

Enhancing Self-Directed Learning (SDL) Skills and Performance of Students Through a Science Ebook

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Abstract—This study examined the relationship between the components and characteristics of science eBook and students' self-directed learning (SDL) skills, as well as their effects on students' performance in General Biology. Specifically, it determined the level of the Science eBook's components and characteristics, students' SDL skills, and learners' performance based on formative and summative test scores. The study employed an experimental research design involving 130 Grade 11 STEM students from Laguna Senior High School, selected through purposive sampling. Data were obtained using researcher-made questionnaires to evaluate the level of the Science eBook's components and characteristics and students' self-directed learning (SDL) skills, while formative and summative tests were used to measure learners' performance. Statistical analyses including weighted mean, standard deviation, frequency, percentage, Pearson Product - Moment Coefficient Correlation, and Multiple regression analysis using t-test for regression coefficients were utilized. The results revealed that the Science eBook's components and characteristics were highly acceptable, while students demonstrated a very high level of SDL skills. Learners also obtained outstanding performance in both formative and summative tests. Results further showed a significant relationship between the Science eBook's components and characteristics and students' SDL skills. Moreover, these components and characteristics of the Science eBook had a significant effect on students' summative test scores but showed no significant collective effect on formative test scores. Overall, findings revealed that the Science eBook's components and characteristics significantly correlate with students' self-directed learning skills and have a significant effect on summative test scores, leading to the rejection of the first, second, and last null hypotheses. This implies the value of well-structured digital tools in fostering independent learning and conceptual mastery. Moreover, the Science eBook did not show a significant collective effect on formative test scores; thus, no sufficient evidence was found to reject the third null hypothesis. Specifically, guided activities, reflection, and visual and graphic quality were the only elements that significantly enhanced learning progress in formative tests. Consequently, while the Science eBook excels in improving long-term retention, its formative effect may be moderated by external factors or by students' initial adjustment to the digital tool. Based on the findings, educational technologists and school administrators are encouraged to support the integration and development of science eBooks in the curriculum. Teachers may also integrate the science eBook into their instructional strategies as it is associated with the high SDL skills of the students. Learners are likewise encouraged to actively engage with these features to strengthen self-directed learning skills specifically time management, goal setting, and critical thinking, fostering independence and responsibility. Future research may further examine the effectiveness of science eBooks across different learning areas, and consider other variables such as motivation, learning styles, technological readiness, and long-term effect on academic performance.

Keywords— electronic books, science eBook, self-directed learning (SDL) skills, independent learning, students' performance, General Biology, digital learning material

I. INTRODUCTION

The integration of technological innovations is one of the significant advancements that has developed in the progressing educational system, fostering the development of more self-reliant and proficient learners. With this shift, electronic books (eBooks) have emerged as versatile and interactive digital tools that foster student growth through multimedia features, accessibility, and flexibility. In comparison with print materials, eBooks meet various learning requirements and simplify the cognitive burden with the help of the targeted usage of visuals, simulations, and interactive activities.

Recent studies have determined the effectiveness of these digital resources. Wen et al. (2022) found that eBooks improve knowledge and positively affect learning behavior, whereas Parveen and Ramzan (2024) revealed that ICT integration with self-assessment tools help students to develop self-regulation and engagement. By allowing learners to revisit and critically analyze complex ideas and concepts independently, eBooks promote the development of self-reliant learners.

In this context, technological integration and advancement are significant for Self-Directed Learning (SDL). UNESCO (2023) reported that personalized learning with the help of digital tools considers the interests and abilities of the students and, consequently, promotes their autonomy. On the same note, Scheel et al. (2022) emphasized the need for digital competence and self-directed learning skills which usually require initiative, responsibility, self-management and monitoring that are now key components of contemporary education.

Moreover, the importance of nurturing Self-directed learning (SDL) skills is supported by modern science education, especially, the discipline has its foundations and specifically grounded on inquiry, discovery, and application. Gerard et al. (2022) depicted the promotion of SDL in science through an open educational resource (OERs), thereby allowing learners to challenge, inquire, and own the learning process even outside the physical classroom during the pandemic. This interdependence demonstrated how the digital space is perfectly aligned to the inquiry-based research in science.

With these insights, the study will develop and utilize a science eBook aligned with science curriculum standards to assist both content mastery and enhancement of self-directed learning skills. Using valid scientific information, visually appealing characteristics and interactive features to control cognitive load, the eBook, as digital resource is expected to improve independent learning abilities and reinforce teaching science in learner-centered classrooms.

1.1 Statement of the Problem

Problem/s which were addressed by the research

The study aimed to determine how the developed science eBook, *Emerging Life and Discoveries*, as a supplementary digital resource, enhances academic development. In addition, this research was designed to examine the association between the science eBook’s components and characteristics and the learners’ independent learning skills.

Specifically, it sought to answer the following questions:

1. What is the level of the science eBook’s components in terms of:
 - 1.1 Learning targets;
 - 1.2 Pre-activity statement;
 - 1.3 Guided activities;
 - 1.4 Post-activity statement;
 - 1.5 Inquiry activity; and
 - 1.6 Reflection?
2. What is the level of the science eBook’s characteristics in terms of:
 - 2.1 Accuracy;
 - 2.2 Relevance;
 - 2.3 Structure;
 - 2.4 Usability; and
 - 2.5 Visual and graphic quality?
3. What is the level of self-directed learning (SDL) skills of students in terms of:
 - 3.1 Goal setting;
 - 3.2 Time management;
 - 3.3 Critical thinking;
 - 3.4 Decision-making; and
 - 3.5 Self-evaluation?
4. What is the level of performance of students based on:
 - 4.1 Formative test scores; and
 - 4.2 Summative test scores?
5. Is there a significant relationship between the components of the science eBook and self-directed learning (SDL) skills of students?
6. Is there a significant relationship between the characteristics of the science eBook and self-directed learning (SDL) skills of students?
7. Is there a significant effect of the science eBook’s components and characteristics on performance of students in terms formative test scores?
8. Is there a significant effect of the science eBook’s components and characteristics on performance of students in terms of summative test scores?

II. METHODOLOGY

The study employed an experimental research design involving 130 Grade 11 STEM students from Laguna Senior High School, selected through purposive sampling. Data were obtained using researcher-made questionnaires to evaluate the level of the Science eBook’s components and characteristics and students’ self-directed learning (SDL) skills, while formative and summative tests were used to measure learners’ performance. Statistical analyses including weighted mean, standard deviation, frequency, percentage, Pearson Product - Moment Coefficient Correlation, and Multiple regression analysis using t-test for regression coefficients were utilized.

III. RESULTS AND DISCUSSION

This part covered the presentation, interpretation and analysis of the data gathered in this study. All specific questions in Chapter 1 under the statement of the problem were answered in this chapter, supported by tables. It provided the statistical evidence regarding the significant relationship between the eBook’s components and characteristics and Self-directed Learning (SDL) Skills. Further, it also presents the results obtained about the significant effect of eBook’s components and characteristics to students’ performance. In particular, the study aimed to address the following:

Level of the Science eBook’s Components

In this study, the level of the science eBook’s components refers to Learning Targets, Pre-activity Statement, Guided Activities, Post-Activity Statement, Inquiry Activity and Reflection. The following tables show the specific statements evaluated, along with the corresponding mean scores, standard deviation, remarks, and verbal interpretation from the perspective of the respondents.

Table 1 indicates the level of the science eBook’s components in terms of learning targets. Specifically, it shows how the learning targets in each lesson assist students in knowing what to expect, how it help them focus on necessary concepts, how it demonstrate the connection between learning outcomes and lesson content, how it highlights these learning targets in providing a clear understanding of the skills and knowledge to be developed and how it assist students in monitoring and reflecting on their own progress.

Table 1. Level of the Science eBook’s Components in terms of Learning Targets

Statement	Mean	SD	Remarks
The learning targets that are presented in the science eBook...			
...clearly show what I am expected to learn by the end of each lesson.	4.62	0.52	Strongly Agree
...help me focus on the most important ideas and concepts in the topic.	4.46	0.66	Strongly Agree
...explicitly demonstrate how the learning outcomes are connected to the lesson content and activities.	4.45	0.61	Strongly Agree
...give me a clear understanding of the skills and knowledge I should develop.	4.45	0.62	Strongly Agree
... help me monitor and reflect on my progress throughout the lessons.	4.32	0.68	Strongly Agree
Weighted Mean	4.46		
SD	0.63		
Verbal Interpretation			Highly Acceptable

Table 1 shows that the learning targets are rated as “Highly Acceptable” with a weighted mean of 4.46 with standard deviation of 0.63. Specifically, data exhibits that all five statements gained “strongly agree” responses. This indicates that learning targets are effectively acting as a cognitive guide for the students. Additionally, by illustrating to the students what exactly they should be able to master in terms of competencies, this component creates a sense of responsibility and purpose, which are important aspects of the independent learning process. Besides, the presented data confirms that learning targets clearly define expectations, while it also helps students to monitor their own personal progress which may lead to strong foundation for goal-oriented learning.

Table 2 shows the level of the science eBook Components in terms of pre-activity statement, specifically, how the eBook gives an interesting overview of the lesson, how it makes students know what they will learn, how it helps students recall what they already know, how it makes students interested in the topic, and how it gives a clear picture of what they will encounter during the activity.

Table 2. Level of the Science eBook’s Components in terms of Pre-Activity Statement

Statement	Mean	SD	Remarks
The pre-activity statement included in the science eBook...			
... presents an interesting overview of the lesson, guiding me to see the main points and anticipate what I will learn.	4.42	0.66	Strongly Agree
...helps me to recall what I already know about the lesson.	4.42	0.58	Strongly Agree
... makes me curious to learn more about the topic that will be discussed.	4.27	0.72	Strongly Agree
... provides me with a clear idea of what to expect in the activities ahead.	4.42	0.62	Strongly Agree
...allows me to connect the new topic to real-life situations or prior experiences.	4.37	0.67	Strongly Agree
Weighted Mean	4.38		
SD	0.65		
Verbal Interpretation			Highly Acceptable

Table 2 reveals that the pre-activity statements are considered “Highly Acceptable” with a weighted mean of 4.38 and standard deviation of 0.65. The presented data shows that all five statements sustained “strongly agree” responses, with mean scores of 4.27 to 4.42. This means that students appreciated how pre-activity statements in every lesson presented an interesting summary and assisted them in remembering previous knowledge. In addition, the data also indicates that these statements are a cognitive support and students can relate new topics to real life situations and previous experiences. The eBook also prepares the students to anticipate what they will learn by giving them a preview of the information, and this is essential to independent learning engagement.

Table 3 shows the level of the components of science eBook in terms of Guided Activities, particularly, how well the eBook delivers step-by-step instructions, how well it promotes active engagement, how well it relates activities with real-life scenarios, how well it allows the application of concepts through exploration, how well it makes learning interesting and enjoyable.

Table 3. Level of the Science eBook’s Components in terms of Guided Activities

Statement	Mean	SD	Remarks
The guided activities featured throughout the science eBook...			
... provide clear, step-by-step, and easy-to-follow instructions that guide me smoothly and help me understand what is expected at each stage.	4.41	0.64	Strongly Agree
...assist me in actively applying the concepts I have learned while doing the activity.	4.38	0.63	Strongly Agree
... allows me to engage actively and meaningfully with the content, encouraging participation and exploration.	4.27	0.72	Strongly Agree
...encourage and challenge me to think critically, analyze information and solve problems independently.	4.38	0.60	Strongly Agree
...make learning more enjoyable, interactive, and meaningful by connecting activities to real-life situations.	4.33	0.65	Strongly Agree
Weighted Mean	4.35		
SD	0.65		
Verbal Interpretation			Highly Acceptable

Table 3 indicates that the guided activities are “Highly Acceptable”, earning a weighted mean of 4.35 and standard deviation of 0.65. Specifically, data exhibits that all five statements sustained “strongly agree” responses, with mean scores of 4.27 to 4.41. This denotes that the eBook effectively eliminates confusion and frustration that often stalls progress of the student in the traditional science modules. The eBook safeguards the mental strength of the student by providing a clear plan and guide in all activities. Moreover, these findings point out the shift of students from passive readers to active learners. These activities are just not constructed to be repetitive tasks or to memorize facts, instead, these activities serve as challenges that allow students to apply what they have learned in the real-world context. By creating a well-balanced approach and a supportive digital structure, the eBook will prevent the student from being just a spectator, it will lead them to be independent in solving problems.

Table 4 demonstrates the level of the components of the science eBook in terms of Post-Activity Statement, specifically, how the science eBooks provide assistance in helping students summarize the main ideas, how it helps review the lessons that are previously learned, how it helps connect results to the main concept, how it gives students a sense of accomplishment, and its guide and reinforce lesson understanding.

Table 4 shows that the post-activity statements are “Highly Acceptable”, with a weighted mean of 4.43 and standard deviation of 0.62. Specifically, data exhibits that all five statements sustained “strongly agree” responses, with mean scores of 4.36 to 4.41. This reveals that these post-activity statements provided in each lesson are powerful in generalizing and strengthening what has been learnt in the other parts of the science eBook. Additionally, this component aid students to remember the lesson and activity contents which implies that students consider such summary statements as incredibly helpful to end the lesson. Subsequently, it is also important to ensure that the students relate the outcomes of the activity to the overall concepts covered during the lessons, as

it will allow them to solidify their understanding. In line with this, the eBook helps in building the confidence needed by students to use their learning in future assignments and practical tests. In addition, these statements aid learners with a sense of completion and accomplishment after doing the activity, as these statements successfully contribute to students' learning experience by helping them acknowledge task attainment and reinforcing a sense of achievement.

Table 4. Level of the Science eBook's Components in terms of Post-Activity Statement

Statement	Mean	SD	Remarks
The post-activity statement created to summarize key concepts in the science eBook...			
...guides me in reviewing what I have learned from the lesson.	4.49	0.61	Strongly Agree
...allows me to connect the results of the activity to the main ideas discussed in the lessons.	4.46	0.61	Strongly Agree
...enables me to remember and retain key concepts more effectively.	4.41	0.66	Strongly Agree
...gives me a sense of completion and accomplishment after doing the activity.	4.36	0.62	Strongly Agree
... is effective in synthesizing and reinforcing what I have understood from the lesson, helping me consolidate my knowledge and apply it confidently in future tasks.	4.41	0.62	Strongly Agree
Weighted Mean	4.43		
SD	0.62		
Verbal Interpretation	Highly Acceptable		

Table 5 shows the level of the components of the science eBook in the in terms of Inquiry Activity, specifically, how the science eBook promotes exploration and discovery, how it assists students in identifying and solving inquiry questions, how it trains logical thinking, how it supports independent research, and how it facilitates generalization.

Table 5. Level of the Science eBook's Components in terms of Inquiry Activity

Statement	Mean	SD	Remarks
The inquiry activities, designed to support exploration and discovery, are integrated in the science eBook to...			
...encourage me to explore and discover answers on my own.	4.38	0.64	Strongly Agree
...help me practice solving a variety of problems and thinking logically, strengthening my reasoning skills and ability to approach challenges effectively.	4.36	0.60	Strongly Agree
...allow me to investigate, recognize, and answer inquiry questions independently.	4.40	0.67	Strongly Agree
...support the development of my critical thinking and reasoning skills, making me more effective in analyzing problems.	4.39	0.64	Strongly Agree
...enable me to apply and transfer what I have learned effectively to new contexts and real-life situations, strengthening my ability to connect knowledge to practical experiences.	4.26	0.70	Strongly Agree
Weighted Mean	4.36		
SD	0.65		
Verbal Interpretation	Highly Acceptable		

Table 5 reveals that the inquiry activities are "Highly Acceptable", with a weighted mean of 4.36 and standard deviation of 0.65. Specifically, data exhibits that all five

statements sustained "strongly agree" responses, with mean scores of 4.26 to 4.40. This implies that the science eBook supports in facilitating exploration and discovery. Moreover, it also shows how the eBook enhances reasoning ability and strategy of the learners when dealing with scientific issues in a logical manner as it also challenges the students to seek and generate their own answers. The result also indicates the role of eBook in transferring knowledge to new contexts. Although the transfer to real-life situation scored slightly lower than the other statements, in general, the results indicate that the development of critical thinking and reasoning skills through independent investigation is evident among the collected responses. This means that the inquiry activities of the science eBook can facilitate active learning and minimize passive intake of information. As a result, the students are provided with the opportunities to be more involved in the learning process by means of questioning and deeper investigation. This component is also effective in enabling learners to gain confidence in using scientific concepts to different situations in school setting and in real life.

Table 6 shows the level of the components of the science eBook in the in terms of Reflection, particularly, how the science eBook enables the students to reflect on the relevance of the lesson, how it enables students to recognize the points of strength and weakness, how it relates lessons to real life, how it keeps track of personal progress, and how it promotes the expression of personal thoughts and experiences.

Table 6. Level of the Science eBook's Components in terms of Reflection

Statement	Mean	SD	Remarks
The reflection tasks built into the science eBook are designed to...			
... guide me to think more deeply about what I have learned, helping me connect ideas and understand their significance.	4.50	0.56	Strongly Agree
...help me in identifying my strengths and areas I need to improve.	4.46	0.64	Strongly Agree
... enable me to recognize the connection between the lesson and everyday life, helping me appreciate its practical significance	4.34	0.67	Strongly Agree
...encourage me to express my personal thoughts and learning experiences.	4.38	0.67	Strongly Agree
...assist me in tracking my progress and understanding my development in learning.	4.40	0.65	Strongly Agree
Weighted Mean	4.42		
SD	0.64		
Verbal Interpretation	Highly Acceptable		

Table 6 shows that reflection is "Highly Acceptable", with a weighted mean of 4.42 and standard deviation of 0.64. Specifically, data exhibits that all five statements gained "strongly agree" responses, with mean scores of 4.34 to 4.50. The data reflects that the science eBook can help students think more meaningfully about the meaning of what they have studied. It means that reflection activities are essential in attaining self-awareness in learning. The eBook helps students to see their progress, and their own learning process by realizing their strengths and areas of improvement through reflection task and prompts. In addition, these reflective activities encourage learners to evaluate how effectively they applied the concepts discussed in the lesson. As a result,

students become more aware about their study habits and more motivated to improve their performance.

Level of the Science eBook's Characteristics

The level of the science eBook's characteristics was evaluated based on five indicators- Accuracy, Relevance, Structure, Usability, and Visual and Graphic Quality which collectively define the quality and functionality of Science eBook. Accuracy and relevance ensure correctness and alignment with science curriculum; structure guides the instructional flow; usability ensures smooth navigation; and visual and graphic quality evaluates how layout and imagery support active learning. The following tables show the specific statements evaluated, along with the corresponding mean scores, standard deviation, remarks, and verbal interpretation from the perspectives of the respondents.

Table 7 presents the of the science eBook's characteristics in terms of Accuracy, specifically, how the information is reliable and trustworthy, how it is free from errors, how the scientific facts are up-to-date, how the explanations are based on evidence, and how the content remains consistent throughout the material.

Table 7. Level of the Science eBook's Characteristics in terms of Accuracy

Statement	Mean	SD	Remarks
Serving as a supplementary material, the science eBook...			
...ensures that the information provided is accurate, reliable, and trustworthy, giving me confidence in what I learn from the lesson.	4.68	0.51	Strongly Agree
...guarantees that the explanations are based on current and up-to-date scientific facts, helping me build a correct understanding of scientific concepts.	4.61	0.54	Strongly Agree
...confirms that the content is free from errors or misleading information, helping me trust and rely on the material presented.	4.59	0.51	Strongly Agree
...helps me understand scientific principles correctly, allowing me to apply them accurately in activities and real-life situations.	4.41	0.64	Strongly Agree
...allows me to trust the examples, data, and information presented in the lessons, giving me confidence in applying the knowledge and concepts learned.	4.52	0.56	Strongly Agree
Weighted Mean	4.56		
SD	0.56		
Verbal Interpretation			Highly Acceptable

Table 7 shows that the Science eBook's Accuracy is "Highly Acceptable", with a weighted mean of 4.56 and standard deviation of 0.56. Specifically, data exhibits that all five statements sustained "strongly agree" responses, with mean scores of 4.41 to 4.68. The statement regarding the information being accurate, reliable, and trustworthy was highly rated by the respondents. This reflects that the students gain confidence in the content. By ensuring that explanations are based on current scientific facts and are not marred with errors, a digital resource avoids the cognitive gap that arises when learners are exposed to erroneous information. Students therefore tend to have more confidence and trust in the eBook and therefore can concentrate on grasping the complex concepts as opposed to doubting the credibility of the source.

Table 8 presents the level of the science eBook's characteristics in terms of Relevance, specifically, how it aligns with the science curriculum, how the examples are relatable to real-life, how the activities are meaningful, how it addresses current scientific issues, and how it connects to the interests of the students.

Table 8. Level of the Science eBook's Characteristics in terms of Relevance

Statement	Mean	SD	Remarks
Designed to enhance the lesson, the science eBook...			
...ensures that the lessons are clearly connected to real-life experiences and practical situations, helping me see the relevance of science in everyday contexts.	4.34	0.63	Strongly Agree
...guarantees that the topics are carefully aligned with the science curriculum, supporting my learning in a structured and meaningful way.	4.63	0.54	Strongly Agree
...assures that the examples and activities are relevant to my interests and daily life, making the lessons more engaging and relatable.	4.22	0.69	Strongly Agree
...helps me understand and see how scientific concepts are applied in the real world, allowing me to relate theory to practice and everyday situations.	4.35	0.63	Strongly Agree
...makes the lessons meaningful, relevant, and applicable beyond the classroom, helping me apply my learning to solve real-life problems.	4.44	0.61	Strongly Agree
Weighted Mean	4.40		
SD	0.63		
Verbal Interpretation			Highly Acceptable

Table 8 shows that the Science eBook's Relevance is "Highly Acceptable", with a weighted mean of 4.40 and standard deviation of 0.63. Specifically, data exhibits that all five statements sustained "strongly agree" responses, with mean scores of 4.22 to 4.63. Notably, the alignment of topics with the science curriculum was highly rated by the respondents. This indicates that the eBook has been properly constructed to improve lesson comprehension. Although, the statement regarding the relevancy of the examples and the activities to the interests of students and their daily life was rated the lowest. Nonetheless, the Science eBook helps to close the gap between theoretical concepts being taught inside the classroom and the practical application of these ideas in the real world, making the lessons in science meaningful. This implies that the contents of the science eBook are relevant and helpful in attaining the targeted learning competencies. Moreover, the relevance of the topics can make students understand the practical usefulness of the scientific knowledge in their daily life.

Table 9 presents the level of the science eBook's characteristics in terms of Structure, specifically, how the lessons are logically arranged, how the ideas flow smoothly from one section to another, how the organization helps focus on main points, how the layout is easy to follow, and how it avoids overwhelming the student with information

Table 9 reveals that the Structure of the science eBook is "Highly Acceptable", with a weighted mean of 4.42 and standard deviation of 0.61. Specifically, data exhibits that all five statements gained "strongly agree" responses, with mean scores of 4.29 to 4.50. The data reveals how the students

valued the logical organization of the information; this implies that a well-organized eBook does not cause cognitive overload. Moreover, science eBook helps learners learn complex ideas and concepts gradually, as it breaks information into a small-manageable task that does not overwhelm the student because of the well-organized content and ideas presented. Furthermore, a systematized system of the science eBook allows the students to find the necessary information with ease and go through key points when necessary.

Table 9. Level of the Science eBook’s Characteristics in terms of Structure

Statement	Mean	SD	Remarks
Organized to support learning, the science eBook...			
...is composed of lessons arranged in a logical and well-structured order, making it easier for me to follow and understand the content step by step.	4.48	0.61	Strongly Agree
...ensures that each section flows smoothly from one topic to the next, helping me build on my understanding without getting lost.	4.48	0.57	Strongly Agree
...presents ideas clearly and arranges information logically, helping me follow the lesson easily and understand the main points.	4.50	0.57	Strongly Agree
...helps me understand complex topics gradually, breaking down information into manageable steps so that I can learn without feeling overwhelmed.	4.36	0.65	Strongly Agree
...keeps my attention focused and prevents confusion by presenting information clearly and in an organized way.	4.29	0.64	Strongly Agree
Weighted Mean	4.42		
SD	0.61		
Verbal Interpretation	Highly Acceptable		

Table 10 shows the level of the characteristics of the science eBook in terms of Usability, to be more precise, how simple it is to navigate the eBook, how fast the pages and activities can be loaded, how easy it is to locate the required topic, how convenient the interface can be, and how it helps to have an effective study session.

Table 10. Level of the Science eBook’s Characteristics in terms of Usability

Statement	Mean	SD	Remarks
Facilitating smooth access to content and activities, the science eBook...			
...is easy to navigate, allowing me to move smoothly between pages or sections without difficulty, which makes it easier to follow the lesson and find the content I need.	4.35	0.66	Strongly Agree
...makes it simple to locate the topics and activities I need, helping me save time and focus on learning.	4.38	0.66	Strongly Agree
...opens smoothly and quickly without any loading or display issues.	4.41	0.61	Strongly Agree
...displays pages and sections correctly and allows easy access, making it convenient for me to browse through the eBook and review the content efficiently.	4.48	0.59	Strongly Agree
...is user-friendly and designed to support my learning effectively, helping me focus on understanding the lesson without technical difficulties or confusion.	4.57	0.58	Strongly Agree
Weighted Mean	4.44		
SD	0.62		
Verbal Interpretation	Highly Acceptable		

Table 10 reveals that the Usability of the science eBook is “Highly Acceptable”, with a mean of 4.44 and standard deviation of 0.62. Specifically, data exhibits that all five statements attained “strongly agree” responses, with mean scores ranging from 4.38 to 4.57. The statement about the user-friendly design of the eBook was highly rated by respondents, this implies that the technical functionality of the eBook facilitates the overall learning of the students. Having the ability to open the pages quickly and display them correctly, students are able to use the time they have to study the material and not waste their energy on technical issues and loading failures. In addition, majority of the students strongly agreed that the pages of the science eBook and its sections are well identified making the navigation easy and effective. This indicates that usability allows the learners to be capable of locating certain topics exceptionally fast, likewise, this feature help them to easily revisit sections for review of the content.

Table 11 presents the level of the science eBook’s characteristics in terms of Visual and Graphic Quality, specifically, how the diagrams and illustrations incorporated in the science ebook are clear and helpful in comprehending science concepts, how the layout is attractive and visually appealing, how the use of color and fonts improves readability, how the graphics help explain complex ideas, and how it increases student engagement.

Table 11. Level of the Science eBook’s Characteristics in terms of Visual and Graphic Quality

Statement	Mean	SD	Remarks
Featuring well-thought visuals and graphics, the science eBook.....			
...contains pictures, diagrams, and graphics that are clear and easy to understand, helping me to comprehend the lesson content more effectively.	4.65	0.54	Strongly Agree
...visuals make the lessons more interesting and enjoyable, keeping me engaged and motivated to learn throughout the activities and lessons.	4.51	0.60	Strongly Agree
...illustrations help me visualize scientific concepts more clearly, allowing me to understand complex ideas and processes more effectively.	4.65	0.54	Strongly Agree
...the layout and design of the eBook make reading comfortable, well-organized, and not overwhelming, which allows me to focus on learning without distractions.	4.54	0.60	Strongly Agree
...uses colors, fonts, and images in a way that helps me remember the lessons and important information more easily.	4.52	0.63	Strongly Agree
Weighted Mean	4.57		
SD	0.58		
Verbal Interpretation	Highly Acceptable		

Table 11 shows that the Visual and Graphic Quality of the science eBook is “Highly Acceptable”, with a weighted mean of 4.57 and standard deviation of 0.58. Specifically, data shows that all five statements attained “strongly agree” responses, with mean scores of 4.51 to 4.65. Both statements about the clarity of diagrams and visualization of scientific concepts through images and pictures are highly perceived among the respondents. This indicates that the graphics and diagrams incorporated in the Science eBook are not mere appealing features but essential visuals that support learning.

Having clear images and meaningful design allow reading to be enjoyable and enables students to imagine abstract scientific processes more efficiently as compared to using text only. Also, the data shows that by using colors, fonts, and images in a strategic manner images allow students to have a more productive and enjoyable learning process, it also ensures that learners are kept active and remember key information much easier.

Level of Self-Directed Learning (SDL) Skills of Students

In this study, the level of Self-Directed Learning (SDL) Skills of Students refers to Goal Setting, Time Management, Critical Thinking, Decision-Making, and Self-Evaluation. The following tables show the specific statements, along with the corresponding mean scores, standard deviation, remarks, and verbal interpretation from the perspectives of respondents.

Table 12 presents the level of Students’ SDL Skills in terms of Goal Setting, specifically, how students set clear goals before a lesson, how they break large tasks into smaller steps, how they stay focused on their objectives, how they adjust goals as they progress, and how they track their achievements through the eBook.

Table 12. Level of Self-Directed Learning (SDL) Skills of Students in terms of Goal Setting

Statement	Mean	SD	Remarks
The science eBook consistently provides support that helps me to...			
...set clear and specific learning goals for myself before starting a lesson or activity, helping me understand what I aim to achieve and stay organized throughout the learning process.	4.51	0.59	Strongly Agree
... identify what I want to achieve after completing a lesson, allowing me to focus my efforts and measure my progress effectively.	4.41	0.54	Strongly Agree
... break down my learning goals into smaller, manageable steps, making it easier for me to accomplish them and track my progress over time.	4.38	0.65	Strongly Agree
...adjust my goals when needed to improve my learning outcomes, ensuring that I stay on track and continue to make meaningful progress.	4.40	0.64	Strongly Agree
...stay focused on my goals throughout the learning process, helping me maintain motivation, overcome distractions, and achieve the intended learning outcomes.	4.40	0.67	Strongly Agree
Weighted Mean	4.42		
SD	0.62		
Verbal Interpretation	Very High		

Table 12 reveals that the Goal-setting skill of the student is “Very High”, with a weighted mean of 4.42 and standard deviation of 0.62. Specifically, data exhibits that all five statements received “strongly agree” responses, with mean scores of 4.38 to 4.51. The results indicate that students have felt the most supported when they set clear and specific learning goals prior to navigating a lesson or activity of the science eBook. This means that eBook offers the required learning targets that can enable students to be organized learners. The eBook would enable students to monitor their progress through time, as it helps them determine what they want to accomplish and the small steps that would assist them to reach their goals.

Table 13 presents the level of Students’ SDL Skills in terms of Time Management, specifically, how they plan their study schedule, how they prioritize tasks within the eBook, how they avoid procrastination, how they allocate enough time for difficult topics, and how they balance their study with other activities.

Table 13. Level of Self-Directed Learning (SDL) Skills of Students in terms of Time Management

Statement	Mean	SD	Remarks
The science eBook provides guidance that helps me to...			
...plan my time effectively, organizing tasks and activities so that I can complete them on schedule while staying focused and productive throughout the lesson.	4.14	0.74	Agree
... prioritize tasks carefully based on their importance and deadlines, helping me manage my workload efficiently and focus on what matters most.	4.34	0.63	Strongly Agree
... avoid procrastination and maintain focus, staying on track with my learning and completing activities in a timely and organized manner.	4.14	0.68	Agree
...allocate sufficient time to study and understand difficult topics thoroughly, ensuring that I cope with challenging concepts before moving on to new lesson.	4.29	0.65	Strongly Agree
...use my time wisely to balance learning with other responsibilities, allowing me to manage both academic and personal tasks effectively.	4.32	0.65	Strongly Agree
Weighted Mean	4.24		
SD	0.67		
Verbal Interpretation	Very High		

Table 13 indicates that the Time management skill of the student is “Very High”, with a weighted mean of 4.24 and standard deviation of 0.67. While respondents "Agreed" with the statements about how eBooks help them in completing work or task on scheduled time, they "Strongly Agreed" that the eBook helped them prioritize the most important tasks. This indicates that the eBook acts as a guide for efficient workload management. It also promotes mastery of challenging concepts by students since it gives them enough time to work on hard aspects before proceeding with the learning; this is vital in self-directed learning. Even though procrastination is still a problem to encounter by certain students, the eBook offers the necessary structural help to enable them to better manage their time and remain focused on their productivity.

In the context of the science eBook, these results demonstrate why clear learning objectives and component trackers are so essential to be included. Since eBooks require advanced skills of self-management to navigate the interactive elements, students should have good time management skills due to the complex nature of science lessons covered by eBooks.

Table 14 shows the level of Students’ SDL Skills in terms of Critical Thinking, specifically how students comprehend information and draw conclusions prior to the analysis of information, how students justify their responses with evidence and how they contrast various solutions, how

students assess the credibility of the source, and how students apply logic to solve scientific problems.

Table 14. Level of Self-Directed Learning (SDL) Skills of Students in terms of Critical Thinking

Statement	Mean	SD	Remarks
The science eBook actively promotes my capacity to...			
...analyze information carefully and thoughtfully before drawing conclusions, helping me make informed and well-reasoned decisions.	4.48	0.61	Strongly Agree
...support my answers with relevant evidence and examples, ensuring that my responses are accurate and well-explained.	4.47	0.59	Strongly Agree
...compare and evaluate different solutions or strategies before deciding on the most effective approach, helping me make logical and informed choices.	4.38	0.64	Strongly Agree
...assess and evaluate the accuracy, reliability, and relevance of the information I use, enabling me to make confident and evidence-based conclusions.	4.43	0.62	Strongly Agree
...apply logic and reasoning skills to solve problems effectively during learning activities, allowing me to approach challenges with a clear and structured method.	4.34	0.69	Strongly Agree
Weighted Mean	4.42		
SD	0.63		
Verbal Interpretation	Very High		

Table 14 shows that the Critical Thinking skill of the student is “Very High”, with a weighted mean of 4.42 and standard deviation of 0.63. Specifically, data exhibits that all five statements were interpreted as “strongly agree” responses, with mean scores of 4.38 to 4.48. The data shows that the science eBook assists learners to critically examine information, provide evidence-based conclusions and answers using relevant evidence and examples. Further, this indicates that the science eBook limits students out of memorization. The logical and evidence-based approach of the science eBook allows students to solve scientific problems by requiring them to support answers with objective evidence and seek explanations from various points of view and solutions. In this way, it allows students to go beyond mere memorization and instead, learn the underlying scientific concepts by learning on their own.

In line with these, students in a digital environment are commonly exposed to real-life issues where they are expected to work together and apply different tools to solve inquiries and challenging tasks. This is an informal, practical method that helps students to navigate complicated information and competing perspectives, finally honing their skills to make rational judgments in highly stressful, technology-intensive environments.

Table 15 presents the level of Students’ SDL Skills in terms of Decision-Making, specifically, how they choose the best strategies for their learning, how they make independent choices in activities, how they reflect on past decisions to improve, how they consider outcomes before acting, and how they prioritize different tasks.

Table 15 reveals that the Decision-making skill of the student is “Very High”, with a weighted mean of 4.46 and

standard deviation of 0.60. Specifically, data exhibits that all five statements were interpreted as “strongly agree” responses, with mean scores of 4.42 to 4.50. This suggests that science eBook enabled students to look back on the past decisions to determine how they can be improved. Additionally, this implies that eBook makes learners strategic in their studies. The science eBook will make sure that the students are making good decisions on how they utilize their study time by assisting them to make choices that are based on their specific needs and priorities. Independence is also a key outcome shown in the data. Learners claimed to feel more empowered in their choice of decisions when tackling problems and using their reasoning abilities to come up with effective solutions without being constantly reminded of the same.

Table 15. Level of Self-Directed Learning (SDL) Skills of Students in terms of Decision-Making

Statement	Mean	SD	Remarks
The science eBook effectively provides assistance for my ability to...			
...make thoughtful choices when selecting strategies to complete tasks, helping me work more efficiently and achieve better results.	4.48	0.60	Strongly Agree
...carefully consider possible outcomes and consequences before planning, allowing me to choose the most effective course of action.	4.42	0.62	Strongly Agree
...choose learning activities that align with my goals and priorities, ensuring that the tasks I engage in contribute meaningfully to my progress that help me achieve my goals.	4.44	0.62	Strongly Agree
...make decisions independently and confidently when solving problems, applying my knowledge and reasoning skills to arrive at effective solutions.	4.48	0.61	Strongly Agree
...reflect on previous decisions and actions to identify areas for improvement, helping me enhance my strategies and achieve better learning outcomes in the future.	4.50	0.57	Strongly Agree
Weighted Mean	4.46		
SD	0.60		
Verbal Interpretation	Very High		

Table 16 presents the level of Students’ SDL Skills in terms of Self-Evaluation, specifically, how students assess their own understanding, how they identify what they have learned, how they recognize areas that need more work, how they use feedback to improve, and how they set new goals based on their assessment.

Table 16 indicates that the Self-evaluation skill of the student is “Very High”, with a weighted mean of 4.49 and standard deviation of 0.61. Specifically, data exhibits that all five statements were interpreted as “strongly agree” responses, with mean scores of 4.45 to 4.52. The data shows that learners become more aware of how they learn and how the eBook’s help students set new goals based on self-assessment. This signifies that science eBook is successful in creating awareness about their own progress and learning. The data presented also demonstrates that with the help of science eBook, students do not just learn science concepts, but they even manage to monitor and evaluate their personal progress, which enables them to identify their strengths and change their practices to achieve improved future results.

Table 16. Level of Self-Directed Learning (SDL) Skills of Students in terms of Self-Evaluation

Statement	Mean	SD	Remarks
The science eBook inspires and encourages me to take an active role in...			
...assessing and evaluating my own understanding of the lesson content, helping me identify what I have learned well and what requires further attention.	4.45	0.65	Strongly Agree
...recognizing my strengths and pinpoint areas that need improvement, allowing me to focus on enhancing my skills and knowledge effectively.	4.49	0.59	Strongly Agree
...reflecting thoughtfully on my progress after completing each activity, helping me understand how much I have learned and how I can improve in future lessons and tasks.	4.48	0.60	Strongly Agree
...becoming more aware of how I learn as a student, allowing me to understand my own learning strategies and adjust for better outcomes	4.52	0.60	Strongly Agree
...setting new goals based on assessing myself, which helps me continuously improve and achieve better outcomes.	4.52	0.61	Strongly Agree
Weighted Mean	4.49		
SD	0.61		
Verbal Interpretation			Very High

In totality, the reflection prompts and activities of the science eBook are the key in the development of Self-evaluation skill among students. The eBook promotes the culture of continuous improvement and academic development by motivating students to engage actively in self-assessment after each activity or lesson. By allowing students to think reflect on their own work, it helps them to become more aware of their strengths and areas for growth.

Level of Performance of the Students

In this study, the level of Performance of the Students refers to Formative Test Scores and Summative Test Scores.

The following tables show the distribution of scores, the frequency and percentage of students in each score bracket, the mean scores, standard deviation, and the corresponding verbal interpretation and descriptive equivalents.

Table 17 presents the level of Students' Performance based on Formative Test Scores, specifically, the distribution of scores across different performance levels, the frequency and percentage of students in each bracket, the weighted mean score, and the descriptive equivalent of their performance during the learning process.

Table 17. Level of Performance of Students based on Formative Test Scores

Score	Formative Test		Descriptive Equivalent
	F	%	
91-100	88	67.69	Outstanding
81-90	36	27.69	Very Satisfactory
71-80	6	4.62	Satisfactory
61-70	0	0.00	Fairly Satisfactory
below 61	0	0.00	Did Not Meet Expectation
Total	N=130	100	
Weighted Mean	91.19		
SD	4.11		
Verbal Interpretation			Outstanding

Table 17 shows an Outstanding level of performance on formative tests, with a weighted mean score of 91.19 (SD =

4.11). Over 67% of the students scored in the highest bracket (91-100). This implies that the eBook is very useful as a digital learning tool. These high scores are an indication that students understand what they are learning as it is being taught to them since formative tests indicate the progress of students in the learning process. Nevertheless, six students or 4.62% achieved a level of Satisfactory, which indicated that there was a need to improve in terms of the knowledge acquisition of the General Biology concepts. Besides, there are no students that have cumulatively scored 70 and below or within the lower groups, which signifies that good level performance is highly observed among the students. The eBook is likely to have effective components and characteristics that can sustain most students at high level of comprehension.

Table 18 presents the level of Students' Performance based on Summative Test Scores, specifically, it indicates the final scores of students after the completion of the unit, the frequency and percentage of students at different mastery levels, the weighted mean of these scores, and the overall verbal interpretation.

Table 18. Level of Performance of Students based on Summative Test Scores

Score	Summative Test		Descriptive Equivalent
	F	%	
41-50	122	78.46	Outstanding
31-40	28	21.54	Very Satisfactory
21-30	0	0.00	Satisfactory
11-20	0	0.00	Fairly Satisfactory
0-10	0	0.00	Did Not Meet Expectations
Total	N=130	100	
Weighted Mean	43.12		
SD	3.70		
Verbal Interpretation			Outstanding

Table 18 reflects an Outstanding performance on summative tests, with a weighted mean of 43.12 and standard deviation of 3.70. An impressive 78.46%(f=122) of students achieved scores in the 41-50 range, which is an increase compared to the formative scores. The increase in the number of students scoring high or in the "outstanding" bracket indicates that the eBook assists in the long-term consolidation of knowledge. Summative tests are the endpoint of a unit, and such outcomes demonstrate that students have adequately absorbed and mastered the lessons. With no students scoring below 31 (Satisfactory), the data proves that the eBook is an effective supplementary material. This shows that the eBook does not only help with immediate learning but also helps in enhancing the retention of concepts in the long term. Therefore, it can be used as a useful instrument in facilitating mastery and confidence of science concepts.

Significant Relationship between the Science eBook's Components and Self-Directed Learning (SDL) Skills of Students

In this study, the significant relationship between the Science eBook's Components and the Students' Self-Directed Learning (SDL) Skills refers to the statistical correlation between the components of the science eBook as to of Learning Targets, Pre-activity Statements, Guided Activities, Post-Activity Statements, Inquiry Activities, and Reflection

and the five domains of SDL skills namely: Goal Setting, Critical Thinking, Time Management, Decision making and Self-Evaluation.

Table 19 presents the statistically significant correlation analysis between the Science eBook's Components and SDL Skills. It shows the specific components evaluated, along with the corresponding Pearson r correlation coefficients along with their significance p-values (2-tailed), and the verbal interpretation of the relationship. The data below provide evidence of the strength and direction of the relationship between the identified variables.

Table 19. Significant Relationship between the Science eBook's Components and Self-Directed Learning (SDL) Skills of Students

Components of the Science eBook	Students' Self-Directed Learning (SDL) Skills					
	Goal Setting	Time Management	Critical thinking	Decision-Making	Self-Evaluation	
Learning Targets	Pearson Correlation	0.446*	0.303*	0.509*	0.414*	0.450*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000
	N	130	130	130	130	130
Pre-activity Statement	Pearson Correlation	0.504*	0.422*	0.561*	0.465*	0.511*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000
	N	130	130	130	130	130
Guided Activities	Pearson Correlation	0.595*	0.474*	0.528*	0.570*	0.574*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000
	N	130	130	130	130	130
Post-Activity Statement	Pearson Correlation	0.518*	0.385*	0.573*	0.547*	0.483*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000
	N	130	130	130	130	130
Inquiry Activity	Pearson Correlation	0.542*	0.432*	0.583*	0.510*	0.435*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000
	N	130	130	130	130	130
Reflection	Pearson Correlation	0.493*	0.404*	0.536*	0.510*	0.528*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000
	N	130	130	130	130	130

Legend: if p-value (2-tailed) < 0.05 = Significant

Table 19 shows that components of the Science eBook exhibit a statistically significant moderate positive relationship with all five SDL skills, as all p-values are less than 0.05. However, the strength of these relationships varies, as reflected in the computed correlation coefficients (r-values). This indicates that all eBook components, from learning targets to reflections, work together to foster independent learning and help students manage their own learning. The strongest correlation is between Guided Activities and Goal Setting (r=0.595), interpreted as a moderate positive relationship, showing that structured activities help students set goals, plan strategies, and monitor progress. In contrast, the

weakest correlation is between Learning Targets and Time Management (r=0.303), interpreted as low positive correlation, suggesting that while learning targets guide focus, they have less direct impact on time management, which may rely more on personal habits or external schedules. Nevertheless, this correlation remains statistically significant, showing that learning targets still support self-directed learning, though to a lesser extent.

Significant Relationship between the Science eBook's Characteristics and Self-Directed Learning (SDL) Skills of Students

In this study, the significant relationship between the Science eBook's Characteristics and the Students' Self-Directed Learning (SDL) Skills refers to the statistical correlation between Accuracy, Relevance, Structure, Usability and Visual and Graphic Quality and the five domains of SDL skills.

Table 20 presents the correlation analysis of the significant between the Science eBook's Characteristics and SDL Skills. It shows the specific features evaluated, along with the corresponding Pearson r correlation coefficients along with their corresponding significance p-values (2-tailed), and the verbal interpretation of the relationship.

Table 20. Significant Relationship between the Science eBook's Characteristics and Self-Directed Learning (SDL) Skills of Students

Characteristics of the Science eBook	Students' Self-Directed Learning (SDL) Skills					
	Goal Setting	Time Management	Critical Thinking	Decision-Making	Self-Evaluation	
Accuracy	Pearson Correlation	0.406*	0.448*	0.455*	0.515*	0.552*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000
	N	130	130	130	130	130
Relevance	Pearson Correlation	0.505*	0.524*	0.565*	0.545*	0.504*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000
	N	130	130	130	130	130
Structure	Pearson Correlation	0.477*	0.493*	0.546*	0.470*	0.530*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000
	N	130	130	130	130	130
Usability	Pearson Correlation	0.520*	0.429*	0.522*	0.450*	0.464*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000
	N	130	130	130	130	130
Visual and Graphic Quality	Pearson Correlation	0.456*	0.366*	0.439*	0.404*	0.474*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000
	N	130	130	130	130	130

Legend: if p-value (2-tailed) < 0.05 = Significant

Table 20 shows that characteristics of the Science eBook exhibit a statistically significant moderate positive relationship with all five SDL skills, as all p-values are less than 0.05. However, the strength of these relationships varies, as

reflected in the computed correlation coefficients (r-values). This indicates that all eBook characteristics, from accuracy to visual and graphic quality, collectively contribute to fostering independent learning and enhancing students' ability to manage their own learning processes. The strongest correlation is between Relevance and Critical Thinking ($r = 0.565$), interpreted as a moderate positive relationship, showing that when the content of the eBook is closely aligned with students' learning needs and real-world applications, it encourages them to analyze, evaluate, and apply knowledge more effectively, thereby strengthening their critical thinking skills. Conversely, the weakest correlation is between Visual and Graphic Quality and Time Management ($r=0.366$), interpreted as a low positive correlation, suggesting that while appealing visuals and graphics can enhance engagement and comprehension, they have a smaller direct impact on students' ability to organize and allocate their study time, which may depend more on personal habits, discipline, or external scheduling. Moreover, even this low correlation is statistically significant, indicating that all characteristics of the eBook, including visual and graphic design, still play a supportive role in the development of students' self-directed learning skills.

Significant Effect of the Science Ebook's Components and Characteristics on the Students' Performance in terms of Formative Test Scores

To test the significant effect of the science eBook's components and characteristics on student performance in terms of formative test scores, the data were statistically treated using a t-test to assess the effect of each independent variable indicator on students' formative learning.

Table 21 shows the specific components and characteristics evaluated, along with the computed t-values along with their corresponding significance p-values (2-tailed). The data provided on the table presents the predictive power of each independent sub-variable in enhancing students' formative test performance. Further, it also highlights how these features affect daily student engagement and knowledge acquisition.

Table 21 indicates that the Science eBook's components and characteristics did not yield a significant immediate effect on formative test scores. Specifically, among the components, only Guided Activities ($t = 1.987$, $p = 0.049$) and Reflection ($t = 2.400$, $p = 0.018$) were found to have a statistically significant effect on students' performance, as their computed t-values are greater than the t-constant of 1.979 and their p-values are less than the significance level of 0.05. The other components like Learning Targets, Pre-Activity Statement, Post-Activity Statement, and Inquiry Activity showed no significant effect, with computed t-values of less than 1.979 and p-values greater than 0.05. Subsequently, among eBook's characteristics indicators, Visual and Graphic Quality ($t = 2.193$, $p = 0.030$) was the only characteristic that significantly influenced students' performance, while Accuracy, Relevance, Structure, and Usability did not show statistically significant effects.

These results signify that certain components and characteristics of the Science eBook play a more critical role

in enhancing students' formative test scores. Specifically, only Guided Activities and Reflection appear to be key components in helping students consolidate their learning, apply concepts, and engage in self-assessment, which may translate into better performance on formative assessments.

Table 21. Significant Effect of the Science Ebook's Components and Characteristics on the Performance of Students in terms of Formative Test

Science Ebook's Components and Characteristics	Performance of Students Formative Test Scores	
Components		
Learning Targets	t-value	1.275
	Sig. (2-tailed)	0.205
	N	130
Pre-activity Statement	t-value	1.477
	Sig. (2-tailed)	0.142
	N	130
Guided Activities	t-value	1.987*
	Sig. (2-tailed)	0.049
	N	130
Post-Activity Statement	t-value	1.830
	Sig. (2-tailed)	0.070
	N	130
Inquiry Activity	t-value	1.917
	Sig. (2-tailed)	0.057
	N	130
Reflection	t-value	2.400*
	Sig. (2-tailed)	0.018
	N	130
Characteristics		
Accuracy	t-value	0.742
	Sig. (2-tailed)	0.459
	N	130
Relevance	t-value	1.79
	Sig. (2-tailed)	0.080
	N	130
Structure	t-value	1.384
	Sig. (2-tailed)	0.169
	N	130
Usability	t-value	0.684
	Sig. (2-tailed)	0.495
	N	130
Visual and Graphic Quality	t-value	2.193*
	Sig. (2-tailed)	0.030
	N	130

t-constant = 1.979

Similarly, the significance of Visual and Graphic Quality indicates that well-designed visuals can facilitate understanding and retention of information, supporting learning outcomes. Collectively, most of the components and characteristics of the Science eBook did not reach statistical significance but may still contribute to overall learning, although their effect on measurable formative test performance may be less direct or more dependent on how students interact with these features. This indicate that while these features support the learning process, their effects may be more evident in long-term engagement with the material.

Significant Effect of the Science Ebook’s Components and Characteristics on the Students’ Performance in terms of Summative Test Scores

To test the significant effect of the Science eBook’s Components and Characteristics on the Students’ Performance in terms of Summative Test Scores, they were treated statistically using t-test for to assess the significant effect of each independent variable indicator on students’ mastery of science concepts.

Table 22 shows the specific components and characteristics evaluated, along with the corresponding t-values along with the corresponding significance p-values (2-tailed). The data provided on the table presents the predictive power of each indicator of science eBook’s components and characteristics in enhancing student success at the end of the unit assessment.

Table 22. Significant Effect of the Science Ebook’s Components and Characteristics on Students’ Performance in terms of Summative Test

Science Ebook’ Components and Characteristics	Students’ Performance Summative Test Scores	
Components		
Learning Targets	t-value	4.983*
	Sig. (2-tailed)	0.000
	N	130
Pre-activity Statement	t-value	7.491*
	Sig. (2-tailed)	0.000
	N	130
Guided Activities	t-value	5.567*
	Sig. (2-tailed)	0.000
	N	130
Post-Activity Statement	t-value	6.551*
	Sig. (2-tailed)	0.000
	N	130
Inquiry Activity	t-value	5.796*
	Sig. (2-tailed)	0.000
	N	130
Reflection	t-value	7.064*
	Sig. (2-tailed)	0.000
	N	130
Characteristics		
Accuracy	t-value	3.647*
	Sig. (2-tailed)	0.000
	N	130
Relevance	t-value	4.430*
	Sig. (2-tailed)	0.000
	N	130
Structure	t-value	5.101*
	Sig. (2-tailed)	0.000
	N	130
Usability	t-value	2.998*
	Sig. (2-tailed)	0.003
	N	130
Visual and Graphic Quality	t-value	5.611*
	Sig. (2-tailed)	0.000
	N	130

t-constant = 1.979

Table 22 reveals that all components of the Science eBook have a statistically significant effect on students’ performance based on summative test scores since their computed t-values are greater than the constant t-value of 1.979 and their p-values are all 0.000, which is lower than the 0.05 level of significance. Specifically, Learning Targets (t = 4.983), Pre-activity Statement (t = 7.491), Guided Activities (t = 5.567), Post-Activity Statement (t = 6.551), Inquiry Activity (t = 5.796), and Reflection (t = 7.064) all significantly influence students’ summative test scores. Similarly, all the characteristics of the Science eBook also demonstrated significant effects, including Accuracy (t = 3.647), Relevance (t = 4.430), Structure (t = 5.101), Usability (t = 2.998), and Visual and Graphic Quality (t = 5.611), as their computed t-values exceeded the critical t-value and their p-values remained below 0.05.

This signifies that the components and the characteristics of the Science eBook are significant in enhancing the performance of the students in terms of summative scores. Having clear learning targets and pre-activity statements will make the students familiar with lesson goals and will prepare them for the learning activities. Guided activities, Inquiry activities, and Reflections help the learners to process information actively, to apply the concepts, and assess their comprehension, which enhances the retention of the knowledge and mastering the subject matter. Similarly, the features of the eBook, including accuracy, relevance, structure, usability and visual and graphic quality, promote the understanding and interaction of students with the learning content. When successfully incorporated, these factors will produce a more conducive learning atmosphere that will allow students to learn scientific subject matter and achieve higher results in summative assessments.

IV. CONCLUSION AND RECOMMENDATIONS

The result shows that there is a significant relationship between the eBook’s components and students’ SDL skills which lead to the rejection of the first null hypothesis. This indicates that instructional elements such as guided activities, inquiry activities, and reflections play an essential role in helping students plan, monitor, and evaluate their own learning.

Likewise, there is a significant relationship between the eBook’s characteristics and SDL skills leading to the rejection of the second null hypothesis. This highlights the importance of well-designed digital materials that are accurate, relevant, structured, user-friendly, and visually appealing in promoting learner engagement and independence.

Conversely, the third null hypothesis stating that there is no significant effect of the science eBook’s components and characteristics on students’ performance in terms formative test scores was accepted. Cumulatively, the components and characteristics of the Science eBook failed to provide statistically significant effect on the formative test scores of students, though the guided activities, reflection, and visual and graphic quality features had significant contribution to the engagement and comprehension of the learning process among the students. These results are indicative of how formative

performance might be affected by other factors in addition to the instruction content. Specifically, factors like the prior knowledge of the students, study habits, time constraints, and even the form of the assessment can have a closer effect on the attainment of formative test results.

Lastly, to complete the conclusion of this study, it is inferred that there is a significant effect of the Science eBook's components and characteristics on students' summative test scores which lead to the rejection of the last null hypothesis. Overall, this denotes that the integration of well-structured instructional strategies and quality design features can lead to improved long-term learning outcomes and mastery of scientific concepts particularly in the selected lessons of General Biology. Overall, the results emphasize the value of a well-structured digital learning materials in fostering self-directed learning and enhancing students' performance.

Based on the conclusions, the following recommendations are offered:

Educational technologists may design and develop digital learning materials, including science eBooks, which include well-organized instructional contents and quality design aspects. Guided activities, inquiry-based tasks, reflections, and visually captivating components may be incorporated to enhance self-guided learning of students and their in-depth comprehension of the subject matter. Additionally, ensuring that digital materials are accurate, relevant, user-friendly, and visually appealing will help maximize learner engagement and improve overall learning outcomes.

School administrators may facilitate the adoption of interactive and well-crafted digital learning resources in the classroom teaching to improve the learning processes of students. They may also offer sufficient training, resources, and technological assistance to the teachers so that they can use science eBooks and other digital aids in their teaching methods effectively. Independent learning skills may be reiterate among students by encouraging the use of innovative instructional resources that will enhance performance.

Teachers may use the science eBook as it improves their teaching methods and enhance interaction and self-learning among students. Educators may consider successfully using

the elements of guided activities, learning tasks based on inquiry and reflection activities to assist learners in acquiring goal setting, critical thinking, and self-monitoring skills. In addition, teachers may also show learners how to optimize the functionality of digital learning resources to improve formative and summative learning results.

Learners may interact with the components and features of the science eBook actively to get the best out of learning. With the help of guided activities, reflective tasks, and inquiry activities, students may enhance self-directed learning, including goal setting, time management, and critical thinking. These skills maybe developed to make learners more responsible and independent in their own learning process.

Future researchers may conduct further investigation on the efficacy of digital learning resources, specifically, science eBooks in different subject areas, grade levels, and learning settings. They may also consider the other variables like motivation of students, learning styles, technological preparedness or long-term academic performance to understand better how digital instructional resources can have an impact on the learning and performance of students especially in formative assessment.

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