

Development and Validation of a Supplemental Learning Resource in Chemistry in Conversational Filipino

Fernando C. Altares, Jr.

Tarlac State University, Tarlac City, Tarlac

Author email: fcaltares@tsu.edu.ph

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ABSTRACT

Insufficiencies in effective learning materials, poor English comprehension, and abrupt shift to alternative learning modalities are a few of the many possible root causes of low proficiency levels of students in science. To address such a problem, a supplemental learning resource in selected topics in Chemistry written in conversational Filipino was developed and validated for Senior High School non-science students. Two research designs were employed, namely, the Research and Development (R&D) design for the development and expert validation of the material, and a Quasi-Experimental design for the end-user validation of the material. Since a modified validation tool was used, five science and education experts assessed the validation tool and rated it to be valid to a very great extent. Another set of five science and curriculum experts, using a reliability-tested modified validation tool, rated the learning material to be valid to a very great extent in terms of objectives, content, language use, instructional characteristics, acceptability, and usability. Non-randomly selected thirty-eight students from an intact class in a Senior High School in Tarlac City were split-halved into control and experimental groups and were administered the pre-test and post-test to establish the effectiveness of the learning material. Pre- and post-tests scores, along with their gain scores, were analyzed using a t-Test. While results showed that there was still an increase in their performance regardless of the use of the supplemental material, it was also revealed that the administration of the supplemental material significantly increased students' performance as compared to its non-supplementation. It is therefore recommended that the integration of local community language in learning materials should be considered as an effective way of contextualizing and deepening the understanding of students in science lessons.

Keywords: Conversational Filipino; Supplemental, Learning resource

Introduction

Ensuring an inclusive and equitable education for all is a universal mission, as it is listed as one of the sustainable development goals for 2030 of the United Nations. Since 2015, the world has called for immediate action to recognize this aim and materialize key strategies in support therewith. Such a goal, however simple, remains to be elusive especially in a developing country like the Philippines where the new educational framework, K to 12, has only been implemented a few years back.

In the current K to 12 curriculum in the Senior High School, all students regardless of specialization need to take the core subjects which include Physical Science. This Science subject could be outside a non-science student's area of interest. As Duchovic et. al (2008) highlighted, non-science students see sciences as an overwhelmingly threatening prospect...constitute an intellectual edifice that is impossible to scale".

However, since Science subjects are not considered electives or optional courses in the K to 12 curriculum for Senior High School students with non-STEM (Science, Technology, Engineering, and Mathematics) strands, it requires students to pass the subject first before being promoted to the next academic level. This is where the problem starts.

Students need to pass all the ‘core subjects’ which include Physical Science and Earth and Life Science, even if it is outside their area of interest. The degree of interest of students in learning Science affects the degree to which they learn and understand it. Students’ perception and familiarity or experience with any knowledge greatly affect their learning (Bloom, 1976). If students are not interested and motivated, they will not exert any effort to do it. Thus, these attitudes towards any subject area lower their academic performance, which does not only impose a problem on the students but also on the teacher and the educational institutions.

Students enrolled in non-STEM strands, such as those under the TVL (Technical, Vocational, and Livelihood), ABM (Accountancy, Business, and Management), and HUMSS (Humanities and Social Science) strands, do not normally treat their science subjects, which are core subjects, as relevant as their specializations. This leads to their lower interest and motivation in learning the subject. Much more, if there is no official textbook from the government, or supplementary learning materials available to scaffold their learning, aside from the rushed Learning Activity Sheets (LAS). This further leads to a bigger problem: a low science proficiency level.

In 2018, the Philippines joined the PISA (Program for International Student Assessment) of the OECD (Organization for Economic Cooperation and Development) as part of the Department of Education’s (DepEd) reform plan for quality basic education towards globalization. Here, the Philippines scored 357 in science, which is way below the average scores of the participating 79 countries. This landed the country 2nd last in science as its rank (Punongbayan, 2019). It means that most of these students have inferior performance in science. Pointing to the discussion earlier, the non-STEM students require more teaching aids than the STEM students. However, challenges must be addressed first.

There are many factors to be considered regarding the low performance of students in science. One such is the lack of needed learning resources. The Senior High School (SHS) program, under the K to 12 curriculum only started last 2016. Therefore, the government is still in the process of supplying necessary teaching materials. In fact, in the Division of Tarlac City, there are still no available textbooks in Physical Science and Earth and Life Science available.

This uncertainty is being faced now by SHS teachers and students. The readily available books in the market are mostly not aligned with the curriculum guide required by DepEd. Some books include activities that are hardly followed and not localized. These materials cannot cover the situation, but only worsen it if not readily remedied. In fact, in one school in Tarlac City Schools Division – South B district, there were less than 20 percent who got grades in Chemistry (first part of Physical Science) higher than 85 (proficient level) and less than 35 percent who got higher than 85 in Physics (second part of Physical Science, cumulatively for the past three years).

Concerning the current health pandemic the country faces, DepEd shifted to the use of other alternative learning delivery modes such as offline modular distance learning. It also shortened the curriculum into now the Most Essential Learning Competencies (MELCS) which merged and even deleted some learning competencies to come up with the most essential ones. With no research study on hand, while it is expected to be effective, there is still no concrete proof as to whether such kind of curriculum effectively delivers the core concepts of the learning area. Hence, there is a possibility on this matter that the academic performance of the students may be compromised, especially since students are only given the self-learning activity sheets (LAS) co-facilitated by parents at home.

With this problem, the teacher needs to be an innovator to come up with something that would cover the situation. One undeniable way teachers do to reach students is to use Filipino as their auxiliary language of instruction in their online discussion.

Such a strategy to use Filipino as the second language of instruction in teaching Science has always been an unwritten rule by most Science teachers. While aiming to produce globally competent graduates is not being undermined since the lectures are all written and presented using the English language, it is only necessary to ensure that science concepts are learned by students in the best and most effective way possible. Perhaps, what might improve the performance of students is to let them use written learning material that is discussed using conversational Filipino.

As a legal support, DepEd Order No. 74 series of 2009 cited various local studies reaffirming the effectiveness of the use of multi-lingual education (MLE). In one of the statements in the enclosure, DepEd emphasized that in secondary education, both the English and Filipino languages may serve as primary modes of instruction, and Filipino may be an auxiliary language of instruction. This directive now becomes a key characteristic of the supplemental learning material the study developed and validated.

The relevance of having supplementary learning material in Chemistry that is written in conversational, Filipino, where students can relate without the issue of language barrier, could be an effective way of ensuring their understanding in the subject area. This is where the study is anchored- in developing and validating a unique and localized learning resource in Chemistry written in conversational Filipino for non-STEM students.

Methodology

Research Design

This study used an educational research method known as Research and Development (R&D) in developing and validating the supplemental material in Chemistry. It is a process used to develop and validate educational products (Alberto, 2019). A product would be developed to address an educational problem. Such a product would then be pilot-tested to determine its viability in addressing the problem. If the product addresses the problem, it would be accepted as another tool for the educational system. If it does not, it will be revised, improved, and assessed until it is proven viable.

Considering the problem raised in the study, the term product refers to the localized supplemental learning resource in Chemistry written in conversational Filipino. The Research and Development design covers the Planning, Development, and Validation phases of the study. The main concern of this study was the development and validation of this supplemental learning resource in Chemistry that is intended for non-STEM students. On the part of end-user validation in terms of the module's effectiveness via pre-/post-tests, a quasi-experimental research design was employed. This research design is commonly used in cases over experimental research design in cases when random selection cannot be performed (Abraham & MacDonald, 2011), as in the case of the present study.

Research Instrument

There were two researcher-made validation tools used in this study, one for the experts and one for the end-users. For the experts, the instrument used is primarily based on Macarandang's (2009) study, with the title, "Evaluation of a Proposed Set of Modules in Principles and Methods of Teaching" and Manzano's (2018) study, with the title, "Researcher and Non-Researcher Teachers' Evaluation of ELT Materials: Converging or Diverging?". However, the instrument was modified to meet the needs of the current study. Hence, the instrument was revised to match the focus and target of the study.

The researcher-made validation tool was titled, "Instrument for the Evaluation of Supplemental Learning Resource in Chemistry in Conversational Filipino." The modified validation tool consists of the following criteria: 1) objectives, 2) content, 3) language use, 4) instructional characteristics, 5) acceptability, and 6) usability. There are seven (7) statements for objectives, five (5) statements for content, seven (7) statements for language use, five (5) statements for instructional characteristics, five (5) statements for usability, and five (5) statements for acceptability for a total of 34 indicators. Cronbach's alpha was used to determine the reliability of the instrument. After the administration of the instrument, the data was tabulated and analyzed using SPSS to determine Cronbach's alpha coefficient, which was equal to 0.83. Since the coefficient is greater than 0.70, the instrument was deemed reliable.

For end-user evaluation in terms of the acceptability and usability of the learning material, the validation tool used was also adapted from the study of Macarandang (2009) and Manzano (2018). The said tool consists of the following criteria: 1.) usability with five (5) statements and 2.) acceptability with five (5) statements for a total of 10 indicators. With regards to determining the effectiveness of the material on students' performance, pre- and post-tests were administered after the utilization of the learning resource. The 60-item test questionnaire used came from a test bank in a local high school and comprised of ten questions for each lesson covered in the supplemental material.

Research Respondents

Purposive sampling was employed in selecting the expert validators of the learning resource. "Purposive sampling relies on the judgment of the researcher when it comes to selecting the units, which is based on the objectives of the study at hand" (Laerd Dissertation, n.d.). The expert validators were chosen based on their qualifications as science and/or curriculum experts. Since the researcher utilized a researcher-made validation tool, it was subjected to face and content validation by the experts using the checklist validation rubric for the expert panel by Veroy (2019). The validators of the tool are five (5) selected Science specialists and/or curriculum experts in Tarlac City. They are shown in Table 1.

After the researcher-made tool was validated, it was then used in the validation of the supplemental learning resource that the researcher developed. The validators of the supplemental learning material included another set of purposively selected Science specialists and/or curriculum experts in Tarlac City consisting of five (5) members. These respondents were considered as evaluators of the learning resource as shown in Table 2.

In the reliability testing of the test questionnaire, scores of twenty-six (26) non-STEM students in their first quarter examination last SY 2018-2019 were used. Also, another set of 38 non-STEM strands of Grade 12 students at the same school in SY 2021-2022 served as participants for the end-user evaluation of the supplemental material. The scores of the 38 students in their pre-test were arranged from highest to lowest and were classified into control and experimental groups (odd/even), each with 19 students. Using the t-Test for independent samples, it was determined that the pre-test scores between the control and experimental groups had no significant difference, and hence it can be said that all students were at the same class standing before the start of the one-quarter experiment. The experimental group used the developed and expert-validated supplemental learning resource in Chemistry, while the control group used no supplemental learning resource in Chemistry.

Table 1: Expert Validators of the Validation Tool and their Qualifications

Number of Validator	Designation	Educational Attainment	Level of Validation
1	Master Teacher in Science	Master of Arts in Education Major in Educational Management	As a Science Expert
1	Assistant Professor	Master of Science in Chemistry Education	As a Science Expert
1	Head Teacher I	Doctor of Education Major in Educational Leadership	As a Curriculum Expert
1	Head Teacher I	Master of Arts in Education Major in English	As a LRMDs Expert
1	Teacher III	Master of Arts Education Major in Physical Science	As a Science Expert

Table 2: Expert Validators of the Learning Resource and their Qualifications

Number of Validator	Designation	Educational Attainment	Level of Validation
1	Master Teacher in Science	Master of Arts in Education Major in Physical Science	As a Science Expert
1	Assistant Professor	Master of Science in Chemistry	As a Science Expert
1	Head Teacher in Science	Master of Arts in Education Major in Physical Science	As a Science Expert
1	Teacher III	Master of Arts Education Major in Physical Science	As a Science Expert
1	Principal	Doctor of Philosophy Major in Educational Leadership	As a Curriculum Expert

Data Gathering Procedures

The procedure followed by the researcher in developing and validating the supplementary learning resource in Chemistry was as follows:

Preliminary Phase

The design of the localized supplemental Chemistry learning resource was based on the Most Essential Learning Competencies in the Curriculum Guide of Physical Science provided by the Department of Education. Through this, the topics included in the learning resource were determined.

Development Phase

The researcher adapted the ADDIE model in designing the materials which stands for the following steps: analysis, design, development, implementation, and evaluation. This model is the generic process traditionally used by instructional designers. However, the present study did not undergo the stage of analyzing the needs of the learners because it intended to cover the first half of the curriculum guide set by the department. The learning resource was divided by chapters, namely: 1) Formation and Synthesis of Heavy Elements, 2) Polarity of Molecules, 3) Intermolecular Forces and Properties of Substances, 4) Biological Macromolecules, 5) Rates of Reactions, and 6) Limiting Reagent. The content units of the learning resource followed the Most Essential Learning Competencies of the Curriculum Guide issued by DepEd. Part of the development of the learning resource is ensuring that the material is free from translation errors and is grammatically correct in all its discussions written in conversational Filipino. Hence, the material was proofread by a Filipino language critic.

Validation Phase

Since the validation tool for the learning material was checked and validated for face and content validity by experts, an adopted tool titled *Checklist Validation Rubric for an Expert Panel (VREP)* by Veroy (2019) was utilized. Five (5) Science experts with master's and doctoral degrees were tapped in the validation of the said tool. After checking the tool, the developed learning resource was subjected to validation by five (5) experts. These are master teachers, college professors, school heads, and science experts with master's degrees and/or doctoral degrees in science and/or Education. All experts were communicated in person for their validation of the material. The supplemental learning resource was

assessed with the following criteria: 1) objectives, 2) content, 3) language use, 4) instructional characteristics, 5) usability, and 6) acceptability. After the validation, the learning material was revised and then re-evaluated.

After the learning material was validated by experts, it was then evaluated by its end-users, the students, in terms of its usability, acceptability, and effectiveness. With regard to the effectiveness of the material, a pre-test was first administered to both the control and experimental groups. The supplemental material was then utilized by the students in the experimental group for one quarter, as opposed to the students in the control group who were not given additional material. After this, a post-test was administered to both the control and experimental groups. A researcher-made validation tool was then used by the students to measure the acceptability and usability of the material. The scores gathered from the validation tool and pre-/post-tests were treated statistically.

Treatment of Data

Frequency count and weighted mean were utilized in this study to describe the quality of the material. For the determination of the significant differences in the pre- and post-test scores, a t-test for correlated samples and a t-test for independent samples were used. All t-test calculations were done using the Data Analysis function of Microsoft Excel (Office 365).

The face and content validity of the researcher-made validation tool was determined using a 5-point Likert scale adopted from Veroy (2018) titled, Checklist Validation Rubric for an Expert Panel (VREP). The interpretation of the mean was based on the following range shown in Table 3.

The quality of the localized learning material was categorized using the researcher-made validation tool. The interpretation of the mean was based on the following range shown in Table 4.

Table 3: Range of Scores for the Face and Content Validity of the Validation Tool

Range	Verbal Interpretation
4.50-5.00	Excellent
3.50-4.49	Very Good
2.50-3.49	Good
1.50-2.49	Fair
1.00-1.49	Poor

Table 4: Range of Scores for the Quality of the Learning Material

Range	Verbal Interpretation
4.50-5.00	To a very great extent
3.50-4.49	To a great extent
2.50-3.49	To a moderate extent
1.50-2.49	To some extent
1.00-1.49	To a small extent

To determine the significant differences between the scores in pre-and post-tests, and between scores of control and experimental groups, t-test scores were compared to two-tailed critical values at an alpha of 0.05 (confidence interval of 95%).

Ethical Consideration

Upon the consent to conduct the study, the researcher notified the School Division Superintendent and the validators about the motive of the study and the significance of its findings. The researcher assured the responses were kept confidential and allowed voluntary withdrawal from the study.

Confidentiality

All the collected data from the evaluators were treated with high confidentiality. It was ensured that any information shared during the conduct of the research was not disclosed outside of the research setting or to unauthorized persons. The participants were also assured that administrative and technical safeguards were observed, specifically in protecting the privacy and confidentiality of participants' information.

Anonymity

It is guaranteed that validators' identities in the study are preserved. The researcher employed a variety of measures to keep the participants' identities and responses securely protected. Sensitive information was not asked of the validators except for the relevant data needed in the study.

Results and Discussion

Development of the Supplemental Learning Resource in Chemistry

The primary objective of the research was to develop a supplemental learning material that was written in conversational Filipino and was intended for non-STEM (Science, Technology, Engineering and Mathematics) students in Senior High School. The supplemental learning resource was designed and laid out using the Office 365 Microsoft Publisher and Microsoft PowerPoint as the software. Microsoft Publisher is a software program that was utilized for content layouting and designing, while Microsoft PowerPoint was used for crafting the graphics used.

The development of these learning resources such as the goal of this research was within strands of the first domain, Content Knowledge and Pedagogy, of the Philippine Professional Standards for Teachers (PPST) as provided by DepEd Order No. 42 series 2017, which aims to promote research-based knowledge and principles of teaching and learning, and utilize mother-tongue, Filipino and English in teaching and learning. Both are a critical nature and baseline concept of the learning material.

Moreover, the learning material, being supplemental, has the following components: 1) Cover Page, 2) Table of Contents, 3) Foreword, 4) Acknowledgements, 5) Learning Competencies (following the Most Essential Learning Competencies for Physical Science Quarter 1 provided by DepEd), 6) Concept in a Box, 7) Lesson Discussions, 8) Try Natin! (Sample Problems), 9) Lesson Summary, and 10) Bibliography.

The module was, *Chemistry Para Sa'yo: A Supplemental Learning Resource in Selected Chemistry Topics*. It is to be highlighted that the name of the module itself is written in conversational Filipino to instantly hint to the reader on the language of instruction used in the material and to give a relatable feeling and contextualized approach to learning Chemistry.

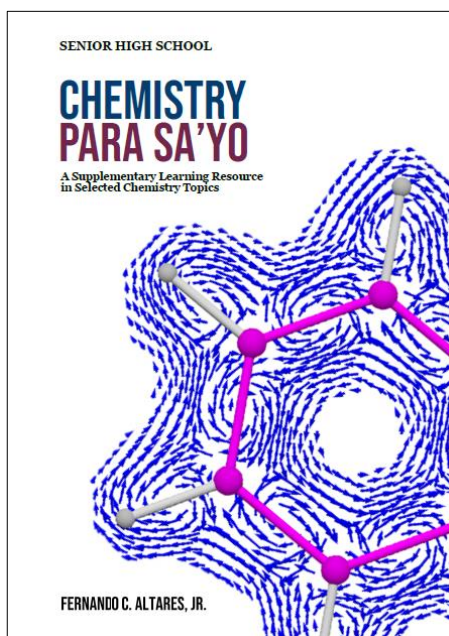


Figure 1: The Developed Learning Resource

Since the intended users of the material were already Senior High School students, elaborate and overly intricate designs were unnecessary. Rather, a minimalist design was done as evident on the cover page. Only one chemistry-related graphic from Creative Commons was used to immediately signify that the content of the material is on Chemistry. The two-color scheme on a plain white background is also observed on the cover page. This is to lessen the cost of mass reproduction of the material once made available for use in the classroom, especially in a pandemic-driven offline/printed modular learning modality. Considering such factors are also of prime importance in the real utilization of the material.

The Table of Contents shows the exact and specific alignment of the material's contents to the topics listed in the Curriculum Guide (CG) for the first half of Physical Science. Since the material was supplementary, it was best to follow the sequence of topics in the CG, as outlined by DepEd, for students to easily partner the material with the available Learning Activity Sheets (LASs) that were being distributed and used in the said subject area during the current alternative learning modality implemented in the school.

Since the material only covered the first six lessons of CG in Physical Science, there were no more chapters or units. Instead, the module was divided into six lessons, namely, Lesson 1: Formation and Synthesis of Heavy Elements; Lesson 2: Polarity of Molecules; Lesson 3: Intermolecular Forces and Properties of Substances; Lesson 4: Biological

Macromolecules; Lesson 5: Rates of Reactions; and Lesson 6: Limiting Reagent. Each lesson followed the minimum competencies in the CG, however, there were some lessons where supplemental information was added to review the students on the pre-requisite ideas needed in the lesson.

A foreword was included in the material as a general introduction to the contents, features, and goals of the learning resource. It talked about the three basic tenets of the material, namely, 1) The material is written in conversational Filipino; 2) The material is intended for non-STEM students in Senior High School; and 3) The material is a supplemental learning resource in nature. Aside from this, a brief description of the Physical Science (Quarter 1 lessons in Chemistry) was given to provide learners with what to expect in the contents of the material. Through the foreword, the end-users or the learners were encouraged to pursue learning Chemistry through a more relatable and contextualized approach using conversational Filipino, despite the difficulties the subject may impose on them.

Acknowledgments were purposely written to express immense gratitude to the people who believed, helped, and supported the researcher in the development and validation of the material. This is the part intended for all those who contributed to the successful materialization of this worthwhile endeavor of truly helping the learners among others, in improving their understanding of Chemistry, and consequently increasing their science performance.

Learning Competencies are the specific skills that DepEd wants students to learn in Physical Science. These are the minimum mandated lesson objectives that teachers need to teach students in a particular subject area. Due to the onset of the pandemic, DepEd released the *Most Essential Learning Competencies (MELCs)*, a shorter version of the usual CG by dropping and/or merging other competencies and thereby producing the most essential ones. The *Learning Activity Sheets (LASs)*, being the primary learning materials utilized in Tarlac City Schools Division, are based on MELCS. Since the developed material was supplemental and was meant to be partnered with the LASs, it also followed the topics and their sequencing to the MELCs.

Through these competencies, students and teachers are guided on the contents of the material. However, since the learning competencies listed in the MELCs are already specific, measurable, attainable, results-based, and time-bound, they can also be considered equivalent to learning objectives. This is the same idea as to why only writing the learning competencies is sufficient in the LASs.

Concept in a Box, as the name suggests, is an illustrated form of the concept in a box. It is a graphical figure mostly in the form of a flow chart that readily encapsulates the gist of the lesson into a single look. Every lesson has a dedicated *Concept in a Box* that is placed right after the learning competency and before the lesson discussion so that students see the overview of the lesson. Such use of visuals would help students to better remember the lesson, mainly because the human brain primarily consists of image processors (Kouyoumdjian, 2012). Moreover, this strategy of using visuals is believed to be effective in improving student's comprehension and retaining information.

The title of each lesson together with the sequencing of the topics is patterned to the LASs to ensure that students are already familiarized with it. Hence, the lesson titles are direct to the point, and plainly following usual science lesson titles. The discussion of the lessons used conversational Filipino alongside the use of English. Specifically, the formal definitions and technical terms, whether difficult to translate or not, were retained and written in English. There are terms found throughout the material that can arguably be easily translated into Filipino, however, they were left untranslated and used colloquially with Filipino grammar and sentences to create an ambiance of a "casual discussion of a Filipino science teacher in a local community," which was in a way a form of contextualization and localization concerning the language of instruction used. It is also believed that there are terms that are critical to topic familiarization and that the forceful and deliberate translation of such will only result in a less effective learning material.

Moreover, the English formal definitions are usually written inside boxes as a way of separating it from the discussion in conversational Filipino to remind students of the definitions that are usually found in other primary learning resources such as textbooks and LASs.

Further, evident in the discussion proper is the wide use of many visuals including illustrations, figures, and tables is the same reason similar to *Concept in a Box* that such inclusion of visuals effectively increases the retainment of information to students. This was also one of the ways to allow students to imagine, mostly, the reactions happening at the microscopic level, rendering them to see Chemistry as a more relatable subject. It is to be noted that all illustrations of atoms and molecules, including graphs and tables, were creatively designed using Microsoft PowerPoint software.

Chemistry lessons are always coupled with challenging activities that require students to use the key concepts they learned to answer the problems posed. In the developed learning material, sample problems were integrated into the discussion of the lesson. Problems shown were aligned with the objectives of the lesson as stated by the learning competencies. This required learners to determine whether they can achieve the competencies or not. This was also an opportunity for students to exercise and practice their lower and higher-order thinking skills that are meant to be improved in every lesson. More so, a step-by-step solution to every problem was given. The problems were also answered in conversational Filipino for easy understanding to students.

At the end of each lesson, a summary was presented to help students remember the key points discussed in the lesson. The inclusion of a summary was also a strategy for students to check whether they learned all the necessary information and skills presented in the lesson. It was also beneficial for them in their review and study sessions. Consistent with lesson discussion, the summary was also written in conversational Filipino, so that students were encouraged to go over it smoothly, without transition in the use of language, after studying the discussion part in the

material. The summary was usually enumerated in bullets per idea or key points. This was to avoid paragraphing in this part and rather focus the students on the most essential statements that need to be remembered.

The Bibliography was included in this learning resource to give credit to the sources of information used. While it was placed at the end part of the material, it still served as an essential component in increasing the reliability of the whole module. It cannot be stressed enough that developing such learning resources require the content to be only accurate and factual as the material was primarily used to educate students. Hence, errors in any form were avoided to ensure the optimal effectiveness of the material and to prevent further problems.

Validation of the Supplemental Learning Resource in Chemistry

The developed supplemental learning resource in Chemistry had undergone both the validation of experts and the end-users. This was done to ensure that the developed material is effective, usable, and acceptable to its consumers.

Experts' Validation of the Material

Chemistry Para Sa'yo was validated by a mixture of five (5) science and materials development experts in the field, in terms of 2.1.1) objectives, 2.1.2) content, 2.1.3) language use, 2.1.4) instructional characteristics, 2.1.5) usability, and 2.1.6) acceptability. The objectives are statements of goals needed to be achieved by students at the end of each lesson. They pertain either to knowledge, skills, or attitudes (KSA) that must be developed in a learner. Table 5 shows the summary of the descriptive statistics for the first indicator of the expert-validation.

The computed grand weighted mean of 4.83 in this indicator means that the pool of validators rates the supplemental learning resource as valid to a very great extent. Also, the validators believed that the objectives of the learning resource agree with the specifications and competencies of DepEd and PPST, and in the MELCs for Physical Science to a very great extent as evident by a grand mean of 5.00.

Table 5: Experts Validation in terms of Objectives

Criteria	Mean	Verbal Interpretation
The objectives are aligned with the specifications and competencies of the Department of Education and the Philippine Professional Standards for Teachers.	4.80	To a very great extent
The objectives are aligned with the learning competencies to be developed as stipulated in the curriculum guide for Physical Science.	5.00	To a very great extent
Specific	4.80	To a very great extent
Measurable	4.80	To a very great extent
Attainable	4.80	To a very great extent
Results-Based	4.80	To a very great extent
Time-Bound	4.80	To a very great extent
Grand Weighted Mean	4.83	To a very great extent

In addition, it should be heavily noted that it is a must that written objectives should be well-formulated, properly constructed, and has a logical structure (Ogbeiwi, 2017). SMART (Specific, Measurable, Attainable, Results-Based, and Time-Bound) applies as the general criteria to assess whether objectives are set effectively. As in the case of the present study, the supplemental learning material had been evaluated to be valid to a very great extent in terms of its specificity, measurability, and result-orientedness as evidenced by the computed mean of 4.80 each.

Moreover, the learning competencies being followed in the module can be greatly achieved by the many components included in the material and were highly beneficial in supplementing students' understanding of the topics that would consequently lead to the attainment of the objectives set in CG-MELCs by DepEd. Likewise, these inferences are supported by DepEd Order No. 42, s. 2017 titled, *National Adoption and Implementation of the Philippine Professional Standards for Teachers* in which within is stated in the fourth domain that educators must ensure that the teaching-learning process will spur learning outcomes that are aligned with the target learning competencies.

Content refers to the different learning topics covered in the supplemental learning resource material in Chemistry. Table 6 shows the descriptive statistics for this second criterion of expert validation.

Table 6: Experts Validation in terms of Content

Criteria	Mean	Verbal Interpretation
The content leads to the attainment of the objectives of the course.	4.80	To a very great extent
There is adequate presentation/discussion of the content.	4.80	To a very great extent
The ideas, concepts, and points are well-expressed.	4.80	To a very great extent
The learning resource emphasizes both the process and the background.	5.00	To a very great extent
The material incorporates the concept of critical thinking and high-order thinking skills.	4.40	To a great extent
Grand Weighted Mean	4.76	To a very great extent

The computed grand weighted mean of 4.76 in this indicator means that the pool of validators rates the content of this supplemental learning resource as valid to a very great extent. This result specifically means that the content of the material is in congruence with achieving the learning competencies set.

This could also indicate that the material has adequate presentation and/or discussion of the content, in which the ideas and concepts were well-expressed. The content was validated to be focusing both on the problem-solving process and theoretical background in every topic, hence nurturing the critical thinking and higher-order thinking skills of the students. Such development of skills is highly supported by certain provisions of the PPST, specifically in the first domain, which asserts that the content shall be developed to promote critical and higher-order thinking skills that contribute to effective lesson delivery.

Language use refers to how well-organized and -expressed the ideas are in connection to the content, context, and reader of the material. It also covers, in this case, the effective use of conversational Filipino in the discussion component of the module, as one of its distinguishing features. Table 7 shows the descriptive statistics for the third criterion of expert validation.

The computed grand weighted mean of 4.83 in Table 7 indicates that the expert validators rated the language use of the supplemental learning material to be valid to a very great extent. As such, the experts believed that the material has instructions that are clear, unambiguous, and easy to follow for students to a very great extent as evident in the computed mean of 5.0, which was the highest possible score for that specific indicator.

Table 7: Experts Validation in terms of Language Use

Criteria	Mean	Verbal Interpretation
Instructions to students are clear, unambiguous, and easy to follow.	5.00	To a very great extent
The words, grammar, and mechanics are correct and accurate.	4.40	To a great extent
The vocabulary used is suitable to the reading and understanding level of students to whom the learning resource is intended.	4.80	To a very great extent
The vocabulary and grammar used in the learning resource are contextualized.	4.80	To a very great extent
The use of scientific terms and jargon are appropriately retained in the learning resource.	4.80	To a very great extent
The learning resource uses a great and accurate command of a language (e.g., Filipino) native to the intended users.	5.00	To a very great extent
The language used in the learning resource is truly a reflection of a conversational type of discussion.	5.00	To a very great extent
Grand Weighted Mean	4.83	To a very great extent

The experts rated words, grammar, mechanics, and vocabulary to be valid to a great extent. Expert validators raised several concerns and suggestions for the improvement in sentence construction within the discussion component of the module. This was addressed and followed as most of the points given by the experts were applied for the betterment of the module.

Considering other perspectives, one of the validators hinted that in the global arena, the use of the English language is of prime importance, and its use should not be left behind in the supplemental material. This was the reason why the formal definition, technical terms, and jargon were left untranslated, to signify that the use of conversational Filipino was only auxiliary, and to still allow students to be fairly familiarized with the lessons in English.

Experts also found the content valid to a very great extent in terms of the use of conversational Filipino as the integrative language of instruction. Hence, the use of jargon were appropriately retained within the module and the effective use of conversational Filipino in lesson discussion was commended as evident in the computed mean of 5.00. This positive response from the experts, with regards to the use of conversational Filipino, is a strong indication that such strategy in the teaching of science marks the effective use of the material.

Instructional Characteristics refer to the strategies, activities, materials, and tasks that are used to further ensure the effectiveness of the teaching-learning process. As such, these instructional characteristics are to be developed carefully, systematically, and skillfully. Table 8 reveals the descriptive statistics for the fourth criterion of experts' validation.

Table 8: Experts Validation in terms of Instructional Characteristics

Criteria	Mean	Verbal Interpretation
The illustrations and graphs from the learning resource enhanced its educational value.	5.00	To a very great extent
The topics are properly and orderly sequenced.	4.40	To a great extent
The design of the learning resource is appropriate and creative.	4.80	To a very great extent
The learning resource provides a topic summary to reinforce students' learning.	4.80	To a very great extent
The learning resource provides examples that ensure students' mastery of lessons.	4.60	To a very great extent
Grand Weighted Mean	4.72	To a very great extent

As disclosed in Table 8, a grand weighted mean of 4.72 was the overall rating of the experts in the instructional characteristics of the material, which means that the module was valid to a very great extent in that specific criterion. Experts credited the illustrations and graphs, together with their creative and appropriate design, as an enhancement to the educational value of the material. This was evident in the computed mean of perfect 5.0 and 4.80 respectively in those two indicators.

The development of a supplementary material requires reliance on the curriculum guide for teaching the first part of Physical Science, which was currently in the form of the *Most Essential Learning Competencies* (MELCs) set by DepEd. This MELCs was followed in the material, and hence most of the expert validators found the sequence of topics to be proper and orderly. However, one validator working in a university noted that there may be a more logical and better sequence of topics for this material. The suggestion is to follow the usual flow of discussion in standard reference Chemistry textbooks at the collegiate level, which is significantly deviant to the MECs-based spiral curriculum in K to12. However since the supplemental material is intended for Senior High School students, the suggestion was set aside and the DepEd-based sequence of topics was followed.

In the same light, the provision of lesson summary and varying examples within the module was also rated to be valid to a very great extent with a computed mean of 4.60 and 4.80 respectively. Such inclusions are also meant to strengthen student's understanding of the key concepts of each lesson in the material. Usability refers to the extent to which a material or product can be used effectively and efficiently by its specified users in a specific context of use to achieve a specific goal. In simple terms, it covers how effective the material is considering the level of cognition of Grade 12 non-STEM students. Table 9 presents the descriptive statistics for the fifth criterion of experts' validation.

The computed grand weighted mean of 4.72 shown in Table 9 means that the expert validators found the usability of the material to be valid to a very great extent. The validators regarded the material to be extremely helpful for students to understand science topics without the issue of language barrier. Moreover, the material was deemed usable even without the help of the teacher since the explanations, examples, and summaries were written and discussed in conversational Filipino.

Table 9: Experts Validation in terms of Usability

Criteria	Mean	Verbal Interpretation
The lesson can be performed without the help of the teacher.	4.80	To a very great extent
The learning resource helps the learner to understand science topics without the use of language barriers.	5.00	To a very great extent
The explanations and examples are understandable and usable to the learners.	4.60	To a very great extent
The lessons help learners who are under or overachievers.	4.60	To a very great extent
The learning resource provides the learners with adequate guidance as they understand key scientific principles.	4.60	To a very great extent
Grand Weighted Mean	4.72	To a very great extent

This material was also found helpful by experts as it can be used by students who are under or overachievers. This serves the purpose of the material to be supplementary. Likewise, the learning resource was also rated valid to a very great extent in terms of its provision of adequate guidance to students in their understanding of key scientific principles. Acceptability refers to the adequacy and sufficiency of the material to meet the requirements of its target users. In this case, the experts validated the material as to the extent of acceptability it has to cater to the students under the non-STEM strands given their level of cognition, background, diversity, and interests. Table 10 presents the descriptive statistics for the sixth criterion of experts' validation.

Table 10: Experts Validation in terms of Acceptability

Criteria	Mean	Verbal Interpretation
The learning resource makes learning Science interesting and easy.	5.00	To a very great extent
The discussion of topics is appropriate to the learners' level of cognition.	4.80	To a very great extent
The lessons are compatible with the background knowledge and level of the learners.	4.80	To a very great extent
The learning resource is sensitive to the cultural background of the learners.	4.60	To a very great extent
The learning resource explicitly utilized the use of a native language as a strategy for better and more meaningful learning.	5.00	To a very great extent
Grand Weighted Mean	4.84	To a very great extent

The computed grand weighted mean in this criterion is 4.84 which indicates that the expert validators appraised the material to be valid to a very great extent in terms of acceptability. Additionally, the validators appraised the material with a perfect score of 5.00 for its features of making science interesting, easy to learn, and meaningful via the use of a native language as a strategy. This is in concurrence with the validation in criterion 3 on language use where the utilization of conversational Filipino in the material was also commended.

Further, it was also viewed that the material is appropriate to the learners' level of cognition and is compatible with the background knowledge and level of the learners, as evident in a score of 4.80 in each specific indicators. The consideration of the cognitive level of learners is an important aspect in the development of the module as it is necessary to match the content of the module to their level of understanding as Grade 12 non-STEM learners.

In another perspective, the material is also rated valid to a very great extent with regard to its sensitivity to the cultural background of the learners. While this indicator only scored a mean of 4.60, the lowest among the indicators in this criterion, it was still acclaimed by the validators.

The summary of the experts' validation presented in Table 11 shows the comparison among the totality of the learning resource's quality in terms of the criteria in the validation tool. Additionally, these criteria were conveniently ranked from the highest to the lowest score for an easy interpretation and analysis of results:

Table 11: Overall Experts' Rating of the Supplementary Learning Resource in Chemistry

Criteria	Mean	Verbal Interpretation
Acceptability	4.84	To a very great extent
Objectives	4.83	To a very great extent
Language Use	4.83	To a very great extent
Content	4.76	To a very great extent
Instructional Characteristics	4.72	To a very great extent
Usability	4.72	To a very great extent
Overall Mean	4.78	To a very great extent

The criterion with the highest weighted mean of 4.84 was acceptability. This means that the material's acceptability by the experts was valid to a very great extent. The second highest scorers were the module's objectives and language use. Both indicators tied up to a score of 4.83, a 0.01 interval as compared to the highest-ranking criterion. This shows that the objectives and the effective use of language were rated valid to a very great extent. The next highest scorer by the validation of experts was the module's content, which was regarded to be valid to a very great extent with a mean score of 4.76. The least scored criteria, both tied with the mean score of 4.72, were the module's usability and instructional characteristics, where both criteria was rated valid to a very great extent. The overall weighted mean garnered by the developed module was 4.78, which means that it was generally valid to a very great extent.

End-Users Validation of the Material

The developed and expert-validated supplemental learning resource in Chemistry was validated by nineteen (19) Grade 12 non-STEM learners of Central Azucarera de Tarlac High School Main under the experimental group in terms of 2.2.1) usability, 2.2.2) acceptability, and 2.2.3) effectiveness.

Usability refers to the extent to which a material or product can be used by the target users to attain objectives with efficiency, efficacy, and satisfaction in a specific context of use. This criterion ensures that the material can be efficiently administered and utilized by the learners. Table 12 presents the descriptive statistics on the first criterion for the end-users validation of the material.

Table 12: End-users' Validation in terms of Usability

Criteria	Mean	Verbal Interpretation
The lesson can be performed without the help of the teacher.	4.79	To a very great extent
The learning resource helps the learner to understand science topics without language barriers.	4.84	To a very great extent
The explanations and examples are understandable and usable to the learners.	4.95	To a very great extent
The lessons help learners who are under or overachievers.	4.89	To a very great extent
The learning resource provides the learners with adequate guidance as they understand key scientific principles.	4.89	To a very great extent
Grand Weighted Mean	4.87	To a very great extent

The computed grand mean of 4.87 for the first criterion signifies that the students rated the supplemental learning resource to be generally usable for them, along the five specified characteristics or indicators. Students also found the material to be adequately helpful in understanding science topics without any language barrier and the help of a teacher. The material was also rated valid to a very great extent in terms of the inclusion of understandable explanations and usable examples, which are helpful both for under- and over-achievers.

This positive feedback from the learners, via their high ratings in the validation tool, agrees with the results of experts' validation as presented in Tables 9 and 11. Such agreement from the experts and end-users points out that the developed learning material is genuinely usable for Grade 12 learners.

The acceptability of the developed material for Grade 12 non-STEM students of CATHS-Main should be in consideration with the level of cognition, diversity, and interests of its intended users. Table 13 shows the descriptive statistics for the second criterion of end-users validation.

Table 13: End-users Validation in terms of Acceptability

Criteria	Mean	Verbal Interpretation
The learning resource makes learning Science interesting and easy.	4.84	To a very great extent
The discussion of topics is appropriate to the learners' level of cognition.	4.89	To a very great extent
The lessons are compatible with the background knowledge and level of the learners.	4.84	To a very great extent
The learning resource is sensitive to the cultural background of the learners.	4.89	To a very great extent
The learning resource explicitly utilized the use of a native language as a strategy for better and more meaningful learning.	4.74	To a very great extent
Grand Weighted Mean	4.84	To a very great extent

The computed grand weighted mean of 4.84 for the second criterion, as shown in Table 13, means that Grade 12 students found the material to be generally acceptable, along the five specified indicators or characteristics. In agreement with the scores of the expert-validators shown in Tables 10 and 11, the students also commend the material for its features that make learning science interesting and easy.

Likewise, the students also agreed that the material followed an appropriate level of cognition to that of the intended users through its sequential flow of lessons, and the compatibility of the lessons to the background and level of understanding of students. As such, learners were able to use the material as a helpful supplement in their study of the first six lessons of Physical Science.

The effectiveness of the supplemental learning resource in Chemistry was analyzed using 60-item pre-and post-tests of the experimental and control groups. This was to determine whether the material caused a significant difference in the scores between those students who used it and those who did not. Hypotheses were tested using t-tests at a 0.05 level of significance.

Students in both groups were comparable in that all the students had scores that fell into the same range before the study. This is seen as the pre-test mean score of the control group of 20.95 is almost the same as the pre-test mean score of the experimental group of 21.05. Statistically speaking, comparing the pre-test scores from both groups merit no significant difference as the absolute t score of 0.171 is less than the t Critical two-tail value of 2.03.

Students in the control group only used the LASs (Learning Activity Sheets) without any additional supplemental material. Pre- and post-tests were both administered to gauge the improvement in their achievement scores. The mean pre-test score of 20.95 is lower than the post-test mean score of 39.26. It also shows that since the absolute value of t Stat (20.764) is greater than the t Critical two-tail value of 2.10, the scores had a significant difference. This means that the scores of the students significantly improved, even without the use of the supplemental material.

Comparing the scores between the pre-test and post-test of students in the experimental group is compared, results show that the mean there is also a significant difference since the absolute value of t Stat of 16.9962 is greater than the t Critical two-tail value of 2.100922. This is also quite evident in the difference in the mean scores of the two tests, the pre-test being 3.68 and the post-test being 8.47. Much like what happened in the control group, the experimental group also showed significant improvement in their achievement scores. It is to be noted that the experimental group utilized the LASs alongside the supplemental learning material.

Since both control and experimental groups showed significant improvement in their test scores, with or without the use of the supplemental material, it is but necessary to determine whether the post-test scores of the two groups have significant differences. This is one way to ensure that the use of the supplemental material potentially results in a better test score.

t -test results give the post-test mean score of the control group to be 39.26, which is lower than the post-test mean score of the experimental group of 50.89. A simple comparison between these two mean scores would tell us that students in the experimental group, those who used the supplemental learning resource, had better post-test scores than those who did not use any supplemental material. In statistics, since the absolute t Stat value of 20.19 is greater than the t Critical two-tail value of 2.0208, there was a significant difference between the post-test scores of the two groups. Since the t Stat is a negative value, it means that the experimental group has generally higher scores than the control group.

Another way to gauge whether the supplemental learning material is effective or not, a comparison between the gain scores of the control and experimental group is usually done. The gain score is the difference between the post-test and pre-test scores. Gain scores represent how much a student improved in a test based on the difference between the pre-and post-test scores. t -Test results between the gain scores of control and experimental groups. Here, the control group only had 18.32 as its mean gain score, while the experimental group had a higher mean gain score of 29.79. Comparing the two, one could easily say that those students in the experimental group, who utilized the supplemental material, had better improvement in their score than those who did not use the supplemental material. Further, it was statistically determined that there was a significant difference between the two gain scores, favoring the experimental group since the absolute value of t Stat of 9.83 is greater than the 2.028 t Critical two-tail value.

Looking deeper, the mean post-test scores per topic can also be compared. Table 14 shows the summary of the mean scores of both groups per topic Six topics or lessons, as in the module and in the test questionnaire, were considered in this analysis.

Table 14: Summary of Mean Post-Test Scores Per Lesson and their Ranks

Lesson	Control		Experimental	
	Mean	Rank	Mean	Rank
1. Formation and Synthesis of Heavy Elements	6	5	8	5
2. Polarity of Molecules	7		9	
3. Intermolecular Forces and Properties of Substances	7		9	
4. Biological Macromolecules	7	2.5	9	2.5
5. Rates of Reactions	7		9	
6. Limiting Reagent	4	6	6	6

It is to be noted that the 60-item test questionnaire comprised of 10 questions in each lesson. Table 19 compares the mean post-test scores per lesson between the control and experimental group. Here, it could be seen that the lowest post-test mean score for both groups belongs to those questions about the sixth lesson, *Limiting Reagent*. This particular lesson is traditionally merited as a difficult topic because of the use of basic algebra as part of the calculation in most of its problems. Fortunately, the supplemental material was able to increase the mean score on this topic from 4 to 6.

On the other hand, the highest post-test mean scores for both groups were those under the second to the fifth lessons. Such lessons are particularly more leaning toward conceptual thinking than problem-solving. This could mean that students are more adept at answering concept-based questions than in problem which usually involves mathematical calculations.

In Table 14, the mean scores of both control and experimental groups per lesson were ranked and analyzed. Now in Table 20, the total raw scores were classified into their corresponding proficiency levels to show the significant effect of the use of supplemental material in the experimental group. This agrees with the result of t-test between the gain scores of the control and experimental groups, results showed that there was a significant difference between the two gain scores favoring the experimental group.

Table 15: Proficiency Levels of Control and Experimental Group in their Pre- and Post-Tests

Proficiency Level	Equivalent Raw Score	Control Group		Experimental Group	
		Pre-Test	Post-Test	Pre-Test	Post-Test
Outstanding (90% - 100%)	54 - 60	0	0	0	2
Very Satisfactory (85% - 89%)	51 - 53	0	0	0	10
Satisfactory (80% - 84%)	48 - 50	0	0	0	7
Fairly Satisfactory (75% - 79%)	45 - 47	0	0	0	0
Did Not Meet Expectations ($< 74\%$)	< 44	19	19	19	0

As presented in Table 15, all 38 students did not meet expectations ($< 74\%$) in their pre-test scores, as in congruence with the fact that all students had the same level of competence at the start of the experiment. The interest here now lies in the difference in the proficiency levels of students in their post-test scores, where it was clear that all 19 students in the control group still did not meet expectations ($< 74\%$) whereas in the experimental group, seven students scored satisfactorily (80% - 84%), ten students scored very satisfactorily (85% - 89%) and two students scored outstandingly (90% - 100%). The only cause, as the study is concerned with, for this difference in performance is the use of the developed and validated supplemental learning material for the selected lessons in Chemistry.

To sum up, the utilization of the material as a supplemental learning resource in the study of the first six lessons of Physical Science is deemed effective since the scores have significant differences between the pre-and post-tests and between the control and experimental groups. This further strengthens the experts' and end-users' overall rating of the supplemental learning material to be valid to a very great extent.

Conclusions

The developed learning resource in Physical Science possessed all the criteria being considered, as prescribed by DepEd and PPST, as the material is in congruence with MELCs, thereby ensuring that it is intended to be supplementary, for the benefit of Grade 12 non-STEM students. The results of the validation of experts and end-users point to a conclusion that the developed material can be an effective supplemental learning resource in understanding the key concepts in the selected Chemistry topics in Physical Science. Five experts rated the module to be exemplary in terms of its objectives, content, language use, instructional characteristics, usability, and acceptability. This ensured that the quality of the module is approved by experts in the field. The selected students, as end-users, validated the material to be valid to a very great extent in terms of its usability and acceptability. The effectiveness of the material in improving the scientific proficiency of students was also deemed significant. These end-user evaluations via a validation tool and pre/post-tests ensure that the quality of the material is perceived by its intended users.

Recommendations

Science teachers, specifically those teaching Physical Science and Chemistry, need to develop and utilize contextualized supplemental learning resources that are quality-assured and usable regardless of the learning delivery modality, as a response to the current needs of learners. The developed supplemental learning material, being rated valid to a very great extent, can serve as a reference for developing learning resources in the future and as a source of information for Science Education students and teachers. Researchers and learning resources are encouraged to integrate local community languages in both written and oral discussions, to factor out the linguistic (English) competence of the student in understanding key scientific principles. Consequently, the development of learning materials written in local language in other subjects with insufficient resources must be investigated. This learning resource must be subjected to experimental research with a greater number of participants, in their own school or local community, to determine whether such a strategy of using conversational Filipino will also be deemed effective.

Contributions of Authors

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References

- Alberto, K. L. (2019). *Development and Validation of a Contextualized Learning Resource in Creative Non-Fiction*. Tarlac State University.
- Balagtas, M., Garcia, D. C., & Ngo, D. (2019). Looking through Philippine's K to 12 Curriculum in Mathematics and Science vis-a-vis TIMSS 2015 Assessment Framework. *EURASIA Journal of Mathematics, Science and Technology Education*. doi:<https://doi.org/10.29333/ejmste/108494>
- Balce, M. E. (2010, February 26). *Teaching Quality Science Education in Filipino*. Retrieved from Multilingual Philippines: www.thelearningplace.com
- Behar, A. (2017, September 28). *The relevance of regional language in teaching*. Retrieved from Mint: www.livemint.com/Opinion/aSPk19PHjbWwIo7HB5HBxN/The-relevance-of-regional-language-in-teaching.html
- Bernardo, A., Limjap, A., Prudente, M., & Roleda, L. (2008). Students' perceptions of science classes in the Philippines. *Asia Pacific Education Review*.
- Bloom, B. (1976). *Human characteristics and student learning*. New York: Mc-Graw Hill.
- Bonney, E. A. (2015). Using mixtures of local language and English in teaching science at the lower primary level. *Research on Humanities and Social Sciences*.
- Daguiang, N., & Dekker, D. (2010, February 18-20). *Mother Tongue Based Multi-lingual Education - The Lubuagan Experience*. Retrieved September 122, 2021, from Multilingual Education-Philippines: Advocacy for Mother Tongue-Based Education: <https://mlephil.wordpress.com/2010/03/06/mother-tongue-based-multilingual-education-the-lubuagan-experience/>
- Department of Education. (2009). *Department Order No. 74, "Institutionalizing Mother-Tongue Based Multilingual Education"*. Pasig City: Central Office.
- DepEd Order 74. (2009). Institutionalizing Mother-Tongue Based Multilingual Education (MLE). (pp. 1-10). Pasig City: Department of Education.

- Duchovic, R., Maloney, D., Majumdar, A., & Manalis, R. (2008). Teaching Science to Non-Science Major - An Interdisciplinary Approach. *Journal of College Science Teaching*, 258-261.
- Etkina, E., & Mestre, J. (2004). Implications of Learning Research to Teaching Science to Non-Science Majors. *A SENSER Backgrounder for Discussion*.
- Glynn, S. M., Taasoobshirazi, G., & Brickman, P. (2007). Non Science Majors Learning Science: A Theoretical Model of Motivation. *Journal of Research in Science Teaching*, 1088-1107.
- Graber, W. (2011). German High School Students Interest in Chemistry - A comparison between 1990 and 2008. *Universidad Nacional Autonoma de Mexico*.
- Hofstein, A., & Maamlok-Namaan, R. (2011). High School Students' Attitudes towards and Interest in Learning Chemistry. *Universidad Nacional Autonoma de Mexico*.
- Holbrook, J. (1999). Promoting Scientific and Technological Literacy through the Use of Supplementary Teaching Materials. *Proceedings of the 23rd Annual Meeting of JSSE & JSSE-ICASE-PME International Joint Conference* (pp. 197-198). Japan Society for Science Education.
- Imam, O., Mastura, M. A., Jamil, H., & Ismail, Z. (2014). Reading Comprehension and Skills Performance in Science Among High School Students in the Philippines. *Asia Pacific Journal of Educators and Education*, 81-94.
- Kafata, F. (2016). An Investigation Into The Impact Of Teaching in Local Languages On Pupils And Teachers (Advantages, Challenges, Opportunities, Etc) In Selected Primary Schools In Kitwe District Of The Copperbelt Province Of Zambia. *INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH*, 5(8).
- Maponga, S. (2017, February 15). *Science, Math in vernacular, no barrier to excellence*. Retrieved from The Herald: www.herald.co.zw/science-maths-in-vernacular-no-barrier-to-excellence/
- Nkonde, E., Siluyele, N., Mweemba, M., Nkhata, L., Kaluba, G., & Zulu, C. (2018). Evaluating the Impact of Teaching and Learning of Mathematics and Science using Local Language (Language of Play) in Primary Schools in Muchinga Province, Zambia, a Case of Chinsali District. *American Journal of Educational Research*, 6(8), 1153-1163. doi:10.12691/education-6-8-14
- Ogbeiwi, O. (2017, July 12). Why written objectives need to be really SMART? *British Journal of Healthcare Management*, 23(7). doi:doi.org/10.12968/bjhc.2017.23.7.324
- Orleans, A. (2007). The condition of secondary school physics education in the Philippines: Recent Developments and Remaining Challenges for Substantive Improvements. *Australian Educational Research*. doi:https://doi.org/10.1007/BF03216849
- PISA. (2019). *PISA Results 2018*. Organization for Economic Cooperation and Development.
- Roth, K., & Garnier, H. (2007). What Science Teaching Looks Like: An International Perspective. *Science in the Spotlight*, 16-23.
- SEAMO INNOTECH. (2014). *Translation of Marie Curie's Science Lessons in Filipino*.
- Soliven, S. R. (2019). *Teaching Styles of High School Physics Teachers*. Retrieved from sammay@smu.edu.ph
- Tapang, G. (2012, January 20). *Don't teach math and science in English*. Retrieved from Science Development Net: SciDev.Net