ASEAN Journal of Educational Research and Technology

Journal homepage: https://ejournal.bumipublikasinusantara.id/index.php/ajert

Development, Validity, and Acceptability of Android-based Applications in Ecology: A Technology Acceptance Model (TAM) Approach

*Jereme Lleva Astaño**

Bicol University Graduate School, Legazpi, Albay 4500, the Philippines
*Correspondence: E-mail: jereme.astano@bicol-u.edu.ph

ABSTRACT

This study aimed to develop, validate, and evaluate the acceptability of Android applications in teaching ecology. Three interactive applications were created using a developmental research approach with AppsGeyser, a free platform for building educational Android apps. These applications (the Learning Guide App, Word Search App, and Quiz Game App) were aligned with the Grade 7 Science Curriculum content standards of the Department of Education in the Philippines. A quantitative approach was employed to assess the apps and evaluate their acceptability through a survey using the constructs from the Technology Acceptance Model (TAM). The applications were examined for content, instructional, and technical quality, with evaluators reporting high validity across all factors. Results showed that user feedback indicated strong agreement with the perceived usefulness (PU) and behavioral intention to use (BIU) of the applications. Additionally, respondents demonstrated general acceptability of perceived ease of use (PEOU) and attitude towards the use (ATU) of Android applications. Overall, the study demonstrates the potential of developed Android-based applications as effective and accessible learning tools for enhancing ecology education.

ARTICLE INFO

Article History:
Submitted/Received 19 Nov 2024
First Revised 20 Dec 2024
Accepted 24 Feb 2025
First Available online 25 Feb 2025
Publication Date 01 Mar 2025

Keyword:
Acceptability,
Android-based applications,
AppsGeyser,
Ecology education,
Validity.

1. INTRODUCTION

Technology plays a significant role in our lives by shaping how we live, work, and connect with others. Moreover, it has become a crucial part of our daily lives. Likewise, technology has revolutionized how we gather information and conduct business. Specifically, with smartphone technology, people can now connect to their relatives within seconds. Aside from this utility, we may now access the news online, including research papers, educational resources, and video tutorials anytime and anywhere. On the other hand, as reported in 2023, there were almost seven billion mobile phone subscriptions worldwide and this is predicted to exceed 7.7 billion in the year 2028. Meanwhile, in the Philippines, it is estimated that the number of mobile users increase between 2024 and 2029 to a total of 5.6 million users (+7.29 percent), and by 2029, the smartphone user base is expected to reach 82.33 million. Over the past years, the number of smartphone users has steadily increased. Additionally, most Filipinos use mobile phones running under the Android operating system.

Some researchers describe mobile technology that changes the lives of everyone in terms of connectivity, communication, and cooperation. With the vast amount of mobile devices such as smartphones, and tablet computers, these technologies offer innovative approaches in education. Generally, literature describes technology as a powerful tool for teaching and learning. It allows educators and learners to refocus their strategies on learning and offers more ways for personalized, engaging, and relevant learning experiences for students. Mobile applications support self-organization, collaboration, information storage, and research processes (Hinze *et al*., 2017). While technology plays an essential role in education, teachers must ensure that all students understand how to use these tools creatively and productively, fostering lifelong learning rather than merely consuming passive content.

In the Philippines, there are various learning approaches to provide students with more engaging, relevant, and meaningful learning experiences in science. The methods concentrate on the development and attainment of three domains of learning: understanding and applying scientific knowledge in local and global settings, applying scientific techniques and abilities, and developing and demonstrating scientific values and beliefs. These domains are achieved through the utilization of multi/interdisciplinary approach, technology-society approach, contextual learning, problem/issue-based learning, and inquiry-based approaches based on several learning theories such as constructivism, social cognition learning model, learning style theory, and brain-based learning.

On the other hand, technology-enhanced inquiry-based learning has gained significant popularity in education, and this approach integrates the capabilities of technology with inquiry-based learning methodologies, allowing students to explore and discover knowledge through active engagement (Becker *et al*., 2020). Following the trend, mobile learning has played a crucial role in this context by utilizing Android applications for educational purposes. These tools help students engage in learning by accessing various educational resources, collaborating with peers, and fostering interactive learning experiences. Overall, technology-enhanced inquiry-based learning focuses on the convenience of mobile learning through Android apps. This approach revolutionized education by promoting active and meaningful learning opportunities for learners.

Additionally, some researchers (Pedro *et al*., 2018) describe mobile learning as the use of digital technologies, especially mobile devices such as smartphones for learning. Furthermore, mobile learning exhibits the following features: increased access to learning materials, improved engagement, greater flexibility, and opportunities for personalized and differentiated learning. Despite this, Pedro and colleagues argue that the use of mobile

learning devices has also been found to have negative impacts on education, such as issues related to multitasking and classroom management. Overall, mobile learning is an emerging approach to teaching and learning.

Moreover, other researchers (Zydney & Warner, 2016) present a comprehensive review of mobile apps designed for science learning, focusing on articles published between 2007 and 2014. The review reveals several standard design features among the apps and identifies the specific theoretical foundations referenced in many studies. However, it also highlights the need for additional research to evaluate students' higher-level cognitive outcomes, establish more robust connections between the underlying theories and measured outcomes, and explore the effectiveness of science mobile apps among diverse students. Similarly, other researchers (Sung *et al*., 2016) argue for developing more sophisticated instructional design strategies to fully utilize the educational opportunities offered by mobile devices, including mobile apps for teaching and learning. Likewise, android-based science instructional media effectively enhance instructional effectiveness and promote scientific understanding among junior high school students (Farida, 2018). Notably, the instructional media must include features such as interesting visualization, ease of use, flexibility, and practicality.

Flexibility and adaptation in utilizing technology are emphasized by the Department of Education. Additionally, addressing the challenges associated with digital learning and educational technology is crucial. With the introduction of productivity tools such as word processing, spreadsheets, and presentations in the classroom, students demonstrate basic skills in digital literacy. Moreover, students need to become active producers of knowledge using ICT tools rather than passive receivers of information. By promoting the use of these technologies and fostering digital literacy skills, the department aims to develop and equip students with the competencies needed to thrive in the 21st century and Industry 5.0 and beyond.

Furthermore, technology emerges as a lifeline that ensures continuous education during the height of the pandemic and the new normal. Several technologies may be employed in teaching and learning (Sakina *et al*., 2020). Platforms like Google Classroom, Quipper School, and Schoology became invaluable for teachers. Meanwhile, various software and mobile applications, such as Kotobee, Articulate Studio 13, Animal 4D+, Ocean 4D+, and Canva, allowed the development of tailored learning resources. Furthermore, assessment applications like Quizziz, Quizlet, Padlet, and Mentimeter made learning interactive and engaging. While these tools are valuable in education, educators and learners face several challenges and limitations, such as poor internet connectivity and device availability. Overall, these technologies, such as mobile applications, may offer positive learning outcomes.

Mobile learning is the future of education. Moreover, one important feature of mobile devices is mobile apps that are valuable in teaching and learning, such as communication, collaboration, and reflection. Similarly, mobile learning reduces the limitation of the idea that education is solely confined to the classroom (Sharples *et al*., 2002). One of the key aspects of mobile learning is its focus on personalized learning that is not limited by time or location (Klímová & Pražák, 2019). Also, the design of mobile applications based on the specific needs of students has proven to be effective in improving learner performance and achieving positive learning outcomes. However, it is important to recognize that mobile applications serve as supplementary tools to complement other methods of instructional delivery.

Furthermore, some researchers (Fikri *et al*., 2023) emphasize the significance of developing Android-based applications that integrate science, Islam, and technology for biology learning media. Similarly, other researchers (Ramos & Comendador, 2019) developed the mobile app

ARTitser as a learning aid for biological science. Other researchers (Osorio & Aliazas, 2022) elaborate on how Android-based applications used in teaching chemistry improve students' experiential learning. Android-based integer learning apps also effectively enhance students' critical thinking skills (Widiyatmoko *et al*., 2021). Furthermore, mobile applications facilitate better student understanding and learning (Farrah & Abu-Dawood, 2018). Despite the extensive literature on the significance of mobile applications across various disciplines, the limited research on the development of Android-based applications for teaching and learning biology, particularly in ecology, highlights the need to generate valuable insights in this area. Notably, this present investigation also addresses challenges related to the limited availability of learning materials, as highlighted in the 2024 statement by the Second Congressional Commission on Education. The report emphasizes that when textbooks are unavailable, learners and teachers must rely on alternative resources such as learning manuals, self-learning modules, activity sheets, and other locally developed materials.

2. LITERATURE REVIEW

On the other hand, the Technology Acceptance Model (TAM) is introduced in the 1980s, focusing on the interplay between cognitive and emotional factors influencing technology adoption (Su & Li, 2021). The model was originally proposed by some researchers. In addition, the TAM comprises four fundamental elements (Tambun *et al*., 2020):

(i) User behavior, which refers to the actual operational actions of users when interacting with new technology;
(ii) Behavioral intention, indicating users' willingness to adopt and try new technologies;
(iii) Perceived usefulness, defined as users' subjective assessment of the utility of the newly adopted technology; and
(iv) Perceived ease of use, which measures the level of effort users believe is required to utilize the new technology effectively.

Some researchers (Rafique *et al*., 2020) investigate the application of the TAM in evaluating the acceptance of mobile library applications. Their study revealed that habit and system quality significantly influence behavioral intention toward using mobile library applications through indirect effects. Additionally, perceived ease of use and perceived usefulness were identified as strong mediators of mobile library application usage. Overall, the model demonstrated a high level of initial acceptance for mobile library applications. Conversely, some researchers determine the acceptability of mobile application technology in personal financial management. The researchers use the following latent factors: perceived usefulness, perceived ease of use, and intention to use. Using confirmatory factor analysis (CFA), data shows that the application was acceptable.

In the local context, some researchers (Liday & Agapito, 2020) investigate the application of a learning management system (LMS) and examine the expanded TAM in higher education. The study revealed that perceived self-efficacy and perceived ease of use, facilitating conditions and perceived ease of use, perceived usefulness and attitude towards use, system quality and perceived usefulness, attitude towards use and behavioral intention to use, and actual use all had significant positive effects. Furthermore, professors who held favorable attitudes toward technology were more likely to exhibit stronger behavioral intentions, leading to increased actual use of the technology. Meanwhile, some researchers (Belmonte *et al*., 2024) investigate the factors influencing e-wallet usage among Generation Z and Millennials in the Philippines using an extended TAM. Key determinants included ease of use, perceived usefulness, trust, security, and social influence. Notably, perceived trust emerged as more critical than perceived value in driving e-wallet adoption. The findings provide

actionable strategies for e-wallet providers to strengthen security measures and build trust among users.

Over the years, the TAM and its extended versions have been widely utilized to assess the adoption of various technologies in various contexts. Similarly, the current study adopted this approach, employing the constructs from the TAM to evaluate the acceptability of Android applications following their implementation in a higher education institution. The present investigation aims to develop, validate, and determine the acceptability of Android-based applications in Ecology. Moreover, assessing the validity and acceptability within the context of Android-based applications provides valuable insights into their suitability and promotes better learning outcomes in the subject matter. In line with this aim, this study specifically seeks answers to the following research objectives.

(i) Describe the development and features of the Android-based applications.
(ii) Discuss the results of the validity evaluations of the Android-based applications in terms of content quality, instructional quality, and technical quality.

Determine the acceptability level of the developed Android-based applications using the factors from the TAM in terms of perceived usefulness (PU), perceived ease of use (PEOU), attitude towards usage (ATU), and behavior intention to use (BIU).

3. METHODS

This section presents the research methods, design, respondents of the study, research instrument used, data collection, and data analysis.

3.1. Research Design

This study employs developmental research to create Android applications, incorporating an evaluation phase to assess their validity and acceptability based on feedback from evaluators and preservice teachers. Moreover, the systematic study of designing, developing, and evaluating instructional programs, processes, and products to ensure they meet the criteria of internal consistency and effectiveness. This investigation focuses on the first type of development research that deals with describing the product or learning material, design development, and evaluation. Additionally, to determine the acceptability of the developed Android applications, a quantitative method with a one-shot case study is employed, this particular design is used when a single group is exposed to a treatment or event (in this case the use of Android applications) and the dependent variable (acceptability based from TAM factors) is measured (Lukitasari *et al*., 2020). Presented is the one-shot case study design of the current investigation (**Table 1**).

Table 1. Study design.

X	***O***
Use of Android-based applications	**(Dependent variable)** Acceptability in terms of PU, PEOU, ATU, and BIU

3.2. Respondents

The respondents of this study include 3 evaluators and 51 pre-service teachers. The evaluators were purposively selected based on their qualifications, such as holding at least a master's degree in science education and having a minimum of ten years of teaching

experience. These evaluators assessed the developed Android applications. Additionally, pre-service teachers from a community college in the province of Albay, Philippines, participated as respondents to assess the acceptability of the developed Android-based applications. Respondents were also purposively selected based on the criteria of majoring in science and having teaching experience in a public school.

3.3. Research Instruments

Several considerations are in the following:

(i) Evaluation Rating Sheet for Non-Print Resources. This validation tool was adopted from the Learning Resources Management and Development System (LRMDS) of the Department of Education. The evaluation tool assesses three factors: content quality, instructional quality, and technical quality, comprising 10, 10, and 13 statements, respectively. A 4-point scale is used, with 4 as Very Satisfactory and 1 as Not Satisfactory. This instrument was employed to evaluate to which extent the Android applications meet the specified criteria. Moreover, the following interpretation was used to assess the validity of the developed applications in each factor: 1.00-1.74 (Not Valid - NV), 1.75-2.49 (Slightly Valid - SV), 2.50-3.24 (Valid - V), and 3.25-4.00 (Highly Valid - HV). This approach deviates from the original pass/fail interpretation, offering a more meaningful evaluation and allowing for a clearer understanding of the material's strengths and areas for improvement, rather than simply categorizing it as a pass or fail.

(ii) Acceptability Survey Questionnaire. This study utilized the adapted survey questionnaire (Olipas, 2022). The instrument consists of 18 statements, divided into four factors: PU, PEOU, ATU, and BIU. It uses a 4-point scale, with 4 as Strongly Agree and 1 as Strongly Disagree. To determine the overall agreement of the respondents in each item and factor the scale ranges are as follows 1.00-1.74 (Strongly Disagree), 1.75-2.49 (Disagree), 2.50-3.24 (Agree), to 3.25-4.00 (Strongly Agree). Conversely, the instrument was modified to make it more suitable for the current study, the researcher employed the content validity indices (CVI) computations described by Yusoff (2019). Likewise, the researcher piloted the survey questionnaire and reliability testing was performed in each factor of the technology acceptance model (see **Table 2**).

(iii) A scale with excellent content validity should achieve a scale-level content validity index of at least 0.8 using the universal agreement method (S-CVI/UA) and 0.9 or higher using the average method (S-CVI/Ave) (Shi *et al*., 2012). Moreover, it is recommended that Cronbach's alpha be at least 0.70 for research purposes. Lastly, it can be observed that the factors in the survey questionnaire demonstrate good reliability, this interpretation is based on common guidelines for interpreting Cronbach's alphaW reliability coefficients.

Table 2. Content validity indices and Cronbach's alpha coefficients of the questionnaire

Factors	Items	S-CVI/ AVE	S-CVI/ UA	Cronbach's alpha	Remarks
Perceived Usefulness	4	1.00	1.00	0.81	Good
Perceived Ease of Use	4	1.00	1.00	0.84	Good
Attitude Towards Usage	5	0.96	0.80	0.82	Good
Behavior Intention to Use	5	0.96	0.80	0.89	Good

3.4. Data Collection

To collect the necessary data for the study, the proponent secured permissions from various institutions and obtained individual consent forms from evaluators and respondents. Additionally, proper documentation of the online platform used for developing the Android applications was prepared. The development phase, which included conceptualization, creation, and initial testing of the applications, took approximately two weeks in November 2024. Following the development and deployment of the applications, the researchers collected evaluations from teacher evaluators to assess the materials. Based on their comments, further improvements were made in the applications. Finally, to assess the level of acceptability, the Android applications were provided to preservice teachers, who used them for a week as part of their class sessions. Afterward, the acceptability survey was distributed via Google Forms to gather their feedback.

3.5. Data Analysis

The mean score was computed to assess the validity of the Android applications based on the criteria outlined in the validation tool. Additionally, the mean scores were calculated to determine the level of acceptability of the material for each item and factor in the questionnaire.

4. RESULTS AND DISCUSSION

This section presents the development, validity, and acceptability of Android applications in ecology. The researcher carefully selected and organized the content to enhance the integration and ensure the seamless delivery of information through the developed Android applications. This investigation aimed to provide an engaging and interactive learning experience for learners.

4.1. Development and Features of the Android-Based Applications in Ecology

The development of the Android-based applications was based on the learning standards from the Second Quarter of the Grade 7 Curriculum Guide of the Department of Education. Specifically, the contents include such as components of ecosystems, ecological relationships (symbiotic and non-symbiotic), and the transfer of energy through trophic levels. Additionally, the material was embedded in the existing lesson as supplementary material.

In the development phase, the researcher employed AppsGeyser as the primary tool for creating Android applications. The design started with the creation of a free account on the website using an email **(Figure 1)**. AppsGeyser is a free, user-friendly app builder that enables individuals and businesses to effortlessly convert web content into Android apps. Its features include a quick app creation process, an extensive library of templates, step-by-step guidance, and monetization options, making it a comprehensive solution for app development. Whether for beginners or experienced users, AppsGeyser provides a convenient platform for transforming ideas into fully functional mobile applications. Moreover, in the Appmaker the researcher selected some sample templates for the applications such as Guide, Word Search, and Quiz. These templates provide general parts for the development of Android applications. The first application that was developed is the use of the Guide template, the researcher was able to develop a *learning guide* for students with the following essential parts: the objectives of the lessons, contents, activities, and assessments.

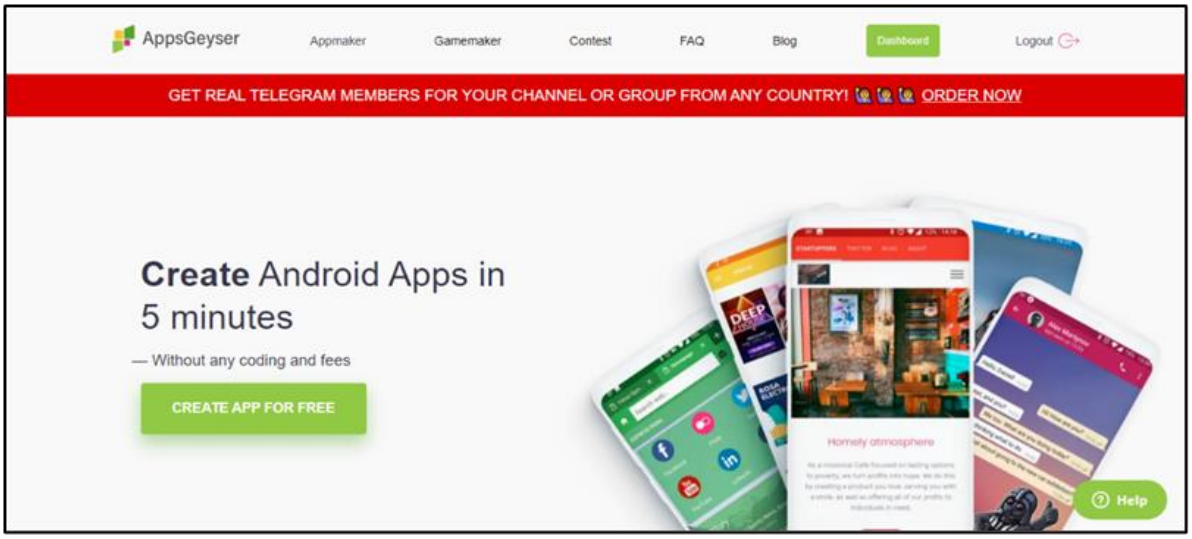

Figure 1. The interface of AppsGeyser website [https://appsgeyser.com]

Meanwhile, the second app developed was a *Word Search Application*, designed as an innovative and engaging motivational tool for students. This application offers a diverse collection of words, systematically categorized into three levels of difficulty: easy, medium, and difficult. By gradually increasing the complexity of the word challenges, the app aims to cater to students of varying skill levels, ensuring inclusivity and sustained interest. The Word Search Application not only serves as a platform for vocabulary enhancement but also fosters critical thinking and problem-solving skills as students search for hidden words within a grid. The interactive nature of the app encourages active participation, making the learning process more meaningful. **Table 3** shows the general features and potential lesson integrations of the developed Android-based applications.

Table 3. General features and possible lesson integration of Android-based applications

Android Applications	General Features	Possible Lesson Integration
Learning Guide App	Interactive modules, ecology lessons, activities, instructions, multimedia	Supplementary learning for lectures, self-paced study, and reviews
Word Search App	Ecology-related terms, with multiple difficulty levels	Vocabulary-building exercises, motivations, icebreaker activities, and group games
Quiz Game App	Ecology-themed quizzes, scoring, and different types of questions (e.g. true or false, picture analysis, multiple choice)	Formative assessments, quiz competitions, and reinforcement activities

Additionally, the third app is the *Quiz Game Application* **(Figure 2)**, which features a diverse range of question types designed to make learning engaging. The question types include: True or False: A straightforward format that challenges users to verify statements, helping to reinforce factual knowledge. 4 Pics 1 Word: A creative approach where users analyze four images to identify the common word that links them, fostering critical thinking and pattern recognition. Multiple Choice: A traditional question style that presents users with several options, requiring them to select the correct answer, enhancing conceptual and critical skills. Picture as an Answer: An innovative format where users respond by selecting or identifying images, which is particularly useful for visual learners and subjects requiring image-based comprehension. This combination of question types not only caters to different learning styles but also keeps users engaged by offering variety and challenge. The Android-based

applications were designed to be both educational and entertaining, providing a platform for learners to test their knowledge while having an enjoyable experience. **Figure 2** presents the user interface of the developed Android applications.

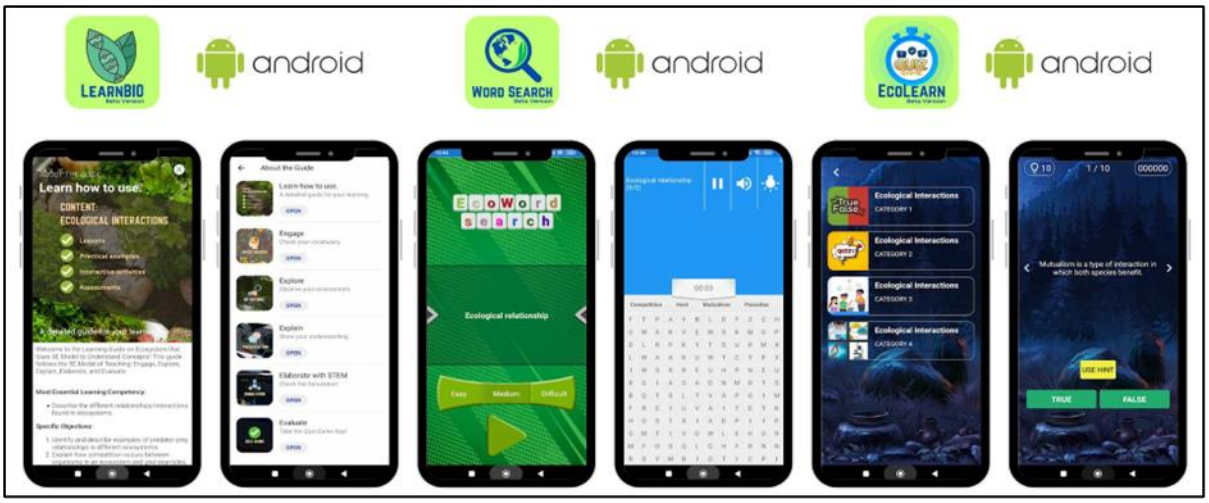

Figure 2. The interface of the developed Android-based applications [https://jereme.my.canva.site/ecolearnapps].

4.2. Validity of the developed Android-based applications

Evaluation of Android-based applications is a crucial step in determining whether the developed apps meet the criteria to function effectively as learning materials. This process ensures that the materials align with educational standards, address learning objectives, and cater to the needs of the target users. Notably, some researchers (Eder *et al*., 2022) highlighted the importance of validation to assess the quality of tools such as assessment tests or learning material. **Table 4**shows that all evaluators rated all the developed Android applications as highly valid across the 3 factors assessed such as content quality, instructional quality, and technical quality.

Table 4. Evaluation results of the developed Android applications.

Factors	Android-based applications					
	Learning Guide	VI	Word Search	VI	Quiz Game	VI
	Mean Score		Mean Score		Mean Score	
Content Quality	3.77	HV	3.80	HV	3.87	HV
Instructional Quality	3.61	HV	3.91	HV	3.73	HV
Technical Quality	3.64	HV	3.64	HV	3.57	HV
Overall Mean	3.67	HV	3.78	HV	3.72	HV

VI: Verbal Interpretation, HV: Highly Valid, Fleiss' kappa (κ)= .47 (Moderate Overall Agreement)

Moreover, to determine the inter-rater agreement among the evaluators, Fleiss' Kappa was calculated. The result indicated a moderate level of agreement between the evaluators, κ = .47, 95% CI [.276, .664], p < .001. Additionally, one evaluator expressed that *"these tools not only support students' engagement and motivation but also enhance their critical thinking and problem-solving skills."* These findings suggest that the material is recommended for use in classrooms and public schools. Despite the promising results of the validation, the recommendations of evaluators were incorporated into the final versions of the applications.

4.3. Acceptability level of Android-based applications based on the Technology Acceptance Model

This section presents the agreement of pre-service teachers based on the constructs of the TAM. Additionally, data are presented according to the PU, PEOU, ATU, and BIU.

As shown in **Table 5**, respondents strongly agreed on the usefulness of the developed Android-based applications, as indicated by an overall mean of 3.35. Notably, based on the data provided, the item with the highest mean score is the statement describing the usefulness of the applications, with a mean score of 3.44. These results demonstrate that users primarily agreed on the usefulness of the materials in understanding concepts. Additionally, the findings suggest that users believe the material helps them better understand the lesson, enhances their academic performance, and increases their engagement in the learning process.

Table 5. The PU of android-based applications.

	Items	Mean	Interpretation
1.	Android applications help me understand the lesson better.	3.28	Strongly Agree
2.	Android applications enhance my academic performance.	3.33	Strongly Agree
3.	I find the Android applications useful for my class.	3.44	Strongly Agree
4.	Android applications make it easier to catch my attention and help me learn the lesson better.	3.33	Strongly Agree
	Overall Mean	**3.35**	**Strongly Agree**

Additionally, learners improve reading proficiency, stimulating interest and deeper understanding using mobile applications (Wang *et al*., 2023). In a qualitative study (Perdana *et al*., 2022), students expressed that using mobile applications enhanced their skills, and working in groups helped them develop communication and relational skills. Likewise, the use of Android applications such as augmented reality apps in biology education can enhance student learning outcomes, foster collaboration, and boost motivation and enthusiasm for learning biology (Schmidthaler *et al*., 2023).

Meanwhile, **Table 6** highlights the perceived ease of use of the developed Android-based applications. Overall, respondents agreed that the applications are easy to use and operate, as reflected by a mean score of 3.16. Notably, the item stating that Android applications are more flexible than traditional learning materials received the highest mean score of 3.26. Conversely, the item with the lowest mean score, at 3.05, pertained to the construct of becoming skillful in using the materials easily. This finding indicates that while the respondents generally acknowledged and accepted the ease of use of the Android applications, there remains variability in user experiences. The variation suggests that some respondents may have encountered challenges or differing levels of familiarity when interacting with the applications. Moreover, these differences could arise from various factors such as individual proficiency with technology, prior experience with similar tools, or personal preferences in learning methods. Addressing these varied experiences could help further refine the applications to ensure they are more inclusive and user-friendly. The ease of use of Android-based applications plays a pivotal role in translating the presentation of content into more visually engaging and interactive material, significantly enhancing students' learning and comprehension (Isrokatun *et al*., 2023).

Table 6. The PEOU of Android-based Applications.

	Items	Mean	Interpretation
1.	It is easy to become skillful at using Android applications.	3.05	Agree
2.	I find it easy to apply the Android applications in my class.	3.15	Agree
3.	Android applications are easy and understandable.	3.18	Agree
4.	Android applications are more flexible than traditional learning material.	3.26	Strongly Agree
	Overall Mean	**3.16**	**Agree**

Consistently, some researchers (Niño, 2015) highlighted the advantages of using mobile applications, including convenience, access to authentic resources, and the ability to provide enjoyable and interactive learning experiences through features such as quizzes and gamified progressions.

Moreover, mobile applications offer several advantages in education, including accessibility and a wide range of learning materials. Compared to traditional resources such as books and other limited materials, mobile applications enable learners to access content, references, and interactive modules quickly and at any time, providing a more flexible and efficient learning experience.

Table 7 illustrates the attitudes of users toward the use of Android applications. Results showed that respondents exhibited a positive attitude toward the apps, as depicted by a mean score of 3.21. Specifically, users reported that the material may have a significant positive influence on their learning experiences, indicating that the applications are not only valuable in the classroom but also contribute to a more engaging and effective learning process. Furthermore, users agreed that the use of these applications could lead to a favorable experience and considered the use of applications to be good. Notably, the item related to the trends in using Android applications received the highest mean score of 3.31, suggesting that users recognize the growing relevance and utility of these tools in modern educational settings. These results highlight the potential of Android applications to transform traditional learning methods by fostering positive attitudes and improving overall learning experiences. Likewise, mobile learning applications may promote academic achievement and authors reported significantly high attitudes towards mobile learning (Demir & Akpınar, 2018). Notably, it highlighted the importance of digital literacy skills, which refer to the ability to access, manage, understand, integrate, communicate, and evaluate information effectively through the use of technology.

Table 7. The ATU of Android-based applications.

	Items	Mean	Interpretation
1.	Using the Android applications in class is good.	3.15	Agree
2.	My experience in using the Android applications in class would be favorable.	3.23	Agree
3.	It is a positive influence for me to use the Android applications in class.	3.08	Agree
4.	I think it is valuable to use Android applications in class.	3.21	Agree
5.	I think it is a trend to use Android applications in class.	3.31	Strongly Agree
Overall Mean		**3.21**	**Agree**

Table 8 presents the respondents' behavioral intention to use the developed Android applications. Overall, respondents expressed strong agreement to utilize the applications, as reflected by the overall mean score of 3.38. The findings indicate that users believe the applications offer diverse approaches to learning, enhance their interest and enjoyment in using the apps, and encourage frequent usage. Interestingly, the statement indicating that the applications enhance users' interest received the highest mean score of 3.41. On the other hand, the lowest mean score of 3.23 was recorded for the item regarding the intention to increase the frequency of using the Android applications.

Table 8. The BIU for the android-based applications.

	Items	Mean	Interpretation
1.	I intend to use the Android applications in my class.	3.31	Strongly Agree
2.	I intend to increase the frequency of using the Android applications in the class.	3.23	Agree
3.	Android applications in my class enhance my interest.	3.41	Strongly Agree
4.	I would love to use Android applications in my class.	3.31	Strongly Agree
5.	I use Android applications to provide multiple approaches to learning.	3.64	Strongly Agree
	Overall Mean	**3.38**	**Strongly Agree**

While the score still indicates agreement, it suggests a slightly lesser emphasis on repeated use compared to other constructs within behavioral intention items. The study of Menon (2022) supports these results, showing that factors like convenience, academic assistance, entertainment, engagement, social influence, and novelty influence the intention to use educational applications. Additionally, Menon noted that social influence gratification is the key factor predicting the use of educational applications. This suggests that social pressure can foster an environment ideal for the adoption of applications among students. Lastly, the findings of this study highlight the importance of social dynamics in encouraging the integration of educational applications, making them more likely to be embraced by students.

4. CONCLUSION

This study focused on the development, validity, and acceptability of the developed Android applications used in teaching ecology. Three interactive applications were created, aligned to the content standards in the Grade 7 Science Curriculum of the Department of Education. The materials were developed using AppsGeyser, a free and user-friendly platform for creating Android applications tailored for educational and business purposes. The applications include the Learning Guide App, which provides the objectives of the lesson, sequence of activities, and contents in ecology; the Word Search App, which utilizes ecology-related terminologies through engaging puzzles; and the Quiz Game App, designed to assess students' understanding of key ecological concepts in a gamified manner.

The developed Android-based applications were rigorously evaluated for content quality, instructional quality, and technical quality. Results from evaluators indicated high validity across all measured factors, highlighting the effectiveness of these tools in delivering the content standards in ecology. Moreover, feedback from respondents and users highlighted strong agreement with the PEOU and BIU of the Android-based applications, indicating that the materials are accessible and relevant to the users. Additionally, learners reported positive attitudes towards the applications, demonstrating agreement with the ATU constructs including the PEOU of Android-based applications. In summary, this study demonstrates the

potential of Android-based applications as effective and accessible learning tools for enhancing ecology education, with reported acceptable validity and positive feedback from educators and learners.

Based on the findings and conclusions, the following recommendations are presented for consideration:

(i) The validated Android applications can be a valuable tool for teachers in making ecology concepts more engaging and interactive for students, enhancing their conceptual understanding, interest, and motivation to learn using the technology.

(ii) The integration of the developed Android applications into lessons is done thoughtfully and purposefully, ensuring they align with specific learning goals and complement traditional teaching methods effectively.

(iii) Furthermore, future studies explore students' behavioral intentions to use by implementing the Android applications in a larger sample size. Understanding the factors influencing students' adoption and consistent use of these educational tools can provide valuable insights for improving their effectiveness.

Despite the promising potential of the developed Android-based applications and the positive feedback from users regarding their PU, PEOU, ATU, and BIU, several limitations were identified in this investigation. Firstly, one of the key limitations is the small sample size, which may not fully represent the broader user population, limiting the generalizability of the findings. Secondly, the acceptability was determined using a one-shot case study design which is limited by its lack of comparison or control group, making it difficult to draw causal conclusions or account for other influencing factors. Additionally, since it involves only a single point of observation, it may not capture the full range of effects or changes over time. Lastly, future developments should incorporate user feedback and allow for continuous refinement to better meet the needs of educators and students.

5. ACKNOWLEDGMENT

The researcher sincerely thanks all the respondents and evaluators for their invaluable contributions to this study. Additionally, the proponent deeply appreciates your time, effort, and expertise, which have greatly enhanced the quality of this research.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

7. REFERENCES

Becker, S., Klein, P., Gößling, A., and Kuhn, J. (2020). Using mobile devices to enhance inquiry-based learning processes. *Learning and Instruction*, *69*, 1–14. 101350.

Belmonte, Z. J. A., Prasetyo, Y. T., Cahigas, M. M. L., Nadlifatin, R., and Gumasing, Ma. J. J. (2024). Factors influencing the intention to use e-wallet among generation Z and millennials in the Philippines: An extended technology acceptance model (TAM) approach. *Acta Psychologica*, *250*. 104526.

Demir, K., and Akpınar, E. (2018). The effect of mobile learning applications on students' academic achievement and attitudes toward mobile learning. *Malaysian Online Journal of Educational Technology*, *6*(2), 48–59.

Eder, M., Gruber, M., and Volk, W. (2022). Validation of material models for sheet metals using new test equipment. *International Journal of Material Forming*, *15*, 1–42. 64.

Farida, Jumadi, Wilujeng, and Senam. (2018). Developing android-based science instructional media to improve the scientific literacy of junior high school students. *Journal of Physics: Conference Series*, *1006*, 1–9.

Farrah, M., and Abu-Dawood, A. K. (2018). Using mobile phone applications in teaching and learning process. *International Journal of Research in English Education*, *3*(2), 48–68.

Fikri, A. A., Zuslia, V., Yusman, M., Agustanti, N. R., Diana, A. R., Muna, V. N., and Nailufa, L. E. (2023). Biologiku: Android-based biology learning media integration of science, islam and technology. *Proceeding International Conference on Religion, Science and Education*, *2*, 699–704.

Hinze, A., Vanderschantz, N., Timpany, C., Saravani, S.-J., Cunningham, S. J., and Wilkinson, C. (2017). Use of mobile apps for teaching and research – implications for digital literacy. *Digital Libraries: Data, Information, and Knowledge for Digital Lives*, *10647*, 173–184.

Isrokatun, I., Hanifah, N., Abdul, Y., Rosmiati, R., and Khoerunnisah, R. (2023). The development of android-based learning mobile app to practice critical thinking skills for elementary school students. *Pegem Journal of Education and Instruction*, *13*(02), 161–172.

Klímová, B., and Pražák, P. (2019). Mobile blended learning and evaluation of its effectiveness on students' learning achievement. *Blended Learning: Educational Innovation for Personalized Learning*, *11546*, 216–224.

Liday, D. N., and Agapito, N. V. (2020). Examining the learning management system adoption in a state university using the extended technology acceptance model. *QSU Research Journal*, *9*(1), 86–99.

Lukitasari, M., Hasan, R., and Sukri, A. (2020). The effect of e-portfolio on biological concepts understanding and responses of students with different academic achievement levels. *International Journal of Instruction*, *13*(1), 685–694.

Menon, D. (2022). Uses and gratifications of educational apps: A study during COVID-19 pandemic. *Computers and Education Open*, *3*, 1–12. 100076.

Niño, A. (2015). Language learners perceptions and experiences on the use of mobile applications for independent language learning in higher education. *IAFOR Journal of Education*, *3*(SE), 73–84.

Olipas, C. N. P. (2022). View of the acceptability of developing mobile learning applications for easy access to electronic learning modules: a technology acceptance model approach. *African Journal of Advanced Pure and Applied Sciences (AJAPAS)*, *1*(2), 163–171.

Osorio, R., and Aliazas, J. V. (2022). Integrating android-based applications in teaching chemistry for improved experiential learning. *International Journal of Science, Technology, Engineering and Mathematics*, *2*(4), 132–144.

Pedro, L. F. M. G., Barbosa, C. M. M. D. O., and Santos, C. M. D. N. (2018). A critical review of mobile learning integration in formal educational contexts. *International Journal of Educational Technology in Higher Education*, *15*, 1-15.

Perdana, I., Aisyah, S., Cakranegara, P. A., Fauzi, Z. A., and Destari, D. (2022). The use of mobile learning in elementary school: Is it important? *Al-Ishlah: Jurnal Pendidikan*, *14*(2), 1431–1438.

Rafique, H., Shamim, A., and Anwar, F. (2020). Investigating acceptance of mobile library application with extended technology acceptance model (TAM). *Computers and Education*, *145*, 897–904. 103732.

Ramos, M. J. H., and Comendador, B. E. V. (2019). ARTitser: A mobile augmented reality in classroom interactive learning tool on biological science for junior high school students. *Proceedings of the 2019 5th International Conference on Education and Training Technologies, 2019*, 135–139.

Sakina, R., Kulsum, E. M., and Uyun, A. S. (2020). Integrating technologies in the new normal: a study of blended learning. *International Journal of Quantitative Research and Modeling*, *1*(4), 181–193.

Schmidthaler, E., Anđic, B., Schmollmüller, M., Sabitzer, B., and Lavicza, Z. (2023). Mobile augmented reality in biological education: perceptions of austrian secondary school teachers. *Journal on Efficiency and Responsibility in Education and Science*, *16*(2), 113–127.

Sharples, M., Corlett, D., and Westmancott, O. (2002). The design and implementation of a mobile learning resource. *Personal and Ubiquitous Computing*, *6*, 220–234.

Shi, J., Mo, X., and Sun, Z. (2012). Content validity index in scale development. *Journal of Central South University. Medical Sciences*, *37*(2), 152–155.

Su, Y., and Li, M. (2021). Applying technology acceptance model in online entrepreneurship education for new entrepreneurs. *Frontiers in Psychology*, *12*, 713239.

Sung, Y.-T., Chang, K.-E., and Liu, T.-C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. *Computers and Education*, *94*(94), 252–275.

Tambun, S., Sitorus, R. R., and Pramudya, T. A. (2020). Pengaruh technology acceptance model dan digital taxation terhadap kepatuhan wajib pajak dengan pemahaman internet sebagai variabel moderating. *Balance Vocation Accounting Journal*, *4*(1), 1.

Wang, F., Yuizono, T., Wang, T.-Y., Kim, E., and Lu, Y. (2023). Integrating reflection into a mobile-assisted reading program for learning English as a second language in China. *Frontiers in Education*, *7*, 1–16. 1067523.

Widiyatmoko, A., Utaminingsih, S., and Santoso. (2021). Android-based math learning to improve critical thinking. *Journal of Physics: Conference Series*, *1823*, 012091.

Yusoff, M. S. B. (2019). ABC of content validation and content validity index calculation. *Education in Medicine Journal*, *11*(2), 49–54.

Zydney, J. M., and Warner, Z. (2016). Mobile apps for science learning: Review of research. *Computers and Education*, *94*, 1–17.