help students to learn.	attained 50 to 74 percent correct answers on the first quarter examination which means that 59.18 percent are nearing mastery students. • 14 students attained 75 to 100 percent correct answers on the first quarter examination which means that 28.57 percent are nearing-mastery

	ng of ideas. • Students made predictions, estimates and/or hypotheses and devised means for testing them. • Students were allowed to reflect about their learning. • Students used a variety of means (models, drawings, graphs, symbols, concrete materials, manipulatives, etc.) to represent phenomena. Observed strategies: • Lecture and Discussion • Discovery approach		students. Students first quarter grades: • 6 students received a grade ranging from 65 to 74 which is equivalent to 12.24 percent of the students who failed in the first quarter of the first semester. • 43 students received a grade ranging from 75 to 100 which is equivalent to the 87.76 percent

	• Use of Inquiry Approach • Group Dynamics • Group Activities and Collaborative Learning • Use of power point presentations with the aid of computer and television • Use of different assessment methods (rubric-based)	of students who passed in the first quarter of the first semester. Main reasons why students were motivated to learn science: • The teacher pays attention to them. • The science subject because it is challenging. • The learning activities are relevant to daily life situations. • The content is exciting and changeable. • The teacher

	does not put a lot of pressure on them.

Table 28 shows ST2's efficacy beliefs and the alignment of the intended, enacted and received curriculum. During the transition of the intended curriculum to the teachers' daily lesson plan, the personal teaching efficacy of ST2 transpired as she designed her lesson in such a way that it allows the students to explore and discover. Furthermore, the outcome expectancy beliefs of ST2, such as paying attention to students without putting any pressure on them created a positive learning environment for the students resulting to their willingness to participate. Hence, the extent and quality of participation of the students in a science class is highly influenced by the teachers' attitude towards the students. Greater efficacy enables teachers to be less critical of students when they make errors (Ashton, 1996; Pajares 2005), and to work longer with a student who is struggling (Pajares, 2005). Moreover, willingness of students to participate in the science class arises when the teacher motivates the students and uses a variety of teaching methods. Teachers with a higher sense of efficacy exhibit greater enthusiasm for teaching, which leads to the use of different strategies that could motivate the students (Pajares, 2006). Teaching enthusiasm is observed in the modern classroom whenever the teacher directs the learning process very well (Joseph, 2010). Therefore, both strategies and classroom management are affected and influenced by the teachers' efficacy that is why an understanding of efficacy beliefs is important to be able to improve the teaching-learning process.

Accordingly, student motivation towards learning (Mojavezi & Tamiz, 2012; Ashton 1996), classroom performance (Santos, 2003) and learning satisfaction (Pan, 2012) can be influenced by and is positively related with teaching efficacy. It is important to engage the students to learn more, thus teachers must possess high level of efficacy beliefs in order to achieve the desired goals in student learning specially among those students who are having difficulties and unmotivated (Bandura, 1997).

Below is a section of ST2 lesson last June 28, 2017 which shows the role of efficacy beliefs on her lesson design and implementation:

Table 29

Role of efficacy Beliefs on the Lesson Design and Implementation of ST2

Efficacy Beliefs	Teacher Delivery	Students Response
• She knows the necessary steps to teach science.	• She started with a review by asking: What are the things found inside the Earth? • She did a motivation activity entitled check or cross. Using her laptop and the television she flashed some descriptions of the Earth's interior and each group did a cross action if the description was wrong and check action if the description was right.	• Majority of the students raised their hands and the students who were called were able to answer and describe a layer. • Members of each group actively participated and enjoyed the activity.

ST2 belief that she knows the necessary steps to teach science transpired in the way she designed her lesson that considered the students' prior knowledge. She believes that identifying the level of students' knowledge is the initial step in teaching. Her review questions solicited information from the students that was used as basis for her lesson that day. Furthermore, when the students raised their hands to answer, it proved that majority of the students were willing to participate and learn from her science class. After the review, she used a motivation activity which further shows her belief to get students' attention and further increase their participation. This process strengthened her belief that she knows the necessary steps in teaching science. The activity was interesting and exciting to the students since it involved selfie poses like crossing both arms and hand in front of the head (which means cross or wrong) or pointing both hands and arms on one side while bowing (which means check). This activity proved that the students were motivated and were willing to learn science from ST2's class because the subject is exciting. In her lesson design, she also used technology when she flashed the questions for the motivation and as the lesson progressed. Her belief that she welcomes and is able to answer students' questions transpired. Table 30 shows a section of ST2's lesson which showcases her characteristics in terms of propositional and procedural knowledge and her efficacy beliefs.

Table 30

Role of efficacy Beliefs on Propositional and Procedural Knowledge of ST2

Efficacy Beliefs	Teacher Delivery	Students Response
• Welcomes students' question. Can answer students' question.	• During the discussion of the results of the activity a student raised her hand to ask a question. The teacher did not ignore the student but entertained his question. • The teacher said that it is because of the earth's pressure and explained further the reason for her answer.	• The student asked a question: Why does the inner core have a solid property if it's very hot? It should melt and turn to liquid ma'am right? • After the teacher answered the question, the students smiled and looked satisfied with the answer.

When one of her students asked a question, ST2 entertained the question. She did not ignore the question because she believes that she can provide an appropriate response to the question of the students. This belief showed that her procedural knowledge of having a solid grasp of the subject matter holds true. This attention given by the teacher to the students also boosts the students' motivation and willingness to learn. Thus, this proved that students are willing to participate in ST3 science class because the teacher pays attention to them. Furthermore, ST2 was able to give the correct answer to the student and explained it well which shows that her belief increased her propositional knowledge of having a solid grasp of the subject matter and content.

STEM Teacher 3 (ST3)

Table 31 shows the efficacy beliefs of ST1 and the alignment of the intended, enacted and received curriculum.

Table 31

Efficacy Beliefs and the Alignment of the Intended, Enacted and Received Curriculum of ST3

Intended Curriculum	Personal Teaching Efficacy	Enacted Curriculum	Outcome Expectancy Beliefs	Received Curriculum
Content standards	The teacher believes that:	Structuring the lesson and mode of delivery	The teacher believes that:	Student achievement
The learners demonstrate an understanding of: • The formation of the universe and the solar system • The subsystem that make up the Earth and the Earth's internal structure • The three main categories of rock and the origin and environment of common minerals and rocks • Geologic process	• She welcome students questions and knows how to turn on students to science • She knows the necessary skills to teach science • She will continue to	Lesson design and implementation: • Lesson was designed to engage students as members of a learning community. • Lesson encouraged students to seek and value alternative modes of investigation or of problem solving. • Student exploration preceded formal presentati	• Finding a more effective teaching approach will improve students' grades. • Good science teaching could compensate inadequacy of science background of students. • Low-achieving	Test Results from the teachers mean profile: • 5 students attained 0 to 49 percent correct answers on the first quarter examination which means that 10 percent are non-mastery students. • 38 students attained 50 to

on the surface of the Earth • Plate tectonics • Historical development of the concept of life, the origin of first life forms and unifying themes in the study of life • How photosynthetic organisms capture light energy to form sugar molecules	find better ways to teach science	on of the lesson. • Good communicative interaction and relationship. Propositional and procedural knowledge: • Lesson promoted strongly coherent conceptual understanding. • Teacher had a solid grasp of the subject matter content inherent in the lesson. • Lesson involved fundamental concepts of the subject. • Students made predictions, estimates and/or hypotheses and devised means for	student progresses in science, due to extra attention given by the teacher.	74 percent correct answers on the first quarter examination which means that 76 percent are nearing mastery students. • 7 students attained 75 to 100 percent correct answers on the first quarter examination which means that 14percent are nearing-mastery students. Students first quarter grades: • 3 student

		testing them. • Students were reflective about their learning. . Observed strategies: • Lecture and Discussion • Role Playing • Use of Inquiry Approach • Group Dynamics • Group Activities and Collaborative Learning • Use of power point presentations with the aid of computer and television • Use of different assessment methods	s received a grade ranging from 65 to 74 which is equivalent to the 6 percent of the students who failed in the first quarter of the first semester. • 47 students received a grade ranging from 75 to 100 which is equivalent to the 94 percent of students who passed in the first quarter of the

	first semester.
	Main reasons why students were motivated to learn science: • The students are involve in discussions. • The teacher does not put a lot of pressure on me. • The teacher pays attention to me. • The science subject is challenging. • The teacher uses a variety of teaching methods.

Having the belief that he/she possesses knowledge of the necessary steps in teaching science (personal teaching efficacy) enabled ST3 to develop lessons that could provide students a general understanding of science concepts (intended curriculum). Furthermore, ST3 says that she continuously finds better ways to teach science that would motivate and engage students and would, in turn, also influence her lesson design. (Protheroe, 2008). Furthermore, ST3 believes that she teaches science well and effectively and this belief influences her strategies (lesson design) as he delivers the concepts (lesson implementation). This efficacy belief makes ST3 capable of establishing and performing sequences of action essential to complete a certain objective successfully (Tschannen-Moran & Woolfolk, 2001). ST3 also believes that extra effort and good science teaching influence students' performance. In effect, these beliefs influenced the students' interest to learn science concepts. They appreciate that the teacher pays attention to them, challenges them and shows them the relevance of the lesson. Moreover, ST3's beliefs also influenced the students' achievement as evidence by the high passing rate and mastery level. Strong correlation exists between teachers' efficacy beliefs and students' achievement (Woolfolk, 2005).

Below is a section of ST3 lesson about life science, which focuses on how organisms capture light energy to form sugar molecules last September 18, 2017 which shows teachers efficacy beliefs and her lesson design and implementation.

Table 32

Role of efficacy Beliefs on the Lesson Design and Implementation of ST3

Efficacy Beliefs	Teacher Delivery	Students Response
• She knows how to turn on students to science	• She made simulation activity about light and dark reaction. The activity used the concept of SINEMOTO which is a segment in the noon time show.	• The students who participated in the role play enjoyed the activity while learning the concepts and the audience students were entertained while learning.

ST3 believes that she knows how to motivate the students to learn science, which was observed in her lesson design, where she included an activity that utilized a segment from a noontime show watched by many people including her students. Her belief helped her develop different activities and use different teaching strategies that would capture students' interest. Furthermore, the activity proved her students' claims that they are motivated to learn science from ST3 class because she uses a variety of teaching methods. The activity was also designed to engage the students as part of the learning community creating a positive learning environment which removes the feeling of pressure from the students. As she continued her lesson, she utilized inquiry approach in the process of abstraction. Table 33 shows ST3 efficacy beliefs and her propositional and procedural knowledge.

Table 33

Role of efficacy Beliefs on Propositional and Procedural Knowledge of ST3

Efficacy Beliefs	Teacher Delivery	Students' Response
• She knows the necessary skills to teach science.	• Used inquiry in the process of abstraction	• Majority of the students participated and they were able to form a process map of the light dependent and light independent reactions.

The high efficacy belief of knowing the necessary skills to teach science was observed in ST3 when she used inquiry in the abstraction of her lesson. This belief transpired when she asked questions to the students and the students' answers gradually built a process model of the light dependent and independent reactions during the lesson abstraction. This belief supported the observed propositional knowledge of ST3 of having a solid grasp of the subject matter and involving coherent fundamental concepts in the lesson. Majority of the students were participating in building the process model, which confirms that the students were able to understand the lesson. Furthermore, the interaction of the teacher and student in building the model confirms the claims of the students that they are motivated to learn in ST3 class because they are involved in the discussion and the teachers pays attention to the students.

Synthesis of the Efficacy Beliefs of the Three STEM Teachers and their Role in the Alignment of the Intended, Enacted and Received Curriculum

ST1 efficacy belief that she knows the necessary steps in teaching science assisted her in developing lessons that considered students' prior knowledge. This created a learning environment which involves students in the discussion. During her implementation her efficacy beliefs further transpired as she showed a solid grasp of the subject matter. Her belief that effective science teaching increases students' achievement allowed her to use strategies that involves students in thought provoking activities which challenge the students, resulting to their willingness to learn in ST3 class.

ST2 designed lessons that gathered prerequisite knowledge and engaged the students as part of the learning environment because of her belief that she knows the necessary steps in teaching science. This belief was also manifested in her use of motivation activities that boost the interest of the student. Because of her belief that effective science teaching enhances students' performance, her propositional knowledge increases as she was able to answer students' questions and process their learning. The attention given by ST3 to the students' questions made them feel that the teacher pays attention to them and this further increased their willingness to learn.

ST3 was able to include in her lesson activities that students can relate with because of her belief that she has the skills to teach science. This belief was highly evident in the claims of the students that they are willing to participate and were motivated in ST3 science class because she uses a variety of teaching methods. Her belief further transpired when she used inquiry in the abstraction of her lesson and supported her observed propositional knowledge of having a solid grasp of the subject matter and involving coherent fundamental concepts in the lesson.

From the aforementioned STEM teacher efficacy beliefs and alignment within the intended, enacted and received curriculum, a conceptual model was developed. Figure 2 shows the efficacy beliefs and the alignment of I-E-R curriculum.

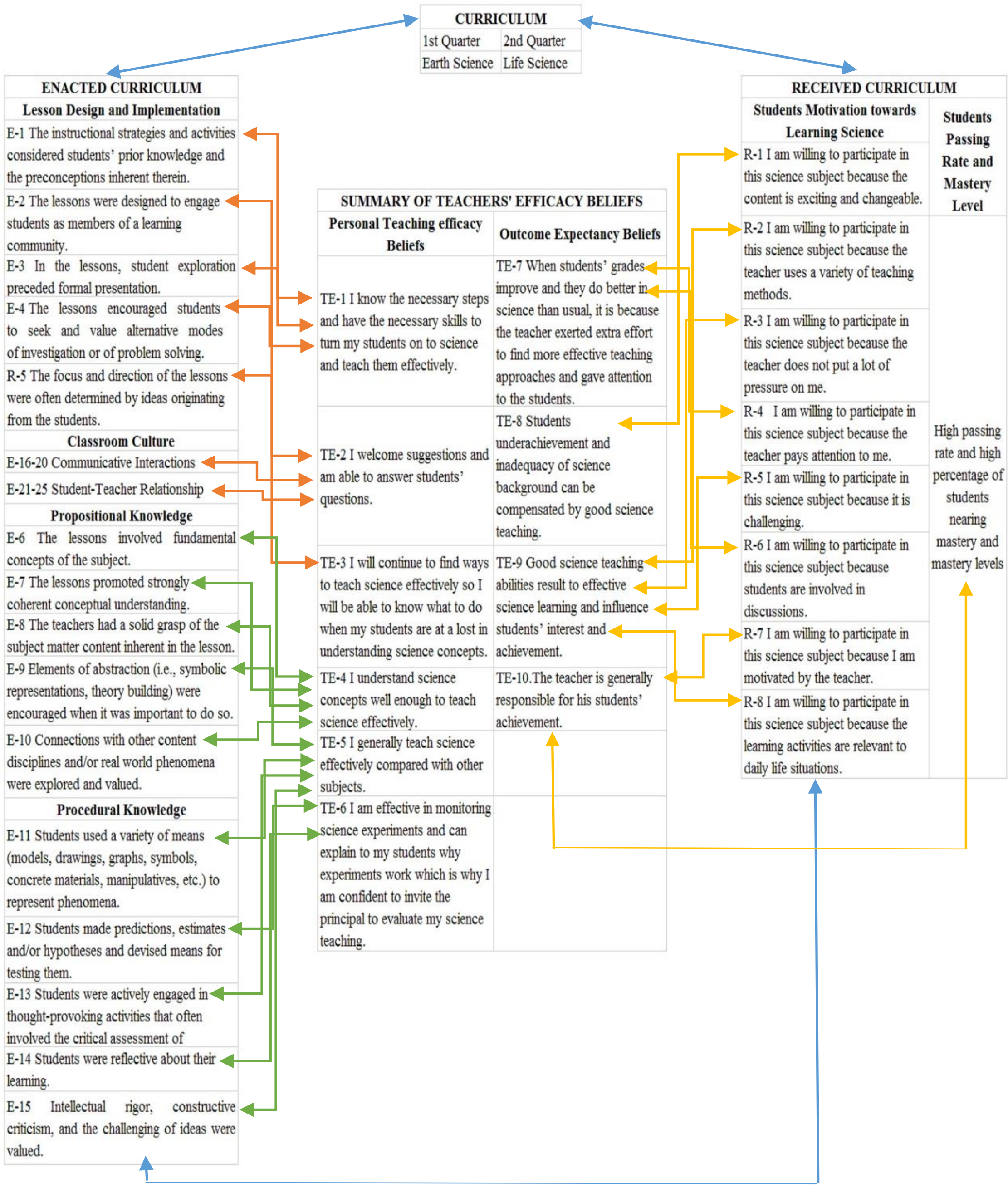

Figure 2. Conceptual Model of the Role of STEM Teachers Efficacy Beliefs in the Alignment of the I-E-R Curriculum

As seen in the model (Figure 2), the extent to which the intended curriculum and its elements (content and competencies) can be properly delivered lies on the components of the enacted curriculum (lesson design and implementation, classroom culture, and propositional and procedural knowledge), which work together to facilitate and enhance students' learning environment and achievement (received curriculum). During this alignment of the intended curriculum, enacted curriculum and received curriculum, a very important factor that might influence the match lies in the center of the teaching and learning process known as teachers' efficacy beliefs. These beliefs contribute to a more proper alignment of the three curricula and they function as a determinant of the degree of match among the three curricula.

The STEM teachers' characteristics, such as good relationship and communication with their students, maintenance of student-centered learning environment, consideration for students' prior knowledge and efforts in directing the lessons with ideas originating from the students are reflected in the model. These characteristics are all possible because of the teachers' effort in teaching science more effectively, having the necessary skills to teach science, trying to help students understand science and answer students' questions. Teachers who are more organized and willing to try different programming and experiments possess higher level of efficacy, and they also possess the ability to deliver the concepts confidently and encourage students' learning (Protheroe, 2008). The teachers confirmed these observations when they conducted their classes.

ST1: Students' interest is enhanced during inquiry and sharing of experiences and thoughts that happen during group dynamics.

ST2: I motivate and encourage students to participate in the classroom activities and discussions.

ST3: The lesson was delivered well and properly because I was prepared.

Furthermore, the students' exploration ability and the courage to seek and value alternative modes of investigation are developed due to their teachers' practices which include using strategies such as discovery approach and group collaboration. Furthermore, the teachers do their best in facilitating students learning through guided inquiry. As seen in the model, this can be attributed to the teachers' belief that they know the necessary steps in teaching and they know how much their students are turned on in learning science. Efficacy affects the effort teachers invest in teaching, the goals they set and their level of aspiration, which is why they tend to exhibit greater levels of planning and organization (Woolfolk, 2005). This was supported by the following teachers' verbatim responses:

ST1: I give instructions and objectives clearly to motivate the students and give direction to the lesson. I give the definition of terms or complex words that are new to the students. I also feel confident when I am able to use computer aided instructional materials.

ST2: Familiarity of concepts, especially the difficult terms, should be achieved for better understanding of the lesson and sharing of ideas.

ST3: We still need to discuss some important concepts. I also make sure that I enter the classroom prepared for my lesson.

In addition, time limitation is also considered by the teachers as a factor that affects how they structure their lessons, which results to limited exploration by the students. But they still try to do their best in planning and organizing their lessons to achieve their objectives and for teaching-learning process to occur. Hence, factors influencing classroom management were affected by teaching efficacy (Hicks, 2012). This is reflected in the model and was claimed as true by the teachers. Their verbatim responses pertaining to this matter include:

ST1: Time is a hindrance in finishing the lesson or attaining the lesson objectives. I need to improve in dividing the lessons that will be delivered or practice good time management in implementing the lesson plan.

ST2: I am patient and still try to involve the students in every part of the lesson.

ST3: If there was more time the students would have been asked to fill out the table individually or do a picture analysis for the students to be able to discover concepts.

The teachers' responses suggest that not only the content but also the propositional and procedural characteristics of the teachers were influenced by their teaching efficacy beliefs. The model shows the identified propositional and procedural knowledge of the teachers and their related efficacy beliefs. The most observed characteristics of the teachers are the coherence of conceptual understanding, solid grasp of the subject matter and inclusion of fundamental concepts in the lesson. These characteristics related to their personal teaching efficacy beliefs allow the teachers to believe that they can be effective in teaching science. Teaching efficacy beliefs result to strong beliefs of teaching abilities because of the familiarity of the lesson content (Tangen, 2010). One of the participants gave emphasis to this.

ST1: I really feel confident when I know the content of the lesson very well.

These areas of propositional knowledge and their alignment to the teachers' efficacy beliefs allow the teachers to use their abilities to develop lesson abstraction, relate their lessons with other disciplines, and show real life applications of the concepts they deliver. Using their abilities leads to the general belief that they are somehow effective in teaching science concepts. Hence, teacher efficacy belief is his/her ability to establish and perform sequences of action essential to complete a certain objective successfully (Tschannen-Moran & Woolfolk, 2001). Furthermore, most of the teachers' procedural knowledge are more on engaging students in thought provoking activities and involving students to reflect about their learning which is in line with their belief that they teach science well as compared to other subjects.

ST1: Teachers need to develop the ability to ask questions or the arrangement of questions which should trigger higher order thinking skills.

ST2: The students enjoyed the activities and presentation of their outputs wherein their thinking skills were applied.

ST3: I make sure that the activities were processed and students were able to reflect on their understanding. The idea is that the misconceptions or misunderstandings of the students were corrected before they left the classroom.

Accordingly, personal teaching efficacy is the belief of an individual teacher that he or she has the ability to reach all students (Tschannen-Moran & Woolfolk, 2001). If the teacher possesses personal teaching efficacy, the teacher is able to monitor experiments of students and can explain to the students how these experiments work. Teaching efficacy is observed in the modern classroom whenever a teacher directs learning of students (Joseph, 2010). These teaching efficacy belief result to having students that are able to use a variety of means in representing a phenomena and are able to test their predictions, estimates, and hypotheses. This belief was manifested by one of the observed teachers.

ST3: I roam around the classroom during the activity to make sure that everyone is cooperating and they are doing it right.

Hence, there is a strong correlation between teaching efficacy and student performance (Czubaj, 1996). Studies have found strong correlations between teacher efficacy and student achievement in the classroom (Woolfolk, 2005). Outcome expectancy belief is the belief that teaching, as a profession, can impact the learning of all students regardless of background. (Tschannen-Moran & Woolfolk, 2001).

Apparently, the most frequently occurring beliefs of the teachers are their extra efforts, adequate science background, and effectiveness in teaching science, use of effective teaching approaches and their good performance which result to students' enhanced achievement, performance and interest. These teachers' outcome expectancy beliefs are proven by the students' responses about their motivation towards learning science. This is reflected in the model. Seemingly, students are willing to participate in their science classes because of the teachers teaching methods, attention and less pressure given to them by the teacher, involvement of the students in the science activities, and exciting and relevant lesson contents included by the teachers. This mutual relationship between the outcome expectancy beliefs of teachers and the students' motivation towards learning science in their classes is further proven by the high percentage of passing students and students with nearing-mastery level and mastery level as seen in the model. Accordingly, the efficacy beliefs of the teachers will further increase if they can adapt to the changes brought about by the K to 12 science curriculum and if their content pedagogical knowledge and technological pedagogical knowledge improve and progress which will further support the alignment of the intended curriculum, the enacted curriculum, and the received curriculum. Support from the school and the teachers' perseverance in upgrading themselves could help the teachers to adapt to the senior high school science curriculum. This was suggested by the teachers involved in the study.

ST1: The school should provide seminars on computer-aided instruction. STEM teachers should study and deepen their knowledge, and this can be done through trainings and seminars to improve science teaching.

ST2: Sessions, trainings and seminars should be given to teachers. Teachers should add more time in researching about the lesson and more time for student preparation.

ST3: There should be a technical assistance from the school like providing trainings and seminars.

Chapter 4

Summary, Conclusion and Recommendations

Summary of the Study

This study determined the alignment of the intended, enacted and received STEM curricula of three STEM teachers in a government school in Angono Rizal using document analysis, questionnaire checklist, observation and semi-structured interview to gather the necessary data. Furthermore, it identified the efficacy beliefs of the said STEM teachers using a questionnaire. The study also attempted to showcase the identified STEM teachers' efficacy beliefs and the alignment of the intended, enacted and received curricula of their Grade 11 science classes.

To thoroughly examine the STEM curriculum and teaching efficacy beliefs, a descriptive case study utilizing both qualitative and quantitative strategies was used. Qualitative strategies used were observation, interview and document analysis while quantitative strategy was used in the analysis of the responses of the participant to the questionnaire checklist.

Three STEM teachers from Angono National High School – Senior High School Department were selected purposively. The criteria in selecting the participants included the following: at least three years of teaching experience in the school, with a master's degree, belongs to the STEM department, female and currently teaching Grade 11 science. Convenience sampling was used to identify the class of each STEM teacher participant for observation. The chosen class schedule was based on the time the researcher and his co-observers were available to observe.

Reformed Teaching Observation Protocol (RTOP) was used as an observation tool and was used once a week for a period of 10 weeks. The STEM teachers' lesson plan was examined during each observation to determine its alignment with the content standards of the Education Department. After the last observation of each STEM teacher, a semi-structured interview was conducted followed by the administration of the Science Teaching Efficacy Beliefs Instrument (STEBI). The Science Motivation towards Science Learning (SMTSL) questionnaire was given to the students in the observed class of each STEM teacher after the last observation to identify their level of willingness to learn and their learning environment motivation. Furthermore, the profile of each teacher and grades of their students were gathered and analyzed.

Summary of Findings

The findings of the study are as follows:

1. Based on the three STEM teachers' lesson plans and the K to 12 curriculum guide, the general objectives of STEM curriculum content standards are for the students to understand and apply scientific knowledge, perform scientific processes and skills, and develop and

demonstrate scientific attitudes and values. These objectives are to be achieving spiral progression. These objectives were attained by observing the teacher respondents who used different strategies such as collaborative learning, group dynamics and activities, inquiry approach, lecture and discussion, discovery approach, role playing, and technology integration. The inclusion of these strategies in their lesson plans was possible because the STEM teachers used reformed teaching in structuring the lesson delivery, reformed teaching includes: (1) consideration of prior knowledge, (2) engaging students as part of a learning community, (3) seeking alternative modes of investigation and problem solving by students, (4) students' use of exploration or discovery, and (5) lessons promoting coherent concepts and connections to other disciplines and real world phenomena. Furthermore, the implementation of the strategies were possible because of their propositional and procedural knowledge using reformed teaching which include: (1) solid grasp of the subject matter, (2) use of various strategies and approaches, (3) developing the students' stability to use various means to represent phenomena, (4) use of the inquiry approach and thought-provoking activities, and (5) directing the lesson in such a way that ideas originate from the students. The success of the designed and implemented strategies was proven by the results of the students' final examination and their grades wherein majority attained good results and this was strengthened by the students' response on their willingness to learn science because of the following: 1) the teacher uses a variety of teaching methods, (2) content is exciting and challenging, (3) the teacher pays attention and include the students in the discussion without putting a lot of pressure, and (4) the learning activities are relevant to daily life situations.

2. Based on the results of STEBI given to the three STEM teachers, the dominant personal teaching efficacy beliefs of the teachers are: (1) find better ways to teach science, (2) teach science concepts well and effectively, (3) have the necessary skills to teach science, (4) welcome students' questions and explain experiments to them, and (5) know how to turn on students to learn science. The dominant outcome expectancy beliefs of the teachers are: (1) students are doing better in science because of the effort of the teachers in finding effective teaching approaches, (2) effective science teaching results to improvement of students' performance and grades, and (3) good science teaching helps students to learn.

3. Based on the data collected, the efficacy beliefs of the STEM teachers may facilitate transition of the intended curriculum to their prepared lesson plans, and as the process continues, efficacy beliefs transpire in

connecting the content and delivery of the enacted curriculum. During the progress of teaching and learning process or as the teacher implements the procedure, the personal teaching efficacy beliefs will transpire for the teacher to build a pleasant learning environment and motivate the students. Furthermore, the STEM teachers' outcome expectancy beliefs support the STEM teachers in improving students' performance and increasing students' achievement.

Conclusion

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

4. There is high degree of alignment between the enacted and intended curriculum, and the received and intended curriculum as implemented by the three STEM teaching cases. This alignment from the three STEM teaching cases is possible because of the appropriate enacted curriculum of the STEM teachers.
5. The personal teaching efficacy belief of the three STEM teachers is they teach science well and effective since they have the necessary skills and knows the necessary steps to teach science, and their outcome expectancy belief is effective science teaching results to the improvement of students' performance and achievement. These

identified efficacy beliefs play a significant role in the alignment of the intended, enacted and received curriculum.

6. As far as the three STEM teaching cases are concern, teachers with high level of efficacy beliefs are likely to be able to have a more congruent alignment of the intended, enacted and received curriculum. These high level of efficacy beliefs help the teachers come up with a better enacted curriculum that is more consistent with the intended curriculum and able to stimulate the received curriculum.

Recommendations

Based on the findings of the study, the following are recommended:

1. The data collected, analyzed and documented from the three STEM teaching cases, their teaching practices and efficacy beliefs may serve as inputs in developing teacher-trainings and in-service programs for science instruction in the STEM strand, and the improvement of instructional processes. These inputs should be taken into consideration when hiring STEM teachers and when planning for their professional growth.
2. The Department of Education should reexamine the K to 12 Science Curriculum to determine a better spiral progression of the content standards and learning competencies for each grade level.

3. Alignment of teaching loads with STEM teachers' specialization should also be considered for the improvement of the STEM teaching and learning processes.
4. Future researchers may do a study that will determine the effect of teachers' efficacy beliefs on the intended, enacted and received curriculum, which will utilize quantitative research design. Furthermore, researchers may also explore the contribution of students' efficacy beliefs on the alignment of the intended, enacted and received curriculum utilizing both quantitative and qualitative research design.

References

Albion, P.R., & Ting, W. (2014). *Remote access laboratories enhancing STEM education.* Rhetoric and Reality: Critical Perspective on educational Technology. 23 – 26. Retrieved from www.ascilite.org/files/184-ting

Aquino, G. (2000). *Fundamentals of Effective Teaching*. Navotas, Rizal.

Arslan, A. (2014). Transition between Open and Guided Inquiry Instruction. Retrieved from https://doi.org/10.1016/j.sbspro.2014.05.071

Ashton, O. (1996). *Making a Difference: Teachers Sense of Efficacy and Student Achievement.* New York, Longman.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York, NY: Freeman.

Bandura, A. (1997). *Social Foundation of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NS: Prentice Hall, INC.

Bandura, A. (2006). Guide for Constructing Self-efficacy Scales. In F. Pajares & T. Urdan (Eds.), *Adolescence and education: Vol. 5. Self-efficacy and Adolescence* (pp. 307–337). Greenwich, CT: Information Age.

Bruner, J. (1997). A Narrative Model of Self-construction. *Annals of the New York Academy of Sciences*, 818, 145-161. doi: 10.1111/j.1749-6632.1997.tb48253.x

Cabansag, M. (2014). Impact Statements on the K-12 Science Program in the Enhanced Basic Education Curriculum in Provincial Schools.

International Research Journal Vol. 2, Issue 2, 31-32. Retrieved from www.researchwrold.com

Calingacion, M. (2008). Teachers' Self-efficacy and Pupils Academic Achievement in Science and Health IV. Philippines: Bulacan State University

Caprara, G. V., Barbaranelli, C., Steca, P., & Malone, P. S. (2006). Teachers' self-efficacy beliefs as determinants of job satisfaction and students' academic achievement: study at the school level. *Journal of School Psychology*, 44, 473-490. Retrieved from https://pdfs.semanticscholar.org/1355/cbc8746b8e4ca44e5a4babb557d2aebcd6e2.pdf

Cohen, D. K., & Hill, H. C. (2001). *Learning policy.* London. Yale University Press.

Crismond, D. P., & Adams, R. S. (2012). The informed Design teaching and Learning Matrix. *Journal of Engineering Education*, 101(4), 738–797. doi:10.1002/j.2168-9830.2012.tb01127.x

Cuban, L. (1992). Curriculum stability and change. *Handbook of research on curriculum.* New York: Macmillan.

Czubaj, C. A. (1996). Maintaining teacher motivation. *Education*, *116*(3), 372. Retrieved from https://scholar.google.com/scholar_lookup?publication_year=1996&pages=372-378&author=C.+Czubaj&title=Maintaining+teacher+motivation

Department of Education (2016). *Dep. Ed. Order No. 39, s. 2016: Adoption of the Basic Education Research Agenda*. Meralco Avenue, Pasig City. Philippines.

Department of Education (2016). K to 12 Science Curriculum Guide. Meralco Avenue, Pasig City. Philippines. Retrieve from http//www.deped.gov. ph/sites/default/files/page/2017/Science 20CG_with%20tagged%20sci%20equipment_revised.pdf

Dockstader, J. 2008. Teacher of the 21st Century Know the What, Why and How of Technology Integration. Retrieved from http://en.wikepedia.org/wiki/TechnologyIntegration

Dotson, J. (2001). Cooperative Learning Structures Can Increase Student Achievement. Retrieved from https://www.kaganonline.com/free_articles/ research_and_rationale/increase_achievement.php

Etkina, E. (2009). *Pedagogical content knowledge and preparation of high school physics teacher*. Graduate School of Education, Rutgers University, New Brunswick, New Jersey 08904, USA 4-12 Retrieved from http://prst-per.aps.org/pdf/PRSTPER/v6/i2/e020110

Evertson, C. (1999). Support for Managing Learning-Centered Classrooms: The Classroom Organization and Management Program. "In Beyond Behaviorism: Changing the Classroom Management Paradigm. Journal of

Educational Psychology, 74(4), 485-498. Retrieved from education.stateuniversity.com/pages/1834/Classroom-Management.html

Fairweather, J. (2008). Linking Evidence and Promising Practices in Science, Technology, Engineering, and Mathematics (STEM) Undergraduate Education. *The National Academies National Research Council Board of Science Education, Center for Higher Education*, Michigan State University 7-10. Retrieved from http://www.nationalacademies.org /bose/Fairweather_Commissionedpaper.pdf

Gibson, S. & Dembo M. H. (1984). "Teacher Efficacy: A Construct Validation". *Journal of Educational Psychology*, 76(4), 569-582.

Given, Lisa M. (2008). *The Sage encyclopedia of qualitative research methods*. Lon Angeles, California: Sage Publications.

Gluckman, P. (2011). Looking ahead: Science education for the twenty-first century. *A paper commissioned by the Royal Society and the Prime Minister's Chief Science Advisor,* Wellington, New Zealand Council for Educational Research. Retrieved from www.macrothink.org /article/download

Goddard, R. D., & Woolfolk, H. A. (2010). Collective teacher efficacy: Its meaning, measure, and effect on student achievement. American Educational Research Journal, 37 (2), 479-507. Retrieved from https://peabody.vanderbilt.edu/departments/tl/teaching_and_learning_res earch/mist/Berebitsky.pdf

Guerrero, S. (2005). Teacher Knowledge and a New Domain of Expertise: Pedagogical Technology Knowledge. Journal of Educational Computing Research, 33(3), 249-267. doi: https://doi.org/10.2190/BLQ7-AT6T-2X81-D3J9

Gulsecen, S., & Kubat, A. (2006). Teaching ICT to teacher candidates using PBL: A qualitative and quantitative evaluation. *Educational Technology and Society*, 9(2), 96-106.

Hall, B. (1992). *Attributions that Teachers Hold to Account for Student Success and Failure and Their Relationship to Teaching Level and Teacher Efficacy Beliefs.* San Francisco CA: Annual Meeting of the American Educational Research Association.

Harrison, A. (1997). Testing the Self-efficacy Performance Linkage of Social Cognitive Theory. *Journal of Social Psychology*, 137(1), 79-87.

Hicks, S. D. (2012). *Self-efficacy and classroom management: a correlation study regarding the factors that influence classroom management.* Liberty University, Lynchburg.

Houtz, B. (2010), *Teaching Science Today*. Huntington Beach, Shell Education. Retrieved from www.shelleducation.org/journal/download

Hynek, F. (2010). *Best Performing Cities 2010: Where America's Jobs Are Created and Sustained.* Milken Institute, California, 2010. Retrieved from www.mikeninstitute.org/publications/
view/442

Igwebuike, T., & Ikponmwosa, I. (2013*).* Influence of School Location and Achievement Level on Integrated Science Students' Perception of their Classroom Environment. *Academic Journal, Developing Country Studies, 3(1),67.* Retrieved fromhttp://connection.ebscohost.com/c/articles/
88998293/influence-school-location-achievement-level-integrated-
science-students-perception-their-classroom-environment.

Joseph, J. (2010). Does Intention Matter? Assessing the science teaching efficacy beliefs of pre-service teachers as compared to general student population. *Electronic Journal of science Education,* 14(1), 1-14. Retrieved from www.googlescholar.com

Kawulich, B. (2005). Participant Observation as Data Collection Method. Forum: *Qualitative Social Research,* 6(2), 43.
doi: http://nbn-resolving.de/urn:nbn:de:0114-fqs0502430.

Lardizabal, A. S. (1997). *Principles and Methods in Teaching.* Quezon City: Phoenix Publishing House, Inc.

Martin, J. J. (2008). The influences of professional development on teachers' self-efficacy toward educational change. *Physical Education and Sport Pedagogy*, *13*(2), 171–190. doi:10.1080/17408980701345683

Meyrick, K. (2011). *How STEM Education Improves Student Learning.* Meridian K-12 School Computer Technologies Journal, 14(1). Retrieved from https://ncsu.edu/meridian/summer2011/meyrick/print.html

Mojavezi, A., & Tamiz, P.A. (2012). The Impact of Self-efficacy on Students' Motivation and Achievement. *Theory and Practice in Language Studies, Finland Academy Publisher*, 2(3), 483-491. doi:10.4304/tpls.2.3.483-491

Morales M. P. E. (2017). Transitions and transformations in Philippine physics education curriculum: A case research. *Issues in Educational Research*, 27(3), 469-492 Retrieved from http//www.iier.org.au/iier27/morales.pdf

Morisson, K. (1993). *Planning and Accomplishing a Student-centered Evaluation.* Norfolk: Peter Francis Publishers.

National Academy of Engineering and National Research Council. (2014). *A Descriptive Framework for Integrated STEM Education - STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research.* Washington, DC: The National Academies Press, 2014. Retrieved from www.nap.edu

National Academy of Sciences, Engineering and Medicine. (2016), Barriers and Opportunities for 2-Year and 4-Year STEM Degrees. Washington, DC: The National Academies Press, 2016. Retrieved from www.nap.edu

National Research Council (NRC). (1996). *National Science Education Standards.* Washington, DC: National Academies Press. Retrieved from www.nap.edu

National Science Teachers Association (NSTA). (2009). *NSTA Position Statement: Scientific Inquiry*. Retrieved from www.nap.edu

National Science Teachers Association (NSTA). (2009). *Partnership for 21st Century Skills (P21). Framework for 21st Century Learning*. Retrieved from http://science.nsta.org/ps/Final21st CSkillsMapScience.pdf

Newman, E. (1993). The Effect of Teacher Efficacy, Locus of Control and Teacher Enthusiasm of Students on Task Behavior and Achievement. *Journal on Educational Psychology,* 8(1), 73-82.

Nolet, M., & McLaughlin J. (2000). *Assessing the General Curriculum: Including Students with Disabilities in Standards-Based Reform.* Sage Publications, 129. Retrieved from https://books.google.com.ph/books/about/accessing _theGeneralCurriculum

Obama, B. (2009). *Current Challenges in Basic Science Education*. UNESCO Education Sector. Retrieved from unnesdoc.unesco.org

Paek, P. L., Braun, H., Trapani, C., Ponte, E. & Powers, D. (2005). The Relationship of AP Teacher Practices and Student AP Exam Performance. *Research Report Series,* i-49.b doi: 10.1002/j.2333-8504.2005.tb01987.x

Pajares F. (1996). Self-efficacy Beliefs in Academic Settings. *Review of Educational Research*, 66(4), 543-578.

Pajares, F. (2005). *Gender differences in Mathematics Self-efficacy Beliefs.* In A. M. Gallagher & J. C. Kaufman (Eds.), *Mind the gap: Gender differences in mathematics* (pp. 294–315). Boston, MA: Cambridge University Press.

Pajares, F. (2006). *"Overview of Social Cognitive Theory and of Self-efficacy".* Retrieved from http://www.emory.edu/EDUCATION/mfp/eff.html.

Pan, Y.H. (2012). The development of a teacher's self-efficacy instrument for high school physical education teachers. *World Academy of Science. Engineering and Technology, 66,* 1152–1157. doi:10.2224/sbp.2013.41.2.241

Petroski, H. (2010). *The Essential Engineer: Why Science Alone Will Not Solve Our Global Problems.* Retrieved from www.goodreads.com/book/show/ 7204397-the-essential-engineer

Piburn, M. D. (2002). Measuring Reform Practices in Science and Mathematics Classrooms: The Reformed Teaching Observation Protocol. *School Science and Mathematics,* 102, 245–253. doi:10.1111/j.1949-8594.2002.tb17883.x

Protheroe, N. (2008). *Teacher Efficacy: What is it and Does it Matter?*. Research Report, 42-43. Retrieved from https://www.naesp.org/resources/pdfs

Riggs, I.M., & Enochs, L.G. (1990). Towards the development of an elementary teachers science teaching efficacy belief instrument. *Science Education*, 74(6), 626-637. doi:10.1002/sce.3730740605

Rothwell, J., (2013). *The Hidden STEM Economy*. Brookings. Retrieved from https://www.brookings.edu/research/the-hidden-stem-economy/

Sadeh, I., & Zion, M. (2009). The development of dynamic inquiry performances within an open inquiry setting: A comparison to guided inquiry setting. *Journal of Research in Science Teaching*, 46, 1137-1160. Retrieved from http://onlinelibrary.wiley.com.rr2p.org/article/205

Sanchez, R. (2014). Spiral Curriculum. *Sun Star Pampanga*. Retrieved from www.pressreader.com/philippines/sunstarpampanga/20150704/281599534160864

Santos, F. M. (2003). Teacher Efficacy and College Student Performance on Written and Oral Discourse. Diliman, Quezon City: College of Education, University of the Philippines. Retrieved from http://koha.nlp.gov.ph/cgi-bin/koha/opac-ISBDdetail.pl?bib=176402

Stohlman, M. (2012). Considerations for Teaching Integrated STEM Education. Journal of Pre-College Engineering Education Research, 2(1), 4. Retrieved from http://dx.doi.org/10.5703/1288284314653

Teaching and Learning International Survey (2013). The TALIS 2013 Conceptual Framework. Paris: Organization for Economic Co-operation and Development. Retrieved from http://www.oecd.org/edu/school/ TALIS%20Conceptual%20Framework_FINAL.pdf

Tangen, D. (2010). Using Microteaching to Enhance Teacher Efficacy in Pre-service Teachers. *Teaching Education*, 21(2). doi:199-210.10.1080/10476210902998466

Thomasian, J. (2011). *Technology and the Innovation Economy*. Brookings. Retrieved from https://www.brookings.edu/research/technology-an-the-innovation-economy/

Thompson, R. E. (2016). The Effects of Teachers' Self-Efficacy and a Positive Learning Environment on Marginal Students in Mainstream High School Settings. *All Theses and Dissertations*, 71. Retrieved from http://dune.une.edu/theses/71

Tschannen-Moran, M., & Woolfolk, H. A. (2001). *Teacher Efficacy: Capturing an Elusive Construct.* Ohio State University College of Education, Columbus, OH 43210, USA, February 2001. Retrieved from https://www.researchgate.net/publication/222564347

Tuan, H., Chin, C., & Shieh S. (2005). The development of a questionnaire to measure students' motivation towards science learning. *International Journal of Science Education,* 27(6), 639–654.

Usher, E.L., & Pajares, F. (2006). Sources of Academic and Self-regulated Efficacy Beliefs of Entering Middle School Students. *Contemporary Educational Psychology.* Retrieved from www.educationalpsycology.com

Walker, E. (2007). The Structure and Culture of Developing a Mathematics Tutoring Collaborative in an Urban High School. *High School Journal, 91*(1), 57-67.

White, P. (2009). *Differences: The Effects of Teacher Efficacy on Student Achievement in an Urban District. Virginia Polytechnic Institute and State University,* 104-105. Retrieved from https;//theses.lib.vt.edu/unrestricted

Windschitl, M. (2009). Science Teacher Readiness for Developing 21st Century Skills. *National Academies Press US,* Washington DC. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK32691/#_NBK32691_pudbet

Woolfolk, H. (2005). *Educational Psychology*. Active Learning Edition. Boston. Retrieved from www.ablongman.com/0205435297_toc

Woolfolk, H. (2010). *Educational Psychology 11th Ed*. Upper Saddle River, New Jersey: Merrill.

Wyatt, M. (2010). Towards a re-conceptualization of teachers' self-efficacy beliefs: tackling enduring problems with the quantitative research and moving on.

International Journal of Research and Methods in Education, 37(4), 166-189. Retrieved from www.port.ac.uk

Xanthoudaki, M. (2010). Quality Science Education: *Where do We Stand? Guidelines for Practice from a European Experience*, 5, 22-23. Retrieved from www.museoscienza.org/setac

Yap, R.D., (2011). K to 12: The Key to Quality Education. *Senate Economic Planning Office*, Senate of the Philippines 11(2). Retrieved from https://www.sepo.gov.ph/policybriefk12

Yin, R. D. (1994). Introduction. *Case study research: Design and methods* (2nd Eds.) (pp. 4-6). Thousand Oaks London New Delhi: Sage Publication.

APPENDIX A

REFORMED TEACHING OBSERVATION PROTOCOL (RTOP)

The RTOP was created as an observational tool to be used in measuring "reformed" teaching, based upon the theory of constructivism. It was developed by the Arizona Collaborative for Excellence in the Preparation of Teachers, and allows for the assessment of a specific instructional segment. The authors of the RTOP share, "Acknowledging this variety (current conceptions of constructivism), perhaps a beginning definition of a constructivist classroom would be one in which people are working together to learn. This has been called a "knowledge- building community" (Bereiter & Scardamalia, 1993, pg. 210-216). The RTOP provides an assessment of constructivist teaching, but lacks feedback for improvement in creation and delivery of the curriculum. The DRSC strongly supports the utilization of the RTOP's criteria, and has made strides to provide feedback and development suggestions on the curricular design demanded by a constructivist approach. Dr. James Rowley of the University of Dayton has developed a STEM Quality Rubric which examines principles that are unique to STEM curriculum. It specifically identifies the uniquities of constructivist (STEM) education, and sets standards for successful development. Utilizing both of the assessment pieces, the DRSC is able to provide educators with immense scaffolding for planning and instructional growth.

Section 1: Background Information

Name of teacher ____

Announced Observation? ☐ **Yes** ☐ **No**
(Explanation)____

Location of class: District_________________ School__________________
Room____________________

Years of Teaching ____________

Teaching Certification (K-6 7-12)

Subject observed and Grade level
Date of observation
Start time ___________________ **End time ___________________**

Section 2: Contextual Background and Activities
In the space provided below please give a brief description of the lesson observed, the classroom setting in which the lesson took place (space, seating arrangements, etc.), and any relevant details about the students (number, gender, ethnicity) and teacher that you think are important. Use diagrams if they seem appropriate. Record here events that may help in documenting.

Time	Description of Events

Section 3: LESSON DESIGN AND IMPLEMENTATION

1. The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.

A cornerstone of reformed teaching is taking into consideration the prior knowledge that students bring with them. The term "respected" is pivotal in this item. It suggests an attitude of curiosity on the teacher's part, an active solicitation of student ideas, and an understanding that much of what a student brings to the mathematics or science classroom is strongly shaped and conditioned by their everyday experiences.

4	The students write or draw a diagram of their hypothesis, estimation or prediction and discuss it in a small group or large group setting, prior to exploration and teacher instruction.
3	The students write, draw or discuss their hypothesis, estimation or prediction prior to exploration and teacher instruction.
2	The teacher solicits information from students concerning prior knowledge of phenomenon.
1	The teacher refers to previous student experiences or relates previous learning. (no respect aspect)
0	The teacher makes no reference to prior knowledge.

2. The lesson was designed to engage students as members of a learning community.

Much knowledge is socially constructed. The setting within which this occurs has been called a "learning community." The use of the term community in the phrase "the scientific community" (a "self-governing" body) is similar to the way it is intended in this item. Students participate actively; their participation is integral to the actions of the community, and knowledge is negotiated within the community. It is important to remember that a group of learners does not necessarily constitute a "learning community."

4	All students in the small group contribute to the construction of ideas and theory building.
3	Some students in the small group contribute to the construction of ideas and theory building.
2	There is some student-to-student interaction and discussion but little or no construction of ideas or theory building.
1	The lesson employs only large group discussion with little evidence of community. Primarily the teacher addresses the class and some students respond.
0	This lesson is completely teacher-centered, lecture only.

3. In this lesson, student exploration preceded formal presentation.

Reformed teaching allows students to build complex abstract knowledge from simpler, more concrete experience. This suggests that any formal presentation of content should be preceded by student exploration. This does not imply the converse...that all exploration should be followed by a formal presentation.

4	The teacher presents no formal content prior to student exploration.
3	The teacher introduces formal content prior to student investigation.
2	The teacher presents the results of the student investigation prior to student exploration.
1	The teacher instruction of formal content occurs prior to student investigation.
0	No student exploration is seen.

4. This lesson encouraged students to seek and value alternative modes of investigation or of problem solving.

Divergent thinking is an important part of mathematical and scientific reasoning. A lesson that meets this criterion would not insist on only one method of experimentation or one approach to solving a problem. A teacher who valued alternative modes of thinking would respect and actively solicit a variety of approaches, and understand that there may be more than one answer to a question.

4	The teacher solicits multiple approaches to solve the problem and has students present the approaches to the large group.
3	The teacher solicits multiple approaches to solve the problem.
2	The students utilize multiple approaches to solve the problem.
1	The student investigation is teacher directed.
0	The students do no investigation or problem solving.

5. The focus and direction of the lesson was often determined by ideas originating with students.

If students are members of a true learning community, and if divergence of thinking is valued, then the direction that a lesson takes cannot always be predicted in advance. Thus, planning and executing a lesson may include contingencies for building upon the unexpected. A lesson that met this criterion might not end up where it appeared to be heading at the beginning.

4	Students generate ideas and questions. Students develop investigation.
3	Students generate ideas and questions. Students have input in designing the investigation. -or- Teacher presents problem and students design
2	The students generate ideas and/or investigation.

1	The student investigation is teacher directed.
0	The lesson is teacher demonstration.

Section 4: CONTENT
(Propositional & Procedural Knowledge)
Knowledge can be thought of as having two forms: knowledge of what is (Propositional Knowledge), and knowledge of how to (Procedural Knowledge). Both are types of content. The RTOP was designed to evaluate mathematics or science lessons in terms of both.

Propositional Knowledge
This section focuses on the level of significance and abstraction of the content, the teacher's understanding of it, and the connections made with other disciplines and with real life.

6. The lesson involved fundamental concepts of the subject.
The emphasis on "fundamental" concepts indicates that there were some significant scientific or mathematical ideas at the heart of the lesson. For example, a lesson on the multiplication algorithm can be anchored in the distributive property. A lesson on energy could focus on the distinction between heat and temperature.

4	The lesson is driven by a fundamental scientific or mathematical content concept.
3	The lesson includes a fundamental scientific or mathematical concept to average depth.
2	The lesson includes a fundamental scientific or mathematical content concept with little or no depth.
1	The lesson is based on a procedural algorithm, not a fundamental scientific or mathematical concept.
0	The lesson has no scientific or mathematical concept at its heart.

7. The lesson promoted strongly coherent conceptual understanding.
The word "coherent" is used to emphasize the strong inter-relatedness of mathematical and/or scientific thinking. Concepts do not stand on their own two feet. They are increasingly more meaningful as they become integrally related to and constitutive of other concepts.

4	The teacher directs the large group discussion/concept building to center on the major math or science concepts of the unit.
3	The teacher solicits a description of the phenomena from the students; but there is little concept building.
2	The students have no opportunity for whole group discussion.

1	The lesson follows a logical progression, but no effort is made to make students aware of the progression or to allow students to organize the structure themselves.
0	The concepts have no interrelatedness; each is isolated from the others.

8. The teacher had a solid grasp of the subject matter content inherent in the lesson.

This indicates that a teacher could sense the potential significance of ideas as they occurred in the lesson, even when articulated vaguely by students. A solid grasp would be indicated by an eagerness to pursue student's thoughts even if seemingly unrelated at the moment. The grade-level at which the lesson was directed should be taken into consideration when evaluating this item.

4	The teacher solicits student input, builds on that input and helps students make sense of the concept.
3	The teacher solicits student input.
2	The teacher does not solicit student input or ideas.
1	The teacher makes a factual error.
0	The teacher makes a factual error in content that when pointed out s/he does not acknowledge.

9. Elements o f abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so.

Conceptual understanding can be facilitated when relationships or patterns are represented in abstract or symbolic ways. Not moving toward abstraction can leave students overwhelmed with trees when a forest might help them locate themselves.

4	The students represent the phenomenon in a symbolic way, and students develop theory through discussion.
3	The students represent the phenomenon in a symbolic way, and teacher develops theory through discussion.
2	The students represent the phenomenon in a symbolic way, or teacher develops theory through discussion.
1	The teacher represents the phenomenon in a symbolic way or teacher explains the theory.
0	No abstract or symbolic representations of the phenomenon are demonstrated and no real theory is developed.

10. Connections with other content disciplines and/or real world phenomena were explored and valued.

Connecting mathematical and scientific content across the disciplines and with real world applications tends to generalize it and make it more coherent. A physics lesson on electricity might connect with the role of electricity in biological systems, or with the wiring systems of a house. A mathematics lesson on proportionality might connect with the nature of light, and refer to the relationship between the height of an object and the length of its shadow.

4	The lesson is connected to a familiar context, and a real world example, application or connection to another discipline is valued with a whole class discussion.
3	The lesson is connected to a familiar context, and a real world example, application or connection to another discipline is explored.
2	The lesson is connected to a familiar context, and a real world example, application or connection to another discipline is mentioned.
1	The lesson is connected to a familiar context, but no real world example, application or connection to another discipline is mentioned.
0	The lesson is not connected to a familiar context.

Procedural Knowledge

This section focuses on the kinds of processes that students are asked to use to manipulate information, arrive at conclusions, and evaluate knowledge claims. It most closely resembles what is often referred to as mathematical thinking or scientific reasoning.

11. Students used a variety of means (models, drawings, graphs, symbols, concrete materials, manipulatives, etc.) to represent phenomena.

Multiple forms of representation allow students to use a variety of mental processes to articulate their ideas, analyze information and to critique their ideas. A "variety" implies that at least two different means were used. Variety also occurs within a given means. For example, several different kinds of graphs could be used, not just one kind.

4	The students represent the phenomenon in at least 2 different ways, at least one of which is student choice.
3	The students represent the phenomenon in at least 2 different ways.
2	The students represent the phenomenon.
1	The teacher represents the phenomenon.
0	There is no representation of the phenomenon.

12. Students made predictions, estimations and/or hypotheses and devised a means for testing them.

This item does not distinguish among predictions, hypotheses and estimations. All three terms are used so that the RTOP can be descriptive of both mathematical thinking and scientific reasoning. Another word that might be used in this context is "conjectures". The idea is that students explicitly state what they think is going to happen before collecting data.

4	The students explicitly make, write down or depict, and explain their prediction, estimation and/or hypothesis. Students devise a means for testing their prediction, estimation and/or hypothesis.
3	The students explicitly make and explain their prediction, estimation and/or hypothesis. Students or teacher devise a means for testing their prediction, estimation and/or hypothesis.
2	The students make a prediction, estimation and/or hypothesis. Students or teacher devise a means for testing the student's prediction, estimation and/or hypothesis.
1	A prediction, estimation or hypothesis is only done in a large group setting.
0	The students do not make a prediction, estimation or hypothesis.

13. Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures.

This item implies that students were not only actively doing things, but that they were also actively thinking about how what they were doing could clarify the next steps in their investigation.

4	The teacher asks the students to reflect upon the procedure. Students critically assess the validity of their procedure.
3	The teacher asks the students to reflect upon the procedure, but no ideas are shared with their group.
2	The students are actively engaged in a thought-provoking activity, but do not assess the validity of the procedure, or how it could be improved.
1	The students are actively engaged, but the activity is not thought-provoking and students do not assess their procedures.
0	The students are passively engaged in the lesson.

14. Students were reflective about their learning.

Active reflection is a meta-cognitive activity that facilitates learning. It is sometimes referred to as "thinking about thinking." Teachers can facilitate reflection by providing time and suggesting strategies for students to evaluate their thoughts throughout a lesson. A review conducted by the teacher may not be reflective if it does not induce students to re-examine or re-assess their thinking.

4	The students discuss questions such as "How do we know this?" "How can we be sure?" "What does this tell us about what we know?" within their small and large group.

3	The students discuss questions such as “How do we know this?” “How can we be sure?” “What does this tell us about what we know?” only within their small group or large group.
2	There is evidence that some students are thinking about their thinking
1	The teacher asks a question to prompt students to consider how they think about their learning, but no discussion occurs.
0	There is no evidence of student reflection.

15. Intellectual rigor, constructive criticism, and the challenging of ideas were valued.

At the heart of mathematical and scientific endeavors is rigorous debate. In a lesson, this would be achieved by allowing a variety of ideas to be presented, but insisting that challenge and negotiation also occur. Achieving intellectual rigor by following a narrow, often prescribed path of reasoning, to the exclusion of alternatives, would result in a low score on this item. Accepting a variety of proposals without accompanying evidence and argument would also result in a low score.

4	There is critical discussion of the ideas within the small groups and cross-group orb whole group.
3	There is critical discussion of the ideas within the small groups or whole group.
2	The students articulate more than one idea.
1	The students articulate one idea, but no competing ideas are offered.
0	The students articulate no ideas related to the activity.

Section 5: CLASSROOM CULTURE
(Communicative and Student/Teacher Relationships)

This section addresses a separate aspect of a lesson, and completing these items should be done independently of any judgments on preceding sections. Specifically the design of the lesson or the quality of the content should not influence ratings in this section. Classroom culture has been conceptualized in the RTOP as consisting of: (1) Communicative Interactions, and (2) Student/Teacher Relationships. These are not mutually exclusive categories because all communicative interactions presuppose some kind of relationship among communicants.

Communicative Interactions

Communicative interactions in a classroom are an important window into the culture of that classroom. Lessons where teachers characteristically speak and students listen are not reformed. It is important that students be heard, and often, and that they communicate with one another, as well as with the teacher. The nature of the communication captures the dynamics of knowledge construction in that community. Recall that communication and community have the same root.

16. Students were involved in the communication of their ideas to others using a variety of means and media.

The intent of this item is to reflect the communicative richness of a lesson that encouraged students to contribute to the discourse and to do so in more than a single mode (making presentations, brainstorming, critiquing, listening, making videos, group work, etc.). Notice the difference between this item and item 11. Item 11 refers to representations. This item refers to active communication.

4	The students share their ideas with their classmates using more than one mode of communication.
3	The students share their ideas with their classmates in a small group discussion.
2	The students share their ideas with their classmates in a large group discussion.
1	The students share procedural information but not ideas.
0	The students do not communicate with each other.

17. The teacher's questions triggered divergent modes of thinking.

This item suggests that teacher questions should help to open up conceptual space rather than confining it within predetermined boundaries. In its simplest form, teacher questioning triggers divergent modes of thinking by framing problems for which there may be more than one correct answer or framing phenomena that can have more than one valid interpretation.

4	The teacher asks open-ended questions and offers multiple explanations or explores connected areas to the large group and to small groups.
3	The teacher asks open-ended questions and offers multiple explanations or explores connected areas to the large group or to small groups
2	The teacher asks at least one open-ended or divergent question.
1	The teacher asks at least one open-ended question, but it is clear the teacher is looking for a specific answer.
0	The teacher asks no open-ended questions.

18. There was a high proportion of student talk and a significant amount of it occurred between and among students.

A lesson where a teacher does most of the talking is not reformed. This item reflects the need to increase both the amount of student talk and of talk among students. A "high proportion" means that at any point in time it was as likely that a student would be talking as that the teacher would be. A "significant amount" suggests that critical portions of the lesson were developed through discourse among students.

4	This lesson is mostly student talk with critical portions of the lesson developed through student-to-student discourse.
3	A larger portion of the talk is student-to-student; however critical portions of the lesson are not developed through this discourse.
2	The proportion of student-to-student talk to teacher-to-student talk is about equal.
1	There is minimal student-to-student dialog.
0	There is no talk amongst students. Student-instructor dialog (answering questions) is not scored for this item.

19. Student questions and comments often determined the focus and direction of classroom discourse.

This item implies not only that the flow of the lesson was often influenced or shaped by student contributions, but that once a direction was in place, students were crucial in sustaining and enhancing the momentum.

4	The students discuss in their groups, between groups, with the teacher and with the large group. This discourse is central to the development of the description and development of understanding of the phenomenon.
3	The students discuss in their groups and with the teacher. This discourse is central to the development of the description of the phenomenon.
2	The students discuss in their small groups, but the discourse is not central to the development of the description of the phenomenon.
1	The students discuss with the teacher, however student input only slightly influences the focus or direction of the discourse.
0	The teacher determines the direction of the lesson with no student input.

20. There was a climate of respect for what others had to say.

Respecting what others have to say is more than listening politely. Respect also indicates that what others had to say was actually heard and carefully considered. A reformed lesson would encourage and allow every member of the community to present their ideas and express their opinions without fear of censure or ridicule.

4	All students are comfortable representing their ideas and expressing their opinions without fear of censure or ridicule. All teacher interactions encourage student exploration and/or discussion.
3	All students are comfortable representing their ideas and expressing their opinions without fear of censure or ridicule. Teacher interactions usually encourage student exploration and/or discussion.
2	Some students are comfortable representing their ideas and expressing their opinions without fear of censure or ridicule. Teacher interactions seldom encourage student exploration and/or discussion.
1	There is some student interaction. Teacher interaction does not encourage student exploration and/or discussion.

0	There is little or no student interaction. If the students interact, negative comments may occur.

Student/Teacher Relationships

21. Active participation of students was encouraged and valued.
This implies more than just a classroom full of active students. It also connotes their having a voice in how that activity is to occur. Simply following directions in an active manner does not meet the intent of this item. Active participation implies agenda-setting as well as “minds- on” and “hands-on”.

4	The students describe the phenomenon and play a significant role in constructing and validating the final explanation of the phenomenon.
3	The students describe the phenomenon but do not play an adequate role in constructing and validating the final explanation. (Some building of explanation)
2	The students describe the phenomenon but do not participate in constructing or validating the final explanation of the phenomenon. (No building of explanation)
1	The teacher’s questioning strategy involves student participation, but is not closely tied to concept building.
0	Student participation was not encouraged and valued.

22. Students were encouraged to generate conjectures, alternative solution strategies, and/or different ways of interpreting evidence.
Reformed teaching shifts the balance of responsibility for mathematical of scientific thought from the teacher to the students. A reformed teacher actively encourages this transition. For example, in a mathematics lesson, the teacher might encourage students to find more than one way to solve a problem. This encouragement would be highly rated if the whole lesson was devoted to discussing and critiquing these alternate solution strategies.

4	This is valued within groups and is discussed with the large group.
3	This is valued within groups; it is not discussed with the large group.
2	The teacher accepts multiple strategies, conjectures or ways of interpreting evidence but makes no effort to solicit multiple ways.
1	The teacher has only one path to the correct answer that is acceptable.
0	The teacher provides all conjectures, solution strategies and ways of interpreting evidence.

23. In general the teacher was patient with students.
Patience is not the same thing as tolerating unexpected or unwanted student behavior. Rather there is anticipation that, when given a chance to play itself out,

unanticipated behavior can lead to rich learning opportunities. A long “wait time” is a necessary but not sufficient condition for rating highly on this item.

4	The teacher provides sufficient wait time and ample opportunity for students to explore on their own terms.
3	The teacher provides sufficient wait time, but does not capitalize on all opportunities to allow students to explore on their own terms.
2	The teacher provides sufficient wait time before accepting student responses.
1	The teacher sometimes provides sufficient wait time before accepting student responses.
0	The teacher provides no wait time.

24. The teacher acted as a resource person, working to support and enhance student investigations.

A reformed teacher is not there to tell students what to do and how to do it. Much of the initiative is to come from students, and because students have different ideas, the teacher’s support is carefully crafted to the idiosyncrasies of student thinking. The metaphor, “guide on the side” is in accord with this item.

4	The teacher uses student investigations or questions to direct the inquiry process.
3	The teacher answers questions instead of directing inquiry.
2	The student investigations are teacher prescribed.
1	The teacher demonstrates the phenomenon followed by large group discussion.
0	The class is lecture based.

25. The metaphor “teacher as listener” was very characteristic of this classroom.

This metaphor describes a teacher who is often found helping students use what they know to construct further understanding. The teacher may indeed talk a lot, but such talk is carefully crafted around understandings reached by actively listening to what students are saying. “Teacher as listener” would be fully in place if “student as listener” was reciprocally engendered.

4	The teacher listens to the students and does not dominate group interactions. The teacher asks questions to help the student construct their own understanding.
3	The teacher listens to the students, the students listens to the teacher reciprocity) but the teacher was too directive. The teacher gives too many answers instead of asking questions to help the student construct their own understanding.
2	Some attempts are made by the teacher to check initial student knowledge, incorporate student ideas into the lesson, and assess final student understanding of the material.

1	At least one attempt is made by the teacher to check initial student knowledge, or incorporate student ideas into the lesson, or to assess final student understanding of the material.
0	There is no attempt by the teacher to check initial student knowledge, or incorporate student ideas into the lesson, or to assess final student understanding of the material.

APPENDIX B

Name: ______________________________
Date: _____________________

Science Teaching Efficacy Belief Instrument (STEBI)

Developed by Larry G. Enochs and Iris M. Riggs, used with permission.
The STEBI is a measurement tool developed to understand teacher behavior which in turn can facilitate the development of strategies which may assist the improvement of science teaching.

Direction: Please indicate the degree to which you agree or disagree with each statement below by checking (✓) the appropriate space.

____

Statements	**Strongly Agree**	**Agree**	**Uncertain**	**Disagree**	**Strongly Disagree**
1. When a student does better than usual in science, it is often because the teacher exerted extra effort.					
2. I will continually find better ways to teach science.					
3. Even when I try very hard, I don't teach science as well as I do most subjects.					
4. When students' grades in science improve, it is often due to their teacher having found a more effective teaching approach.					
5. I know the steps necessary to teach science concepts effectively.					

6. I am not very effective in monitoring science experiments.					
7. If students are underachieving in science, it is most likely due to ineffective science teaching.					
8. I generally teach science ineffectively.					
9. The inadequacy of a student's science background can be overcome by good teaching.					
10. The low science achievement of some students cannot generally be blamed on their teachers.					
11. When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher.					
12. I understand science concepts well enough to be effective in teaching it.					
13. Enhanced effort in science teaching produces little change in some students' science achievement.					
14. The teacher is generally responsible for the achievement of students in science.					

15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.					
16. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.					
17. I find it difficult to explain why science experiments work to my students.					
18. I am typically able to answer students' science questions.					
19. I am curious if I have the necessary skills to teach science.					
20. Given a choice, I will not invite the principal to evaluate my science teaching.					
21. When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand it better.					
22. When teaching science, I will usually welcome student questions.					

23. I do not know what to do to turn students on to science.					
24. Effectiveness in science teaching has a little influence on the achievement of students.					
25. Even teachers with good science teaching abilities cannot help some kids learn science.					

Signature

APPENDIX C

Your Name: ____________________Teacher's Name: __________________
Subject: ________________________Grade Level and Section: ___________

Student Motivation towards Science Learning (SMTSL) Questionnaire
Part F (Learning Environment Stimulation)

Directions for Students

1. This questionnaire contains statements about your willingness in participating in this science class. You will be asked to express your agreement on each statement. There are no "right "or "wrong" answers. Your opinion is what is wanted. Think about how well each statement describes your willingness in participating in this class.
2. Please indicate the degree to which you agree or disagree with each statement below by checking (✓) the appropriate space.
3. Be sure to give an answer for all questions. If you change your mind about an answer, just cross it out and circle another.
4. Some statements in this questions are fairly similar to other statements. Don't worry about this. Simply give your opinion about all the statements.

Statements	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1. I am willing to participate in this science subject because the content is exciting and changeable.					
2. I am willing to participate in this science subject because the teacher uses a variety of teaching methods.					
3. I am willing to participate in this science subject because the teacher					

does not put a lot of pressure on me.					
4. I am willing to participate in this science subject because the teacher pays attention to me.					
5. I am willing to participate in this science subject because it is challenging.					
6. I am willing to participate in this science subject because students are involved in discussions.					
7. I am willing to participate in this science subject because I am motivated by the teacher.					
8. I am willing to participate in this science subject because the learning activities are relevant to daily life situations.					

____

Signature

APPENDIX D

Republic of the Philippines
Department of Education
Region IV-A CALABARZON
Division of Rizal
Angono National High School
Lt. Aguinaldo Street, Brgy. Kalayaan, Angono, Rizal

POST-OBSERVATION CONFERENCE/INTERVIEW GUIDE
INTERVIEW PROTOCOL

Name of Teacher: ______________________________
Name of the Observer: __________________________
Subject Observed and Year Level: __________________
Date of Observation: _____________________

PART 1. Focusing with the observation.

1. Preliminaries (greetings, etc.)

You may ask:
a.. How do you feel now?
(Ask Why the teacher feels the way he/she does.)
b. Did you enjoy your class?
(What made you enjoy your class? /why did you enjoy your class?)
c. Do you feel confident that you delivered the lesson well and proper? Why?

2. The observer asks the following questions to process the observed classroom instruction. (Note: the observer may ask follow-up/probing questions)
   a. Identify the things that went well during the lesson.

You may use any of the following questions.

- What were the high points of the lesson?
- Which part of the lesson were highly participated by your pupils/students?
- Which part of the lesson did you and your pupils/students enjoy the most?

(ask the reason for his/her answer)

b. Still focusing on the things went well, what could you do differently next time to get the same or a better result?
c. Was there any part of the lesson that your pupils/students find difficult? Why?
d. Recognizing this difficulty, what could you do with this difficulty next time to get a better result?
e. If there will be a next observation, what would you like to be the focus of the next observation?
f. What help do you need to accomplish that?

Note: When the teacher replied to Questions “C and E”, the observer may suggest anything using any of the following expressions:

- If I may suggest, you may use…
- Do you think it would be helpful if…

PART 2. Focusing with the curriculum and efficacy.

3. How do you know that learning occurs in a science class?

4. What do you think are your characteristics that help students learn?

5. What are the strategies you usually use in your class?

6. Do you think you effectively use the strategies? Why?

7. How would you describe the Sciences classes in the senior high school?

8. What can you say about the Grade 11 science curriculum?

9. Is it different from the junior high school curriculum? In what ways?

10. Did you make any changes in your strategies and personality when you first started teaching science classes in the senior high school? Why?

11. What is the importance of the senior high school science curriculum

12. What are the things the teacher need to focus on and improve in order to teach well in the senior high school science classes? How will they be able to do this?

____

Signature

APPENDIX E
Checklist Questionnaire for RTOP

Personal Data

Direction: Please fill in the necessary info asked for in the questionnaire by supplying the data or by checking the item in the space provided for in each item.

Name ________________________ Gender ________________________

Present Position/Rank ___________ Years of Teaching Experience ____

School ________________________ Subjects Taught ________________

Highest Educational Attainment
______ Doctorate Degree _____Bachelor's Degree with MA units
______ Master's Degree with PhD units _____ Bachelor's Degree
______ Master's Degree

Specialization ___________________

Checklist Questionnaire for the Validation of RTOP

Direction: Please put a check mark on your assessment on the observation tool adapted by the researcher. This observation tool will used to 4 STEM classes.

Please assess using the following scales:

Scale	Interpretation	Description
5	Very Acceptable	The statement is highly evident in the Observation Tool
4	Acceptable	The statement is evident in the Observation Tool
3	Moderately	The statement is somehow evident in the Observation Tool
2	Least Acceptable	The statement is not that evident in the Observation Tool
1	Not Acceptable	The statement is really not evident in the Observation Tool

A. PURPOSE:

	5	4	3	2	1
1. Geared to the subject for which it is prepared.					
2. Practical (can be used in an actual class observation).					
3. Written in a clear and understandable manner congruent with the purpose.					

B. CONTENT:

	5	4	3	2	1
1. Sufficient and appropriate.					
2. Includes information necessary for the achievement of the stated purposes.					
3. Includes all the essential parts of an observation tool.					

C. ORGANIZATION AND PRESENTATION

	5	4	3	2	1
1. Font size and type are uniform throughout.					
2. There are no grammatical errors.					
3. Instructions are clear, concise, and easily understood.					

D. COMMENTS AND SUGGESTIONS:

Rater's Signature

Checklist Questionnaire for STEBI

Personal Data

Direction: Please fill in the necessary info asked for in the questionnaire by supplying the data or by checking the item in the space provided for in each item.

Name ________________________ Gender ________________________

Present Position/Rank ___________ Years of Teaching Experience ____

School _______________________ Subjects Taught ________________

Highest Educational Attainment

______ Doctorate Degree _____Bachelor's Degree with MA units

______ Master's Degree with PhD units _____ Bachelor's Degree

______ Master's Degree

Specialization ___________________

Checklist Questionnaire for the Validation of STEBI

Direction: Please put a check mark on your assessment on the questionnaire adapted by the researcher. This questionnaire will be given to 4 STEM teachers.

Please assess using the following scales:

Scale	Interpretation	Description
5	Very Acceptable	The statement is highly evident in the Questionnaire
4	Acceptable	The statement is evident in the Questionnaire
3	Moderately	The statement is somehow evident in the Questionnaire
2	Least Acceptable	The statement is not that evident in the Questionnaire
1	Not Acceptable	The statement is really not evident in the Questionnaire

A. PURPOSE:

	5	4	3	2	1
1. Geared to the subject for which it is prepared.					
2. Practical (can be used as an actual questionnaire).					
3. Written in a clear and understandable manner congruent with the purpose.					

B. CONTENT:

	5	4	3	2	1
1. Sufficient and appropriate.					
2. Includes information necessary for the achievement of the stated purposes.					
3. Includes all the essential parts of a questionnaire.					

C. ORGANIZATION AND PRESENTATION

	5	4	3	2	1
1. Font size and type are uniform throughout.					
2. There are no grammatical errors.					
3. Instructions are clear, concise, and easily understood.					

D. COMMENTS AND SUGGESTIONS:

____

Rater's Signature

Checklist Questionnaire for SMTLS

Personal Data

Direction: Please fill in the necessary info asked for in the questionnaire by supplying the data or by checking the item in the space provided for in each item.

Name ________________________ Gender _______________________

Present Position/Rank ___________ Years of Teaching Experience ____

School _______________________ Subjects Taught ________________

Highest Educational Attainment

______ Doctorate Degree _____Bachelor's Degree with MA units

______ Master's Degree with PhD units _____ Bachelor's Degree

______ Master's Degree

Specialization ___________________

Checklist Questionnaire for the Validation of SMTLS

Direction: Please put a check mark on your assessment on the questionnaire adapted by the researcher. This questionnaire will be given to the students of 4 STEM teachers.

Please assess using the following scales:

Scale	Interpretation	Description
5	Very Acceptable	The statement is highly evident in the Questionnaire
4	Acceptable	The statement is evident in the Questionnaire
3	Moderately	The statement is somehow evident in the Questionnaire
2	Least Acceptable	The statement is not that evident in the Questionnaire
1	Not Acceptable	The statement is really not evident in the Questionnaire

A. PURPOSE:

	5	4	3	2	1
1. Geared to the subject for which it is prepared.					
2. Practical (can be used as an actual questionnaire).					
3. Written in a clear and understandable manner congruent with the purpose.					

B. CONTENT:

	5	4	3	2	1
1. Sufficient and appropriate.					
2. Includes information necessary for the achievement of the stated purposes.					
3. Includes all the essential parts of a questionnaire.					

C. ORGANIZATION AND PRESENTATION

	5	4	3	2	1
1. Font size and type are uniform throughout.					
2. There are no grammatical errors.					
3. Instructions are clear, concise, and easily understood.					

D. COMMENTS AND SUGGESTIONS:

Rater's Signature

Checklist Questionnaire for Post-Observation Conference Guide

Personal Data

Direction: Please fill in the necessary info asked for in the questionnaire by supplying the data or by checking the item in the space provided for in each item.

Name ________________________ Gender ________________________

Present Position/Rank ___________ Years of Teaching Experience ____

School ________________________ Subjects Taught ________________

Highest Educational Attainment
______ Doctorate Degree _____Bachelor's Degree with MA units
______ Master's Degree with PhD units _____ Bachelor's Degree
______ Master's Degree

Specialization ___________________

Checklist Questionnaire for the Validation of Post-Observation Conference Guide

Direction: Please put a check mark on your assessment on the post-observation conference guide adapted by the researcher. This tool will be used to 4 STEM teachers.

Please assess using the following scales:

Scale	Interpretation	Description
5	Very Acceptable	The statement is highly evident in the interview guide.
4	Acceptable	The statement is evident in the interview guide.
3	Moderately	The statement is somehow evident in the interview guide.
2	Least Acceptable	The statement is not that evident in the interview guide.
1	Not Acceptable	The statement is really not evident in the interview guide.

A. PURPOSE:

	5	4	3	2	1
1. Geared to the subject for which it is prepared.					
2. Practical (can be used in an actual post-observation conference guide).					
3. Written in a clear and understandable manner congruent with the purpose.					

B. CONTENT:

	5	4	3	2	1
1. Sufficient and appropriate.					
2. Includes information necessary for the achievement of the stated purposes.					
3. Includes all the essential parts of a post-observation conference guide.					

C. ORGANIZATION AND PRESENTATION

	5	4	3	2	1
1. Font size and type are uniform throughout.					
2. There are no grammatical errors.					
3. Instructions are clear, concise, and easily understood.					

D. COMMENTS AND SUGGESTIONS:

____

Rater's Signature

APPENDIX F

PHILIPPINE NORMAL UNIVERSITY
GRADUATE RESEARCH OFFICE

Consent Form for Participation in a Research Study

Introduction

You are invited as a respondent in a research study to be conducted by **ZALDY JOSE M. LAZARA JR.** entitled ***Cases of STEM Teaching Efficacy***. You are asked to read this form before answering the questionnaire.

Purpose of the Study

The purpose of this research is determine the match between the STEM teaching practices and the efficacy beliefs of teachers that will help in the enhancement of the teaching and learning processes in STEM. The research is in partial fulfillment of the requirements for the degree Master of Arts in Education.

Description of the Study Procedures

If you agree to be in this study, you will be asked to do the following things:

1. Expect a once a week class observation with documentation in a selected class for a period of 10 weeks.
2. During the last week of observation you will be asked to answer a questionnaire checklist and cooperate in a one on one interview. The expected time of answering the questionnaire is from 15 to 30 minutes and the length of interview is 30 minutes to 1 hour.
3. Complete the questionnaire during your free time. However, you are not allowed to take the questionnaire at home nor consult your colleagues regarding the content of the questionnaire while answering the items;
4. submit your questionnaire either to the researcher; and
5. observe that the data you have submitted must be placed in an envelope.

Potential Risks/Discomforts

It is of extreme importance for the researcher to let the respondents know what are the possible risks or discomforts when chosen to be a respondent in this research. However, this study poses a minimal risk on the side of the respondents. To be able to minimize the risk you are asked to:

a) avoid sharing your answer to anyone in the school community;
b) refrain from asking questions to anyone in the school community if in case the statement is unclear to you. In this case, you may contact the researcher on the number indicated in this consent form.

Potential Benefits

This research will help STEM teachers unlock connections between their instructional practices and efficacy beliefs that could help enhance science teaching in the STEM strand. The students' daily activity that is based on the curriculum could be a starting point in making connections between STEM instructional practices and efficacy beliefs that will make STEM learning more relevant and meaningful resulting to student success and achievement. Moreover, this study will serve as a guide in the design and assessment of teacher-training and in-service programs for science instruction in the STEM strand, improvement of instructional processes, consideration in hiring STEM teachers and provisions for their professional growth. It could also result in polishing administrative policies and supervisory strategies that would serve as bases for appropriate action with regard to STEM instruction.

Protection of Confidentiality

The researcher assures the protection of your privacy by assigning a respondent number. The data will be personally collected and gathered by the researcher. In this case, you are secured that the data you provided and your privacy will be protected.

Contact Information

If you have any question about this study, please contact **Zaldy Jose M. Lazara Jr.** at +639059189918. You may also email zaldy.lazara@deped.gov.ph for any concern.

Consent

Your signature below indicates that you have decided to participate in this study, and that you have read and understood the information provided above.

Subject's Signature:________________________ Date:__________________

Researcher's Signature:______________________

PHILIPPINE NORMAL UNIVERSITY
GRADUATE RESEARCH OFFICE

Consent Form for Participation in a Research Study

Introduction

You are invited as a respondent in a research study to be conducted by **ZALDY JOSE M. LAZARA JR.** entitled ***Cases of STEM Teaching Efficacy***. You and your parents are asked to read this form before you answer the questionnaire.

Purpose of the Study

The purpose of this research is determine the match between the STEM teaching practices and the efficacy beliefs of teachers that will help in the enhancement of the teaching and learning processes in STEM. The research is in partial fulfillment of the requirements for the degree Master of Arts in Education.

Description of the Study Procedures

If you agree to be in this study, you will be asked to do the following things:

1. answer the questionnaire by checking the extent of your agreement or disagreement as to how you are stimulated in your learning environment in your science class. The expected time of answering the questionnaire is from 15 to 30 minutes;
2. complete the questionnaire during your free time. However, you are not allowed to take the questionnaire at home nor consult your school head regarding the content of the questionnaire while answering the items;
3. submit your questionnaire either to the researcher; and
4. observe that the data you have submitted must be placed in an envelope.

Potential Risks/Discomforts

It is of extreme importance for the researcher to let the respondents know what are the possible risks or discomforts when chosen to be a respondent in this research. However, this study poses a minimal risk on the side of the respondents. To be able to minimize the risk you are asked to:

c) avoid sharing your answer to anyone in the school community;
d) refrain from asking questions to anyone in the school community if in case the statement is unclear to you. In this case, you may contact the researcher on the number indicated in this consent form.

Potential Benefits

This research will help STEM teachers unlock connections between their instructional practices and efficacy beliefs that could help enhance science teaching in the STEM strand. The students' daily activity that is based on the curriculum could be a starting point in making connections between STEM instructional practices and efficacy beliefs that will make STEM learning more relevant and meaningful resulting to student success and achievement. Moreover, this study will serve as a guide in the design and assessment of teacher-training and in-service programs for science instruction in the STEM strand, improvement of instructional processes, consideration in hiring STEM teachers and provisions for their professional growth. It could also result in polishing administrative policies and supervisory strategies that would serve as bases for appropriate action with regard to STEM instruction.

Protection of Confidentiality

The researcher assures the protection of your privacy by assigning a respondent number. Once completed, the data will be collected personally by the researcher. In this case, you are secured that the data you provided and your privacy will be protected.

Contact Information

If you have any question about this study, please contact **Zaldy Jose M. Lazara Jr.** at +639059189918. You may also email zaldy.lazara@deped.gov.ph for any concern.

Consent

Your signature below indicates that you have decided to participate in this study, and that you have read and understood the information provided above.

Subject's Signature:________________________ Date:____________________

Researcher's Signature:______________________

APPENDIX G

PHILIPPINE NORMAL UNIVERSITY
The National Center for Teacher Education
COLLEGE OF GRADUATE STUDIES AND TEACHER EDUCATION RESEARCH
Taft Avenue, Manila

May 26, 2017

PROF. DOMINGO O. BARCARSE
Faculty
Department of Psychology
Far Eastern University

Dear Sir:

Good Day!

The undersigned is a graduate school student of Philippine Normal University and currently undertaking a research study entitled, **"Cases of STEM Teaching Efficacy"** as a requirement for the degree of Master of Arts in Science Education – Physics Specialization. The instruments that will be used by the researcher such as post-observation conference guide, observation tool, and questionnaires will need to undergo validation procedures.

In connection to this may I humbly request for your expertise to examine and to validate the instruments. Attached with this letter are the instruments and checklist-questionnaires for validation.

Thank you in anticipation for your favorable response and your dedicated time is highly appreciated.

God bless and God speed.

Respectfully yours,

ZALDY JOSE M. LAZARA JR.
MA Sci. Ed. Physics
PNU-Manila

MARIE PAZ E. MORALES, Ph.D.
Thesis Adviser

PHILIPPINE NORMAL UNIVERSITY
The National Center for Teacher Education
COLLEGE OF GRADUATE STUDIES AND TEACHER EDUCATION RESEARCH
Taft Avenue, Manila

May 30, 2017

PROF. BRANDO C. PALOMAR
Physics Faculty
Faculty of Science, Technology, Engineering and Mathematics
Philippine Normal University

Dear Sir:

Good Day!

The undersigned is a graduate school student of Philippine Normal University and currently undertaking a research study entitled, **"Cases of STEM Teaching Efficacy"** as a requirement for the degree of Master of Arts in Science Education – Physics Specialization. The instruments that will be used by the researcher such as post-observation conference guide, observation tool, and questionnaires will need to undergo validation procedures.

In connection to this may I humbly request for your expertise to examine and to validate the instruments. Attached with this letter are the instruments and checklist-questionnaires for validation.

Thank you in anticipation for your favorable response and your dedicated time is highly appreciated.

God bless and God speed.

Respectfully yours,

ZALDY JOSE M. LAZARA JR.
MA Sci. Ed. Physics
PNU-Manila

MARIE PAZ E. MORALES, Ph.D.
Thesis Adviser

PHILIPPINE NORMAL UNIVERSITY
The National Center for Teacher Education
COLLEGE OF GRADUATE STUDIES AND TEACHER EDUCATION RESEARCH
Taft Avenue, Manila

May 26, 2017

PROF. ISAAC ENRIQUEZ
Physics Assistant Professor
Physics Department
De Lasalle University Manila

Dear Sir:

Good Day!

The undersigned is a graduate school student of Philippine Normal University and currently undertaking a research study entitled, **"Cases of STEM Teaching Efficacy"** as a requirement for the degree of Master of Arts in Science Education – Physics Specialization. The instruments that will be used by the researcher such as post-observation conference guide, observation tool, and questionnaires will need to undergo validation procedures.

In connection to this may I humbly request for your expertise to examine and to validate the instruments. Attached with this letter are the instruments and checklist-questionnaires for validation.

Thank you in anticipation for your favorable response and your dedicated time is highly appreciated.

God bless and God speed.

Respectfully yours,

ZALDY JOSE M. LAZARA JR.
MA Sci. Ed. Physics
PNU-Manila

MARIE PAZ E. MORALES, Ph.D.
Thesis Adviser

PHILIPPINE NORMAL UNIVERSITY
The National Center for Teacher Education
COLLEGE OF GRADUATE STUDIES AND TEACHER EDUCATION RESEARCH
Taft Avenue, Manila

May 26, 2017

PROF. REGGIE C. PANTIG
Physics Assistant Professor
Physics Department
De Lasalle University Manila

Dear Sir:

Good Day!

The undersigned is a graduate school student of Philippine Normal University and currently undertaking a research study entitled, **"Cases of STEM Teaching Efficacy"** as a requirement for the degree of Master of Arts in Science Education – Physics Specialization. The instruments that will be used by the researcher such as post-observation conference guide, observation tool, and questionnaires will need to undergo validation procedures.

In connection to this may I humbly request for your expertise to examine and to validate the instruments. Attached with this letter are the instruments and checklist-questionnaires for validation.

Thank you in anticipation for your favorable response and your dedicated time is highly appreciated.

God bless and God speed.

Respectfully yours,

ZALDY JOSE M. LAZARA JR.
MA Sci. Ed. Physics
PNU-Manila

MARIE PAZ E. MORALES, Ph.D.
Thesis Adviser

APPENDIX H

June 7, 2017

To: Marites A. Ibañez, CESO V
Schools Division Superintendent
Division of Rizal

Dear Ma'am Ibañez:

Greetings!

I, Mr. Zaldy Jose M. Lazara Jr., is conducting a research entitled, ***"Cases of STEM Teaching Efficacy"*** this school year 2017-2018 at Angono National High School-Senior High School, in partial fulfillment of the requirements for the degree, Master of Arts in Education with specialization in Physics at the Philippine Normal University. This study aims determine the match between the STEM teaching practices and the efficacy beliefs of teachers.

In this connection, I am asking for your permission to conduct the said study in your respective school and teacher participants together with their selected classes.

Attached herewith is the Notice to Proceed given by the Research Ethics Committee of the Philippine Normal University which indicates the approval of the collection of data.

Thank you in anticipation of your favorable response.

Very truly yours,

ZALDY JOSE M. LAZARA JR.
Researcher

Noted by: Approved by:

MARIE PAZ E. MORALES, Ph.D. **MARITES A. IBAŇEZ, CESO V**
Thesis Adviser Schools Division Superintendent

APPENDIX I

Validation Results for Reformed Teaching Observation Protocol (RTOP)

A. PURPOSE	V1	V2	V3	V4	AVERAGE	INTERPRETATION
1. Geared to the subject for which it is prepared.	5	5	5	5	5	
2. Practical (can be used in an actual class observation).	4	4	3	5	4	
3. Written in a clear and understandable manner congruent with the purpose.	5	5	4	5	4.75	
MEAN					**4.58**	**VERY ACCEPTABLE**
B. CONTENT	V1	V2	V3	V4	AVERAGE	INTERPRETATION
1. Sufficient and appropriate.	4	5	5	5	4.75	
2. Includes information necessary for the achievement of the stated purposes.	5	4	5	5	4.75	
3. Includes all the essential parts of an observation tool.	5	4	4	5	4.5	
MEAN					**4.67**	**VERY ACCEPTABLE**
C. ORGANIZTION AND PRESENTATION	V1	V2	V3	V4	AVERAGE	INTERPRETATION
1. Font size and type are uniform throughout.	5	5	4	5	4.75	
2. There are no grammatical errors.	5	5	4	5	4.75	
3. Instructions are clear, concise, and easily understood.	5	5	3	5	4.5	
MEAN					**4.67**	**VERY ACCEPTABLE**

Validation Results for Science Teaching Efficacy Beliefs Instrument (STEBI)

A. PURPOSE	V1	V2	V3	V4	AVERAGE	INTERPRETATION
1. Geared to the subject for which it is prepared.	5	5	5	4	4.75	
2. Practical (can be used in an actual class observation).	5	5	4	4	4.5	
3. Written in a clear and understandable manner congruent with the purpose.	5	5	4	4	4.5	
MEAN					**4.58**	**VERY ACCEPTABLE**
B. CONTENT	V1	V2	V3	V4	AVERAGE	INTERPRETATION
1. Sufficient and appropriate.	5	5	4	5	4.75	
2. Includes information necessary for the achievement of the stated purposes.	5	5	5	5	5	
3. Includes all the essential parts of a questionnaire.	5	5	4	5	4.75	
MEAN					**4.83**	**VERY ACCEPTABLE**
C. ORGANIZTION AND PRESENTATION	V1	V2	V3	V4	AVERAGE	INTERPRETATION
1. Font size and type are uniform throughout.	5	5	3	4	4.25	
2. There are no grammatical errors.	5	5	3	4	4.25	
3. Instructions are clear, concise, and easily understood.	5	5	4	4	4.5	
MEAN					**4.33**	**ACCEPTABLE**

Validation Results for Students Motivation towards Learning Science (SMTLS)

A. PURPOSE	V1	V2	V3	V4	AVERAGE	INTERPRETATION
1. Geared to the subject for which it is prepared.	5	5	4	5	4.75	
2. Practical (can be used in an actual class observation).	5	5	4	5	4.75	
3. Written in a clear and understandable manner congruent with the purpose.	5	5	4	5	4.75	
MEAN					**4.75**	**VERY ACCEPTABLE**
B. CONTENT	V1	V2	V3	V4	AVERAGE	INTERPRETATION
1. Sufficient and appropriate.	5	5	4	4	4.50	
2. Includes information necessary for the achievement of the stated purposes.	5	5	4	5	4.75	
3. Includes all the essential parts of a questionnaire.	5	5	3	5	4.50	
MEAN					**4.58**	**VERY ACCEPTABLE**
C. ORGANIZTION AND PRESENTATION	V1	V2	V3	V4	AVERAGE	INTERPRETATION
1. Font size and type are uniform throughout.	5	5	3	5	4.50	
2. There are no grammatical errors.	5	5	4	5	4.75	
3. Instructions are clear, concise, and easily understood.	5	4	3	5	4.25	
MEAN					**4.50**	**VERY ACCEPTABLE**

Validation Results for Semi-Structured Interview Guide

A. PURPOSE	V1	V2	V3	V4	AVERAGE	INTERPRETATION
1. Geared to the subject for which it is prepared.	5	4	4	4	4.25	
2. Practical (can be used in an actual class observation).	5	5	5	4	4.75	
3. Written in a clear and understandable manner congruent with the purpose.	4	5	4	4	4.25	
MEAN					**4.42**	**ACCEPTABLE**
B. CONTENT	V1	V2	V3	V4	AVERAGE	INTERPRETATION
1. Sufficient and appropriate.	5	5	4	4	4.5	
2. Includes information necessary for the achievement of the stated purposes.	5	5	5	4	4.75	
3. Includes all the essential parts of a post-observation conference guide.	5	5	5	4	4.75	
MEAN					**4.67**	**VERY ACCEPTABLE**
C. ORGANIZTION AND PRESENTATION	V1	V2	V3	V4	AVERAGE	INTERPRETATION
1. Font size and type are uniform throughout.	5	5	4	4	4.5	
2. There are no grammatical errors.	4	4	3	4	3.75	
3. Instructions are clear, concise, and easily understood.	5	5	4	4	4.5	
MEAN					**4.25**	**ACCEPTABLE**

APPENDIX J

Spiral Progression of the Grade 11 Science Curriculum for Earth Science

Grade 3 to 10			Grade 11
Content	**Content Standard - The learners demonstrate an understanding of:**		**Content**
(Grade 8) Other Members of the Solar System - Comets, Meteors and Asteroids **(Grade 9) Constellations -** Characteristics of Stars, Arrangement of Stars in a Group	(Grade 8) characteristics of comets, meteors and asteroids (Grade 9) the relationship between the visible constellations in the sky and the Earth's position along its orbit	the formation of the universe and the solar system	**Origin and Structure of the Earth -** Universe and Solar System
(Grade 3) Earth and Space - The Surroundings **(Grade 4) Water in the Environment -** Sources and Importance of Water and, **Weather -** Components of Weather **(Grade 6) The Solar System -** Planets **(Grade 7) The Philippine Environment -** Location of the Philippines with respect to landmasses	(Grade 3) people, animals, plants, rivers, streams, hills, mountains and other landforms and their importance (Grade 4) the different sources of water and Components of weather using simple instrument (Grade 6) characteristics of planet in the solar system (Grade 7) The relationship of geographic location of the Philippines to its environment	the subsystems (geosphere, hydrosphere, atmosphere and biosphere) that makes up the Earth	**Origin and Structure of the Earth -** Earth and Earth Systems

and bodies of water			
(Grade 8) Earthquakes and Faults - How Earthquake waves provide information about the interior of the Earth **(Grade 10) Plate Tectonics -** Internal Structure of the Earth	(Grade 8) the relationship between faults and earthquakes (Grade 10) the relationship among locations of volcanoes, earthquake epicenters and mountain ranges	the Earth's internal structure	
(Grade 5) Processes that shape the Earth's Surface - Weathering and Soil Erosion	Weathering and soil erosion shape the Earth's surface and affect the living things and environment	the three main categories of rocks	**Earth Materials and Processe**s - Minerals and Rocks
(Grade 9) Volcanoes - Volcanic Eruption	volcanoes found in the Philippines	the origin and formation of common minerals and rocks	
(Grade 5) Processes that shape the Earth's Surface - Weathering and Soil Erosion	Weathering and soil erosion shape the Earth's surface and affect the living things and environment	geologic processes that occur on the surface of the Earth such as weathering, erosion, mass wasting, and sedimentation (including the role of	**Earth Materials and Processes** - Exogenic Processes

		ocean basins in the formation of sedimentary rocks)	
(Grade 9) Volcanoes - Volcanic Eruption **(Grade 10) Plate Tectonics** - Distribution of: Volcanoes, Earthquake Epicenters and Mountain Ranges	(Grade 9) volcanoes found in the Philippines (Grade 10) the relationship among locations of volcanoes, earthquake epicenters and mountain ranges	geologic process that occurs within the Earth	**Earth Materials and Processes** - Endogenic Processes
(Grade 10) Plate Tectonics - Processes and Landforms along plate boundaries and Mechanism (possible causes of movement)	(Grade 10) the relationship among locations of volcanoes, earthquake epicenters and mountain ranges		
(Grade 8) Earthquakes and Faults - Active and inactive faults and Earthquake focus, epicenter, magnitude and intensity	the relationship between faults and earthquakes	the folding and faulting of rocks	**Earth Materials and Processes** - Deformation of The Crust
(Grade 10) Plate Tectonics - Plate Boundaries and Evidence of plate movement	(Grade 10) the relationship among locations of volcanoes, earthquake epicenters and mountain ranges	plate tectonics	

(Grade 8) Earthquakes and Faults - How Earthquake waves provide information about the interior of the Earth **(Grade 10) Plate Tectonics** - Internal Structure of the Earth	(Grade 8) the relationship between faults and earthquakes (Grade 10) the relationship among locations of volcanoes, earthquake epicenters and mountain ranges	how the planet Earth evolved in the last 4.6 billion years (including the age of the Earth, major geologic time subdivisions and marker fossils)	**Earth Materials and Processes** - History of the Earth
(Grade 8) Earthquakes and Faults - How movements along the fault generate earthquakes and how earthquakes generate tsunamis, and Earthquake preparedness **(Grade 9) Volcanoes** - Volcanic Eruption	(Grade 8) the relationship between faults and earthquakes (Grade 9) volcanoes found in the Philippines	the different hazards caused by geological processes (earthquakes, volcanic eruptions, and landslides)	**III. Natural Hazards, Mitigation and Adaptation -** Geologic Process and Hazards
(Grade 4) Weather - Components of Weather and Weather Instrument **(Grade 7) Interactions in the Atmosphere** - Greenhouse Effect and Global Warming, Monsoons and Intertropical Convergen	(Grade 4) Components of weather using simple instrument (Grade 7) the different phenomena that occur in the atmosphere (Grade 8) the formation of typhoons (Grade 9) factors that affect climate, and the effects of changing climate and how to adapt accordingly	the different hazards caused by hydro meteorological phenomena (tropical cyclones, monsoons, floods and tornados or ipo-ipo)	**III. Natural Hazards, Mitigation and Adaptation -** Hydro meteorological Phenomena

ce Zone **(Grade 8) Understanding Typhoons** - How typhoons develop **(Grade 9) Climate -** Factors affect climate and Global Climate Phenomenon

Source: Department of Education K to 12 Science Curriculum Guide 2016

APPENDIX K

List of Teaching Strategies, Technology Integration and Assessment Practices of ST1 Based on Lesson Plan and Observation

Teaching Strategies	Technology Integration	Assessment Practices
-Lecture and Discussion -Use of Inquiry Approach -Group Dynamics -Group Activities and Collaborative Learning	-Used of video clips and short films with the aid of computer and television -Used of power point presentation with the aid of computer and television	-Recitation and participation during discussion -Group Output/Project presentation -Use of : multiple choice, fill in the blanks and identification, and True or False types of test -Group presentation

List of Teaching Strategies, Technology Integration and Assessment Practices of ST2 Based on Lesson Plan and Observations

Teaching Strategies	Technology Integration	Assessment Practices
-Lecture and Discussion -Discovery approach -Use of Inquiry Approach -Group Dynamics -Group Activities and Collaborative Learning -	-Presentation with the aid of computer and television -Use of video clips and short films with the aid of computer and television -	-Recitation and participation during discussion -Group Output/Project presentation -Use of : multiple choice, fill in the blanks and identification, and True or False types of test -Group presentation -Performance-based Assessment with the use of rubric

.

List of Teaching Strategies, Technology Integration and Assessment Practices of ST3 based on Lesson Plan and Observation

Teaching Strategies	Technology Integration	Assessment Practices
-Lecture and Discussion -Role Playing -Use of Inquiry Approach -Group Dynamics -Group Activities and Collaborative Learning -	-Presentation with the aid of computer and television -Use of video clips and short films with the aid of computer and television -	-Recitation and participation during discussion -Group Output/Project presentation -Used of : multiple choice, fill in the blanks and identification, and True or False types of test -Group presentation -Performance-based Assessment with the use of rubrics -

APPENDIX L

Approval to Use the Adapted Instruments

Michael Piburn

to me

Hide details

From: Michael Piburn mike.piburn@asu.edu

To: Zaldy Jose Lazara zaldyzaldyzaldy0131@gmail.com

Date: Jul 3, 2017, 7:59 AM

See security details

Please feel free to use the RTOP in its original form and with proper attribution. Modifications are not allowed, since that would violate the integrity of the instrument. You are, of course free to create your own measure.

Good luck with your work.

Mike

Sent from my iPad

suhltuan
to me
Hide details

From: suhltuan suhltuan@cc.ncue.edu.tw
Reply to: suhltuan suhltuan@cc.ncue.edu.tw
To: Zaldy Jose Lazara zaldyzaldyzaldy0131@gmail.com
Date: Jul 2, 2017, 4:22 PM
See security details

Hi Zaldy Jose M. Lazara Jr,
You are welcome to use SMTSL to your thesis.
Best wishes
Hsiao-Lin Tuan, Professor
Graduate Institute of Science Education
National Changhua University of Education
Changhua, Taiwan

I am hoping for you positive response and kind consideration.

Thank you in advance!

Sincerely,
Zaldy Jose M. Lazara Jr.

Iris M. Riggs to you Aug 25, 2017

Of course, you can use the STEBI. It has no copyright! Good luck!

APPENDIX M

Authenticity Test Results from PNU CGSTER

79% 2:47 PM

Office, Graduate Research
to me
Hide details

From: Office, Graduate Research gradres.cgster@pnu.edu.ph
To: Zaldy Jose Lazara zaldyzaldyzaldy0131@gmail.com
Date: Jan 17, 2018, 9:05 AM
See security details

Congratulations for passing the authenticity test with 21% similarity index. Please refer to Publications Office at Pedro Orata Hall, 2nd Floor for Certification.

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2	www.iier.org.au Internet Source	2%
3	www.icaseonline.net Internet Source	1%

APPENDIX N

March 13, 2017

C E R T I F I C A T I O N

This is to certify that I did the language editing of the paper entitled "Curriculum Alignment and Efficacy Beliefs of STEM Teachers", prepared by Mr. Zaldy Jose M. Lazara Jr., a Master of Arts student with specialization in Physics.

This certification is issued to Mr. Lazara for whatever purpose it may serve him.

LUCILLA R. FETALVERO
Retired Professor

CURRICULUM VITAE

NAME	: Zaldy Jose M. Lazara Jr.
ADDRESS	: 52 Taurus St. Sta. Rita Olongapo City
DATE OF BIRTH	: January 31, 1988
PLACE OF BIRTH	: Olongapo City, Zambales
PARENTS	: Zaldy D. Lazara
	: Rizalina M. Lazara
CIVIL STATUS	: Single

EDUCATIONAL BACKGROUND

Elementary	: Elementary Certificate-2000 Sta. Rita Elementary School Sta. Rita Olongapo City
Secondary	: High School Diploma-2004

Olongapo City National High School
Olonapo City, Zambales

Tertiary : Bachelor of Secondary Education
Major in Physics-2008
Philippine Normal University
Taft Avenue, Manila

ELIGIBILITY : Licensure Examination for Teachers (LET) - Passed

PROFESSIONAL EXPERIENCES

: Secondary School Teacher III
2011 to date
Angono National High School

: Secondary School Teacher
2009-2011
Green Park High School Cainta

: Secondary School Teacher
2008-2009
La Salle College Antipolo