



Utilization of Electronic - Strategic Intervention Material (E-SIM) in Teaching General Biology for STEM Students

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DOI: <https://doi.org/10.55248/gengpi.4.1023.102621>

ABSTRACT

This study aimed to design and test the effectiveness of instructional material for STEM learners. The research objectives encompassed e-SIM development, assessment of its content, instructional, and technical quality, analysis of its effectiveness using pre-test and post-test results, and refinement of the instructional material based on evaluation and effectiveness findings. A mixed-methods research approach was utilized, with instructors evaluating the e-SIM before implementing it with a sample of 15 students. The evaluation of e-SIM's content, instructional, technical, and other aspects revealed generally satisfactory ratings, with some areas requiring improvement. The pre- and post-test results demonstrated significant improvements in students' performance in specific topics, such as Mitosis and the Circulatory System but not in Meiosis. Consequently, an action was carried out to address the identified areas for improvement, focusing on refining content, adjusting activity difficulty, and incorporating additional learning resources. The study's conclusions carry implications for instructional design, teaching practice, and future research, highlighting the potential of e-SIMs in promoting better learning outcomes in General Biology. The research emphasizes the importance of continuous evaluation and improvement of instructional materials to ensure their alignment with learners' needs and capabilities.

Keywords: ADDIE model, Biology education, instructional material, mixed-methods research, pre-post-test

INTRODUCTION

The aftermath of the COVID-19 pandemic had tremendous effects on the learning acquisition of students. It resulted in learning gaps and worsened learning crises due to the closure of schools, which halted face-to-face classes. Studies show that school closures have caused learning loss (Patrinos, 2022) and decreased student achievement (Hammerstein et al., 2021).

With the sudden change in teaching methods brought about by the pandemic, new learning modalities like Online learning, Modular distance learning, and TV and Radio-based learning were born (Llego, 2020). Teachers modified their teaching and learning strategies as the various learning modalities were implemented (Dayagbil et al., 2021). The abrupt shift to new forms of learning modalities posed several challenges for students, parents, and even teachers.

According to a World Bank report, Filipino learners still found the distance learning system ineffective more than a year after the pandemic began (Simeon, 2021). The World Bank reported that due to the COVID-19 pandemic, learning poverty in the Philippines reached a new high of 90 percent in 2021, significantly higher than the pre-pandemic level of 69.5 percent in 2019 (Vera, 2021). This is a clear indication that remote learning is ineffective, resulting in little or no progress while learning from home (Engzell et al., 2021).

According to Daniels (2021), using tried and tested strategies such as homework, tutoring, and play can help reduce the overall effect of learning loss. Furthermore, implementing remedial programs to provide additional learning support in target content learning areas (Accelerated Education Working Group, 2020). Remedial programs are additional targeted support to learners with learning difficulties than their peers and who are struggling with one or more subject areas (UNESCO, 2021).

DepEd Order No. 39, series of 2012, which governs the Philippine educational system, requires the creation of interventions to bridge learning gaps. The use of Strategic Intervention Materials (SIMs) is one of the interventions discussed. Teachers create SIMs, worksheets that focus on the skills that students have the least mastery in. SIM is a remedial tool for pupils at their comprehension level, improving their academic performance (Dacumos, 2016).

An innovative instructional learning tool called a SIM, or strategic intervention material, aims to assist students in grasping challenging courses or ideas, also known as the Least Mastered Learning Competencies. A learning tool for remediation programs is the Strategic Intervention Material (SIM), which helps students acquire learning abilities they were unable to grasp in normal sessions (Cordova et al., 2019). It is conceptualized similarly to assure and boost learning retention. The guide card, activity card, assessment card, enrichment card, and reference card make up the majority of its sections.

Electronic Strategic Intervention Material or E-SIM is a new and emerging form of remediation material. It is a digitalized and shared version of a normal SIM that can be accessed through various electronic gadgets. E-SIM is widely known to educators during the pandemic targeting to improve online learning and provide high-quality teaching and learning.

According to Bonitez (2021), students' scores in science after using Strategic Intervention Material were noticeably higher than they had been previously, indicating an improvement in their performance level. Similarly, the usage of SIM is superior than conventional education, according to studies by Mojar (2020) and Dapitan & Caballes (2019). Additionally, their data revealed that using SIM had increased student performance in science.

E-SIM is a useful instrument for boosting students' learning success, according to Dandan (2022). De Jesus (2019) also came to the conclusion that E-SIM had greatly improved student comprehension of the class in their least-mastered skills.

The results of the study of Balazo (2021) demonstrated that using eSIMath-based education in Statistics & Probability is a successful strategy to raise the accomplishment level of struggling students in addition to other fields.

The use of SIM is popular in the Philippines, however, there are few studies focusing on innovating and developing this kind of instructional material for STEM students. The idea of "no size fits all" maintains that learning materials should be diverse to cater individual learning preferences. It is for these reasons that the researcher embarks on developing Electronic Strategic Intervention Material (E-SIM) attempting to enhance learning and remedy the least mastered skills and competencies of the students. The researcher strongly believed that this instructional material would be of great help to improve the learning and understanding of STEM students in achieving the expected or intended curriculum.

Numerous studies have demonstrated the effectiveness of SIMs and E-SIMs in improving student performance and understanding of difficult concepts. However, there is a need for more research on the development of innovative instructional materials for STEM students to cater to individual learning preferences. The development of E-SIMs in the Philippines could potentially address the learning gaps and enhance the academic achievement of STEM students in the current remote learning environment.

Research Objectives

The primary objective of this study was to develop and test the effectiveness of Electronic Strategic Intervention Material (E-SIM) in enhancing the performance of Grade 11 STEM students in General Biology. To achieve this goal, the following specific research objectives were identified:

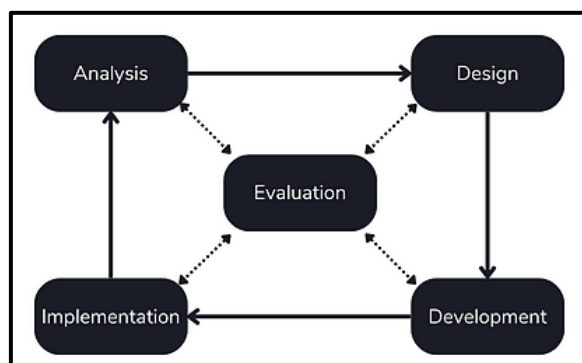
1. Design an E-SIM focused on General Biology 1 tailored to the needs of STEM learners.
2. Evaluate the developed E-SIM in terms of Content Quality, Instructional Quality, Technical Quality, and other relevant factors.
3. Assess the effectiveness of the E-SIM by comparing student performance through pre-test and post-test results.
4. Refine and improve the E-SIM based on the evaluation findings and its demonstrated effectiveness in enhancing student performance.

Research Framework

This research, which closely matches the ADDIE model, is built on the UNESCO recommended roadmap for the efficient implementation of catch-up programs. Teachers frequently utilize the ADDIE paradigm, which stands for Analysis, Design, Develop, Implement, and Evaluate, to create educational resources that support performance-based learning.

The conceptual framework of this study follows the iterative steps of the ADDIE model:

1. Analyze: Identification of Least Mastered Learning Competencies in General Biology
2. Design: Setting goals and objectives, as well as the preparation and development of content, activities, and assessment tools comprising the Electronic Strategic Intervention Materials (E-SIMs) and e-games
3. Develop: Validation of the developed E-SIMs and e-games using the DepEd LRMS Assessment and Evaluation Tool
4. Implement: Delivery of the E-SIMs and e-games to students
5. Evaluate: Measurement of the effectiveness of the developed E-SIMs in achieving the learning goals



Double-headed arrows between each stage signify the opportunity for revision based on formative evaluation, ensuring congruency and allowing the researcher to revisit earlier stages as needed. The ADDIE model is utilized in this research because it provides a systematic approach to designing, developing, and evaluating instructional materials, which is essential for creating effective E-SIMs that address the learning gaps in General Biology.

METHODOLOGY

Research Design

This study utilized descriptive and evaluative research designs. The descriptive design aimed to gather, analyze, classify, and tabulate data on prevailing conditions, practices, beliefs, processes, trends, and cause-effect relationships and then made an adequate and accurate interpretation of such data with or without the aid of statistical methods (Calderon, 1993). Evaluative design, on the other hand, focused on evaluating a product or concept and collected data to improve its quality and effectiveness.

The identification of the least mastered learning followed descriptive research. The measurement of the effectiveness of the integration of E-Strategic Intervention Material in teaching General Biology through pre-tests and post-tests, as well as the evaluation of its quality, entailed evaluative research.

Respondents of the Study

Respondents of this study were three (3) science teachers/instructors, one (1) Head Teacher, one (1) Master Teacher, and fifteen (15) Grade 11 STEM students of Governor Alfredo M. Abueg Sr. National Technology and Vocational Memorial High School enrolled during the 2nd Semester of the School Year 2022-2023. Grade 11 STEM students were purposively selected as the respondents of the study because they were the only Strand in SHS who were taking General Biology during the 2nd semester of School Year 2022-2023.

Data Gathering Tool

To collect the needed data, the following instruments were used: (1) standardized DepEd LRMDs Assessment and Evaluation tool for Instructional Material (Non-Print) for E-SIM evaluation and (2) Pre-test and Post-test to determine the effectiveness of the E-SIMs. Educational games were incorporated into the activity portion of the E-SIM.

Data Gathering Procedure

Before conducting the research and data gathering, informed consent was secured and addressed to the respondents' parents. Respondents were appropriately dealt with, following the minimum health protocols, ensuring that their health would not be compromised. They were also oriented that their participation in this study was completely voluntary and would not affect their academic grades.

At the onset of data collection, the researcher identified the Least Mastered Learning Competencies in the subject General Biology 1 for the STEM strand based on the school's reported MPS result per subject and grade level. The researcher ensured that the developed E-SIMs and educational games would be related to the Least Mastered Learning Competencies. E-SIMs and games were carefully structured in such a way that they would help learners to master competencies and also motivate and engage learners. The behavioral settings of the game were revised and edited to ensure that they would substantially achieve the ultimate purpose of the games – to enrich the students' learning experience. These instructional materials were designed and anchored on pedagogical theories in education such as Social Learning Theory, Social Development Theory, and Theory of Constructivism.

The E-SIMs and educational games were developed for three (3) weeks. A total of three (3) E-SIMs and eight (8) educational games were created. These materials were presented to three (3) science major teachers, one (1) head teacher, and one (1) master teacher in Science. The necessary revisions were carried out according to the suggestions. The revised and final output was presented once again, and evaluators assessed the instructional materials based on the LRMDs Assessment and Evaluation tool. Teacher evaluators were given enough time to evaluate the learning materials.

Before the beginning of the class, E-SIMs and educational games to be used for a specific lesson of the day were given or transferred to the students' tablets and android phones. Each student had an individual gadget and a copy of the game. Students were instructed not to play or open the game until required to do so. Games were played during the activity part based on the sequence of lessons. Activities were varied, targeting the different learning styles of the students; hence some of the activities were in groups, while others were in pairs and individually.

Before the class ended, a 10-item quiz, adopted from SLM, capturing the learning standards or learning competencies, was administered to assess the student's understanding of the lesson. This also served as the baseline for the researcher-teacher to determine if the learning objectives were met. Moreover, the scores of the students were analyzed to find out the students' performance using the developed instructional materials.

Data Analysis

To analyze the gathered data, the researcher employed the following statistical treatment:

1. The content analysis method was used. It includes an analysis of the STEM curriculum in Biology and a school report on the least mastered learning competencies. These serve as basis for the development of instructional material.
2. Mean and Standard Deviation were used to analyze the data about the evaluation of Science teachers, head teacher, and master teacher on E-SIM. Mean and Standard Deviation were also used to describe the mean score of the students based on the 10-item quiz in every topic. Below is a description of the statistical range that was utilized to evaluate the LRMSD Tool evaluation's findings. The scale below was utilized to interpret the gathered data.

Table 1. Score and Quantification of Data

Scale	Range	Descriptive Rating	Qualitative Interpretation
4	3.50 – 4.00	Strongly Agree	Very Satisfactory (VS)
3	2.50 – 3.49	Agree	Satisfactory (S)
2	1.50 – 2.49	Disagree	Poor (P)
1	1.00 – 1.49	Strongly Disagree	Not Satisfactory (NS)

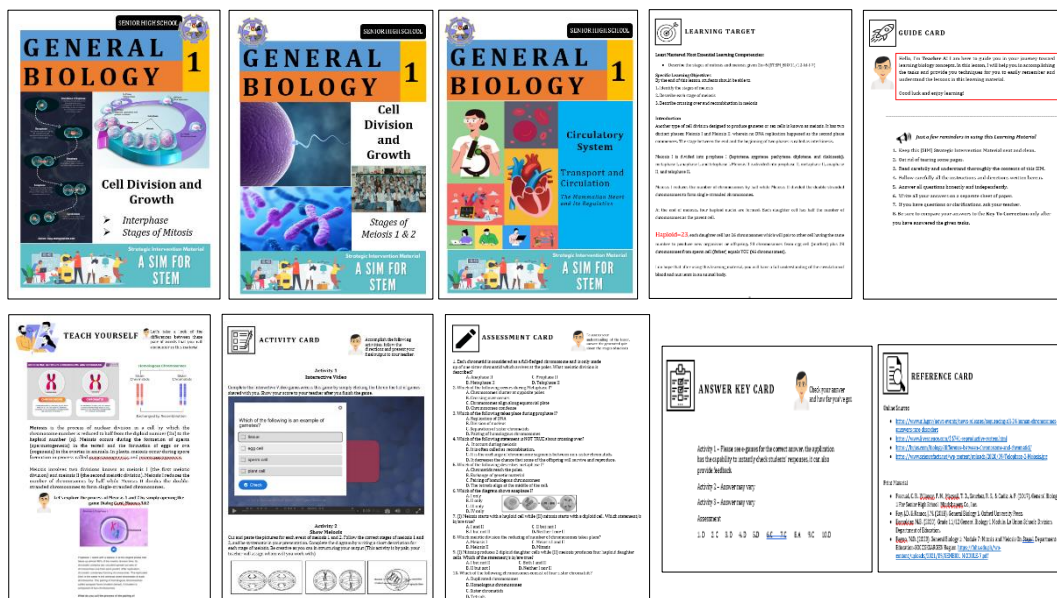
3. The T-test was used to test the significant difference in the performance level of the students before and after using E-SIM.
4. Thematic analysis of the feedback and suggestions of the experts after the evaluation of the developed e-SIM was employed to determine the changes and improvement needs.

Ethical Consideration

The study adhered to ethical guidelines in conducting research with human participants. Before starting the data collection process, the researcher ensured that informed consent was obtained from all participants. Participants were informed about the purpose of the study, how the data would be used, and the voluntary nature of their participation. Additionally, the confidentiality of the participants' information was guaranteed, and any identifying information was removed during the data analysis process to protect their privacy.

RESULTS AND DISCUSSIONS

Research Objective 1. To design instructional material on General Biology 1 for STEM learners.

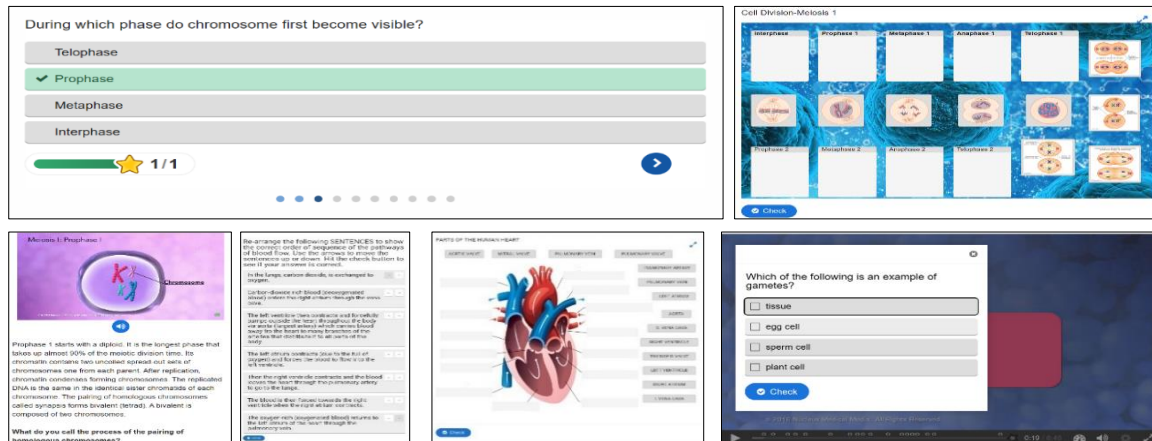


The instructional materials, Electronic Strategic Intervention Material (E-SIM), were developed and designed based on the Least Mastered Learning Competencies in General Biology 1 for STEM learners. The E-SIM consisted of five integral components: guide card, activity card, assessment card,

enrichment card, and reference card. Each component played a specific role in facilitating the learning process, making the material effective in addressing the students' needs.

The guide card provided an overview of the lesson, learning objectives, and the expected outcomes for the students. The activity card contained engaging tasks and activities designed to promote active learning and enhance students' understanding of the concepts. The assessment card offered a variety of evaluation tools, including quizzes and self-assessment tasks, to measure the learners' grasp of the subject matter. The enrichment card supplemented the core content with additional resources and materials to further expand the students' knowledge and deepen their understanding. Finally, the reference card listed the sources and related literature used in developing the E-SIM, allowing students to explore further if desired.

The use of E-SIM aimed to help learners develop and improve their least-mastered skills, as supported by Cordova et al. (2019), who confirmed that Strategic Intervention Material (SIM) effectively assisted learners in enhancing their understanding and mastery of the subject.



Educational games were also incorporated into the content to enhance the students' learning while using the E-SIM. The visual, auditory, and kinesthetic learning modalities as well as other preferences of the pupils were taken into consideration when creating these games and exercises. By incorporating various learning styles into the E-SIM, the material aimed to be accessible and engaging for all students, regardless of their preferred learning methods.

Pasion (2019) concluded that SIMs were instrumental in improving students' retention of the subject's content and sustaining their interest in learning. By incorporating audiovisual materials and interactive elements, students were able to relate the lessons to their real-life experiences and identify with the characters and scenarios presented. This immersive approach to learning helped to create a more engaging and effective learning environment, ultimately leading to better student outcomes and mastery of the subject matter.

Research Objective 2. To evaluate the instructional materials in terms of Content Quality, Instructional Quality, Technical Quality, and Other Findings.

Table 2.1 Evaluation of e-SIM in terms of Content Quality

ITEM	MEAN	SD	QUALITATIVE DESCRIPTION
1. Content is consistent with topics/skills found in the DepED Learning Competencies for the subject and grade/year level it was intended.	4.00	0.00	Very Satisfactory
2. Concepts developed contribute to enrichment, reinforcement, or mastery of the identified learning objectives.	4.00	0.00	Very Satisfactory
3. Content is accurate.	3.80	0.45	Very Satisfactory
4. Content is up-to-date.	4.00	0.00	Very Satisfactory
5. Content is logically developed and organized.	3.80	0.45	Very Satisfactory
6. Content is free from cultural, gender, racial, or ethnic bias.	3.80	0.45	Very Satisfactory
7. Content stimulates and promotes critical thinking.	3.60	0.55	Very Satisfactory
8. Content is relevant to real-life situations.	3.80	0.45	Very Satisfactory
9. Language (including vocabulary) is appropriate to the target user level.	3.80	0.45	Very Satisfactory
10. Content promotes positive values that support formative growth.	4.00	0.00	Very Satisfactory
AVERAGE	3.86	0.24	Very Satisfactory

Legend: 3.50-4.00-Very Satisfactory; 2.50-3.49-Satisfactory; 1.50-2.49-Poor; 1.00-1.49-Not Satisfactory

The evaluation of E-SIM in terms of Content Quality is shown in Table 2.1. The highest mean score of 4.00 was observed in items 1, 2, and 10, indicating that the content is consistent with the DepED Learning Competencies, contributes to enrichment, reinforcement, or mastery of the identified learning objectives, is up-to-date, and promotes positive values that support formative growth. It demonstrates that all items received a qualitative description of "Very Satisfactory." Item 7 had the lowest mean score, 3.60, indicating that there may be potential for improvement even though the material encourages and stimulates critical thinking. The overall average mean score for Content Quality is 3.86, with a standard deviation of 0.24, which falls within the "Very Satisfactory" range according to the legend provided. This suggests that the instructional materials used in the E-SIM were of high quality and effectively addressed the content needs of the target user level.

Table 2.2. Evaluation of e-SIM in terms of Instructional Quality

ITEM	MEAN	SD	QUALITATIVE DESCRIPTION
1. Purpose of the material is well defined	4.00	0.00	Very Satisfactory
2. Material achieves its defined purpose.	4.00	0.00	Very Satisfactory
3. Learning objectives are clearly stated and measurable.	4.00	0.00	Very Satisfactory
4. Level of difficulty is appropriate for the intended target user.	3.60	0.55	Very Satisfactory
5. Graphics / colors / sounds are used for appropriate instructional reasons.	3.80	0.45	Very Satisfactory
6. Material is enjoyable, stimulating, challenging, and engaging.	3.80	0.45	Very Satisfactory
7. Material effectively stimulates creativity of target user	3.80	0.45	Very Satisfactory
8. Feedback on target user's responses is effectively employed.	4.00	0.00	Very Satisfactory
9. Target user can control the rate and sequence of presentation and review.	4.00	0.00	Very Satisfactory
10. Instruction is integrated with target user's previous experience.	4.00	0.00	Very Satisfactory
AVERAGE	3.90	0.25	Very Satisfactory

Legend: 3.50-4.00-Very Satisfactory; 2.50-3.49-Satisfactory; 1.50-2.49-Poor; 1.00-1.49-Not Satisfactory

The evaluation of E-SIM in terms of instructional quality is shown in Table 2.2. According to the statistics, the created instructional materials scored on average 3.90 with a standard deviation of 0.25, falling inside the "Very Satisfactory" category as indicated by the accompanying legend. This shows the E-SIMs to have excellent educational quality. When the individual things are examined more closely, it becomes clear that the teachers gave each one a "Very Satisfactory" rating. The highest possible mean scores for five items—1, 2, 3, 8, 9, and 10—were 4.00 with a 0.00 standard deviation, indicating excellent performance in defining the purpose of the material, achieving that purpose, stating clear and measurable learning objectives, providing effective feedback, allowing user control over presentation and review, and integrating instruction with the user's prior experience.

Item 4, which analyses the appropriateness of the level of difficulty for the intended target user, had the lowest mean score, 3.60 (SD=0.55). This data suggests that in order to better engage students and improve their performance, the E-SIM's level of difficulty may need to be adjusted. To promote successful learning experiences, Duran et al. (2018) stress the need of matching the difficulty of learning activities with learners' skills. Overall, the findings show that the E-SIM's instructional quality is quite good, however there is some potential for improvement in terms of the degree of difficulty.

Table 2.3. Evaluation of e-SIM in terms of Technical Quality

ITEM	MEAN	SD	QUALITATIVE DESCRIPTION
1. Audio enhances understanding of the concept.	4.00	0.00	Very Satisfactory
2. Speech and narration (correct pacing, intonation, and pronunciation) is clear and can be easily understood.	4.00	0.00	Very Satisfactory
3. There is complete synchronization of audio with the visuals, if any	3.80	0.45	Very Satisfactory
4. Music and sound effects are appropriate and effective for instructional purposes.	4.00	0.00	Very Satisfactory
5. Screen displays (text) are uncluttered, easy to read, and aesthetically pleasing.	3.80	0.45	Very Satisfactory
6. Visual presentations (non-text) are clear and easy to interpret.	3.80	0.45	Very Satisfactory
7. Visuals sustain interest and do not distract user's attention.	3.80	0.45	Very Satisfactory
8. Visuals provide accurate representation of the concept discussed.	3.80	0.45	Very Satisfactory
9. The user support materials (if any) are effective.	3.00	0.00	Satisfactory
10. The design allows the target user to navigate freely through the material.	4.00	0.00	Very Satisfactory
11. The material can easily and independently be used.	4.00	0.00	Very Satisfactory
12. The material will run using minimum system requirements.	4.00	0.00	Very Satisfactory
13. The program is free from technical problems.	4.00	0.00	Very Satisfactory
AVERAGE	3.85	0.23	Very Satisfactory

Legend: 3.50-4.00-Very Satisfactory; 2.50-3.49-Satisfactory; 1.50-2.49-Poor; 1.00-1.49-Not Satisfactory

Table 2.3 displays the evaluation of E-SIM in terms of Technical Quality. The results show an average mean score of 3.85 and a standard deviation of 0.23, placing the E-SIM in the "Very Satisfactory" range according to the provided legend. This indicates that the technical quality of the E-SIM is highly satisfactory and meets the standards set by the DepEd.

A closer look at the individual items reveals that the majority (7 out of 13) received the highest mean scores of 4.00 (SD=0.00), signifying excellent performance in areas such as audio enhancement, speech and narration clarity, music and sound effects, navigation, independent usability, system requirements, and absence of technical issues.

However, item 9, which evaluates the effectiveness of user support materials, received the lowest mean score of 3.00 (SD=0.00), falling into the "Satisfactory" category since this item is not applicable to the design material.

The remaining items, which assess aspects such as synchronization of audio with visuals, screen displays, visual presentations, and accurate representation of concepts, were rated as "Very Satisfactory," with mean scores of 3.80 (SD=0.45). The evaluation of E-SIM's technical quality demonstrates that it is highly satisfactory, with some room for improvement in the user support materials to better assist learners in their educational journey.

Table 2.4. Evaluation of e-SIM in terms of Other Findings

ITEM	MEAN	SD	QUALITATIVE DESCRIPTION
1. Conceptual errors.	3.80	0.45	Very Satisfactory
2. Factual errors.	3.80	0.45	Very Satisfactory
3. Grammatical and / or typographical errors	3.20	0.45	Satisfactory
4. Other errors (i.e., computational errors, obsolete information, errors in the visuals, etc.).	4.00	0.00	Very Satisfactory
AVERAGE	3.70	0.22	Very Satisfactory

Legend: 3.50-4.00-Very Satisfactory; 2.50-3.49-Satisfactory; 1.50-2.49-Poor; 1.00-1.49-Not Satisfactory

The evaluation of E-SIM is shown in Table 2.4 in terms of Other Findings, which cover conceptual mistakes, factual mistakes, grammatical and/or typographical mistakes, and other mistakes (such as computational mistakes, outdated information, visual mistakes, etc.). With an average mean score of 3.70 and a standard deviation of 0.22, the E-SIM achieved an overall grade of "Very Satisfactory" in this area. When examining the individual questions, item 4—which evaluates additional mistakes such as computational, out-of-date information, and visual errors—received the highest mean score of 4.00 (SD=0.00), demonstrating that the E-SIM is devoid of these kinds of problems. The mean scores for the items that dealt with conceptual and factual mistakes were 3.80 (SD=0.45), and they both obtained "Very Satisfactory" ratings. This suggests that the E-SIM effectively presents accurate concepts and facts to learners. However, the evaluation identified grammatical and/or typographical errors as an area for improvement, with a mean score of 3.20 (SD=0.45), falling into the "Satisfactory" range. This indicates that the E-SIM would benefit from thorough proofreading and editing to correct grammar and spelling issues. The E-SIM's evaluation in terms of Other Findings demonstrates that it is generally very satisfactory, with a need for improvement in grammatical and typographical accuracy to enhance the overall quality of the instructional material.

Research Objective 3. To determine the effectiveness of the instructional materials based on pre and post-test results.

Table 3.1. Pretest and Posttest Result of the Learners

n=15

		Mean	sd	T-test	p-value	Interpretation
Mitosis	Pretest	4.87	1.60	-6.76	0.00**	Significant
	Posttest	7.73	1.67			
Meiosis	Pretest	5.13	1.73	-1.97	0.07	Not Significant
	Posttest	6.07	2.15			
Circulatory System	Pretest	1.93	1.58	-6.79	0.00**	Significant
	Posttest	6.13	2.29			

Legend: Significant at 0.05**

Table 3.1 presents the results of a paired t-test analysis comparing the mean scores of the pretest and posttest for the topics of Mitosis, Meiosis, and the Circulatory System. The analysis reveals significant improvements in the learners' performance for the topics of Mitosis and the Circulatory System, while the improvement in the topic of Meiosis was not found to be statistically significant. For the topic of Mitosis, the mean pretest score was 4.87 (SD=1.60), while the posttest mean score increased to 7.73 (SD=1.67). The computed t-value was -6.76, and the p-value was 0.00, which is less than the significance level of 0.05, indicating a significant improvement in the learners' performance on this topic. Similarly, for the Circulatory System, the mean pretest score was 1.93 (SD=1.58), and the posttest mean score increased to 6.13 (SD=2.29). The computed t-value was -6.79, and the p-value was 0.00, also demonstrating a significant improvement in the learners' performance on this topic. However, for the topic of Meiosis, the mean pretest score was 5.13 (SD=1.73), and the posttest mean score increased to 6.07 (SD=2.15). The computed t-value was -1.97, and the p-value was 0.07, which is greater than the significance level of 0.05, indicating that the improvement in the learners' performance on this topic was not statistically significant.

The results suggest that the use of e-SIMs has a significant positive impact on the performance of learners in General Biology concepts, particularly for the topics of Mitosis and the Circulatory System. However, further investigation may be needed to determine the factors that contributed to the nonsignificant improvement in the topic of Meiosis.

Research Objective 4. To enhance the instructional material based on the evaluation and effectiveness results.

The developed instructional material in the form of Electronic Strategic Intervention Material still needs improvements. According to the suggestions of the evaluators, grammatical and typographical errors must be corrected. The level of difficulty of the games and activities should be decreased. They have also recommended adding more activities to fully achieve the learning objectives. The use of actual photos was also recommended.

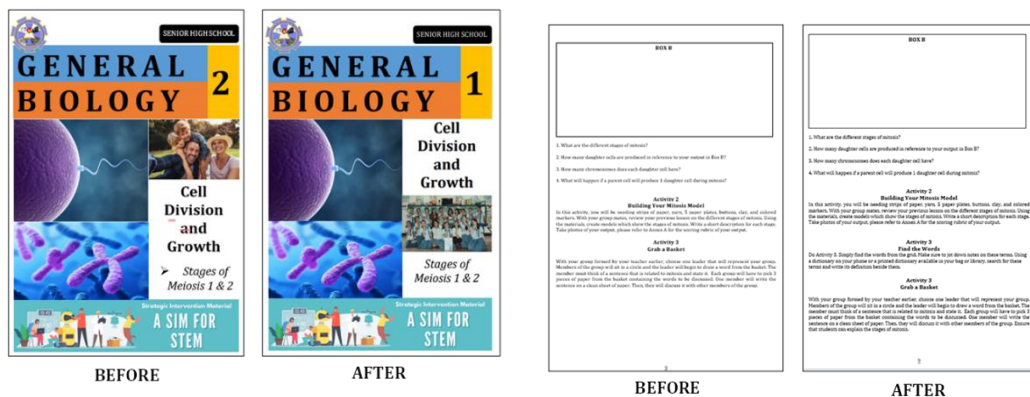
Hence, to address these suggestions and recommendations an action plan was formulated:

Area (s) and Project Title	Objectives	Person (s) Responsible	Activities	Time Frame	Expected Output
Checking Grammar and Typograph	To correct grammatical and typographical	English Teacher/Language Editor	Communicate with English teachers available in school to do proofreading or editing Hire a competent proofreader/grammarian	April 2023	Grammatical and Typographical error-free e-SIM
Additional educational games	To develop educational games	Researcher	Develop additional educational games based on learning competencies. Revision of e-SIM incorporating the newly developed material.	April 2023	An updated version of e-SIM and new e-games
Leveling Difficult Activities	To align activities according to the learner's capacity	Researcher and other Science Teachers teaching the same subject	Revisiting and revising the level of the difficulties of activities in collaboration with other science teachers handling the same subject.	May 2023	Suitable and child-friendly e-SIM adhering to learners capabilities

The study identified several areas for improvement. The evaluators pointed out that the Electronic Strategic Intervention Material (e-SIM) requires corrections in grammatical and typographical errors, a decrease in the level of difficulty of games and activities, and the addition of more activities to fully achieve learning objectives. They also recommended incorporating actual photos to enhance the learning experience.

To address these recommendations, an action plan was developed, focusing on three main areas: checking grammar and typograph, adding educational games, and leveling difficult activities. For the first area, the objective is to correct grammatical and typographical errors by engaging English teachers or hiring a competent proofreader/grammarian. This is expected to result in an error-free e-SIM by April 2023. The second area aims to develop additional educational games and incorporate them into the e-SIM. The researcher will be responsible for creating these games based on learning competencies and updating the e-SIM accordingly. This is expected to produce an updated version of e-SIM and new e-games by April 2023. Lastly, the third area focuses on aligning activities according to the learner's capacity. The researcher, along with other science teachers teaching the same subject, will revisit and revise the level of difficulties of activities to ensure they are suitable and engaging for learners. This collaborative effort is expected to produce a more learner-friendly e-SIM that adheres to learners' capabilities by May 2023.

The action plan aims to improve the instructional material by addressing the identified weaknesses, thus ensuring that the e-SIM effectively supports learners in achieving their educational goals. The following are photos of changes made in the instructional materials:



The photos above illustrate the changes and refinement made in the e-SIM based on the evaluation, suggestion, and recommendation of the science teachers, head teacher, and master teacher. Firstly, animated/copied image from the internet were replaced with an actual image. Secondly, new interactive educational game called “Find the Words” – a word puzzle game developed through Lumi education software was added. Thirdly, with the help of an

English teacher, grammar and typographical errors were fixed. Fourthly, some of the educational games and activities were revised based on the knowledge level of the students and time-frame of the lesson it should be taught.

CONCLUSIONS

1. The E-SIM focused on General Biology 1 tailored to the needs of STEM learners was successfully designed and implemented in this study.
2. The evaluation of the developed E-SIM in terms of Content Quality, Instructional Quality, Technical Quality, and other relevant factors revealed that it was very satisfactory. However, some areas required improvement, such as correcting grammatical and typographical errors, adjusting the level of difficulty in activities, and incorporating additional learning resources such as actual photos and more engaging activities.
3. The assessment of the E-SIM's effectiveness by comparing student performance through pre-test and post-test results demonstrated significant improvements in students' understanding of specific topics, such as Mitosis and the Circulatory System but not in Meiosis. This indicates that the E-SIM has the potential to enhance students' learning outcomes in General Biology.
4. Based on the evaluation findings and its demonstrated effectiveness in enhancing student performance, the E-SIM should be refined and improved to better cater to learners' needs and capabilities.

RECOMMENDATIONS

1. The developed Electronic- Strategic Intervention Material (e-SIM) in General Biology for STEM students can be used to facilitate mastery of the learning competencies in biology topics.
2. To further improve the developed E-SIM in terms of Content Quality, Instructional Quality, Technical Quality, and other relevant factors, developers should continuously evaluate the material and make necessary revisions based on feedback from educators and learners.
3. Given the demonstrated effectiveness of the E-SIM in enhancing student performance, educators should consider adopting E-SIMs as supplementary instructional materials for General Biology, specifically in Mitosis and Circulatory System lessons as well as in Meiosis with some refinements, thereby fostering a more engaging and interactive learning environment for students.
4. To ensure the E-SIM remains relevant and effective in enhancing student performance, developers should regularly refine and improve the material based on new evaluation findings, feedback from users, and advancements in educational technology, thereby better catering to learners' needs and capabilities.
5. Schools and educational institutions should provide support for the development and integration of e-SIMs in their curricula, recognizing their potential in improving student learning outcomes.
6. Future research should explore the long-term effects of using e-SIMs on students' academic performance and retention of knowledge. Additionally, researchers could investigate the applicability of e-SIMs to other subject areas and the potential benefits of integrating various multimedia elements and innovative technologies to further enhance the learning experience.

Acknowledgements

The author wishes to thank the Department of Science and Technology, Science Education Institute for the provision of the scholarship to complete this undertaking. The science teachers and students of Gov. A. Abueg Sr. National Technology and Vocational Memorial High School are likewise acknowledged for taking part in this academic endeavor.

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