Development of Digital Interactive Module in Teaching Science 5 at Cervantina Elementary School

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A B S T R A C T

This study focused on the development of digital interactive modules using the Kotobee application for teaching Science 5 at Cervantina Elementary School. Guided by Sharon Smaldino's ASSURE Model, the researcher employed a descriptive-developmental research design to identify the least-learned competencies, develop digital modules, and validate their effectiveness. Using the Sukdanan Standardized Test and the adapted 50-item Science 5 questionnaire from the Department of Education (DepEd) Caraga Region, the findings revealed that the least-mastered competencies included describing modes of reproduction in animals, identifying reproductive parts of plants and their functions, and explaining modes of reproduction in flowering and non-flowering plants. Based on these, three digital interactive modules were developed and validated using the Level 2 DepEd Evaluation Rating Sheet for Learning Area Books and Information in Digital Format. The modules were found valid in terms of content, format, presentation, accuracy, and up-to-dateness of information. Results also showed a significant increase in post-test scores after learners were exposed to the digital interactive modules, indicating their effectiveness in bridging learning gaps and enhancing mastery of competencies. Revisions suggested by the validators included consistency in formatting, originality of illustrations, proper placement of rubrics, and alignment of information. The study concludes that the developed modules are valid, effective, and may be used to support Science 5 instruction.

Keywords: **Digital Interactive Module, Kotobee Application, E-module, Digitized Module, Contextualize Instructional Materials,**

1. INTRODUCTION

The educational system was highly affected when the COVID-19 pandemic broke out in our nation. On June 19, 2020, the Department of Education released DO No. 012, which aimed at exploring technologies that could be useful in ensuring that learners receive a quality education despite the abrupt change in the mode of instruction from face-to-face to blended learning. Additionally, Philippine education under COVID-19 offered webinars and online training to equip Filipino teachers to work in the new normal of an educational setting. One of which is the utilization of the e-book using Kotobee Application as an interactive learning tool. Kotobee Application is designed in such a way as to cater to the needs for interactivity, digitization, and delivery of 21st Century Skills to make learners future-ready. This is the beginning of revolutionizing education in the Philippines to teach minds, touch hearts, and transform the lives of learners.

Kotobee Application is a feature-rich interactive e-book production tool for producing high-quality digital material. Users can simply add interactive components to their books with an easy-to-use interface. Furthermore, Kotobee Application is one of the leading tools for creating interactive books. Thousands of writers, publishers, and educators worldwide have trusted it to produce engaging, interactive eBooks (Otico et al., 2023).

Additionally, according to Calatrava (2022), Kotobee is the ultimate digital publishing platform for education and training. It gives the users the keys to create rich interactive content that runs in different formats or even in their own branded apps.

A case study in Egypt, Marwa Rakha (2022), an Egyptian author and a dedicated Montessori educator who has written several books on a range of subjects in the past. When the time came to publish her latest e-book, which she made for children, she began searching for a creative method to explain complex ideas clearly and interestingly. Then that was the time she discovered the Kotobee application, which helped turn her vision into reality. By leveraging its various interactive features, Marwa successfully delivered educational content like never before, all while generating revenue. She added that Kotobee Author provided the exact interactive features, including games, quizzes, links, videos, and audio clips.

According to Otico et al. (2023), a study, Kotobee Reader is the recommended app for reading interactive books on desktop, mobile, and web platforms. Teachers and curriculum designers can use this freemium application to create interactive books for their classrooms and schools. Even without internet access, it allows readers to access downloaded books on desktop and mobile apps.

Mijanes (2023) study shows how learners feel about using online learning. The findings made clear that learners now have a favorable opinion of using e-learning as a part of their learning method. E-learning provides an engaging and supportive learning environment for learners.

Apart from this, on May 28, 2021, Deped issued OUA Memo 00-0521-0219, which launched a nationwide 1st Deped Best OER Contest using the Kotobee Application to capacitate the teachers and provide an opportunity for them to apply the different soft skills in creating a good e-book-book and to complete the Deped Learning Management System (DLMS) in support of additional resources.

Furthermore, on July 15, 2023, the Division of Agusan del Norte, during the Division Science Fair and Quiz Plus, held an Online Educational Resources (OER) Contest using the Kotobee Application, which covers all quarters in Science.

Based on the Most Essential Learning Competencies (MELC), the science curriculum was created with the understanding that, in a world that is becoming more technologically advanced, scientific, and demanding, Science is both relevant and essential for Filipino learners. Science provides systematic procedures and approaches for studying the natural and man-made worlds, forging new ideas, working together to tackle difficulties, exploring frontiers, and solving issues in the actual world. Furthermore, Science provides a solid corpus of knowledge at various conceptual levels that is becoming more widely available to everyone. Additionally, Science offers distinctive methods of behaving and thinking in both more formal and technical contexts as well as in ordinary social settings. It provides strategies for living morally and with attitudes that will make the world a better place.

However, in the 2019 Year-end report of the Department of Education, Science, and Mathematics education in the Philippines, there were downward trends in the learners' performance due to either unavailable or inadequate learning materials in many schools in the country. The performance of Filipino learners in large-scale assessments—the National Achievement Test (NAT) shows a low proficiency level. NAT is administered for Grade 6, Grade 10, and Grade 12 learners (Hernando-Malipot, 2019).

In December 2023, she added that PISA was designed and developed by the Organization for Economic Co-operation and Development (OECD), and in 2022, 81 countries participated in it. The PISA results indicated that the country's average 2022 results in mathematics, reading, and science "were about the same as in 2018." The Philippines is still among the countries with the lowest proficiency, especially in reading, mathematics, and Science. Among the results in Mathematics, Science, and Reading, Science is the third lowest in the 81 countries, scoring 356. It has a negative 1 (-1) score compared to the 2018 PISA result. According to Manalastas and De Leon (2021), the struggling ranking of Science is still manifested in the studies conducted by PISA 2018 and PISA 2022. Despite the many conducted research aiming to uplift its present rank in the international education arena, there is still no best way to do it. Collectively, Science is still extremely low in terms of significant learning areas.

Moreover, based on the school comparative report of MPS in Science for the school year 2020–2021, 2021–2022, and 2022–2023, they are 75, 76, and 78, respectively. The MPS results in Science for the school year 2023-2024 in the First Quarter revealed that among 73 learners in Grade 5, the MPS is extremely low, at only 65.50, comparatively low to what is standard, which is 75. Furthermore, during the regional consolidation of the first quarter test result via iCLASS v.2.1 (as of November 27, 2023, with 492 respondents), it was shown that 80% of the respondents, which is 393, had the least-learned MELC(s) in Science 5 for the 1st quarter (materials): Investigate changes that happen in materials under the following conditions: (1) presence or lack of oxygen; and (2) application of heat.

Science performance is low, so there is a need to craft additional learning resources to aid learners' performance (Paraiso, 2023).

The researcher thus saw that the teachers could not only reside in this sad reality and be complacent with the learners' consistently low performance. Instead, every teacher should accept this reality and take this as a challenge to be more creative in providing affordable and appropriate instructional materials to engage learners in a more meaningful learning experience. In addition, the need and relevance of seeing how accessible the Kotobee Application may further improve learners' academic performance.

The conditions cited challenged the researcher to undertake the study of developing a digital interactive module for the identified least-learned competencies in the Second Quarter using the Kotobee Application in teaching Science 5 at Cervantina Elementary School.

1.1 Research Questions

The study aimed to develop a digital interactive learning module using the Kotobee Application for the Second Quarter as the basis for developing a digital interactive module using the Kotobee Application in teaching Science 5 at Cervantina Elementary School.

Specifically, it sought to answer the following questions:

1. What are the least-learned competencies in Science 5 based on the Second Quarter Examination Result?

2. Based on the least mastered competencies, what digital interactive modules can be developed to master the least learned competency in Science 5?

3. How valid are the developed digital interactive modules using the Kotobee Application in terms of:

    3.1   Content;

    3.2   Format;

    3.3   Presentation and Organization; and

    3.4   Accuracy and Up-to-dateness of Information?

4. Is there a significant difference in the test scores before and after the utilization of the developed digital interactive modules?

5. Based on the findings of the study, what revision can be designed to improve the utilization of the Kotobee Application in teaching Science 5?

2. METHODOLOGY

2.1 Research Design

The researcher used the descriptive-developmental research design. The least-learned competencies for the Second Quarter in Science 5 were the first to be identified and used as the basis for developing a digital interactive module using the Kotobee Application. The level of validity during the validation of the digitalized interactive module using the Kotobee Application was carefully examined by the identified Quality Assurance (QA) Team of the Learning Resource in the Division of Agusan del Norte. The members of the Division Quality Assurance Team were the LR Manager, EPS in Science, Librarian, and CID-Chief of Education Supervisor. The result of the evaluation tool serves as a pointer to the validity of the materials. It is either the material passed or failed.

2.2 Research Respondents

The study's respondents were the Grade 5 learners of Cervantina Elementary School for the SY 2023-2024. Table 1 shows the distribution of respondents in Grade 5. As shown in Table 1, there were two sections in this grade level with a total population of 73 learners. There were 38 learners in Grade 5 Molave and 35 learners in Grade 5 Narra. The total enumeration was used considering the population of Grade 5.

Table 1

Name of Section	Number of Learners
Molave	38
Narra	35
Total	**73**

Distribution of Respondents in Grade V

Table 2 shows the inventory of the gadgets available at home for Grade 5 learners. Based on the inventory for gadgets in Grade 5 as one of the primary requirements in this study, 100% of these 73 learners have the availability of gadgets such as cellphones, tablets, laptops, etc., at home, as shown in Table 2 below.

Table 2

Gadgets	Number of Learners
Smartphone	73
Tablet	3
Laptop	10
Desktop Computer	1

Inventory on the Gadgets Available at Home

2.3 Research Instruments

The researcher used an adapted 50-item Science 5 questionnaire, which was given by the Department of Education, particularly in the Caraga Region. Sukdanan Standardized Test was used in their 2nd Quarterly Examination and is used to determine the least-learned competency in Science 5. The Sukdanan Standardize Test was used for two school years since it was used in the SY 2022-2023. The questionnaire was based on the seven Most Essential Learning Competencies (MELCs) in the Second Quarter of Science 5, namely: Describe the parts of the reproductive system and their functions (S5LT-IIa-1); Explain the menstrual cycle (S5LT-IIc-3); Describe the different modes of reproduction in animals such as butterflies, mosquitoes, frogs, cats and dogs (5LT-IIe-5); Describe the reproductive parts in plants and their functions (S5LT-IIf-6); Describe the different modes of reproduction in flowering and non-flowering plants such as moss, fern, mongo and others (S5LT-IIg-7); Discuss the interactions among living things

and non-living things in estuaries and intertidal zones (S5LT-IIh-8); and Explain the need to protect and conserve estuaries and intertidal zones (S5LT-Ii-j-10).

Table 3 shows the distribution of test scores to determine the learners' mastery level. According to the mastery level set by the Department of Education, scores from 75% to 100% have a proficiency level of mastered, scores from 51% to 74% have a proficiency level of Nearly Mastered, and scores from 0 to 50% have a proficiency level of least learned.

Table 3. Distribution of Test Scores for the Mastery Level

Mean Percentage Scores	Mastery Level
75%-100%	Mastered
51%-74%	Nearly Mastered
0%-50%	Least-Learned

For the validation of the developed digital interactive modules using the Kotobee Application, the researcher used the Level 2 DepEd Evaluation Rating Sheet for Learning Area Books and Information in Digital Format from the Learning Resource. The validators are from the identified Development and Quality Assurance Team of the Learning Resource in Science in the Division of Agusan del Norte.

2.4 Data Gathering Procedure

Upon the approval by the panel of examiners of the proposal, the researcher asked permission from the higher authorities before undertaking the study. The researcher sent a letter of authorization to the Schools Division Superintendent of Agusan del Norte. Upon its approval, the researcher sent a letter request to the District Supervisor of Carmen, who attached the approved letter from the superintendent to allow the study to be conducted on the Development of a Digital Interactive Module in Teaching Science 5 at Cervantina Elementary School. After the approval of the District Supervisor, the researcher gave a letter of permission to the School Principal of Cervantina Elementary School for the conduct of the study. The researcher then sent an Informed Consent Letter to the parents to inform them. Finally, the researcher personally conducted the research using the ASSURE Model.

Analyze Learner

This phase involved administering and recording the Second Quarterly Examination of Science 5, using the 50-item Sukdanan Standardized Questionnaire to determine the least-learned competencies. The researcher administered the test questionnaire to 73 Grade 5 learners in SY 2023-2024.

The first step was for the researcher to administer the 2nd Quarter Examination in Grade V-Molave and Grade V-Narra. After that, the test papers were checked, the scores were tabulated, and the test results were recorded.

State Standards & Objectives

This phase was the identification of the least-learned competencies in Science in the Most Essential Learning Competencies (Eviota & Boyles, 2022).

In the Second Quarter, there are seven Most Essential Learning

Competencies (MELCs): (1) Describe the parts of the reproductive system and their functions; (2) Explain the menstrual cycle; (3) Describe the different modes of reproduction in animals such as butterflies, mosquitoes, frogs, cats, and dogs; (4) Describe the reproductive parts in plants and their functions; (5) Describe the different modes of reproduction in flowering and non-flowering plants such as moss, fern, mongo and others; (6) Discuss the interactions among living things and non-living things in estuaries and intertidal zones; (7) Explain the need to protect and conserve estuaries and intertidal zones.

With the Table of Specifications, Item Analysis, and the MPS of the examination, the researcher identified the least learned competencies for the 2nd Quarter Examination in Science V.

Select Strategies, Technology, Media & Materials

This phase was the selection of strategies, technology, media, and materials. In this study, the researcher used the Kotobee Application. Since the Kotebee Application is timely and relevant nowadays, and DepED encourages broad use of this application, the researcher takes the challenge to use this application. Kotobee Application is also a versatile teaching tool that can be incorporated into different lessons to aid and direct learners and give them a greater understanding of what they must learn (Sagge et al.; J. L., 2023).

Regarding gadget availability, all learners have gadgets at home, including desktop computers, laptops, tablets, and smartphones. This supports McDermott and Gormley's (2016) claim that technology is inevitable not only in modern society but also in the modern classroom. In addition, all respondents were able to participate and were guided by the researcher as well as their parents/guardians.

Moreover, the Speedtest download speed was 48 Mbps, and the upload speed was 19.47 Mbps. Thus, this served as the basis for the researcher's employing the Kotobee Application. Furthermore, the Kotobee application is an offline application, so connectivity was not a barrier to the development of interactive digital modules.

The researcher ensured that the tailored digital module meets the demands of the learners. The included activities were student-centered, localized, and contextualized. The researcher considered the big picture and built exercises like relatable observations and experiences when developing these learning activities.

Utilize Technology, Media & Materials

This phase was the designing of the digital interactive modules using the Kotobee application in teaching Science 5 at Cervantina Elementary School since the least-learned competencies were identified. The Kotobee Application had more activities that make learning more fun and exciting.

The content in a digitized interactive module was generally visualized in pictures and videos with texts aligned with the three identified least learned competencies. This supports Irwansyah, Lubab, Farida, and Ramdhani's (2017) claim that this visualization aims to help the user understand the content.

The researcher carefully and strategically planned the module based on the least-learned competencies. The researcher thus made sure that the developed digital interactive modules meet the standard of the Department of Education based on the Level 2 DepEd Evaluation Rating Sheet for Learning Area Books and Information in Digital Format from the Learning Resource-Agusan del Norte.

Then, the researcher conducted an orientation for the parents and learners on how they were going to use the Kotobee Application. After the orientation, they were guided on how to install the Kotobee Application. Then, the application is installed on any of their devices, such as phones, laptops, or tablets. Parents and guardians were given an orientation on the installation and utilization of this application, as well as the distribution of the developed digital interactive modules. Since Kotobee was also an offline application, the digital interactive module can now be used even without internet access.

Require Learner Participation

This phase was the utilization of the digital interactive modules using the Kotobee application for all learners in Science 5. Each module corresponds to only one least-learned competency. Since there were three least-learned competencies, there were also three modules.

The modules have interactive activities, videos, quizzes, pictures, and hyperlinks that only Kotobee Applications can offer without compromising the standards set by the Department of Education. The researcher followed a thorough process for quality assurance and validation of this study, gauged the material's formatting and content based on the tools used for the standardized Crafting of Digital Interactive Modules for DepEd, gathered the results of the Evaluation Rating Sheet, and applied those comments and suggestions from the Quality Assurance Team.

Also, the researcher administered the post-test based on the Standardized Test for Science 5 in the second Quarter. The validated digital interactive module was sent to the Learning Resource personnel for wide dissemination and utilization in the division.

Evaluate And Revise

The developed digital interactive modules using the Kotobee application were subject to validation by the members of the Division Quality Assurance Team: the LR Manager, EPS in Science, Librarian, and CID-Chief of Education Supervisor. It also assessed the quality of the developed materials in terms of content, format, presentation and organization, accuracy, and up-to-date (Eviota & Boyles, 2022).

After the validation, the learners took a post-test using the Sukdanan Standardized Questionnaire with 50 items to determine if there were improvements in the identified least-learned competencies after the utilization of the developed digital interactive modules. The post-test revision was applied based on the findings of the results on the Level 2 DepEd Evaluation Rating Sheet for Learning Area Books and Information in Digital Format from the Quality Assurance Team to improve the utilization of the Kotobee Application in teaching Science 5. Finally, the researcher submitted the three developed digital interactive learning modules for wide dissemination in the Division of Agusan del Norte.

Statistical Treatment

The following statistical tools are used in the treatment of data and for appropriate analysis and interpretation.

Mean Percentage Score (MPS). This statistical tool is used to establish the quantitative analysis of the level of Science among Grade 5 Learners.

Paired t-test. To determine the significant difference between the pre-test and post-test using the Sukdanan Standardized Questionnaire in Science 5.

3. RESULTS and DISCUSSION

1. What are the least-learned competencies in Science 5 based on the Second Quarter Examination Result?

Table 4 shows the seven most essential learning competencies in Science 5 for the Second Quarter. It also shows the least learned competencies of the learners in the Science 5 subject based on the item analysis conducted before the development of the digital modules. Three (3) out of seven (7) competencies were least mastered, as supported by the respective MPS, as shown in the same table.

Table 4

Most Essential Learning Competencies	No. of Items	Correct responses	%	Description
1. Describe the parts of the reproductive system and their functions.	7	433	84.74	Mastered
2. Explain the menstrual cycle.	7	423	82.78	Mastered
3. Describe the different modes of reproduction in animals	**7**	239	**46.77**	**Least Learned**
4. Describe the reproductive parts in plants and their function.	**7**	251	**49.12**	**Least Learned**
5. Describe the different modes of reproduction in flowering plants and non-flowering plants	**7**	245	**47.95**	**Least Learned**
6. Discuss the interactions among living things and non-living things in estuaries and intertidal zones.	7	481	82.36	Mastered
7. Explain the need to protect and conserve estuaries and intertidal zones.	6	420	82.19	Mastered

Least-Learned Competencies in Science 5 Based on the Second Quarter

Legend: *75%-100%= Mastered; 51%-74%=Nearly Mastered; 50% and below= Least Learned*

As shown in Table 4, the least-learned competencies were (1) Describe the different modes of reproduction in animals, (2) Describe the reproductive parts in plants and their function, and (3) Describe the different modes of reproduction in flowering plants and non-flowering plants.

The first least-learned competency was describing the different modes of reproduction in animals with an MPS of 46.77. It indicates that the learners do not master the desired competency. According to Blackburn (2018), one of the most fundamental aspects of animal reproduction is whether females lay eggs or give birth to live young. The factors underpinning the reproductive mode are complex; thus, it is essential to understand these processes because such innovations underpin much of the diversity of life on Earth (Whittington et al., 2022).

The second and third competencies described the reproductive parts in plants and their function and the different modes of reproduction in flowering plants and non-flowering plants, evidenced by the respective MPS of 49.12 and 47.95. According to Pereira and Coimbra (2019), understanding reproductive parts in plants and their function and reproductive modes of reproduction in flowering plants and nonflowering plants was another piece of the puzzle that highlights many knowledge gaps that remain to be filled. We cannot overstate the importance of these competencies in plants because they will help us to face all the challenges that the coming years will bring to humankind (Anastasiadi et al., 2021).

The learner's academic performance is crucial in education, according to Abaidoo (2018). Thus, these least-learned competencies should not be neglected but should provide support by integrating digital supplemental instructional materials such as digital interactive learning modules, which is the Kotobee Application to cater to 21st-century learners (Reddy et al., 2021). Because of these evidently least-learned competencies, the digital learning module is developed.

2. Based on the least-learned competencies, what digital interactive module using the Kotobee Application can be developed to master the least-learned competency in Science 5?

Relative to the findings in problem no. 1, those least-learned competencies were the basis for the development of a digital interactive module using the Kotobee Application to teach Science 5.

Figure 2. Cover Page of the Digital Interactive Modules

Figure 2 shows the cover page of the developed digital interactive module. It showed that on the cover page, it follows the standard set by the Department of Education. Furthermore, these modules were based on the identified least-learned competencies in teaching Science 5 for the Second Quarter.

Based on the test results, 4 out of 7 competencies were only mastered by the learners of Grade V, and the three competencies were identified as the least learned. The three competencies were (1) Describe the different modes of reproduction in animals such as butterflies, mosquitoes, frogs, cats, and dogs; (2) Describe the reproductive parts in plants and their functions; and (3) Describe the different modes of reproduction in flowering and non-flowering plants such as moss, fern, mongo, and others. These three (3) identified least learned competencies served as the basis for the development of digital interactive learning modules using the Kotobee Application.

On March 11-15, 2024, Module 1: Week 3, entitled Describe the different modes of reproduction in animals; on March 18-22, 2024, Module 2: Week 4, entitled Describe the reproductive parts in plants and their function; and on March 25-29, 2024, Module 3: Week 5, entitled Describe the different modes of reproduction in flowering plants and non-flowering plants. The modules can be accessed through this link: https://acesse.one/digitalinteractivemodules.

Based on the study of Tarigan, Sipahutar, and Harahap (2021), the results showed that learners' activities and autonomy who learned with interactive digital modules were significantly different from learners who learned using text learning modules. Learners under digital interactive instruction performed better than in text module classes. It is also supported by the study of Dewi, Zaim, and Rozimela (2022) that learning using the interactive learning module has advantages such as interactive learning.

Furthermore, the studies of Uncad (2022), Baring and Berame (2022), and Martinez (2022) concluded that the Kotobee Application was effective and efficient in improving the pupils' performance. The effectiveness of the e-module using Kotobee Application in the development of science teaching and by providing alternative ways to properly utilize the use of e-module in addressing and solving issues and problems in the teaching and learning process. Also, E-modules have the advantages of being practical, durable, and lower production costs than print modules in general (Ramadhan & Linda, 2020).

Figure 3. **Overview of the Interactive Modules Using Different Platforms**

Figure 3 shows the different overviews in different platforms such as mobile phones, desktops, and tablets or iPads. Kotobee Reader for learners is a downloadable application installed on their Android phones, desktops, laptops, tablets, or iPads (Perocho et al., 2023). Recently, it has been observed that the majority of the population quickly adapted to the use of advanced technologies in the field of education all around the world. Moreover, people have started to use iPads, tablets, and devices to read electronic learning materials as personal digital devices (Chiu, 2017).

Unlike a physical book, with text printed on paper and readable by flipping pages, e-books have text shown on a computer or e-book reader's screen. It is also a digital file embedded with texts and images that are ideal for on-screen displays, like a printed book (Attwell, 2019). Moreover, Alshehri (2021) said that using e-books to teach makes lessons more exciting and gets learners thinking about their learning. Using an e-book has also made it easier for learners and teachers to talk to and with each other. Also, he added that the learners enormously improve their academic engagement when a collaborative learning environment is provided with digital e-books.

Thus, figure 3 shows the various ways in which the user can manipulate the interactive module. It can be viewed on multiple platforms depending on the learner's available devices. Since Kotobee was also an offline application, the digital interactive learning module can now be used even without internet access. Thus, with or without internet access, there is never a hindrance to motivating learners to learn when and anywhere.

Figure 4 shows the module's interactive parts, such as hyperlinks, interactive quizzes, and videos.
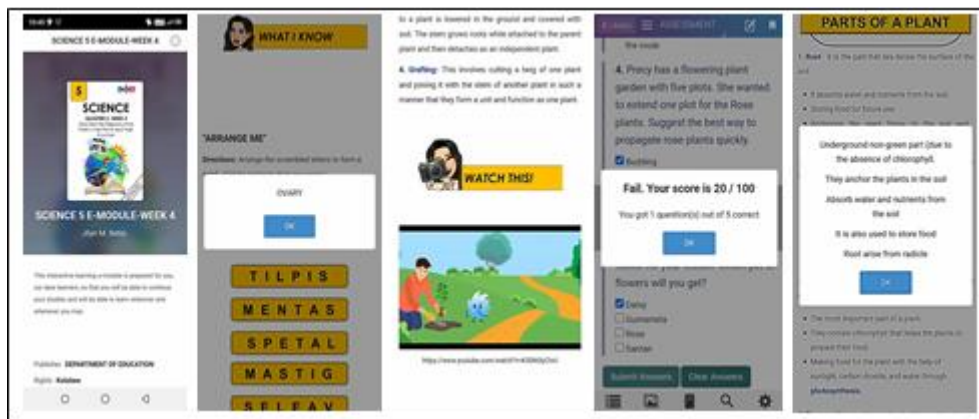

Figure 4. Interactive Parts of the Modules

As shown in Figure 4, it has a guide that helps the learners on how to use the module at the start and the end of the lesson. Kotobee Reader can be a tool to read modules interactively. It has an interface, the Kotobee Author, where the teacher can design interactive modules in a way that they can attach pictures, videos, online links, games, and quizzes (Bawal & Cuenca, 2023). During the utilization of the digital interactive module, most of the learners enjoyed the interactive learning module. They engaged the learners with interactive Content, such as video, audio, image click-animations, self-assessment questions, book widgets, and more to motivate learners to learn meaningfully.

Electronic books (E-books) have created space, context, opportunities for teaching and learning activities, and interactive and adaptive experiences to meet the diverse learning needs of learners (Lam et al., 2022). Additionally, according to Goneda et al. (2021), incorporating technology into educational settings, such as using an interactive e-learning design, can boost learners' engagement in asynchronous distance learning.

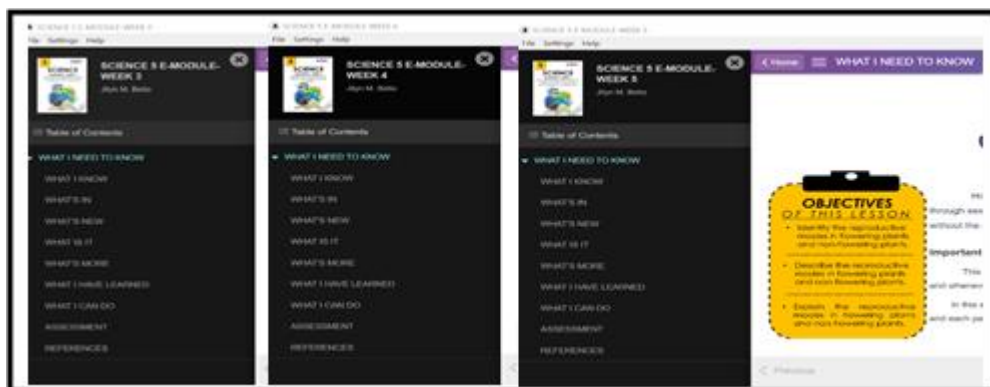Figure 5 shows the different parts of the digital interactive module.

Figure 5. Different Parts of the Digital Interactive Module

As shown in Figure 5, the parts of the digital interactive modules were based on the template design of the E-Module aligned with the Alternative Delivery Model (ADM) Module recommended by the Department of Education with the following parts: (1) What I Need to Know; (2) What I Know; (3) What is In; (4) What is New; (5) What is it; (6) What is More; (7) What I Have Learned; (8) What I Can Do; (9) Assessment; and (10) References.

What I Need to Know: This part has the Essential Learning Competencies (MELCs), objectives, and an overview of the lesson of what is expected to be learned in the digital interactive module. Each digital interactive modules have different objectives since they are different competencies. This part has a 10-item self-assessment quiz.

What I Know: This part has a variety of activities to check what the learners already know about the previous lesson. Since these modules were in weeks 3-5, this part gave a quick review of the lesson by answering interactively. Some activities included in the digital interactive modules were Choose Me and Tick Me, where learners choose the letter of the correct answer and fill out the crossword puzzle.

What is In: This part bridged activities with the new lesson. In the digital modules, the researcher used pictures, self-assessment quizzes, and guessing games through poems so the learners would pay attention and have a clue of what the new lesson might be. The researcher included activities such as Guess Me, Arrange Me, and Click Me, where learners identify, choose either Yes or No, and arrange the scrambled letters to form a word.

What is New: This part introduced the new lesson in ways that relate it to the new topic. The digital modules have self-assessment interactive quizzes, poems, a problem opener, or situational activities. Questions help the learners discover and understand the new concept. The activities included were Click Me, Check Me, and Guess Me, which gave learners a bigger picture of the new topic.

What is it: In this part, each module comprehensively discusses the least-learned competencies. Unlike any other module, these digital interactive modules were embedded with pop-up messages through hyperlinks; they also had videos relevant to the topic of that week, which made them more different from a typical module we had. In that way, they promoted excitement and a meaningful experience. Moreover, it caters to various types and styles of learners.

What's More: This part comprises activities for the learners' guided practice. Each digital interactive module has unique activities, namely Arrange Me, where learners arrange the sequence of events; Fill Me, where the learners explain the reproductive parts of the plants; and Think Before You Click Me, where learners choose the correct answer.

What I Have Learned: This part includes questions for the learners to fill out and process from the lesson. The digital interactive modules have activities such as Describe Me, Click Me, and Click Me Now, where learners identify, describe, and give examples of the questions being asked.

What I Can Do: This part provides independent activities for the learners to apply their new knowledge and skills in real life. In the three digital interactive modules, the titles of the activities were Look For Me and Think of Me, Tick Me, and Describe Me, where learners looked around outside of where they were and gave a short description of what was being asked. In this part, some rubrics guided the learners on what was expected of them.

Assessment: This part evaluates the learners' progress and learning through a formal evaluation. This evaluates the learner's level of mastery in achieving the learning objectives. The assessment has ten items; it is not what we think an evaluation is that waits for the teacher to check, but a self-assessment quiz in which the learners immediately know their scores.

References: This part includes all the sources for developing the interactive digital modules. Most of the pictures were initially illustrated and captured by the researcher.

Those parts mentioned above were constructively, logically, and strategically crafted. In that way, the learners knew precisely what they were expected to learn and how to apply or use the new information. The researcher worked diligently and collaboratively to plan, organize, and deliver instruction that made challenging concepts understandable. The logical, clear, and concise lessons we observed helped learners acquire more significant levels of mastery.

Teachers must develop and create instructional learning materials that traverse the learners' learning gap, allowing them to attain their educational objectives, understand ideas, and master skills (Luzano, 2020).

In Summary, Figures 2-5 show that the Kotobee Application is a feature-rich interactive e-module production tool for producing high-quality digital material (Otico et al., 2023). Also, Otico et al. (2023) and Espina (2021) recommended the Kotobee application where learners had meaningful learning experiences. Moreover, creating an interactive module that can be utilized offline and improving the learners' learning strategies. Thus maximizing the utilization of the gadgets the learners have and promoting mastery of the lessons that identified least-learned competencies of the Grade 5 learners in Science.

3.How valid are the developed digital interactive modules using the Kotobee Application?

The Development and Quality Assurance Team of the Learning Resource in the Division of Agusan del Norte validated the digital interactive modules utilizing the Level 2 DepEd Evaluation Rating Sheet for Learning Area Books and Information in Digital Format. The evaluators and members of the Quality Assurance Team of the digital interactive modules were the Division Librarian, Education Program Supervisor in Science, LR Manager, Division Coordinator in NSEd, and the CID-Chief of Education Supervisor.

Table 5 shows the validity test results on Content. It also demonstrates that all other indicators have a mean score of 4, which is Very Satisfactory, except indicator no. 7, which scores three and is Satisfactory. With a total points of 27 out of 28 points, this means that the digital interactive modules are suitable to the learners' level of development; contribute to the achievement of specific objectives of the learning area and grade level for which it is intended; provide for the development of higher cognitive skills such as critical thinking, creativity, learning by doing, inquiry, problem-solving, and 21st Century Skills; free of ideological, cultural, religious, racial, and gender biases and prejudices; Material enhances the development of desirable values and traits such as Creativity and Innovation, Communication and Collaboration and Information, Media, and ICT Literacy; arouses the interest of the target reader; and adequate warning / cautionary notes are provided in topics and activities where safety and health are of concern.

Table 5

Validity test results on Content

No.	Factor 1: Content	Mean Score	Descriptive Interpretation
1	Content is suitable to the learners' level of development.	4	Very Satisfactory
2	Material contributes to the achievement of specific objectives of the learning area and grade level for which it is intended.	4	Very Satisfactory
3	The material material provides for the development of higher cognitive skills, such as critical thinking, creativity, learning by doing, inquiry, problem-solving, and 21st-century Skills.	4	Very Satisfactory
4	Material is free of ideological, cultural, religious, racial, and gender biases and prejudices	4	Very Satisfactory
5	Material enhances the development of desirable values and traits such as: (Put a check mark only to the applicable values and traits)	4	Very Satisfactory
	☐ 5.1 Creativity and Innovation		
	☐ 5.2 Critical Thinking and Problem Solving		
	☐ 5.3 Communication and Collaboration		
	☐ 5.4 Information, Media, and ICT Literacy		
	☐ 5.5 Flexibility and Adaptability		
	☐ 5.6 Social and Cross-cultural Skills		
	☐ 5.7 Productivity and Accountability		
	☐ 5.8 Leadership and Responsibility		
	☐ 5.9 Initiative and Self-direction		
	☐ 5.10 Others (Please specify) _____		
6	Material arouses the interest of the target reader.	4	Very Satisfactory
7	Adequate warning / cautionary notes are provided in topics and activities where safety and health are of concern.	3	Very Satisfactory
	Total Points	**27**	**Passed**

Note: SLR must score at least 21 points out of a maximum of 28 points to pass this criterion

Since the total score is 27, the digital interactive learning modules have passed the content validation.

Nickerson (2023) argues that content validity is essential to ensure that the material measures what it intends to measure. Moreover, Spoto et al. (2023), Obilor (2018), and Clark and Watson (2019) emphasize that content validity focuses on the extent to which a set of items is relevant to the target construct, constructed test items, desirable values, and traits, and the difficulty level of items.

This can have profound implications for learners' performance. For instance, a test that poorly measures learners' abilities can lead to poor performance and be unsuitable for learners; ultimately, learners fail (Obilor, 2022).

Table 6 shows the validity of Factor 2, which is the Format. All the indicators, such as prints, illustrations, design and layout, paper and binding, and size and weight of SLR, have a score of 3, which is satisfactory. The materials are expected to have an acceptable rate since they are digital interactive modules and will not undergo some indicators such as prints, paper, and binding. With a total of 15 out of 20 points, this means that the digital interactive modules follow the Format in terms of prints, illustrations, design and layout, paper and binding, and size and weight of SLR.

Radovan and Makovec (2015) supported the importance of the format validity of the materials being developed. They asserted that educational materials can be defined as the didactically adapted materials that the teacher can use during the teaching process as teaching materials; for the learners who are acquiring or revising their knowledge with the help of the materials, these materials are learning materials or learning sources.

Table 6

Validity test results on Format

No.	Factor 2: Format	Mean Score	Descriptive Interpretation
1	Prints	3	Satisfactory
	1.1. The size of the letters is appropriate for the intended user.		
	1.2. Spaces between letters and words facilitate reading.		
	1.3. The font is easy to read.		
	1.4. Printing is of good quality (i.e., no broken letters, even density, correct alignment, properly placed screen registration).		
2	Illustrations	3	Satisfactory
	2.1 Simple and easily recognizable		
	2.2 Clarify and supplement the text		
	2.3 Properly labeled or captioned (if applicable)		
	2.4 Realistic/appropriate colors		
	2.5 Attractive and appealing		
	2.6 Culturally relevant		
3	Design and Layout	3	Satisfactory
	3.1. Attractive and pleasing to look at		
	3.2. Simple (i.e., does not distract the attention of the reader)		
	3.3. Adequate illustration in relation to text		
	3.4. The harmonious blending of elements (e.g., illustrations and text)		
4	Paper and Binding	3	Satisfactory
	4.1 Paper used contributes to easy reading		
	4.2 Durable binding to withstand frequent use		
5	Size and Weight of SLR	3	Satisfactory
	5.1 Easy to handle		
	5.2 Relatively light		
	Total Points	**15**	**Passed**

Note: SLR must score at least 15 points out of a maximum of 20 points to pass this criterion.

Since the total score is 15, the digital interactive modules passed Format Validation.

Table 7 shows the validity of Factor 3, which is Presentation and Organization. It demonstrates that all other indicators have a mean score of 4, which is Very Satisfactory, except indicator no. 5, which scores three and is Satisfactory.

Table 7

No.	Factor 3: *Presentation and Organization*	Mean Score	Descriptive Interpretation
1	The presentation is engaging, interesting, and understandable.	4	Very Satisfactory
2	There is a logical and smooth flow of ideas.	4	Very Satisfactory
3	The vocabulary level is adapted to target the reader's experience and understanding.	4	Very Satisfactory
4	The length of sentences is suited to the comprehension level of the target reader.	4	Very Satisfactory
5	Sentences and paragraph structures are varied and exciting to the target reader.	3	Satisfactory
	Total Points	**19**	**Passed**

Validity test results on Presentation and Organization

Note: SLR must score at least 15 points out of a maximum of 20 points to pass this criterion.

With total points of 19 out of 20 points, this only means that the digital interactive learning modules present an engaging, interesting, and understandable; there is a logical and smooth flow of ideas; the vocabulary level is adapted to the target reader's experience and understanding; length of sentences is suited to the comprehension level of the target reader; and sentences and paragraph structures are varied and exciting to the target reader. Since the total score is 19, it is, therefore, the digital interactive modules passed in Presentation and Organization validation.

According to Ajoke (2017), in making use of any instructional materials, such materials must be reviewed, that is, having full knowledge of the material, preparing the environment where it will be used, preparing the audience utilizing making sure that the materials to be used will attract attention, arouse, motivate and provide the rationale that could be used in the beginning, middle or end. Hence, Mijanes (2023) asserted that the Kotobee Application offers an encouraging and engaging learning environment among learners. Thus, the study reveals that the positive impact of E-learning on learners' learning reflects their belief that using technology to enhance learning interest will motivate them to learn. It also has proven that the use of technology and collaborative and interactive activities in groups may positively influence learner engagement.

Table 8 shows the Validity test results on Accuracy and Up-to-dateness of Information in terms of conceptual errors, factual errors, grammatical errors, computational errors, obsolete information, typographical and other minor errors (e.g., inappropriate or unclear illustrations, missing labels, wrong captions, etc.).

Table 8

No.	Factor 4: *Accuracy and Up-to-dateness of Information*	Mean Score	Descriptive Interpretation
1	Conceptual errors	4	Very Satisfactory
2	Factual errors	4	Very Satisfactory
3	Grammatical errors	4	Very Satisfactory
4	Computational errors	4	Very Satisfactory
5	Obsolete information	4	Very Satisfactory
6	Typographical and other minor errors (e.g., inappropriate or unclear illustrations, missing labels, wrong captions, etc.)	4	Very Satisfactory
	Total Points	**24**	**Passed**

Validity test results on Accuracy and Up-to-dateness of Information

Note: SLR must score at least 18 points out of a maximum of 24 points to pass this criterion.

Table 8 also demonstrates that all other indicators have a mean score of 4, which is Very Satisfactory. With a total score of 20 points, this only means that the digital interactive learning modules are accessible from conceptual errors, factual errors, grammatical errors, computational errors, obsolete information, and typographical and other minor errors. Since the total score is 24, the digital interactive modules passed that in Accuracy and Up-to-dateness Information validation.

According to Ashar (2023), data is the backbone of any developed learning materials, and the information must be accurate, up-to-date, and complete. This process is essential to maintain the integrity and reliability of the data and to ensure that it is fit for its intended purpose. By identifying and removing errors, inconsistencies, and duplicates, data cleansing can help to improve the quality of information and the overall performance of the organization.

Mobinizad (2018) also stated that teachers are responsible for closing the technology gap by providing students with up-to-date learning resources and developing instructional materials that integrate technology to enhance the teaching-learning process.

Table 9 shows the Summary of the Validity test results on the Digital Interactive Modules in Science 5 per DepEd Standard. Hence, Table 9 posits support for the validity of the developed digital modules relative to DepEd standards. The quantitative results shown in the given table established the validity of the material. In particular, the said digital interactive modules had passed the four criteria of evaluation, namely, Content, Format, presentation and organization, and accuracy and Up-to-dateness of information obtained the respective passing scores of 27, 15, 19, and 24. Since all the factors passed in the validation, the results definitely showed that the developed learning materials are valid and that the digital interactive modules are recommended for possible use in public schools.

Table 9

Summary of the Validity test results on the Digital Interactive Modules in Science 5 per DepEd Standard

Criteria for Validity	Standard	Actual Score	Highest Score	Remarks
Content	You must score at least 21 points out of the maximum 28 points to pass this criterion.	27	28	Passed
Format	You must score at least 15 points out of the maximum of 20 points to pass this criterion.	15	20	Passed
Presentation and Organization	You must score at least 15 points out of the maximum of 20 points to pass this criterion.	19	20	Passed
Accuracy and Up-to-dateness of Information	You must score at least 18 points out of the maximum 24 points to pass this criterion.	24	24	Passed

Note: A material that Failed in at least one of the factors in this rating sheet should not be recommended for possible use in public schools.

According to Siano et al. (2021), "when interactive learning modules are used, learners are motivated to learn." The digitized interactive learning module provided learners with an exceptional learning opportunity. The Kotobee Application in Self-Learning Modules helps learners acquire adequate academic knowledge. Yuliento (2022) added that it provides support for this study by stating that the use of technology in education has an impact on a variety of factors, especially learning sources. Additionally, Uncad (2022), Secadron et al. (2023), and Lasala Jr (2023) studies revealed that the learner participants performed Very Satisfactory after exposure to interactive, active, and self-directed learning thereby, improving learners' motivation, engagement, interest, and performance to the intervention material using Kotobee application. Hence, digital interactive learning modules improved learners' learning outcomes and motivation (Yuyun et al., 2022).

Consequently, Imtiaz et al. (2022), when learners fail to grasp subject matters, they lose interest in their studies and either start to rote learning or lose interest and motivation, which results in poor academic achievement. Their study shows that teaching integrated Science via interactive digital modules has led to significant improvements in learners' conceptual understanding. Perocho et al. (2023) said that there was an improvement in the pupils' performance level in Science when Kotobee-digitalized modules were used. Moreover, according to Latif and Talib (2021), the study found that the developed and validated interactive mathematics teaching materials in the form of e-modules were valid, practical, and effectively used in learning to improve learners' cultural and civic literacy.

4. Are there significant differences in the test scores before and after the utilization of the developed digital interactive modules?

Table 10 displays the paired t-test results comparing the learners' pre-test and post-test MPS on the seven competencies shown in problem 1. On February 5, 2024, and April 15, 2024, the researcher conducted the Pre-test and Post-test in Science 5 in the two sections of Grade 5 using the Sukdanan Standardized Questionnaire.

Table 10

Paired t-test results on the MPS on the competencies before and after the use of digital interactive modules

Most Essential Learning Competencies	Pre-Test (MPS)	Post-Test (MPS)	Mean Gain	p-value	Conclusion	Remarks
1. Describe the different modes of reproduction in animals	46.77	84.15	37.38	0.001	Reject H_o	**Significant**
2. Describe the reproductive parts in plants and their function.	49.12	84.93	35.81	0.001	Reject H_o	**Significant**
3. Describe the different modes of reproduction in flowering plants and non-flowering plants	47.95	83.95	36.00	0.001	Reject H_o	**Significant**

Note: Tested at a 5% level of significance

Table 10 shows that the least-learned competencies in post-test Mean Percentage Scores (MPS) were significantly higher, with mean scores of 84.15, 84.93, and 83.95, respectively, compared to the pre-test, which only obtained 46.77, 49.12, and 47.95, mean scores. It must be noted that the competencies are least mastered before the utilization of the module, as supported by the relatively lower MPS values. On the other note, the post-test MPS values show that learners have already mastered the same set of competencies after using the digital module. It further implies that the potential contribution of the digital interactive module in teaching Science 5 improves the competencies, and the learners perform better after the intervention than before the intervention. Moreover, the results of the T-test calculation show that there is a significant difference between the pre-test and post-test learning outcomes.

Furthermore, the careful examination, drawing on all available sources of knowledge and informed judgment, of the objectives of teaching, whether in particular subject courses or over the curriculum as a whole (Manurung, 2017).

Ramadhani and Andriani (2024), their study revealed the feasibility and effectiveness of an Interactive E-Module. The effectiveness of Interactive E-Modules has increased, which shows that pre-test and post-test data are typically distributed. The results of the T-test calculation show that there is a significant difference between the pre-test and post-test learning outcomes. The conclusion of the research on the learning-based interactive e-modules was successfully developed, and it was very feasible and effective for improving the cognitive learning of the learners. Siano et al. (2022) asserted that findings indicated that learners achieved satisfactory levels when exposed to the interactive e-book. There was a statistically significant difference in how well learners did on their tests before and after. Learners are motivated to learn when using an interactive e-book to enhance their knowledge. Learners had a remarkable learning experience with the interactive e-book.

5. Based on the findings of the study, what revision can be designed to improve the utilization of the Kotobee Application in teaching Science 5?

Relative to the findings presented, as shown in the results in Problems 1, 3, and 4, the three digital interactive modules based on the three (3) identified least-learned competencies improved after being utilized and validated with a remark of "passed" to all the factors in the validation, namely Content, Format, presentation and organization, and Accuracy and Up-to-dateness of Information.

According to Camba (2023) studies entitled "Digitized Remedial Instructional Materials in Afro-Asian Literature for Grade 8 Learners", the validators evaluated the developed Digitized Remedial Instructional Materials in Afro-Asian Literature for Grade 8 Learners as Very Acceptable in terms of Content Quality, Instructional Quality, and Technical Quality. Likewise, it was found that there were significant differences among the evaluations of the three groups of respondents. Moreover, the validators provided comments and suggestions to improve the developed instructional materials further. Likewise, based on the Level 2 DepEd Evaluation Rating Sheet for Learning Area Books and Information in Digital Format, the comments and suggestions of the validators in the areas that need to be revised to improve the modules.

Table 11 presents the comments and recommendations on the digital Interactive modules in teaching Science 5 evaluated by the identified Quality Assurance Team in the Division of Agusan del Norte.

Table 11

Comments and Recommendations on the Digital Interactive Modules

Comments and Recommendations on the Material
Be consistent with the font style and font size used.
Make original illustrations to eliminate copyright infringement.
Put your rubrics after your activities.
In Science 5 Week 5, there are statements/information misaligned. Review and organize the information.

As shown in Table 11, the researcher needs to address the following comments and recommendations to improve the digital interactive modules in teaching Science 5. After these findings, the researchers immediately crafted a new version of the digital interactive modules based on the comments and recommendations of the evaluators. Finally, after the revision, the researcher sent the digital interactive modules to the Learning Resource in the Division for further approval for possible use in the public schools of the Division of Agusan del Norte.

4. CONCLUSIONS and RECOMENDATIONS

4.1 Conclusions

Based on the findings of the study, the following conclusions are drawn.

Learners only mastered four out of seven competencies in the Second Quarter for Science 5, so there is a need to develop supplementary learning materials.

Three digital interactive modules, including pictures, videos, hyperlinks, and interactive learning activities, were developed using the Kotobee Application based on the standard set by DepEd. Thus, the learners learn at their own pace, assess their learning, promote meaningful learning experiences, maximize the utilization of their gadgets, and help master the least-learned competencies in teaching Science 5.

The developed digital interactive modules show that all indicators in the tool have passed, which means that the quality assurance of the developed digital interactive learning module is desirable and can be utilized in the teaching-learning process.

The digital interactive module enhances the least-learned competencies in teaching Science 5. It can be deduced that learners can learn significantly when exposed to various modes of instruction, specifically digital interactive modules, using the Kotobee application.

Improving the digital interactive modules by incorporating the validators' comments, suggestions, and recommendations signifies that the developed digital interactive module has successfully undergone the validation process; hence, it can be utilized in elementary public schools in the division.

4.2 Recommendations

The following recommendations are offered based on the conclusions drawn from the study.

School Administrator. They may help to provide these digital interactive modules to improve the teaching-learning process since the developed digital interactive module has been validated by the Development and Quality Assurance Team of the Learning Resource in Science.

Teachers. They may use the developed digital interactive modules in teaching Science 5. In addition, they may develop more interactive digital modules using the Kotobee application in different learning areas since it's an offline application that may utilize the gadgets the learners have.

Learners. They may use the digital interactive modules not just as an intervention but also as additional learning materials for them to master the competencies.

Parents. They may encourage their children to maximize the use of their gadgets for educational purposes by having the Kotobee Application.

Future Researchers. They may use this study as an offshoot of their study and consider relevant ideas not included in the present study.

To my love, for being her number-one supporter and always being there from the beginning of this study. The presence, financial support, guidance, and motivation mean a lot to her throughout this journey, and

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