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DEVELOPMENT AND VALIDATION OF A LOCALIZED LEARNING MODULES IN GENERAL CHEMISTRY 2



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ABSTRACT

Title: DEVELOPMENT AND VALIDATION OF A LOCALIZED LEARNING MODULES IN GENERAL CHEMISTRY 2
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The study aimed to develop and validate localized learning modules that contain the least learned competencies of students in General Chemistry 2. The least learned topics were under the four Chapters - Intermolecular Forces and Solids and Liquids, Physical Properties of Solutions, Thermochemistry, and Chemical Kinetics. The learning modules were carefully designed and followed the principles of localization and contextualization. 106 Grade 11 students used the learning modules as an attempt to improve their competencies in General Chemistry 2. Findings showed that experts rated the content very satisfactory, with means ranging from 3.25 to 4.0. The format, including print, illustration, design, layout, paper quality, and size, was also rated very satisfactory. The total score of 18.40 for presentation and organization, and 24 for overall evaluation, indicated that the learning modules meet the Department of Education standards. In addition, the t-test value to compare the pretest and posttest scores is 36.58 and the p-value is <0.05, leading to the rejection of the null hypothesis. There is a significant difference between the pretest and posttest scores. The study concludes that the localized learning modules were effective in enhancing the competencies of the students. The study recommends the development of localized learning modules in other Chemistry topics. Additionally, teachers should be trained on how to effectively integrate these localized and contextualized modules into their teaching strategies, ensuring that they can fully leverage the familiarity and relevance of the content to boost student comprehension and engagement.

Key Words: development, validation, localized learning modules, General Chemistry 2, pretest, posttest, experts



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Chapter 1 THE PROBLEM AND ITS BACKGROUND

Background of the Study

Global school closures were enforced as part of public health initiatives to contain COVID-19 and the results in education are unprecedented challenges. Government agencies are collaborating with foreign organizations, private-sector partners, and civil society to deliver education in remote places using various technologies to ensure the continuity of curriculum-based study and learning for all [United Nations Educational, Scientific, and Cultural Organization (UNESCO), 2020]. In the Sustainable Development Goals (SDG) Progress Report of 2022, it is estimated that 147 million children missed more than half of their in-class instruction over the past two years and school closures affected girls, children from disadvantaged backgrounds, those living in rural areas, children with disabilities and children from ethnic minorities more than their peers. These devastating consequences of the global crisis in the education systems have affected children's learning and well-being.

Teaching science is a challenge, especially today. While there was the gradual resumption to full face-to-face classes, there are learning gaps that teachers must address to ensure students' acquisition of science competencies which they need as they go higher in the educational ladder and as they live in a world where knowledge of science is needed to cope with life-threatening problems such as environmental pollution and climate change. The learning gaps are attributed to problems of learning quality transfer, module distribution, and retrieval, students' difficulties in following instructions, power disruption, internet connection, and health risks posed by the viral pandemic.

The myriad of problems faced by science educators is being felt worldwide. The problems include the low performance of students in science achievement tests; unavailable books and classroom resources that are appropriate for the students; the preparation and training of science teachers; and political and religious opposition to cutting-edge science instruction; and the need to meet standards and prepare students for standardized examinations (Anderman & Sinatra, n.d.).

One of the identified problems in science teaching is the lack of learning materials that are appropriate for the students. In the article of the National Academies of Sciences, Engineering, and Medicine (2022), the importance of learning materials in science was presented. Accordingly, instructional materials for K to 12 science must include textbooks, laboratory manuals, other books about scientific matters, kits, software, CDs, and other multimedia materials, such as videos, that provide equipment and materials for specific inquiry-based lessons.

The Department of Education in the Philippines has streamlined the K to 12 Curriculum into the Most Essential Learning Competencies (MELCs) which is a result of a curriculum review for two years as accelerated by the response to the challenge of delivering learning in the time of COVID-19. This response to the overlaps and congestion of the K to 12 Curriculum. MELCs serve as a supplementary guide for teachers as they address the instructional needs of learners considering various settings and learning environments field implementers are urged to contextualize the MELCs which consider various settings of students, teachers, learning environments, and both the performance standards and the content, to provide Filipino students both guaranteed relevant and quality basic education amidst the pandemic (Deped, 2020).

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In addition, DepEd Order No. 018 s. 2022, "Policy Guidelines for the Provision of Learning Resources in the Implementation of the Basic Education Learning Continuity Plan (BE-LCP)" establishes the guidelines that will enable DepEd to provide learning resources in the implementation of the BE-LCP. Also, the release, utilization, and liquidation of support funds for the printing and delivery of self-learning modules and other learning resources.

To achieve the learning goals of the standard benchmarks, students, and teachers must be provided with instructional materials that reflect the standards. Moreover, teachers will be more likely to provide the requisite classroom experiences if professional development programs provided by school systems are grounded in standards-based instructional materials. However, according to Tuimur and Chemwei (2015), teaching materials needed for inquiry-based teaching are sometimes non-existent and if available, they are relatively expensive. In addition, some textbooks in science are not localized, which brings into the equation the inappropriateness of learning materials because they do not relate well with the student's life experiences.

The concept of localization and contextualization has relevance to developing instructional materials. According to Pecson (2014), students learn best when classroom experiences have meaning and relevance in their lives. Things that students do and associate with them are learnings that last for a long time. Contextualization and localization must apply the rule for learning by doing and manipulative learning. Relating and presenting a lesson helps teachers and students comprehend concepts. This is possible if lessons are within the context of the prevailing local environment, culture, and resources. Lessons are more real-life, customized, and appropriate.

Contextualized and localized teaching materials are beneficial in teaching and learning. In the study of Posadas (2019), findings showed that using contextualized and localized teaching materials help improve the academic performance of Grade VI learners. The use of localized materials motivated the learners to solve problems. The study concluded that lessons had become more real-life, customized, and appropriate on the context of the prevailing local environment, culture, and resources. Grade VI pupils were able to manipulate, relate, and adapt to various learning opportunities and resources available within the locality or community.

Being a science teacher, the researcher observed that the challenge of science teaching always relates to the inadequacy of learning resources including laboratory materials, books, and localized modules. This is felt in the school where the researcher is teaching. While there are science books and modules available, these are inadequate and are not localized.

Hence, the researcher decided to develop localized modules for General Chemistry 2. The topics covered are the least mastered/least learned competencies and concepts for the 3rd Quarter. If the localized modules for the concepts above are found effective, then, while the challenge of having scanty modules for General Chemistry 2 would not be completely addressed, it will at least provide significant assistance.

Statement of Objectives

The focus of the study is to develop and validate a localized learning module in General Chemistry 2 for Grade 11 STEM learners.

Specifically, the study has the following objectives:

1. To develop a learning module in General Chemistry 2.
2. To validate the learning module by:

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- 2.1. The Experts – in terms of:
 - 2.1.1. Content;
 - 2.1.2. Format;
 - 2.1.3. Presentation and Organization.
 - 2.1.4. Accuracy and Up-to-dateness of Information.
- 2.2. The Users – in terms of:
 - 2.2.1. Effectiveness.
3. To draw implications of the study to Science Education.

Hypothesis

There is no significant difference between the pretest and posttest scores of the students. The hypothesis was tested at a 0.05 level of significance.

Scope and Delimitation

The study developed and validated a localized module in General Chemistry 2 covering the least mastered/least learned competencies and concepts for the 3rd Quarter. The least learned competencies in the 3rd Quarter are under the topics of Intermolecular Forces and Solids and Liquids, Physical Properties of Solutions, Thermochemistry, and Chemical Kinetics. Localization refers to the researcher's attempt to provide illustrations and discussions that capture the real-world experiences and culture of the students. After the development of the module, it was subjected to experts' validation. After this, the module was used to teach General Chemistry 2 among Grade 11 students. This study employed the same group of participants to evaluate the effectiveness of the module by comparing the learners' performance in General Chemistry 2 before and after the module usage.

The localized module was tested in the 3rd Quarter which started on February 5, 2024, and ended on April 30, 2024. Before discussing each topic, the researcher administered a pretest and a posttest after the discussions. The difference in performance was analyzed to know if the localized module was effective in the students' learning acquisition.

The pretest was taken from the test banks which were previously administered to students in the past years and were modified to be more appropriate and localized.

Significance of the Study

The localized learning module will be an additional learning material to teach General Chemistry 2. Hence, the study will be significant to the school stakeholders.

To the **students**, the localized learning module will enable them access to other learning sources that will help them understand General Chemistry 2 concepts easily.

To the **Science teachers**, the findings of the study will be significant inputs to understanding students' learning needs in General Chemistry 2. Additionally, they can use the learning module developed in this study as an additional learning resource.

To the **school heads**, the findings of the study will provide information and insights that they can consider in planning and allocating resources to enhance science teaching.

To the **DepEd**, the learning module may be promoted to science teachers as an alternate learning resource for General Chemistry 2 instruction.

To **other researchers** embarking on a related study, the findings of the present study may be considered in developing their framework.

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To **the researcher**, the study will enhance her research and teaching skills. Also, conducting a study will develop her critical thinking skills which are needed to understand learners' needs and provide solutions to problems besetting science teaching.

Review of Related Literature and Studies

Instructional materials (IMs) aid the delivery of knowledge and skills that teachers are expected to transfer to the learners. Instructional materials are essential tools that allow students to interact with words, symbols, and ideas in ways that develop their abilities in reading, listening, solving, viewing, thinking, writing, and using media and technology. In addition, IMs contribute to the overall development of learners (Marbas, 2022).

However, the lack of classroom materials is one of the problems besetting public classrooms. Mostly, teachers are spending their own money on buying materials that will sustain the productivity of the classroom. The lack of classroom materials, like books, translates into an inability for students to take books for homework. The lack of classroom materials is a negative cycle (Oden, 2022). The negative effects are seen in the academic performance of the learners.

To address the inadequacy of instructional materials, especially books, teachers may develop learning modules. Essentially, modules consist of learning materials where a particular subject is broken down into segments or units (Atha, 2021). Modules are used to organize course content by weeks, units, or a different organizational structure. Modules essentially create a one-directional linear flow of what students should do in a course. Each module can contain files, discussions, assignments, quizzes, and other learning materials. Module items can be added to the course from existing content or new content shells within the modules. Course content can be added to multiple modules or iterated several times throughout an individual module. Modules can be easily organized using the drag-and-drop feature. Elements within the modules can also be reorganized by dragging and dropping.

Self-learning modules can be useful for students who cannot physically attend classroom sessions. According to Juneja (2015), self-learning modules are important since learning is effective only when such learning happens from within and is not forced due to external circumstances. Self-learning is motivated by a desire from within which makes it useful for learners to actualize the drive and the necessary motivation from within so that such learning is enriching. In addition, the advantage of the luxury of learning at one's own pace and at a time of choosing means that learners can pick up from where they left off in addition to learning from any device or location that makes such learning a leisurely experience.

Learning modules during this time of pandemic is very useful. While there are gradual face-to-face meetings, some parents do not allow their children back to school, especially in the Philippines. Initially, the Department of Education (DepEd) only allowed 100 public schools to take part in its pilot run of face-to-face classes in November 2021. Only five thousand students went back to the physical classroom. However, with the current wave of COVID-19 cases due to the Omicron variant still being managed, in-person classes have been disrupted again. The Philippine national government has no choice but to continue to rely on remote learning. This has set the Philippines back in attaining UN Sustainable Development Goal (SDG) 4: Quality Education which aims to achieve inclusive and equitable quality education and to promote lifelong educational opportunities for all (Yacub and Eadie, 2022).

One of the benefits of using modules for instruction is the acquisition of better self-study or learning skills among students. Students engage themselves in learning the concepts

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presented in the module. They develop a sense of responsibility in accomplishing the tasks provided in the module. With little or no assistance from others, the learners progress on their own.

Another beneficial feature in developing learning modules is the contextualization or localization principle. According to Perin (2013), contextualization can strengthen the links between the learning environment and the community. Materials for the provision of teaching in the classroom are essential aspects of any interaction to acquire learning. It has been proven by making learning in school relevant and meaningful. To learner's everyday lives and needs, the interaction among the learners, society, and school will become a more active and enriching experience.

Localization on the other hand is a subfield of contextualization, wherein teachers utilize local knowledge, material, language, and culture in designing curriculum instructions (Pardilla, 2020). The teaching-learning process greatly depends on the instructional materials utilized by the teacher. If the materials are readily available and students can access all of them, learning is highly possible. In developing learning modules, it is thus beneficial to students if they can relate to the illustrations presented.

The Department of Education also encourages teachers to develop localized instructional materials. Teachers must be able to relate learning content specified in the curriculum to local information and materials in the learners' community. Section 10.2 of the Implementing Rules and Regulations (IRR) of Republic Act (RA) 10533 states that "Curriculum shall be contextualized and be flexible enough to enable and allow schools to localize and enhance the curriculum based on their respective educational and social contexts" (City Schools Division of Dasmariñas, 2019).

A study by Abdelmohsen (2020) developed and tested the validity of a module on enhancing the students' collaboration, critical thinking, and writing skills. The Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model was used to develop the module. The study participants were 20 students who studied English at a private college in Oman. The study employed a pretest-posttest quasi-experimental design to determine if the learning module was effective in teaching English to the participants. Results showed that there is a statistically significant mean difference between the mean scores of the pretest and posttest. Further, it was found that the module has good validity and reliability.

Similarly, a study by Gustiani et al. (2017) intended to investigate and validate simple machine instructional material based on Science, Technology, Engineering, and Mathematics (STEM) framework that guides to help students learn and practice for real life and enable individuals to use knowledge and skills they need to be an informed citizen. The study consisted of one class of 8th graders at a junior secondary school in Bandung, Indonesia. To measure student learning, a pre-test and post-test were given before and after the implementation of the STEM-based instructional material. A questionnaire of students' responses towards instructional material was given to students and teachers at the end of the instructional material reading session to measure layout aspects, content aspects, and utility aspects of instructional material for being used in the junior secondary school classroom setting. The results showed that the readability aspect and students' response towards STEM-based instructional material were categorized as very high. Pretest and posttest responses revealed that students retained significant amounts of information upon completion of the STEM instructional material. The student's overall learning gain is 0.67 which is categorized as moderate. In summary, the STEM-based instructional material that was developed is valid enough to be used as educational materials necessary for conducting effective STEM education.

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In this study of Torre Franca (2017), instructional modules on two content areas of Algebra taught to second-year high school students were developed and validated. Specifically, module 1 consisted of 11 lessons on Rational Expressions, and module 2 consisted of nine lessons on Variations. Findings revealed that all the evaluators strongly agreed that the instructional modules satisfied the criteria for evaluating the modules. Meanwhile, the significant change in the pretest and posttest scores of student-participants before and after they were exposed to the modules signify that the modules brought out improvement in their knowledge of Rational Expressions and Variations. Possible replication of the study to cover other topics in Intermediate Algebra is recommended.

Hoffman et al. (2017) developed, implemented, and assessed stand-alone modules that integrate quantitative reasoning into introductory Biology courses. Modules are designed to improve skills in quantitative numeracy, interpreting data sets using visual tools, and making inferences about biological phenomena using mathematical/statistical models. They also examined demographic/background data that predicts student improvement in these skills through exposure to these modules. They carried out pre/post-assessment tests across four semesters and used student interviews in one semester to examine how students at different levels approached quantitative problems. They found that students improved in all skills in most semesters, although there was variation in the degree of improvement among skills from semester to semester. One demographic variable, transfer status, stood out as a major predictor of the degree to which students improved. Pretest scores in each focus area were similar between transfer and non-transfer students. The researchers recommend that increased exposure to quantitative skill development in Biology courses is effective at building competency in quantitative reasoning.

The cited foreign studies are similar to the present study since the focus was on the development and validation of learning modules. All cited studies have their learning modules validated by experts and were used by students to determine their effectiveness. The difference lies in the subject or course that the researchers have developed. Abdelmohsen (2020) focused on developing learning modules in English; simple machines instructional material based on the Science, Technology, Engineering and Mathematics (STEM) framework for Gustiani et al. (2017); and Algebra for Torre Franca (2017). The present study will focus on developing localized learning modules in General Chemistry 2.

Locally, the study of Alovera et al. (2021) determined the validity and effectiveness of utilizing the contextualized Learning Module in Science Five for the First Grading in an elementary school. The researchers found out that the Pre-Test MPS of the experimental group was 44% or Moderately Acceptable (MA) and the Post-Test MPS was 65% or Acceptable (A). The significant difference is 21%. The Pre-Test MPS of the control was 62% or Acceptable (A). The Post Test MPS was 78% or Acceptable (A). The significant difference is 16%. Finally, the study suggested that using a developed contextualized learning module enhances learning and remediates the least mastered skills of the learners thus attaining growth in their academic performance specifically in the experimental group.

A study by Gallardi (2021) also developed and validated a self-learning module in Horticultural production for grade 9. The level of appropriateness of the developed self-learning module in Horticultural production in terms of its components such as objectives, content, discussion, activities, and assessment as rated by TLE teachers and TLE master teachers was very high. The level of validity in terms of suitability, relevance, and aesthetic value, as rated by TLE teachers was very highly validated and only highly validated as rated by TLE master teachers. There is a significant difference in the level of appropriateness and

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validity of the developed self-learning module as rated by the TLE master teachers and TLE teachers. This means that the groups of respondents have a different evaluation of the development of the self-learning module in Horticultural Production, therefore the hypothesis stating that there is no significant difference in the level of appropriateness and validity of the developed self-learning module in Horticultural production was not sustained. It is highly recommended that the developed and validated self-learning module be used as instructional materials in teaching grade 9 students as well as be used for the improvement of learning strategies as in modular modality.

Likewise, Madrazo and Dio (2020) developed contextualized learning modules for the bridging course on the identified learning gaps in Calculus with Analytic Geometry for the Bachelor of Secondary Education (BSEd) major in Mathematics. The content, format, presentations and organizations, accuracy, and up-to-date information of the learning modules passed the evaluation of 13 experts (Mathematics Professors) from the different Higher Education Institutions (HEIs) in the Bicol Region, Philippines. Also, the 18 student participants were very much satisfied with the utilization of the learning modules that bridged their learning gaps in the conic section through independent learning.

Additionally, the study of Tolentino et al. (2020) sought to develop digital modules in select topics in health education with an emphasis on hygiene among indigenous pupils in the Division of Mabalacat City, Pampanga, Philippines. Research and Development Design (R&D) was used in the study. The modules were evaluated by pedagogy experts, basic education teachers in health education, and educational technology experts in terms of three factors such as content, instructional, and technical quality. Mean scores revealed that the DMs were found to be "very satisfactory". This indicated that the developed and evaluated materials were perceived to be acceptable for mainstream use given the content and the elements.

The study of Tolentino et al. (2020) and the present study are similar in the sense that the development and validation of a learning material is the concern. Both studies also used R&D design to meet the study objectives. However, the cited study developed a learning module for Health while the present study developed localized learning modules in General Chemistry 2 lessons.

Moreover, Andrade (2019) developed and validated modules in selected topics in Earth Science for Grade 11 students. The purpose is to provide alternative ways of learning to give each learner a chance to work independently and go through to his/her own pace of learning. Findings showed that the activities helped increase the understanding of the concepts in science. The comparison of the test results in the pre-test and post-test supported the positive result that the module helped to increase the performance of learners as respondents in this study.

The study of Urbano (2019) developed and evaluated a module on Earth and Space that provides activities and lessons for students to learn and eventually improve their academic performance in science. Following the protocol of utilizing a learning material, the Module was evaluated using a set questionnaire. Based on the collected, computed, and tabulated data, the Module was described by the teacher respondents to have specific, measurable, attainable, realistic, time-bound, and relevant learning objectives. The module has simple, appropriate, and enjoyable illustrations which are logically and properly sequenced. It also provides procedures and contains available materials prescribed in the activities. Furthermore, the Module allows the learners to think logically and critically, all of which are relevant requirements for students to learn and eventually improve their academic performance. The teacher respondents strongly agreed that the evaluation portion of the

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module provides effective measurement in determining the students' understanding as it reflects behavioral activities that are highly appropriate to the learners' mental development and provides rubrics to evaluate the students objectively.

Another study conducted by Rogayan Jr. and Dollente (2016) was an attempt to develop relevant, research-based, and responsive instructional materials because few reference materials were prepared for the required senior high school competencies under the K to 12 Curriculum implementation. The authors developed a workbook in physical science for SHS based on the students' least learned concepts in a government-owned university in Central Luzon, the Philippines. Results revealed that the developed workbook was found to be very much acceptable ($M = 3.90$) by expert validators. In particular, the workbook was acceptable in terms of adequacy ($M = 3.85$), coherence ($M = 3.90$), appropriateness ($M = 3.90$), and usefulness ($M = 3.95$). Student-validators who were enrolled in a physical science course also rated the workbook acceptable ($M = 3.79$). The validated material is recommended for use as a supplemental instructional tool in physical science courses in the SHS. The material that was anchored to the analysis, design, development, implementation, and evaluation model may serve as a prototype for the development of workbooks for other courses in the K-12 SHS curriculum. The authors recommended further review and evaluation of the workbook to make it more contextualized, localized, and indigenized in the Philippine setting.

The study by Rogayan Jr. and Dollente (2016) and the present study are similar as both focused on developing learning material for science discipline and involve senior high school students. Both involve the validation of learning materials and consider the acceptability of the users. However, the present study developed localized learning modules in General Chemistry 2 while the cited study developed learning modules in Physical Science.

Conceptual Framework

Modular learning primarily considers the student's learning needs (Friestad-Tate et al., 2014). Learners want a more individualized approach to the course content, so their prior knowledge and personal characteristics are considered. Modulization generally allows students to learn at their own pace. Offering pretests for each module is a critical element of modularization.

Considering the benefits of modular learning, the researcher decided to develop learning modules in General Chemistry 2 that teachers can use over face-to-face classes or modular distance learning environments. The Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model was used to develop the module. Aside from the development of learning modules, the study then focuses on the validation of the learning modules. Figure 1 shows the framework of the study.

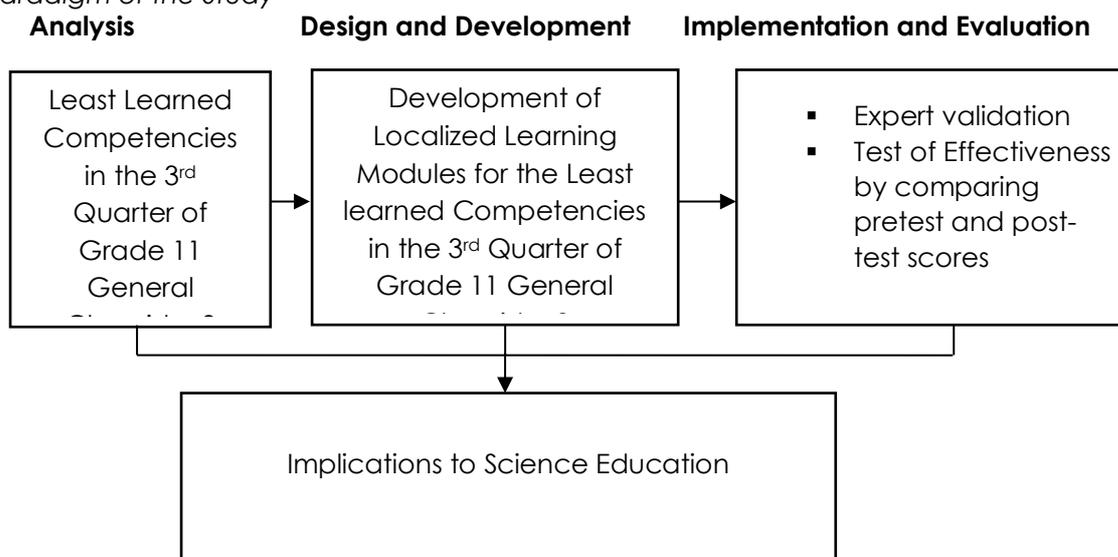
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Figure 1
Paradigm of the Study



As seen in Figure 1, the first part of the study is the development of localized learning modules in General Chemistry 2 for the Grade 11 students. The learning modules shall include the least mastered/least learned competencies and concepts for the 3rd Quarter under the topics: Intermolecular Forces and Solids and Liquids, Physical Properties of Solutions, Thermochemistry, and Chemical Kinetics lessons, which are the coverage of Grade 12 General Chemistry 2 in the 3rd Quarter.

After the development of the localized learning modules is validation. The researcher tapped five experts to do the face validation. Then, after the experts' validation, the students used the localized learning modules to determine their effectiveness.

The output of the study is an enhanced localized learning module in General Chemistry 2 which can be used to teach Grade 11 students.

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Chapter 2

METHODS OF STUDY AND SOURCES OF DATA

This chapter presents the research design, locale, respondents, instruments, data-gathering procedure, and data analysis techniques to be used in this study.

Research Design

The Research and Development (R&D) study design was used in this study. This R&D design refers to investigative activities that an educational institution conducts to make discoveries that can either lead to the development of new educational products like learning materials or procedures to improve existing educational products or procedures (Gulzar, 2015). The present study developed and validated localized learning modules for the least learned concepts in General Chemistry 2.

The ADDIE Model - Analysis, Design, Development, Implementation, and Evaluation was used in the development and evaluation of the localized module. The ADDIE model is a framework for creating and evaluating instructional design or instructional materials (Mc Griff, 2022). The Analysis phase serves as the basis for all other phases since in this phase, the problem must be defined during this phase, along with its origin and potential solutions. During the Design phase, a method for creating the learning module is planned to utilize the results of the Analysis phase. There must be a description of how to accomplish the educational objectives established during the analysis phase and broaden the instructional base during this step. Both the Analysis and Design phases are built upon in the Development phase. The generation of lesson plans and teaching resources is the goal of this stage. The Implementation stage is the actual use of the learning material. The last phase is the Evaluation of the outcomes of the implementation of the learning modules.

As to the testing of the effectiveness of the learning modules, the quasi-experimental one-shot design was used. Studies that try to evaluate interventions but do not employ randomization are referred to as quasi-experiments. Quasi-experiments, like randomized trials, seek to prove the relationship between an intervention and a result (Harris et al., 2006).

Research Locale

The study was conducted at Tarlac National High School, Tarlac City. Tarlac National High School or TNHS used to be named Tarlac High School, is a public secondary school in Tarlac City, Philippines. The school was established on September 2, 1902, by American Thomasites. The school is the second oldest public high school system in the country. The first principal of the school was Frank Russell White, a Thomasite teacher assigned as the deputy division superintendent for Tarlac Province in 1900 (DBPedia, n.d.).

At present, TNHS is offering Senior High School along the following Tracks: Academic, Arts and Design, Sports, Technical, Vocational, and Livelihood. For the present study, the localized learning modules for Grade 11 students were the ones in the Academic Track - Science, Technology, Engineering, and Mathematics Strand.

Participants of the Study

The participants of the study were Grade 11 Senior High School students enrolled at the Academic Track - Science, Technology, Engineering, and Mathematics Strand who are taking up General Chemistry 2, a 40-hour specialized subject for the Second Semester, of the Academic Year 2023-2024.

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Sampling Design

The sampling design employed by the researcher for the student respondents was a non-probability sampling design, specifically, convenience sampling. The respondents were only selected based on their strand which is Science, Technology, Engineering, and Mathematics. The researcher believed that by doing so, the respondents provided the needed data for this study. The participants were 106 students in two STEM sections.

Research Instrument

A mixed research instrument was used in the study. To know if the localized learning modules are effective in aiding the learning acquisition of students, a 10-item pretest/posttest was constructed for each lesson. The pretest/posttest was taken from the test bank of the Grade 11 Science teachers and was modified by the researcher to be more contextualized and appropriate for the learners. There are four chapters covered for the 3rd Quarter thus, the 50 total items were broken down into 10 questions for each of the five identified least learned competencies. The least learned competencies were based on the performance of the Batch 2022-2023 who took up General Chemistry 2. Their scores were analyzed and a frequency count was done in their quarter examination and identify the five items/questions that the learners were not able to answer correctly.

As to the experts' validation of the localized learning modules, a rubric was provided to them. The evaluation rubric is based on the Division Memorandum Number 441, series of 2019 which indicated the parameters for evaluating the Learning Resources Management and Development System (LRMDS) (Please see Appendix C).

The five experts to validate the localized learning modules were the Public Schools District Supervisor from Schools Division Office – Tarlac Province (1) Assistant Dean in a University (1), and Master Teachers (3) who are teaching in public high schools within Tarlac Province.

The District Supervisor (1) came from the Schools Division Office Tarlac Province - Curriculum Implementation Division, with a degree Doctor of Philosophy (Educational Management) handled Science and Math Subjects and been serving for 14 years. The Assistant Dean (1) came from Tarlac Agricultural University – College of Education had a degree of Doctor of Philosophy in Science Education, handled Chemistry, Science Education, and Research Courses for 30 years. The Master Teachers (3) came from the Tarlac National High School, one of them had the degree of Doctor of Philosophy in Science Education, handled Chemistry, Biology, and Research in Senior High School, and been teaching for 32 years. The other two had the degree of Master in Arts in Education, both teaching in Junior High School and handling Science such as Chemistry, Physics Biology, and have been teaching for 23 and 31 years. They were selected based on these qualifications, and most importantly, based on their responses to the request letters sent by the researcher to voluntarily validate the material.

Table 1 summarizes the profile of the expert-validators. Interviews were also conducted among them to clarify their evaluation of the localized learning modules.

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Table 1
Expert-Validators' Profile

Experts	School/Office	Department	Highest Educational Attainment	Position	Subjects Handled	Years in Service
E1	SDO Tarlac Province	Curriculum Implementation Division	Doctor of Philosophy (Educational Leadership)	District Supervisor	Science, Math	14
E2	Tarlac Agricultural University	College of Education	Doctor of Philosophy Science Education	Assistant Dean	Chemistry, Science Education, Research	30
E3	Tarlac National High School	Senior High School - Science	Doctor of Philosophy Science Education	Master Teacher II	Biology, Chemistry, Research	32
E4	Tarlac National High School	Junior High School - Science	Master of Arts in Education	Master Teacher II	Chemistry, Physics	23
E5	Tarlac National High School	Junior High School - Science	Master of Arts in Education - Natural Science	Master Teacher II	Chemistry	31

Data Gathering Procedure

The gathering of data commenced upon receipt of approval to conduct the study. First, the localized learning modules underwent validation by five experts (one in terms of content, format, presentation and organization, accuracy, and up-to-datedness information). The five experts were provided with a validated rubric to guide them in their evaluation. This took around two weeks. All the comments and suggestions of the experts were considered by the researcher in revising the module. The experts also evaluated the pretest/posttest before administering it to the actual respondents.

In addition, sixty (60) students from the Grade 11 Science, Technology, Engineering, and Mathematics (STEM) took the test in the same quarter where the study was conducted. The purpose of the pilot testing and item analysis is to assess the quality of an item and the test. All the comments and suggestions of the experts were considered by the researcher in revising the modules and test questions.

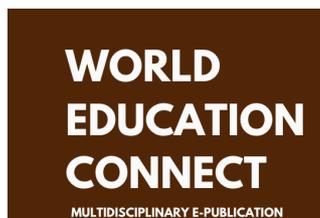
After the experts validated the localized learning modules, the researcher used them to teach General Chemistry 2 for the 3rd Quarter. Before using the localized learning modules, a pretest was administered, and a posttest followed using the localized learning modules. Since there are four chapters to be covered for the 3rd Quarter, one competency was identified as least learned in Chapter 1 Intermolecular Forces of liquids and Solids, two competencies in Chapter 2 Physical Properties of Solutions, one competency in Chapter 3 Thermochemistry and one competency for Chapter 4 Chemical Kinetics for a total of five least learned competencies. 10 items for each competency were allotted for the pretest and posttests which were composed of 50 items. The pretest and posttest performances were

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compared to know if the learning modules were effective in enabling students to understand the chemistry concepts covered in the localized learning modules. The use of localized learning modules was used in the discussions for eight weeks.

All the data gathered underwent statistical computations to aid in the interpretation. The results of the data analysis were presented in tables and texts.

Data Analysis

The data from the pretest and post-test scores of the students were analyzed using frequency and percentage.

The data from the experts' validation of the localized learning modules were analyzed using a weighted mean. The formula is as follows:

The formula according to Altares (2004) is:

WM=

Where:

$$\frac{\sum TWf}{N}$$

N:

WM: weighted mean

TWf: total weighted frequency; the sum of weighted frequency total number of respondents

Based on the Evaluation Rating Sheet for Print Resources, the modules were validated by the Experts – in terms of Content and the seven parameters that must score at least 21 points out of 28, Format, and the eighteen parameters, which the material must score at least 54 points out of a maximum 72 points, Presentation and Organization, and the five parameters and must score at least 15 points out of a maximum 20 points to pass the respective criterion. The range of weighted mean has the following descriptive ratings based on the standard evaluation rating from the DepEd for developed LRMS.

Table 2

Numerical Equivalent and Descriptive Rating in terms of Content, Format and Presentation and Organization

Numerical Equivalent	Range	Descriptive Rating
4	3.25– 4.00	Very satisfactory
3	2.50 – 3.24	Satisfactory
2	1.75 – 2.49	Poor
1	1.00 – 1.74	Not satisfactory

In terms of Accuracy and Up-to-date Information with the six parameters, the modules were validated by the experts and must score 24 out of a maximum of 24 points to pass the criterion. Comments and recommendations of the Experts that were not captured on these four factors were accepted and integrated with the modules. The range of weighted mean has the following descriptive ratings based on the standard evaluation rating from the DepEd for developed LRMS.

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Table 3

Numerical Equivalent and Descriptive Rating in terms of Accuracy and Up-to-date Information

Numerical Equivalent	Range	Descriptive Rating
4	3.25– 4.00	Not Present
3	2.50 – 3.24	Present but very minor and must be fixed
2	1.75 – 2.49	Present and requires major redevelopment
1	1.00 – 1.74	Poor, do not evaluate further

To compare the pretest and post-test of the students, the T-test for dependent means shall be used. The following is the formula for the t-test dependent samples:
The formula for the paired t-test is:

$$t = \frac{\sum d}{\sqrt{\frac{n(\sum d^2) - (\sum d)^2}{n-1}}}$$

Where $\sum d$ is the sum of the differences and n = the number of participants.

Research Ethics

To ensure that ethics is properly observed in the study, the researcher protected the identity and confidentiality of the respondents. Their names did not appear in any part of the research report and participation was voluntary. Hence, students were not forced to participate. In addition, the researcher sought the informed consent of the parents and the assent of the student respondents.

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Chapter 3

PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

This section of the study presents the data interpretation on the validation and evaluation of learning modules in General Chemistry 2 for Grade 11 Students.

1. The Development of the Learning Modules

Analysis of the Learning Gaps

The modules were developed based on the least learned concepts from the First Quarter, SY 2022-2023. Table 4 shows the Report on Least Learned Competencies for the First Quarter.

Table 4

Least Learned Competencies in General Chemistry 2, First Quarter SY 2022-2023

Rank	Least Learned Competencies
1	Calculate boiling point elevation and freezing point depression from the concentration of a solute in a solution
2	Calculate the change in enthalpy of a given reaction using Hess Law
3	Use different ways of expressing the concentration of solutions: percent by mass, mole fraction, molarity, molality, percent by volume, percent by mass, ppm
4	Describe the following properties of liquids, and explain the effect of intermolecular forces on these properties: surface tension, viscosity, vapor pressure, boiling point, and molar heat of vaporization
5	Determine the effect of various factors on the rate of a reaction

The least learned topics are essential to the students' performance in future Chemistry topics so they must relearn them. Specifically, calculating boiling point elevation and freezing point depression from the concentration of a solute in a solution are important competencies that students need to fully understand since these are essential for many scientific, industrial, and daily applications, providing insight into the properties and behaviors of solutions.

On the other hand, calculating the change in enthalpy of a given reaction using Hess Law enables the development of the students' essential skills, deepens their knowledge of the principles of thermodynamics, and prepares them for further scientific study and real-world applications. Hess's Law connects chemistry with physics (thermodynamics) and mathematics (algebraic manipulation).

Likewise, knowledge about the different ways of expressing the concentration of solutions: percent by mass, mole fraction, molarity, molality, percent by volume, percent by

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mass, and ppm is important for the Grade 11 students since they will be equipped with essential skills and knowledge for future Chemistry studies. The lessons foster a deep understanding of chemical principles, enhance their problem-solving abilities, and prepare them for various scientific and professional fields.

Moreover, describing the properties of liquids, and explaining the effect of intermolecular forces on surface tension, viscosity, vapor pressure, boiling point, and molar heat of vaporization are important foundation topics because these are crucial foundations for more advanced topics in Chemistry and Physics.

Lastly, determining the effect of various factors on the rate of a reaction is significant in the understanding of the principles of chemical reactions. Also, high school students' interest in Chemistry may be increased as they can relate chemical reactions in daily life experiences such as spoiling of food, rusting of nails or any iron-made things, and other changes in the living environment.

Designing the Learning Modules

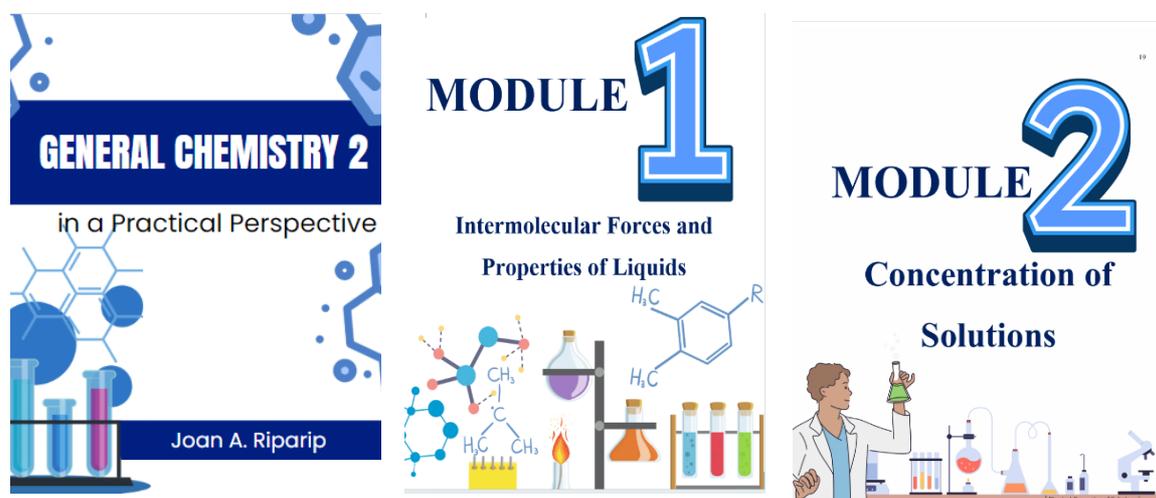
The learning modules were designed to suit the learning needs of the students. It consists of main parts such as Introduction, Pretest, Lesson Proper, Application, Posttest, and Enrichment, and which was based on the Elements and Technical Specifications of LR Module from Regional Memo No. 91 S. 2020. (Please see Appendix J). Specifications and other formats were modified by the researcher to make the learning modules more understandable to the learners.

Developing the Learning Modules

The researcher developed the learning modules following the parts from the Regional Memo No. 91 S. 2020 for several months and consultations were done with the thesis adviser for the initial draft and format. The modules were also presented to colleagues for their comments on the lay out and was then accomplished with the use of MS Word and Canva. Some of the parts of the Learning Modules are shown in Figures 2 to 6.

Figure 2

The Cover page and Learning Modules 1 and 2 Cover



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The font sizes of the learning modules were mostly big to make them more readable (Luna et al., 2019) and the letters were in pastel colors for a more relaxed mood while reading. According to Barnhart (2021), since pastel colors are less saturated, they are attributed to calmness and a peaceful vibe. In addition, pastel colors include green, yellow, brown, and white which are gender-neutral. This means that the learning modules are suitable for diverse audiences. The colors avoid reinforcing stereotypes associated with traditional gender-specific colors, promoting inclusivity and accessibility in educational materials (Velarde, 2017).

The learning modules were also localized and contextualized. In Figure 2, examples of substances or materials being discussed are known to the students. The advantage of localization in teaching was shown in the study by Dioneda Jr. (2019). Grade 7 students were more likely to show motivation and improved scores when the learning modules included situations familiar to the students.

Figure 3

Samples of Localization and Contextualization in the Learning Modules

Food Preservation

1. When processing and preserving food, boiling point elevation and freezing point depression are used.

For instance, adding salt to ice when creating ice cream lowers the freezing point of the ice, making it more capable of absorbing heat from the cream mixture and solidifying the ice cream.

Try to buy *sorbetes* in your community and ask the vendor if they really use salt in their ice.



Photo Source: Sandra Dans

Figure 6. *Sorbetes*

2. The boiling point elevation is employed in canning to guarantee that the product is sterilized at a higher temperature, extending its shelf life. Small and growing businesses make use of this concept in producing their canned products.

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The products shown in Figure 3 are familiar to the students which makes the learning modules more relevant as they can relate classroom learning to their immediate surroundings, experiences, and cultural backgrounds. Burong Isda and bagoong for instance are common in the kitchen of Tarlaqueños. According to Saro et al. (2023), the contextualized instruction approach enables the use of the crucial context of moral wisdom and the astounding Filipino values and culture.

Figure 4
Localized Discussions

Cooking

We use salt to increase the boiling point of soup of our bulalo, sinigang, etc. in that way, we can tenderize our meat faster.



Photo Source: Getty Images-Canva for Education

Figure 10. Sinigang na Baboy



Photo Source: Getty Images-Canva for Education

Figure 11. Nilagang Baka

For example: How does Brand A dishwashing liquid be compared to Brand X dishwashing liquid?



Figure 1. Dishwashing Liquids



Guide Question: Which alcohol concentration is best for disinfection?



Photo Source: Getty Images-Canva for Education

Figure 3. Rubbing Alcohol used at Home

By using situations that are known to the students, their interest is awakened, and they will eventually focus on the discussions. By embracing local contexts and cultures, education becomes more meaningful, empowering, and transformative for students.

Even the enrichments provided in every module (see example in Figure 5) used localized situations to stimulate the learners and motivate them to do the activities in the learning modules.

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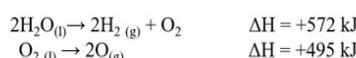
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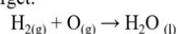
Figure 6

Sample of Steps in Performing Chemical Equations

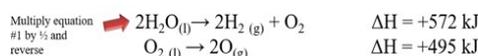
Sample Problem 4



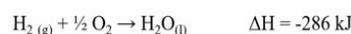
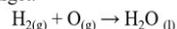
Target:



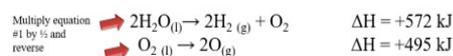
Step 1: Multiply equation #1 by ½ and reverse



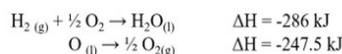
Target:



Step 2 Multiply equation #1 by ½ and reverse



Target:



Step 3 Add the individual steps

By the solution step-by-step educators students' starting with concepts gradually more ones. This approach students to their existing and skills.

presenting process in a manner, can scaffold learning, simpler and progressing to complex sequential allows build upon knowledge

Implementation

After the evaluation from experts, the learning modules were implemented among the Grade 11 students from February 5, 2024, to April 30, 2024. There were two sections included in this study. The total number of students is 106.

Evaluation

The learning modules were evaluated through their utilization with Grade 11 students' pretest and post-test scores. The students took their Pretest last February 5, 2024, and their Posttest last May 6, 2024.

2. Validation of the Modules

The learning modules were validated by five experts. They were given a rubric adopted by the Department of Education.

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2.1. By the Experts

Five experts who validated the learning modules were one PSDS, one Assistant Dean in a University, and three Master Teachers who earned their master’s or doctorate in science education and are teaching in public high schools within Tarlac.

2.2.1 Content

The content of the learning modules refers to the lessons or competencies students need to acquire in General Chemistry 2. Learning Module 1 focused on describing the properties of liquids, and explaining the effect of intermolecular forces on surface tension, viscosity, vapor pressure, boiling point, and molar heat of vaporization; Module 2 focused on using different ways of expressing the concentration of solutions: percent by mass, mole fraction, molarity, molality, percent by volume, percent by mass, ppm; Module 3 was on calculating boiling point elevation and freezing point depression from the concentration of a solute in a solution; Learning module 4 was on calculating the change in enthalpy of a given reaction using Hess Law; and the learning module 5; was confined to determining the effect of various factors on the rate of a reaction.

Table 5
Evaluation of the Modules' Content

Parameters	Mean	Verbal Description
1. Content is suitable for the student's level of development.	4.00	Very satisfactory
2. Material contributes to the achievement of specific objectives of the subject area and grade/year level for which it is intended.	4.00	Very satisfactory
3. Material provides for the development of higher cognitive skills such as critical thinking, creativity, learning by doing inquiry, problem-solving, etc.	3.40	Very satisfactory
4. Material is free of ideological, cultural, religious, racial, and gender biases and prejudices.	3.60	Very satisfactory
5. Material enhances the development of desirable values and traits such as:		
5.1. Scientific attitude and reasoning	3.80	Very satisfactory
5.2. Critical and creative thinking	3.60	Very satisfactory
6. Material has the potential to arouse the interest of the target reader.	3.60	Very satisfactory
7. Adequate warning/cautionary notes are provided in activities where safety and health are of concern.	3.40	Very satisfactory
Total Points		25.7
Interpretation		Passed

Legend: Passed	3.25-4.0 = Very satisfactory	Legend:	≥21-28 points =
	2.50-3.24 =Satisfactory		0-20 points = Failed
	1.75- 2.49 = Poor		
	1.0- 1.74 = Not satisfactory		

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The experts evaluated the content to be very satisfactory as attested by means falling within the range of 3.25 to 4.0. The experts claimed that the content is suitable for the student's level of development (4.00) and the material contributes to the achievement of specific objectives of the subject area and grade/year level for which it is intended (4.00). The high satisfaction ratings from experts imply that the content is well-regarded and meets quality standards. The perfect score of 4.00 for both suitability to the student's developmental level and contribution to specific educational objectives suggests that the material is highly effective and appropriately tailored for its intended audience. The applications for the topics can be done without the teacher's supervision, thus making it a self-learning material. This indicates a strong alignment with educational goals and reinforces the material's value in enhancing student learning outcomes.

Likewise, the modules provide for the development of higher cognitive skills such as critical thinking, creativity, learning by doing inquiry, and problem-solving (3.40). Among the parameters under this criterion, this resulted in one with the lowest mean score, and one of the validators suggested providing varied activities/problem sets that enhance numeral and critical thinking, getting rid of monotonous activities and exercises and design it to enhance their application of concepts to real life situation to promote greater and better understanding. In addition, one validator also suggested that some activities may be designed to be performed in groups, and allow learners to collaborate with their peers. These comments were integrated into the final draft of the module. The learning modules are free of ideological, cultural, religious, racial, and gender biases and prejudices (3.60). The mean computations indicate that the content of the modules based on the two indicators was very satisfactory based on the assessment from the experts. The evaluation results suggest that the modules are highly effective in fostering higher-order cognitive skills, including critical thinking, creativity, inquiry-based learning, and problem-solving, as evidenced by a mean score of 3.40. This suggests that the learning modules support inclusivity among the students and prevent partiality that may prejudice the accessibility of quality education. The learning modules then support the Sustainable Development Goal number four which is "Quality Education" for all students regardless of race, culture, and circumstances as mentioned in the study by Cologon (2020).

Additionally, the modules are commendably free from ideological, cultural, religious, racial, and gender biases, with a mean score of 3.60. These ratings indicate that the content is not only pedagogically sound but also inclusive and fair, making it suitable for a diverse student population. The overall high satisfaction from experts underscores the modules' quality and their potential to enhance equitable and advanced learning experiences.

Moreover, the materials enhance the development of desirable values and traits such as having a scientific attitude and reasoning (3.80) and critical and creative thinking (3.60). The high mean scores of 3.80 for fostering a scientific attitude and reasoning, and 3.60 for promoting critical and creative thinking, imply that the materials are effective in cultivating essential values and traits in students. This suggests that the materials are not only academically robust but also instrumental in developing well-rounded individuals equipped with important cognitive and ethical skills. The strong endorsement by experts highlights the materials' role in nurturing a thoughtful, innovative, and scientifically-minded student body, which is crucial for their overall intellectual and personal growth. According to Rogovaya et al. (2019), critical thinking plays an important role in learning among students. This enables students to analyze and appraise issues surrounding them and make informed decisions.

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Lastly, materials have the potential to arouse the interest of the target reader (3.60), and adequate warning/cautionary notes are provided in activities where safety and health are of concern (3.40). The materials' ability to captivate the target readers, indicated by a mean score of 3.60, suggests they are engaging and likely to maintain students' interest. Additionally, the inclusion of adequate warning and cautionary notes, with a score of 3.40, demonstrates a commitment to safety and health in relevant activities. This was the other parameter that resulted in a lower mean score which implies that the materials are not only engaging but also responsibly designed, ensuring that students are both interested and protected during their learning experiences therefore suggest that in this parameter, reminders and further instructions should be stated in the modules before the learners perform the tasks without or with adult/guardian supervision since most of the activities can be performed at home. The overall positive evaluation by experts highlights the materials' potential to be both stimulating and safe for students.

Based on the standard points set by the Department of Education, a total of 25.7 suggest that the content of the learning modules passed.

2.1.2 Format

The format of the learning modules refers to the prints, illustrations, design and layout, paper and binding, and size and weight. These were also included in the evaluation by the experts.

The data reflected in Table 6 shows that the experts were very satisfied with the format of the learning modules. In terms of print, the experts were very satisfied with the size of letters that are appropriate to the intended user (3.80) and the spaces between letters and words facilitating reading (4.00). The font is easy to read (3.80) and of good quality prints (3.6). The experts' high satisfaction with the format of the learning modules, as evidenced by a mean score of 3.80 for letter size appropriateness and 4.00 for readability facilitated by spacing, implies that the modules are well-designed for their intended users. The appropriate letter size and font ensure that the text is easily readable for students, reducing strain and enhancing comprehension. Similarly, the optimal spacing between letters and words and quality printing further supports smooth and efficient reading. This high level of satisfaction indicates that the design considerations effectively support readability and accessibility, making the learning experience more user-friendly and effective for students. This meaningful learning among students is supported by Echiverri et al. (2020) in their assertion that classroom participation encourages better acquisition of learning. If the learning modules can encourage classroom participation, then science learning will be more effective.

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Table 6
Evaluation of the Modules' Format

Parameters	Mean	Verbal Description
Prints		
The size of the letters is appropriate to the intended user.	3.80	Very satisfactory
Spaces between letters and words facilitate reading.	4.00	Very satisfactory
The font is easy to read.	3.80	Very satisfactory
Printing is of good quality (i.e., no broken letters, even density, correct alignment, properly placed screen registration).	3.60	Very satisfactory
Illustrations		
Simple and easily recognizable.	3.40	Very satisfactory
Clarify and supplement the text.	3.60	Very satisfactory
Properly labeled or captioned (if applicable).	3.80	Very satisfactory
Realistic/appropriate colors.	3.80	Very satisfactory
Attractive and appealing.	3.60	Very satisfactory
Culturally relevant.	3.40	Very satisfactory
Design and Layout		
Attractive and pleasing to look at.	4.00	Very satisfactory
Simple (i.e., does not distract the attention of the reader).	4.00	Very satisfactory
Adequate illustration in relation to text.	3.60	Very satisfactory
Harmonious blending of elements (e.g., illustrations and text).	3.60	Very satisfactory
Paper and Binding		
The paper used contributes to easy reading.	3.80	Very satisfactory
Durable binding to withstand frequent use.	3.80	Very satisfactory
Size and Weight of Resource		
Easy to handle.	3.60	Very satisfactory
Relatively Light	3.60	Very satisfactory
Total Points		59.40
Interpretation		Passed

Legend:
 points = Passed
 3.25-4.0 = Very satisfactory
 2.50-3.24 = Satisfactory
 Failed
 1.75- 2.49 = Poor
 1.0- 1.74 = Not satisfactory

Legend:
 ≥54-72
 0-53 points =

Based on the illustrations, the experts were very satisfied since to them these were simple and easily recognizable (3.40). Also, the illustrations clarified and supplemented the text (3.60). Illustrations were properly labeled or captioned (3.80), realistic/appropriate colors (3.80), attractive and appealing (3.60), and culturally relevant (3.40).

The experts' high satisfaction with the illustrations, reflected in mean scores ranging from 3.40 to 3.80, suggests that the visual elements of the learning modules are both effective and appealing. Simple and easily recognizable illustrations (3.40) help students quickly grasp

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concepts, while those that clarify and supplement the text (3.60) enhance understanding. Proper labeling and captioning (3.80), along with realistic and appropriate colors (3.80), ensure that the illustrations are informative and visually coherent. Additionally, the illustrations' attractiveness and appeal (3.60) engage students, and their cultural relevance (3.40) makes the content more relatable. Overall, these high ratings imply that the illustrations significantly contribute to the modules' educational effectiveness and student engagement.

As to the design and layout, the experts were very satisfied with the attractiveness (4.0), simplicity (4.0), adequate illustration of text (3.60), and harmonious blending of elements (3.60). The experts' high satisfaction with the design and layout of the modules, with perfect scores of 4.0 for attractiveness and simplicity, and 3.60 for the adequacy of illustrations and harmonious blending of elements, implies that the modules are visually appealing and well-organized. The attractiveness and simplicity ensure that the materials are engaging without being overwhelming, making them accessible to students. The adequate use of illustrations concerning the text and the harmonious blending of design elements enhance the overall readability and aesthetic appeal, contributing to a positive learning experience. This high level of satisfaction indicates that the design and layout effectively support student engagement and comprehension.

The paper and binding showed a very satisfactory evaluation. The paper used contributes to easy reading (3.80), and durable binding to withstand frequent use (3.80). The very satisfactory evaluation of the paper and binding, with mean scores of 3.80 for both ease of reading and durability, implies that the physical quality of the learning modules is well-suited for educational use. The paper's quality facilitates easy reading, enhancing the overall learning experience by reducing eye strain and making the text more accessible. The durable binding ensures that the modules can withstand frequent handling and use, making them a reliable resource for students over time. These attributes contribute to the practicality and longevity of the materials, supporting sustained and effective learning.

In terms of size and weight of resources, the learning materials were easy to handle (3.60) and relatively light (3.60). The evaluation of the learning materials in terms of size and weight, with mean scores of 3.60 for both ease of handling and lightness, implies that the resources are user-friendly and convenient for students to use. Their manageable size and lightweight nature make them easy to carry and manipulate, reducing physical strain and enhancing accessibility. This practicality supports more frequent and comfortable use, contributing positively to the overall learning experience by ensuring that students can easily and regularly engage with the materials.

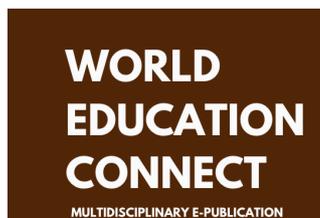
The total points earned for the format is 59.40, which indicates that the format of the learning modules was very satisfactory.

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2.1.3 Presentation and Organization

The presentation and organization of the learning modules were also included in the evaluation. Table 7 shows the findings.

Table 7
Evaluation of the Modules' Presentation and Organization

Parameters	Mean	Verbal Description
1. The presentation is engaging, interesting, and understandable.	3.80	Very satisfactory
2. There is a logical and smooth flow of ideas.	3.80	Very satisfactory
3. Vocabulary level is adapted to the target reader's likely experience and level of understanding.	3.40	Very satisfactory
4. The length of sentences is suited to the comprehension level of the target reader.	3.60	Very satisfactory
5. Sentences and paragraph structures are varied and interesting to the target reader.	3.40	Very satisfactory
Total Points		18.40
Interpretation		Passed
Legend: points = Passed	3.25-4.0 = Very satisfactory	Legend: ≥15-20
	2.50-3.24 =Satisfactory	0-14 points = Failed
	1.75- 2.49 = Poor	
	1.0- 1.74 = Not satisfactory	

The experts claimed that the presentation was very satisfactory in terms of being engaging, interesting, and easy to understand. A score of 3.80 suggests that the audience found the presentation enjoyable and comprehensible, indicating effective communication and presentation skills. The logical and smooth progression of ideas was also rated highly, with a score of 3.80. This implies that the presentation was well-structured, with a clear and coherent flow that helped the audience follow the content easily. This indicates that the learning modules were well structured and contained a clear and coherent flow of thoughts. These features helped the students understand the content easily. One of the validators also observed that the modules were easy to follow, and the ideas and discussions were also organized. According to Barroga and Matanguihan (2021), creating a coherent and seamless flow of concepts, phrases, paragraphs, and content that leads to a strong conclusion requires logical flow in the presentation of ideas.

The vocabulary used in the presentation was deemed to be suitably adapted to the target reader's experience and understanding level, scoring 3.40. While this is a positive score, it suggests there might be some room for improvement in ensuring the language perfectly matches the audience's level. According to Ellman (2019), comprehension of materials being read is highly affected by the readers' wealth of vocabulary. Hence, definitions of terms were provided before the lesson proper to ensure comprehension of the learners as they go along with the learning modules.

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The length of the sentences was appropriate for the target reader's comprehension level, with a score of 3.60. This indicates that the sentences were neither too long nor too short, striking a good balance for clarity or understanding. The variation in sentence and paragraph structures was considered interesting to the target reader, with a score of 3.40. This suggests that while the presentation was engaging in this aspect, there could be further enhancements to make the structure more dynamic and captivating.

The total score generated based on the ratings is 18.40 indicating that the presentation and organization passed the DepEd standards. This means that the presentation was highly effective in engaging the audience and presenting ideas logically and understandably. The feedback indicates solid performance in most areas, with potential minor improvements in vocabulary and structural variation to achieve even higher engagement and comprehension levels.

2.1.4 Accuracy and Up-to-datedness of Information

The accuracy and up-to-dateness of the information presented in the learning modules were assessed as well.

The learning modules were found to be completely free of any conceptual or factual errors. A score of 4.00 indicates that the content is accurate, reliable, and well-researched, providing a solid foundation for learning.

Table 8

Evaluation of the Modules' Accuracy and Up-to-datedness of Information

Parameters	Mean	Verbal Description
1. Conceptual errors	4.00	Not present
2. Factual errors	4.00	Not present
3. Grammatical errors	4.00	Not present
4. Computational errors	4.00	Not present
5. Obsolete information	4.00	Not present
6. Typographical and other minor errors (e.g., inappropriate, or unclear illustrations, missing labels, wrong captions, etc.)	4.00	Not present
Total Points		24
Interpretation		Passed

Legend: 3.25-4.0 = Not Present Legend: 24 points = Passed

2.50-3.24 = Present but very minor and must be fixed

1.75- 2.49 = Present and requires major development

1.0- 1.74 = Poor; Do not evaluate further

The modules also scored perfectly in terms of grammar and computational correctness. This means that the text is grammatically sound, and any calculations or data presented are accurate and error-free, ensuring clarity and precision.

There were no instances of obsolete information, with a perfect score of 4.00 indicating that all content is up-to-date and relevant. This ensures that learners are receiving the most current and applicable information.

The evaluation found no typographical errors or other minor mistakes such as inappropriate or unclear illustrations, missing labels, or wrong captions. A perfect score here

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means that the presentation of the material is polished and professional, with clear and accurate visuals and text. In the past, DepEd books released to students in public schools were met with criticism because of typographical errors (del Mundo, 2015). The learning modules developed by the researcher were free from typographical errors.

The total score garnered was 24, indicating that the learning modules passed the Department of Education standards. Overall, the evaluation highlights that the learning modules are of exceptional quality, with flawless content in terms of accuracy, currency, and presentation. These perfect scores across all assessed areas reflect a high level of diligence and attention to detail in the creation of the learning materials.

2.2. User performance in a test

To determine if the learning modules were effective for the learners, pretest and posttest were administered.

Table 9 shows that the pretest scores of the students have a mean of 17.92 out of a total of 50 items. Based on the 50% criterion reference. The means score failed to reach 50% of 50 items. Hence, students in the pretest failed. Only 17 had gained passing scores. The overall performance of the students in the pretest was below the expected standard, as the average score did not reach the 50% mark. This outcome may indicate a need for additional instructional support or review of the material covered, as most students did not achieve the minimum passing score.

Table 9
Pretest and Posttest Score in General Chemistry 2

Score Range	% Range	Pretest	Posttest
40 and above	90% and above	0	10
36-39	85-89%	0	12
30-35	80-84%	9	11
25-29	75-79%	8	50
Below 25	Below 75%	89	23
Mean Score		17.92	28.43
Total		106	106

In summary, the pretest results reveal that most students failed to meet the 50% criterion, highlighting potential areas for improvement in understanding or teaching the subject matter.

After the use of learning modules, students were given posttests. Based on the results, the mean score increased from the previous result. From a mean score of 17.92, the posttest rose to 28.43. This means that more students passed the post-test. However, there were still 23 students who failed the post-test. The substantial increase in the mean score demonstrates that the learning modules were effective in enhancing students' understanding and performance. The mean score of 28.43 is well above the 50% threshold (25 out of 50), indicating that, on average, students performed much better on the posttest. More students passed the posttest compared to the pretest, reflecting the positive impact of the learning modules on student

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performance. However, the fact that 23 students still failed the posttest indicates that while there was overall improvement, a significant number of students continued to struggle with the material. This suggests a need for further support or differentiated instruction to help these students achieve the passing standard.

In summary, the post-test results show marked improvement and increased passing rates following the use of the learning modules, but also highlight ongoing challenges for a portion of the student population. Further interventions may be necessary to support the remaining students who did not pass.

Table 10
T-Test Result of the Pretest and Posttest Performance

Test	Mean Score	T-test	P-value	Decision
Pretest	17.92	36.58	<0.00001	Reject Ho
Posttest	28.43			
Interpretation		<i>Significant</i>		

To test whether the pretest and posttest differed significantly, a t-test was performed. As shown in Table 10 the t-test computation is 36.58, higher than the critical value at 0.05 level of significance. This leads to the rejection of the null hypothesis. This means that the difference between the pretest and the post is significant. This is attested by a p-value which is <0.05 at 0.5 level of significance.

The results support the use of similar learning modules or educational interventions to enhance student learning outcomes. This could justify further investment in such educational tools and methodologies. Despite the overall improvement, some students still did not pass the posttest. This suggests that while the learning modules were generally effective, additional support or alternative instructional strategies may be needed for students who continue to struggle.

In summary, the t-test results demonstrate that the use of learning modules led to a significant improvement in student performance from the pretest to the posttest. This underscores the effectiveness of the intervention and suggests potential areas for further instructional enhancement to address the needs of all students.

3. Implications of the Findings

The significant improvement in test scores of the students in the posttest validates the effectiveness of the learning modules. This suggests that they are a valuable tool for enhancing student learning and comprehension.

Educational institutions may consider integrating similar learning modules into their curriculum. The success of these modules indicates that they can be an effective part of instructional strategies, potentially leading to better student outcomes.

The results encourage further development and refinement of instructional materials based on the principles used in the learning modules. This could involve creating more engaging, interactive, and tailored content to address various learning needs.

Educators might benefit from professional development that focuses on effectively implementing and utilizing such learning modules. Training teachers to integrate these tools into their teaching practice can enhance their instructional effectiveness.

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Educational policymakers and administrators may allocate more resources toward the development and distribution of similar learning modules. Investing in such educational resources can be justified by the demonstrated improvement in student performance.

Despite the overall success, the fact that 23 students still failed the posttest indicates the need for targeted interventions. Educators can identify and support students who are struggling even after the general improvement, perhaps through personalized learning plans or additional tutoring.

The findings open avenues for further research to understand why certain students did not benefit as much from the modules. Research can explore factors such as learning styles, prior knowledge, and other variables to tailor future interventions more effectively.

Educational policies could be influenced by these findings, promoting the use of evidence-based teaching aids and resources. Policymakers might encourage or mandate the use of such effective educational tools to improve overall student achievement.

The improvement in scores suggests that students were more engaged and possibly more motivated when using the learning modules. Understanding what aspects of the modules contributed most to this engagement can help in designing future educational materials.

If learning modules consistently lead to significant improvements, their continued use could contribute to long-term academic success and better preparedness for future educational challenges.

In summary, these findings support the integration of effective learning modules into educational practices, highlight the need for continued support for all students, and suggest several areas for future research and resource allocation.

CHAPTER 4

Summary of Findings, Conclusions, and Recommendations

This final chapter presents a summary of the findings, conclusions, and recommendations.

Summary of Findings

1. The least learned topics in General Chemistry 2 were Intermolecular Forces and Solids and Liquids, Physical Properties of Solutions, Thermochemistry, and Chemical Kinetics. The learning modules were carefully designed and followed the principles of localization and contextualization.
2. Validation of the Learning Modules
 - 2.1 The experts evaluated the content to be very satisfactory as attested by means falling within the range of 3.25 to 4.0. The format in terms of print, illustration, design and layout, paper and binding, and size and weight resources were also very satisfactory. Additionally, the total score generated based on the ratings is 18.40 indicating that the presentation and organization passed the DepEd standards. Likewise, the total score garnered was 24, indicating that the learning modules passed the Department of Education standards.
 - 2.2 A mean score of 17.92 in a pretest indicates that the competence of the pupils in General Chemistry 2 was low. The posttest was 28.43. This means that more students passed the post-test. However, there were still 23 students who failed the post-test.

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The substantial increase in the mean score demonstrates that the learning modules were effective in enhancing students' understanding and performance.

The t-test computation is 36.58, higher than the critical value at 0.05 level of significance. This leads to the rejection of the null hypothesis. This means that the difference between the pretest and the post is significant. This is attested by a p-value which is <0.05 at 0.5 level of significance.

3. Schools and educational institutions might consider integrating similar learning modules into their curriculum. The success of these modules indicates that they can be an effective part of instructional strategies, potentially leading to better student outcomes.

Conclusions

1. The learning modules for the least learned competencies in General Chemistry 2 were localized and contextualized. This enabled the students to understand the competencies since the materials were familiar to them.
2. The very satisfactory evaluation of the experts and high scores in post-test students suggest that the learning modules were effective.
3. Educational institutions may sustain the development of localized modules. The success of these modules indicates that they can be an effective part of instructional strategies, potentially leading to better student outcomes.

Recommendations

1. To further enhance the effectiveness of the learning modules for the least learned competencies in General Chemistry 2, localizing and contextualizing more learning materials be continued. This approach should be expanded and refined by incorporating more region-specific examples and applications relevant to students' daily lives and local environments. Additionally, teachers should be trained on how to effectively integrate these localized and contextualized modules into their teaching strategies, ensuring that they can fully leverage the familiarity and relevance of the content to boost student comprehension and engagement. Regular feedback from students should be gathered to continuously improve the contextualization of the materials, making them even more relatable and effective for future use.
2. Given the very satisfactory evaluation from experts and the high scores achieved by students in the posttest, it is recommended to:
 - 2.1. *Implement the Learning Modules Broadly*: Expand the use of these effective learning modules across other classes and schools to benefit a wider range of students.
 - 2.2. *Continuous Improvement*: Regularly review and update the modules based on ongoing feedback from both students and educators to ensure they remain relevant and effective.
 - 2.3. *Teacher Training*: Provide professional development for teachers on how to effectively use and integrate these learning modules into their curriculum, enhancing their teaching strategies and student engagement.
 - 2.4. *Monitor and Evaluate*: Establish a system for continuous monitoring and evaluation of the modules' impact on student learning outcomes, adjusting as necessary to maintain high standards of effectiveness.

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- 2.5. *Effectiveness of the Modules*: For stronger internal validity, it is recommended to test the effectiveness of the learning modules in two groups. Since the study employed the same group of participants, the Pretest-Posttest Control Group Design could be used.
3. The best practices of the researcher may be shared: Facilitate forums or workshops where educators can share their experiences and best practices regarding the use of these learning modules, fostering a community of continuous improvement and innovation in teaching.

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