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Research Paper

Development and Validation of Laboratory Manual in Life Science for Grade 11 Senior High School: An Input to Instructional Material Development

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Abstract

The primary purpose of this study was to develop and validate a laboratory manual in Life Science intended for Grade 11 Senior High School using the first three stages of the ADDIE Model. A descriptive evaluative method of research was utilized in gathering and analyzing data. Fifty (50) Science experts of the institution and experts from National High School in the Second and Third District of Laguna were selected as respondents using purposive sampling. A questionnaire checklist using Likert Scale was adopted to determine the mean acceptability level of the teacher-respondents in terms of the manual's content, organization and presentation, language and style, accuracy, up-to-datedness, and usefulness. Findings revealed that experts strongly agreed that the developed laboratory manual has sufficient content and technical qualities, making it an acceptable supplementary material in teaching life science. Meanwhile, the average weighted means for each category range from 4.27 to 4.46, which is interpreted as highly acceptable. These results suggest that the laboratory manual is well-designed, organized, and written effectively and accurately. The findings suggest that the manual is useful and provides a valuable resource for teaching Life Science.

Keywords *Laboratory manual, life science, instructional material, senior high school students, development, science education, validation*

INTRODUCTION

Instructional materials development is essential to STEM education (Huang et al., 2022). It highlights educational tools that provide students with education, knowledge, and facilitate thought processes (Bukoye, 2019). Hence, strengthening its use and development as it may serve as a principal catalyst of quality learning and education (Rotoras, 2012). Demand for this to materialize continues to grow as Filipino students repeatedly ranked lowest in international assessment in math and science, putting the country on the tail end regarding quality education (Rogayan Jr. & Dollete, 2019).

As a response, higher education teachers are encouraged to create high-quality educational materials to improve student learning skills, teaching methods (Cruz, 2014), and student performance in local and international assessments. Such implementation has been further strengthened as Philippine education transitions to a K-12 curriculum that aims to produce literate, career-ready students worldwide. The curriculum guidelines require all Filipino students to complete one year of kindergarten, six years of elementary school (grades 1-6), four years of middle school (grades 7-10) and two years of high school (Grades 11-12). High school students choose career paths that include Academic, Technical-Vocational-Livelihood, and Sports and Arts. Regardless of their path, Earth and Life Science are compulsory core subjects. However, a recent study suggests that the preparation for the development of educational resources was insufficient because the curriculum implementation was sudden and abrupt (Ednave et al., 2018).

Several studies have emphasized the effectiveness of instructional materials development in significantly improving student readiness, engagement and student learning outcomes (Asogwa et

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al., 2013; Cano, 2022; Dantic, 2023; Fryer et al., 2021). However, because these studies focus on instructional materials in general, they have yet to do much to clarify the contribution of learning experiences in the laboratory set-up and one designed specifically to the needs of students at the senior high school level. It is in this context that the study was conceptualized. A more flexible and adaptable approach like the ADDIE model was used as a guide in developing the laboratory manual as it caters for deliverables and teaching delivery receptive to students' changing needs and education's changing landscape (Kadakia & Owens, 2020). However, it is essential to note that this study failed to include the last stage of the ADDIE model, the try-out stage.

This quantitative study falls under the institution's research thrusts and priorities as part of the teaching and learning development initiatives. The study's findings will further strengthen the institution's Curriculum Instruction Development (CID) Plan through Instructional Materials (IMs) Development. In particular, a developed laboratory manual was created in response to a lack of instructional materials responsive to the needs of the Grade 11 Senior High School Students under the K-12 curriculum.

Conceptual Framework

Developing instructional materials, specifically, laboratory manuals, is essential in the Science teaching and learning process. The Instructional Design Theory outlines procedures for designing and developing instructional materials, emphasizing problem-based and student-centred learning. Additionally, the ADDIE Model is used as a basis for developing and designing the laboratory manual. Instructional theories and models play a significant role in developing materials for instructional purposes and cover all phases of good instructional design. This study aims to develop and validate material to supplement Life Science's teaching and learning conditions.

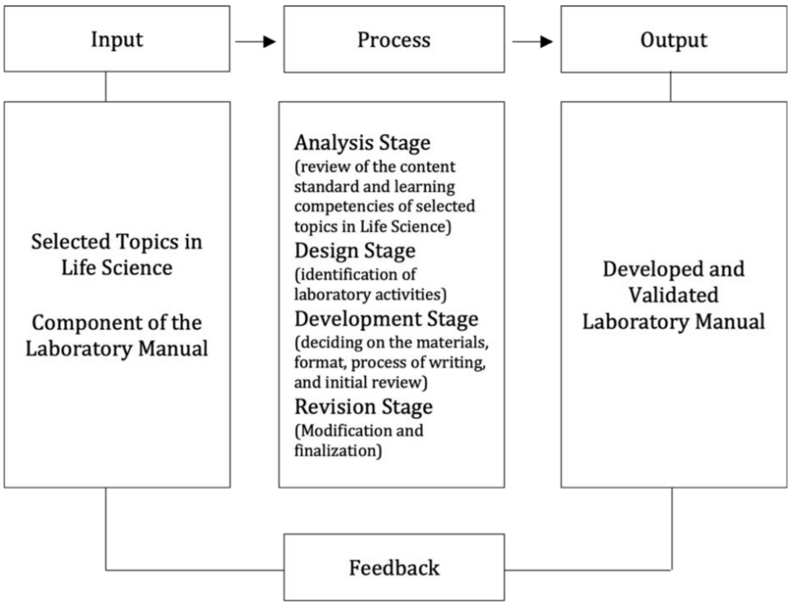

Figure 1. Research Paradigm

Figure 1 presents the Input-Process-Output (IPO) model where selected topics in Life Science were identified based on the Grade 11 Science Curriculum Guide and comprise the input (I). The process (P) included analysing, developing, and revising the Laboratory Manual for Life Science. The output (O) is the developed and validated laboratory manual.

Purpose of the Study

The study aimed to develop and validate a laboratory manual in life science for Grade 11 Senior High School students. Specifically, this study aimed to (1) describe the demographic profile of the evaluators; (2) identify the component of the laboratory manual; (3) determine the level of acceptability of the developed laboratory manual; (4) determine the overall acceptability of the developed manual as evaluated by experts.

LITERATURE REVIEW

According to Asad et al. (2021), instructional materials are anything that helps students and teachers learn in various subject areas more effectively. These materials fall under two categories: teacher-centred and student-centred. The student-centred model makes it possible to conduct tutorials, solve problems, engage in exploration, and conduct reviews. In the teacher-centred model, resources are used to present supplemental information. Resources for education make it easier to learn new information and develop new skills, claims (Boettcher & Conrad, 2021). Because of this, instructional materials are created to support textbooks and instructors rather than replace them in the student-teacher learning process.

Consistent with Asogwa et al. (2013), the most common factors that facilitate increased classroom interaction and student interest are adequate educational materials that are efficient, appropriate, and adaptable to the nature or type of students. As a result, instructional materials must be developed to students' needs, interests, knowledge, comprehension, cultural background, and language used. On the other hand, Huang et al. (2022) highlight the importance of considering both self-efficacy and metacognitive monitoring behaviours in instructional materials development to enhance academic performance.

Numerous studies prove that learning materials, besides textbooks, impact achievement. Aside from the impact of instructional materials on the success of the teaching-learning process, it also aids in attaining the instructional objectives set at the beginning of the course. Classroom activities based on real-life context will positively contribute to the student's in-depth understanding of the subject matter. Varieties of activities have to be offered depending on the interest and characteristics of students. Students from different schools vary in culture, attitude and characteristics, which is why teachers are encouraged to design instructional materials based on the nature of these learners. The ADDIE model was used to design instructional materials since numerous researchers have positively identified its success in terms of improvement in student performance, and effective execution of practical work (Suryanda et al., 2019) and knowledge acquisition (Kadakia & Owens, 2020).

The ADDIE model is a well-known approach for developing education and training programs used by instructional educators and training professionals. Its origins can be traced back to 1975 when it was first shown at the University of Florida. The model is divided into five major phases: analysis, design, development, implementation, and evaluation (Spatioti et al., 2022). In this model, each stage produces an output that influences the next stage, albeit the process does not have to be strictly sequential. This implies that designers can take a more flexible approach and may need to revisit prior phases of the development process. To detect any gaps in knowledge or abilities, the analysis stage entails obtaining information on the learners, the learning objectives, and the learning environment. Designers develop ways to accomplish the learning objectives defined in the analysis stage during the design phase. Creating learning materials, tests, and other training tools is part of the development process. These materials are presented to the learners during the implementation stage, and the efficacy is assessed during the assessment stage.

The ADDIE model is a robust and adaptable approach to varied learning environments and demands. It is frequently utilized in instructional design because it gives a systematic approach to building excellent education. Others argue that it can be excessively linear and prescriptive, failing to account for the multifaceted and dynamic nature of learning. However, it is a reliable and commonly utilized instructional design.

Many studies have investigated the educational effectiveness of laboratory work in science education in terms of facilitating the achievement of cognitive, affective, and practical goals. These studies have been critically and thoroughly reviewed in the literature. In general, these reviews show that research has been unable to demonstrate clear links between lab experiences and student learning despite the science laboratory being assigned a distinct role in science education. Some have criticized laboratory work, claiming it is ineffective and confusing because it is frequently used without a clear purpose. Consequently, several studies have found that using developed materials, such as manuals and modules, improves students' ability to complete practical work, acquire knowledge, and have more positive learning experiences. On the other hand, (Rafa, 2010) emphasized the importance of using the pre-test and post-test methods to determine the appropriateness and applicability of Instructional Materials (IMs), although using devised materials produced positive results in terms of student learning.

Before implementing the K-12 curriculum, the Philippines was one of only three countries in the world and the only country in Asia with ten years of primary education, putting students at an increasingly global level of competition. Educators and curriculum planners believe this is one of the reasons Filipino students lag behind students worldwide in math, language, and science. The poor performance of Filipino students in mathematics and science was reflected in the 2019 Third International Mathematics and Science Survey as well as the 2018 Programme for International Student Assessment (PISA) report (Philippine News Agency, 2022).

Many factors can contribute to poor student performance in local and international assessments. First, the Philippines has the shortest period of formal education (Ogena et al., 2010) and limited learning materials available to students (Iji et al., 2014). This issue can be "solved" by introducing new curricula, using improved textbooks, and employing effective and efficient teaching methods and approaches (Nwike & Catherine, 2013). The numerous references to academic works and studies in this section significantly contributed significantly to the current study by laying the groundwork for what to consider when developing instructional materials and emphasizing the importance of developing and validating them. Instructional material is critical to developing a curriculum and ensuring that teachers and students learn effectively.

Many academics and educators saw it as an effective way to improve students' learning. On the other hand, creating a laboratory manual provides a deeper understanding of the lessons, which benefits both teachers and students. The laboratory manual's design and development are somewhat similar to other manuals or modules already in use in the following ways: (1) topics covered in the manual are chosen based on the student's interests and the Life Science curriculum for Grade 11 students; (2) exercises are designed to help students improve their cognitive, affective, and psychomotor abilities and foster a positive attitude toward laboratory activities. In contrast to other available materials, student supervision is minimal because the procedures are simpler.

RESEARCH METHOD

Research Design

This study employed the descriptive evaluative method of research in analyzing the gathered data, which led to the realization of the objective to develop and validate a laboratory manual based on the Learning Program of Life Science for Grade 11 Senior High School. Descriptive research provides a detailed account of a social setting, group, community, or situation. This approach was used only to describe variables rather than to test a predicted relationship between variables (Siedlecki, 2020).

Respondents of the Study

Fifty (50) Science instructors and professors of the institution and teachers from national high schools in the Second and Third District of Laguna, particularly in Los Baños, Bay, Calauan and Calamba, were purposively selected as respondents of the study.

Research Instrument

A questionnaire – checklist was administered to gather the required data. It is composed of two parts: (a) a Socio-demographic Profile of the Respondents and (b) an Evaluation of the laboratory manual in terms of the criteria and overall acceptability of the manual. The first part of the questionnaire includes the name, age, sex, highest educational attainment, number of years in service and field of specialization of the respondents. The second part includes evaluating the laboratory manual in terms of the criteria: content/subject matter, organization and presentation, language and style, accuracy and up-to-datedness and usefulness. The questionnaire – checklist was adopted from the questionnaire of Jimenez (2008) in her study of the Development and Validation of Laboratory Manual in General Chemistry.

A few modifications to the questionnaire checklist were made to fit the data needed for the research. A 5-Point Likert Scale was employed to evaluate the laboratory manual in content, organization and presentation, language and style accuracy, up-to-datedness and usefulness.

Table 1. Scale for evaluating the developed laboratory manual

Scale	Content/ Subject Matter	Organization and Presentation	Language and Style	Accuracy and Up-to-datedness	Usefulness
5	Very Highly Sufficient	Very Highly acceptable	Very Highly acceptable	Very Highly acceptable	Very Useful
4	Highly Sufficient	Highly Acceptable	Highly Acceptable	Highly Acceptable	Useful
3	Moderately Sufficient	Moderately acceptable	Moderately acceptable	Moderately acceptable	Moderately Useful
2	Slightly Sufficient	Slightly acceptable	Slightly acceptable	Slightly acceptable	Slightly Useful
1	Not Sufficient	Not acceptable	Not acceptable	Not acceptable	Not Useful

Regarding the content/subject matter, organization and presentation, language and style and usefulness evaluation in terms of its sufficiency, effectiveness and usefulness, the ratings were interpreted respectively. On the other hand, a 9-Point Likert scale was used to determine the overall acceptability level of the manual: 9-like extremely, 8-like very much, 7-like moderately, 6-like slightly, 5- neither like nor dislike, 4-dislike slightly, 3-dislike moderately, 2-dislike very much, 1-dislike extremely. Two different scales were used based on previous studies cited in the literature review. The teacher of science, instructors and professors, experts and practitioners were asked to evaluate the developed manual.

Research Procedure

The researcher developed a laboratory manual in Life Sciences for Grade 11 students based on the subject's learning program design. The K-12 Senior High School Core Curriculum for Earth and Life Science was used as a guide to determine the exercises to be included in the manual. In particular, the subject's content and performance standards were considered to determine the design of the laboratory activities.

From there, eleven exercises were created: (1) Abiogenesis, (2) Cellular Respiration, (3) Photosynthesis, (4) Extracting DNA, (5) Membrane Transport Mechanism, (6A) External Anatomy and Support System of Vertebrae, (6B) Internal Anatomy of Vertebrae, (7) Root and Shoot System of Plants, (8) Reproductive Organs of Plants: Fruits and Seeds, (9) Natural Selection and Adaptation, (10) Effect of Pollutants on Plant Growth, (11) Population ecology. After identifying the topics, the researcher anchored the laboratory manual's development and validation using the ADDIE Model by Instructional Design Central (2012). The study employed only until the third stage: Stage 1- Preparation, Stage 2- Development, Stage 3- Validation Stage, and 4- Try-out. The last stage will be conducted as the study's second phase since the data-gathering procedure was disrupted due to the pandemic.

The preparation stage involved the identification of contents or laboratory exercises of the manual based on the K-12 Basic Education Curriculum learning competencies of Life Science for Grade 11 Senior High School. The development stage involved the following: deciding on the manual's format, the process of writing the manual and initial revisions needed to improve the first draft of the manual. Each laboratory exercise has the following parts: (a) Brief introduction, (b) Objectives, (c) Materials, (d) Procedure, (e) Report Sheet, (f) Assessment and (g) References. For the validation stage, science teachers, instructors and professors were asked to assess the manual in content, format, organization and presentation, language and style, accuracy and up-to-datedness of information and usefulness. Nevertheless, the research adviser reviewed and edited the material before the manual was validated. After that, the manual was reproduced for validation purposes.

A questionnaire checklist was made to determine the validity and acceptability of the laboratory manual in Life Science. Before administering the questionnaire, a request letter was submitted to the Dean and Principal. Data were collected and analyzed. Comments and suggestions were considered for the final revision of the manual to improve the overall package of the material.

Statistical Treatment of Data

Frequency, counts, and percentages were used on the demographic profile of the respondents. To determine the validity and acceptability of the manual as evaluated by the respondents, Average Weighted Mean and Standard Deviation were employed.

FINDINGS AND DISCUSSION

Demography of the respondents

The majority of respondents are female. According to the NCES (2021), nearly 80% of public elementary and middle school teachers are female. Most primary and secondary school teachers in the Philippines are also women. This pattern is common in the countries mentioned above and in other countries (Rich, 2014). The increase in teaching staff can be attributed to gender roles and cultural expectations of women in society (Kelleher et al., 2011).

Table 2 below shows that science teachers, instructors, and professors are either older or young adults. According to a 2014 report, the average age of faculty and staff dropped from 55 to 30 between 2008 and 2012 (Scholarly commons et al., 2018).

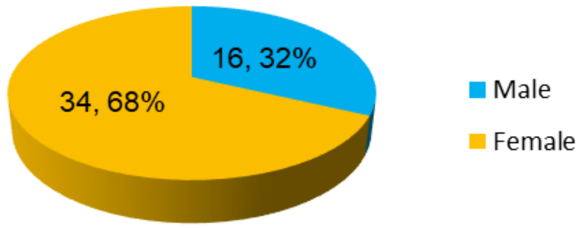

Figure 2. Gender Distribution

Table 2. Age Distribution

Age	Frequency	Percentage (%)
25-29	10	21
30-34	8	17
35-39	9	19
40-44	5	11
45-49	1	2
50-54	3	7
55-59	8	17
60-64	3	6

Table 3. Academic Rank Distribution

Academic Rank	Frequency	Percentage (%)
Teacher I	22	48
Teacher II	2	5
Teacher III	6	13
Master Teacher I	1	2
Master Teacher II	1	2
Instructor I	1	2
Instructor III	1	2
Asst. Prof. I	2	4
Asst. Prof. II	4	9
Asst. Prof IV	3	7
Assoc. Prof. III	1	2
Assoc. Prof. V	2	4

Of the 49 respondents, 22 or 45% earned units in Master's Degree, followed by 10 or 21% who had already completed their Master's Degree and have earned either Ed.D or Ph.D units. While 9 or 18% were master's degree graduates and 5 or 10% were college graduates. Very few were Ph.D/Ed.D. graduates. These data show that most respondents want to understand their skills better and improve their professional qualifications. Professional educators are encouraged to continue their professional development to meet the needs of 21st-century students.

Evaluation of the developed laboratory manual

The data indicate that all the evaluated criteria were highly sufficient, with a weighted mean score of 4.27 and a standard deviation of 0.65. One key finding from Table 4 is that the objectives are behavioural in nature. This result suggests that the developed manual's objectives are clear, measurable, and achievable. This finding is consistent with the current trend in education to use behavioural objectives to ensure that learners have specific and observable learning outcomes.

However, it would be useful to explore how these behavioural objectives are linked to higher-order thinking skills, as they are essential for learners to succeed in the workplace and higher education.

One of the primary goals of instructional materials development is to improve students' STEM content knowledge, critical thinking, and problem-solving skills. One way to achieve this is to ensure that the developed course content adheres to the K-12 curriculum and standards. This step is critical to ensuring the material's validity and dependability. Furthermore, the material's content must be aligned with the learning competencies specified by the Senior High School Basic Education Curriculum Planner. While the topics to be covered are important, framing your objectives is equally important. Objectives are established at the start of the lesson to help students understand what they need to do. As a result, these goals must be specific and measurable (Mahajan & Singh, 2017).

Table 4. Evaluation on the content of the developed manual

Content	Weighted Mean	SD	Descriptive Interpretation
1. The objectives are behavioral in nature	4.34	0.59	Highly Sufficient
2. The content lessons meet the English learning of the students.	4.24	0.59	Highly Sufficient
3. Expected learning competencies are contained in the topics	4.32	0.62	Highly Sufficient
4. Sufficient illustrative examples were provided.	4.10	0.81	Highly Sufficient
5. The topics cover the essential lessons in the subject.	4.34	0.66	Highly Sufficient
Average	4.27	0.65	Highly Sufficient

Legend: 4.51-5.0 Very Highly Sufficient; 3.51-4.50 Highly Suffiicient; 2.51-3.50 Moderately Suffiicient; 1.51-2.50 Slightly Suffiicient; 1.0-1.50 Not Suffiicient

The above findings are consistent with the Hernandez (2016) and Guido (2014) papers demonstrating the importance of developing instructional material regarding content. To ensure more valid data, the former mentioned the following: (1) there must be sufficient information about the subject, (2) the language used must be within the student's reach, and (3) the content must always be based on the student's needs, abilities, and cultural background. On the other hand, the latter stressed using simple, clear, and easy-to-understand terms and language. Overall, good instructional material should be accurate, relevant, well-defined, and standard-compliant (Sadiq & Zamir, 2014).

Table 5. Evaluation on the organization and presentation of developed manual

Organization and Presentation	Weighted Mean	SD	Descriptive Interpretation
1. Topic headings are clear and well presented	4.54	0.61	Very Highly Acceptable
2. The topics are presented in a logical and orderly sequence	4.34	0.80	Highly acceptable
3. The varied exercises are sufficient enough to realize the objectives	4.14	0.67	Highly acceptable

4. The presentation of exercises effectively reinforces the students to answer the post-lab questions	4.18	0.75	Highly acceptable
5. The illustrations, examples, figures and exercises serve as instruments to attain the learning process	4.16	0.68	Highly acceptable
Average	4.27	0.70	Highly acceptable

Legend: 4.51-5.0 Very Highly Acceptable; 3.51-4.50 Highly Acceptable; 2.51-3.50 Moderately Acceptable; 1.51-2.50 Slightly Acceptable; 1.0-1.50 Not Acceptable

The findings in Table 5 indicate that the developed laboratory manual was Highly Acceptable in terms of organization and presentation, with a weighted mean score of 4.27 and a standard deviation of 0.70. The results suggest that the developed laboratory manual is easy to understand and navigate, critical for promoting learner engagement and motivation. It also suggests that the content is structured and sequenced to facilitate learning and retention, activities are aligned with the learning objectives and provide learners with opportunities to practice, demonstrate, and apply what they have learned. Finally, the table shows that the developed manual is designed for better comprehension as it promotes the use of infographics. Materials that are simple to understand and well-organized entice students to learn more. This only means that organization is one factor for students to achieve learning competencies and capabilities. Meanwhile, to be effective, the overall format of the material must encourage students to read and interact with it. Gustiani et al. (2017) emphasized the importance of content organization, mechanics, language, and adequate illustrations (Salandanan, 2001) in encouraging students to perform better and with ease.

Table 6. Evaluation on the Language and Style of developed laboratory manual

Language and Style	Weighted Mean	SD	Descriptive Interpretation
1. The directions give clear information about the topic	4.48	0.68	Highly Acceptable
2. Language used is simple and easy to understand in terms of vocabulary and technical terminologies	4.42	0.76	Highly Acceptable
3. Language structure used avoids misinterpretations	4.46	0.79	Highly Acceptable
4. There are provisions for learning new meaning	4.46	0.71	Highly Acceptable
5. Language used is suitable to the ability of the students	4.46	0.66	Highly Acceptable
Average	4.46	0.72	Highly Acceptable

Legend: 4.51-5.0 Very Highly Acceptable; 3.51-4.50 Highly Acceptable; 2.51-3.50 Moderately Acceptable; 1.51-2.50 Slightly Acceptable; 1.0-1.50 Not Acceptable

With an average mean of 4.46 (SD 0.72), evaluators rated the developed laboratory manual highly acceptable in language and style. The table above reflects that the laboratory manual provides learning for new meanings and the suitability of the language used on the students' ability. Material presentation and visual appeal influence students' positive attitudes and activities toward learning materials (Conceição & Schmidt, 2007). These are referred to as the readability of instructional materials. Language and style, typographic presentation features, visual features, and the use of vocabulary appropriate to the student's level of understanding determine overall readability. As a result, the text becomes less readable if it (1) introduces too many concepts at once, (2) has promiscuous sentences that make deciphering its meaning difficult, and (3) has images that do not correspond to the content (Carraway et al., 2008). This means that when creating instructional materials, the end user's ability, particularly the reader's level of comprehension, must be considered.

Furthermore, communicating ideas in short sentences makes decontextualising written work easier and avoids misunderstandings. Associating the words in preparing the educational materials with the student's prior knowledge will help them read the text more easily. This includes materials with no typographical errors.

Table 7. Evaluation on the accuracy and up-to-datedness of information of developed manual

Accuracy and up-to-datedness of information	Weighted Mean	SD	Descriptive Interpretation
1. The content of the manual is accurate to the teaching and learning process.	4.37	0.64	Highly Acceptable
2. Independent learning or less teacher supervision is possible through this manual	4.06	0.77	Highly Acceptable
3. It caters the need for supplementary instructional material in Science	4.30	0.74	Highly Acceptable
4. The applications discussed in the manual are relevant to the course of the students.	4.46	0.68	Highly Acceptable
5. The manual magnifies the learning interest of the students.	4.30	0.74	Highly Acceptable
Average	4.30	0.71	Highly Acceptable

Legend: 4.51-5.0 Very Highly Acceptable; 3.51-4.50 Highly Acceptable; 2.51-3.50 Moderately Acceptable; 1.51-2.50 Slightly Acceptable; 1.0-1.50 Not Acceptable

Table 7 reflects the evaluator's mean assessment of the laboratory manual's accuracy and up-to-date information. The dates and editions of the references used, including those of the images used, can be used to determine the accuracy of the information (Carraway et al., 2008). The laboratory manual was rated highly acceptable by respondents regarding accuracy and up-to-dateness of information, with an average mean of 4.30 (SD 0.71). The respondents generally found the laboratory manual's accuracy and up-to-dateness highly acceptable. When creating self-instructional materials, one must carefully examine the subject's content and learning competencies (Marasigan, 2019). The accuracy of content is determined by objectivity, representativeness, and correctness. Objectivity is concerned with the factual and bias-free nature of knowledge and events. In contrast, representativeness concerns content based on accepted theories, laws, and standards.

Finally, correctness guarantees that the material is free of errors and inconsistencies. This includes facts, dates, names, numbers, and statistics. As suggested by Harsono (2015), the main principle of textbook development is to pique students' interest in the textbook, allowing for independent learning. Practising independence builds confidence and fast learners.

Table 8. Evaluation on the usefulness of developed manual

Usefulness	Weighted Mean	SD	Descriptive Interpretation
1. The work text makes the students interested in applications based on theories gained.	4.44	0.76	Useful
2. The work text is useful in developing skills and analysis, which are tools to effective learning.	4.32	0.71	Useful
3. The students can learn, understand and answer the exercises thoroughly by reviewing the examples and illustrations which are provided after each topic.	4.34	0.77	Useful
4. The work text is useful to supplement and reinforce the transfer of learning.	4.34	0.75	Useful
5. The worktext encourages one to work efficiently at his pace.	4.30	0.79	Useful
6. The worktext answer the students' need to understand drawing.	4.28	0.70	Useful
Average	4.34	0.75	Useful

Legend: 4.51-5.0 Very Useful; 3.51-4.50 Useful; 2.51-3.50 Moderately Useful; 1.51-2.50 Slightly Useful; 1.0-1.50 Not Useful

As presented in Table 8, the evaluators agreed that the developed laboratory manual is useful, with an average weighted mean of 4.34 (SD 0.75). These aspects included the statement that the developed manual piques students' interest in applications based on theories learned and skills that reinforce the transfer of learning.

Overall acceptability of the laboratory manual

In general, teachers, instructors, and professors who evaluated the laboratory manual gave the manual an overall acceptability rating of 8.00 (SD 0.64), interpreted as Like Very Much. Overall, the average weighted mean results for all criteria (content, organization and presentation, language and style, accuracy and up-to-date of information, and usefulness) were highly acceptable.

CONCLUSIONS

In conclusion, the research indicates that the developed laboratory manual objectives are clear, measurable, and achievable, focusing on behavioural objectives. The research also highlights the importance of developing instructional material in terms of content, language, and organization, emphasising ensuring that the material is accurate, relevant, well-defined, and standard-compliant. The findings demonstrate that the laboratory manual developed as part of the K-12 curriculum was highly acceptable regarding language and style, accuracy and up-to-dateness of information, and usefulness. It is essential to consider the end user's ability, particularly the reader's level of comprehension when creating instructional materials to ensure that they are readable, understandable, and engaging, promoting independent learning and building confident and fast learners.

LIMITATION & FURTHER RESEARCH

The study focused on the development and validation of a Laboratory Manual in Life

Science for Grade 11 students of Senior High School with the ADDIE Model as a reference framework, although the implementation and evaluation phase was not covered. Other researchers may solicit the validity and acceptability of the manual by trying it out in classroom instruction to provide insight into how effective the material is in realizing the learning competencies of the subject. Results and feedback from the end-user can be used as a basis for the improvement of the laboratory manual.

REFERENCES

Asad, M. M., Hussain, N., Wadho, M., Khand, Z. H., & Churi, P. P. (2021). Integration of e-learning technologies for interactive teaching and learning process: an empirical study on higher education institutes of Pakistan. *Journal of Applied Research in Higher Education, 13*(3), 649–663. https://doi.org/10.1108/JARHE-04-2020-0103

Asogwa V. C., Onu D. O., & Egbo B. N. (2013). Availability and utilization of instructional materials for effective teaching of fish production to students in senior secondary schools in Benue State, Nigeria. *African Journal of Agricultural Research, 8*(49), 6601–6607.

Boettcher, J. V., & Conrad, R. M. (2021). *The Online Teaching Survival Guide: Simple and Practical Pedagogical Tips* (3rd ed.). Jossey-Bass Inc.

Bukoye, R. O. (2019). Utilization of Instruction Materials as Tools for Effective Academic Performance of Students: Implications for Counselling. The 2nd Innovative and Creative Education and Teaching International Conference, 1395. https://doi.org/10.3390/proceedings2211395

Cano, J. S. (2022). Development and Validation of Simulation-Based Instructional Materials on Central Dogma of Molecular Biology for Senior High School. *International Journal of Technology in Education and Science, 6*(2), 373–387. https://doi.org/10.46328/ijtes.368

Carraway, C., Ceci., P., & Vaccari, D. (2008). *Priorities for evaluating instructional materials: Research report.*

Conceição, S. C. O., & Schmidt, S. W. (2007). *The Development and Validation of an Instrument to Evaluate Online Training Materials.* Retrieved from https://files.eric.ed.gov/fulltext/ED504339.pdf

Cruz, E. D. (2014). Development and Validation of Worktext in Drawing 2*. International Journal of Scientific and Research Publications, 4*(9).

Dantic, M. J. P. (2023). Development and Validation of Instructional Material in Astronomy. *International Journal of Multidisciplinary: Applied Business and Education Research, 4*(1), 19–26. https://doi.org/10.11594/ijmaber.04.01.03

Ednave, R. E., Gatchalian, V. M., & Mamisao, J. C. (2018). Problems and Challenges Encountered in the Implementation of the K to 12 Curriculum: A Synthesis [Undergraduate Thesis]. Saint Louis University.

Fryer, L. K., Shum, A., Lee, A., & Lau, P. (2021). Mapping students’ interest in a new domain: Connecting prior knowledge, interest, and self-efficacy with interesting tasks and a lasting desire to reengage. *Learning and Instruction, 75*, 101493. https://doi.org/10.1016/j.learninstruc.2021.101493

Guido, R. M. (2014). Evaluation of a Modular Teaching Approach in Materials Science and Engineering. *American Journal of Educational Research, 2*(11), 1126–1130. https://doi.org/10.12691/education-2-11-20

Gustiani, I., Widodo, A., & Suwarma, I. R. (2017). Development and validation of science, technology, engineering and mathematics (STEM) based instructional material. AIP Conference Proceedings, 060001. https://doi.org/10.1063/1.4983969

Harsono, Y. M. (2015). Developing Learning Materials for Specific Purposes. *Teflin Journal - A*

Publication on the Teaching and Learning of English, 18(2), 169. https://doi.org/10.15639/teflinjournal.v18i2/169-179

Hernandez, K. (2016). Development and validation of module in selected topics in Grade V Science: An impact to K-12 Program [Master's Thesis]. Laguna State Polytechnic University-Los Baños Campus.

Huang, X., Bernacki, M. L., Kim, D., & Hong, W. (2022). Examining the role of self-efficacy and online metacognitive monitoring behaviors in undergraduate life science education. *Learning and Instruction, 80*, 101577. https://doi.org/10.1016/j.learninstruc.2021.101577

Iji, C. O., Ogbole, P. O., & Uka, N. K. (2014). Effect of improvised instructional materials on students achievement in Geometry at the Upper Basic Education Level in Makurdi Metropolis, Benue State, Nigeria. *Educational Research and Reviews, 9*(15), 504–509. https://doi.org/10.5897/ERR2014.1778

Jimenez, M. S. (2008). Development and Validation of Laboratory Manual in General Chemistry [Master's Thesis]. University of Rizal System.

Kadakia, C., & Owens, L. M. D. (2020). *Designing for Modern Learning: Beyond ADDIE and SAM*. ATD Press. Retrieved from https://viewer.ebscohost.com/EbscoViewerService/ebook?an=2505498&callbackUrl=https%3a%2f%2fdiscovery.ebsco.com&db=e095mww&format=EK&profId=eds&lpid=&ppid=&lang=en&location=https%3a%2f%2fdiscovery.ebsco.com%2fc%2ffk6kem%2fdetails%2f74gsgpjv4v&isPLink=False&requestContext=&profileIdentifier=fk6kem&recordId=74gsgpjv4v

Kelleher, F., Severin, F. O., Samson, M., De, A., Afamasaga-Wright, T., & Sedere, U. M. (2011). *Women and the teaching profession: Exploring the feminisation debate*. Commonwealth Secretariat and United Nations Educational, Scientific and Cultural Organization (UNESCO)).

Mahajan, M., & Singh, M. K. S. (2017). Importance and Benefits of Learning Outcomes. *IOSR Journal of Humanities and Social Science, 22*(03), 65–67. https://doi.org/10.9790/0837-2203056567

Marasigan, N. V. (2019). Development and Validation of a Self-Instructional Material on Selected Topics in Analytic Geometry Integrating Electronic Concepts. *International Journal of Recent Innovations in Academic Research, 3*(5), 129–141.

Nces. (2021). Characteristics of Public School Teachers.

Nwike, M. C., & Catherine, O. (2013). Effects of Use of Instructional Materials on Students Cognitive Achievement in Agricultural Science. *Journal of Educational and Social Research, 3*(5), 103. https://doi.org/10.5901/jesr.2013.v3n5p103

Ogena, E. B., Lana, R. D., & Sasota, R. S. (2010). Performance of Philippine High Schools with special curriculum in the 2008 trends in International Mathematics and Sciences study (TIMSS-Advanced). 11th National Convention on Statistics.

Philippine News Agency. (2022). Solon sees need for math, science high schools in every province.

Rafa, C. F. (2010). Development and Validation of English 10. *MSEUF Research Studies, 12*(1).

Rich, M. (2014). *Why don't more men go into teaching*. The New York Times.

Rogayan Jr., D. V., & Dollete, L. F. (2019). Development and Validation of Physical Science Workbook for Senior High School. *Science Education International, 30*(4), 84–290. https://doi.org/10.33828/sei.v30.i4.5

Rotoras, R. E. (2012). Roadmap Public Higher Education Reform. https://pages.store.office.com/addinsinstallpage.aspx?assetid=WA104382081&rs=en-US&correlationId=4e21dc74-5a9b-3260-3f6f-b0856e70a41b

Sadiq, S., & Zamir, S. (2014). Effectiveness of Modular Approach in Teaching at University Level.

Journal of Education and Practice, 5(17), 103–109.

Salandanan, F. (2001). *Teacher education journal*. Katha Publishing Co., Inc.

Scholarlycommons, S., Ingersoll, R. M., Merrill, E., Stuckey, D., Collins, G., Ingersoll, R. M., Merrill, E., & Stuckey, D. (2018). *Seven Trends: The Transformation of the Teaching Force-Updated.* In CPRE Research Reports. Retrieved from https://repository.upenn.edu/cpre_researchreportsRetrievedfromhttps://repository.upenn.edu/cpre_researchreports/108

Siedlecki, S. L. (2020). Understanding Descriptive Research Designs and Methods*. Clinical Nurse Specialist, 34*(1), 8–12. https://doi.org/10.1097/NUR.0000000000000493

Spatioti, A. G., Kazanidis, I., & Pange, J. (2022). A Comparative Study of the ADDIE Instructional Design Model in Distance Education. *Information, 13*(9), 402. https://doi.org/10.3390/info13090402

Suryanda, A., Sartono, N., & Sa'diyah, H. (2019). Developing smartphone-based laboratory manual as a learning media. *Journal of Physics: Conference Series, 1402*(7), 077077. https://doi.org/10.1088/1742-6596/1402/7/077077