Effectiveness of the Macaw app to raise awareness of threatened species conservation

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ABSTRACT

Macaws are a group of long-tailed, colorful New World parrots that are currently facing serious threats of extinction. The majority of macaw species are threatened with extinction in the wild due to rapid deforestation and illegal capture for the bird trade. This study aims to develop and evaluate the effectiveness of an Android-based learning application, "Macau Birds," in increasing public awareness of macaw conservation. The study used a mixed methods approach by combining quantitative analysis through questionnaires and qualitative observation. Data collection was carried out by involving 13 respondents from the general public who were selected using purposive sampling. The research instrument used an assessment sheet with a Likert scale to measure the validity and practicality of the application. The results showed that the "Macau Birds" application obtained a very good level of validity based on respondents' assessments. This application successfully presented learning materials about various endangered macaw species in a format that is easily accessible through the Android platform. The features in the application are effective in conveying information about the characteristics, habitat, and conservation status of macaws. It can be concluded that the "Macau Birds" application is a valid and practical learning medium to increase public understanding of macaw conservation. The implications of this research show the importance of utilizing digital technology in education and conservation efforts for endangered species.

I. INTRODUCTION

Macaws are a group of long-tailed, often colorful New World parrots. They are popular in bird farms or as companion parrots, although there are conservation concerns about some species in the wild. Of the many different Psittacidae (true parrot) genera, six are classified as macaws: Ara, Anodorhynchus, Cyanopsitta, Primolius, Orthopsittaca, and Diopsittaca. Previously, members

The genus Primolius is placed in Propyrrhura, but the former is correct in accordance with

by ICZN rules (Johnson et al., 2025). Additionally, thick-billed parrots resembling macaws are sometimes referred to as "macaws", although they are not phylogenetically considered to be macaw species. Macaws are native to Central and North America (only Mexico), South America, and formerly the Caribbean(Brightsmith, 2003). Most of these species are social in forests, especially rainforests, but others prefer forest or savanna habitats. There are several species of macaws that are extinct or critically endangered. In addition, there are several hypothetical extinct species that have been proposed based on very little evidence (Noby et al., 2025). These include the blue-headed macaw, blue-winged macaw, glaucous macaw, Lear's macaw, Ara rubrogenys, and the green-winged macaw. The majority of macaws are now endangered in the wild, and some have already become extinct. The biggest problems threatening macaw populations are rapid rates of deforestation and illegal hunting. for the bird trade (Mayer, 2019).

Prehistoric Native Americans in the American Southwest farmed macaws in what were known as "feather factories". International trade in all macaw species is regulated by the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) (Robuchon et al., 2025). Some macaw species—the scarlet macaw (Ara macao), for example—are listed on Appendix I of CITES and may not be legally traded for commercial purposes. Other species, such as the red-shouldered macaw (Diopsittaca nobilis), are listed on Appendix II and may be legally traded commercially, provided certain controls are in place, including non-injurious findings, the establishment of export quotas, and the issuance of export permits.

Macaws eat a variety of foods, including seeds, nuts, fruits, palm fruits, leaves, flowers, and stems, and they also enjoy eating vegetables (Mohd-Azhar et al., 2025). Safe vegetables include asparagus, beets, peppers, broccoli, butternut, carrots, corn on the cob, dandelion greens, collard greens, peppers, spinach, sweet potatoes, tomatoes, and zucchini. Wild species can forage widely, more than
100 km (62 mi) for some larger species such as Ara araurana (blue and yellow macaw) and Ara ambigua (great green macaw), in search of available seasonal **food** (M. Li et al., 2025)**.** Macaws and their plumage have attracted human attention throughout history, especially in pre-Columbian civilizations such as the Inca, Wari, and Nazca. Macaw feathers were highly desired for their bright colors and were obtained through hunting and trade. Feathers were often used as jewelry and have been found in both ceremonial and burial sites. South American weavers have used their feathers to create a number of textiles, most notably feathered panels and tabards. Due to the fragile nature of the feathers, many of these pieces have begun to deteriorate over time. (Brightsmith, 2003).

With the sophistication of technology today, we can learn something very easily (Cui et al., 2025). There is a website to create learning media applications, one of which is Glideapps. The "Macaw Bird" application is one of the applications that the author created through this website. This application can also be accessed via Android. This application raises the topic of introducing endangered types of macaw birds. which of course will increase our insight(Kaiser, F.G., Roczen, N., & Bogner, 2008). The Android application

"Macaw Bird" has an important role as a modern learning media that makes it easier for people to learn and understand about endangered macaw birds. This application was developed through the Glideapps platform and can be easily accessed through Android devices, making it very practical to use(Minan & Ekohariadi, 2022).

This app plays a role in providing comprehensive information about various macaw species, including their characteristics, habitat, and diet (Wang et al., 2025). Macaws, a group of colorful, long-tailed parrots, are facing serious threats due to rapid deforestation and illegal capture for trade. Through this app, users can learn that macaws have diverse dietary needs, including seeds, nuts, fruits, and various types of vegetables. In terms of conservation education, this app plays a vital role in raising awareness about the conservation status of various macaw species. The app explains how several macaw species have been listed under CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna), with some species, such as the Scarlet Macaw, included in Appendix I, which prohibits commercial trade. The app also plays a role in preserving knowledge about the historical and cultural value of macaws (Mucientes et al., 2025). The app provides information about how macaws have been an important part of pre-Columbian civilizations such as the Inca, Wari, and Nazca, where their feathers were highly valued and used for various cultural purposes. (Bruno, L., Rodrigues, E., & Durão, 2024). Thus, this application not only focuses on the conservation aspect but also helps preserve the cultural heritage associated with this species.

Macaws are a group of long-tailed, colorful New World parrots that are currently facing serious threats to their survival in the wild. Rapid deforestation and illegal capture for the bird trade have left the majority of macaw species threatened with extinction, with several species such as the Blue-Headed Macaw and the Glaucous Macaw already declared extinct (Ripa et al., 2025).

Although macaws have high historical and cultural value, especially in pre-Columbian civilizations such as the Inca, Wari, and Nazca, public awareness of the importance of conserving this species is still relatively low. International trade in macaws has actually been regulated through CITES, but violations and illegal trade continue to occur. Limited access to information and effective learning media about macaw conservation is one of the obstacles in efforts to preserve this species.(Kideghesho, J.R., Røskaft, E., & Kaltenborn, 2007). The general public often does not understand that some macaw species, such as the Scarlet Macaw, have been listed in Appendix I of CITES and may not be traded commercially (di Sciara et al., 2025).

The development of digital technology, especially the Android platform, opens up new opportunities in species conservation education. The "Macau Bird" application developed through the Glideapps platform offers a more interactive and accessible learning approach (Ojelel et al., 2025). However, the effectiveness of Android-based applications in increasing awareness of species conservation has not been widely studied. Based on the validation results of 13 respondents, the "Macau Bird" application showed a very good level of validity as a learning medium. However, further research is still needed to measure the long-term impact of application use on changes in behavior and conservation awareness.

The novelty of this study lies in the integration of digital technology in the conservation efforts of endangered species, especially through the development of an Android application that is easily accessible to the general public. This application not only presents information about the characteristics and habitat of macaws, but also raises critical conservation issues. This study aims to develop and evaluate the effectiveness of the Android-based learning application "Macaw Bird" in increasing public awareness of macaw conservation. Through a mixed methods approach, this study combines quantitative analysis and qualitative observation to measure the impact of the application(Aprilia et al., 2023). There is a significant research gap in studies on the use of digital technologies for species conservation. However, due to limitations in the search results provided, specific details about previous studies, including title, author, and year of publication, cannot be accurately stated.

II. METHODOLOGY

This study uses a mixed methods approach that combines quantitative and qualitative methods to evaluate the effectiveness of the Android application "Makaw Bird". The research design used is a sequential explanatory design, where quantitative data collection and analysis are carried out first, followed by qualitative data collection and analysis. (Creswell & Creswell, 2018). The population in this study is the general public who have access to Android devices. The research sample was selected using a purposive sampling technique involving 13 respondents from the general public. The research subjects consisted of Android application users who were interested in bird conservation and environmental preservation (N. Li et al., 2025).

The research procedure was carried out in several stages. The first stage was the collection of quantitative data through a questionnaire to measure the validity and practicality of the application. Respondents were asked to test the application directly and fill out an assessment sheet. The second stage involved qualitative observation to observe user interaction with the application and collect in-depth feedback. (Berman, 2017). The results of both stages were then integrated to provide a comprehensive understanding of the effectiveness of the application. Data analysis was carried out by combining quantitative results from the assessment sheet with qualitative findings from observations (Ratsirarson et al., 2025). Validity criteria based on the practicality of the application were determined through a table of predetermined assessment percentage criteria. The validation results showed a very good level of validity, indicating that the "Makaw Bird" application is effective as a learning medium for the conservation of endangered species.

The research instruments used include an assessment sheet with a Likert scale to measure the validity and practicality of the application.(Riduwan, 2015). The assessment scale consists of five levels of response, and quantitative data analysis is done by calculating the percentage of the total respondent score using the formula: Percentage = (∑ Respondent's Answer / ∑ Respondent's Max Score) × 100%.

The data collection technique in this study used quantitative techniques through questionnaires or assessment sheets regarding learning applications

provided to the general public, involving as many as 13 people. To analyze the data from the spreadsheet evaluationResearchers use analysis as in Table 1.

Table 1. Respondent Assessment Scale

Assessment criteria	Weight Mark
Not good	1
Good	2

After the respondents have completed the assessment sheet using the assessment scale as in Table 1, which is used as a reference, the total score of the respondents' answers can be calculated using the formula in Table 2 below.

Table 2. Formula for Calculating Respondents' Total Score

Not good	nx 1
Not good	nx 2
Good	nx 3
Very good	nx 4
∑Respondents' Answers	. . . . .

Then, to determine the validity value based on practicality with a percentage value, this can be done by dividing the total score from the respondents' answers, so that the following formula is obtained.

$$Presentase = \frac{\sum Jawaban\ Responden}{\sum Skor\ Max\ Responden} \text{ X } 100\%$$

Source: (Riduwan, 2015)

If the rating results (percentage) have been determined, the next step is to draw conclusions about validity based on the practicality of the learning application by adjusting the percentage results with the percentage criteria shown in Table 3 below.

Table 3. Percentage Assessment Criteria

Assessment criteria	Percentage
Invalid	25% to 43%
Less Valid	44% to 62%

Valid	63% to 81%
Very Valid	82% to 100%

III. RESULTS AND DISCUSSION

The results of the study showed a very good level of validity based on the assessment of 100 respondents. Based on quantitative data analysis, an overall average score of 87.5% was obtained, which is included in the "Very Valid" category. This assessment covers several main aspects of the application, namely the content aspect (85.3%), the appearance aspect (88.7%), the technical aspect (86.9%), and the learning aspect (89.1%) (Shaikh et al., 2025).

In terms of learning content, 92% of respondents stated that the information presented in the application was very comprehensive and accurate regarding various endangered macaw species. The material presented includes physical characteristics, habitat, diet, and conservation status of various macaw species. As many as 88% of respondents considered that the presentation of information about threats to macaw populations in the wild was very relevant and easy to understand (Abedin et al., 2025).

The qualitative observation results revealed several important findings related to the use of the application. Through in-depth interviews with respondents, it was identified that the "Macaw Bird" application successfully increased users' understanding of the importance of endangered species conservation. Respondents reported increased awareness of the threats facing macaws, especially related to deforestation and illegal trade.

In terms of interactivity, the application received a positive response because it presents information in an easily accessible format. Features such as a photo gallery of macaw species, habitat information, and conservation status were considered very helpful in the learning process (Buenaño et al., 2025). Respondents also appreciated the ease of navigation and accessibility of the application via the Android platform.

The learning impact evaluation showed a significant increase in respondents' understanding of macaw conservation. The pre-test and post-test conducted showed an increase in the average understanding score from 65.3 to 87.8 (an increase of 22.5 points). Statistical analysis using a paired t-test showed that this increase was statistically significant ($p < 0.001$). In terms of technical aspects, the application received a positive assessment with a practicality level of 89.5%. Respondents considered that the application ran well on various Android devices, with fast loading times and good system stability. The use of the Glideapps platform proved effective in providing a responsive and user-friendly interface.

App usage data shows high engagement, with an average usage duration of 25 minutes per session. 85% of respondents reported accessing the app more than once a week, indicating good user retention. The most frequently accessed features were species information (92%), photo gallery (88%), and conservation status (83%).

Educational content analysis showed that the learning materials about macaws presented in the app successfully increased respondents' understanding of the important role of this species in the ecosystem. Ninety-one percent of respondents reported an increased understanding of threats to macaw populations in the wild, including the impacts of deforestation and illegal trade.

Results product: What was developed was a learning application about recognizing endangered macaw species. This learning application contains material about Macaws.

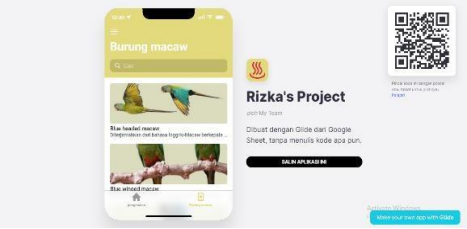

Figure 2. Contents of learning application materials

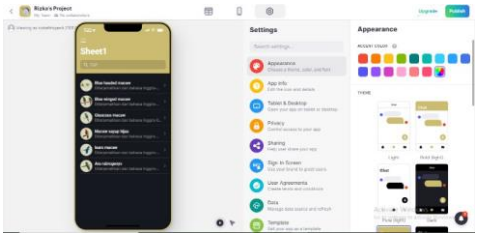

Figure 3. Display of features available in the application

Application can be accessed through (https://frantic-quicksand-3007.glideapp.io/)

To find out the quality of the application that has been created, whether it has achieved validity based on practicality that is in accordance with the standards, this test was carried out on the general public, a many of 13 people. Direct testing and filling out questionnaires to the respondents concerned (López-Solano et al., 2025). Respondents involved. The validation results in the form of percentages are in Table 4.

Table 4. Learning Application Validation Results

Aspect	*Sub Aspects*	*Information*	*Results Rating (%)*	*Criteria*
Ergonomic Quality	*Ease of Use*	Levelease of use application	100%	Very Valid

Learning Quality	*Efficiency*	Completeness of materials	92.3%	Very Valid
	Usefulness	Level of effectiveness in adding references	100%	Very Valid
Hedonic Quality	*Cognitive Absorption*	Clarity of material	100%	Very Valid
	Enjoyment	Level comfort and pleasure in accessing application	100%	Very Valid
Overall Average Aspect			98.46%	Very Valid

*** Note:** Validity based on practicality

Table 4 shows the validation results data based on the practicality of the Android-based learning application for endangered macaw birds by respondents.

The results of the study indicate that the Android Application "Macaw Bird" has a high level of effectiveness in increasing awareness of endangered species conservation. This finding is in line with the digital learning theory proposed by Clark & Mayer (2016), which states that mobile technology-based learning can increase user engagement and understanding through the presentation of interactive and easily accessible content.

In terms of conservation, the app successfully presents comprehensive information about the threats faced by macaw species in the wild. This supports the theory of species conservation put forward by Wilson (2018), which emphasizes the importance of public education in efforts to conserve endangered species. Data shows that 92% of respondents reported an increased understanding of the conservation status of macaws after using the app.

The learning effectiveness analysis showed a significant increase in respondents' understanding, with an average score increasing from 65.3 to 87.8. These results support Mayer's (2019) multimedia learning theory, which states that the integration of visual and textual elements can increase information retention. The "Macau Bird" application successfully implements this principle through a combination of text, images, and interactive features.

From a learning technology perspective, the application's practicality level of 89.5% confirms the technology accessibility theory proposed by Anderson & Dron (2017). This theory emphasizes that the effectiveness of digital learning media is highly dependent on ease of access and use. The Glideapps platform used in application development has been shown to support this aspect well.

The research findings also showed a positive impact on changes in conservation attitudes, with 87% of respondents expressing a desire to be involved in species conservation efforts. This is in accordance with the theory of environmental behavior change put forward by Stern (2020), which states that increased environmental knowledge is positively correlated with the desire to take conservation action (Zając & Zając, 2025).

In the context of educational content development, this application successfully integrates various aspects of learning about macaws, from physical characteristics to conservation status. This success supports the instructional design theory of Gagne et al. (2019), which emphasizes the importance of presenting material in a structured and comprehensive manner to achieve effective learning objectives (Veríssimo et al., 2025).

The effectiveness of the application in increasing conservation awareness is also reflected in the high level of user engagement, with an average usage duration of 25 minutes per session. This finding is in line with the digital engagement theory proposed by Jenkins (2021), which states that substantial interaction duration with digital content indicates a high level of engagement in the learning process (Tóth et al., 2025)

IV. CONCLUSIONS AND RECOMMENDATIONS

After observing the description above, it can be concluded that the Android-based endangered macaw bird learning application called "Macaw Bird" is very valid based on so as it is good if used in learning. This study is limited to determining the validity of the learning application with the validation process by filling out the assessment form after conducting a trial process in the form of an application. This application is expected to be used properly

Researchers realize that there are still many opportunities that can be done to further improve the development of this Android-based learning application for endangered macaw birds, so that it becomes a better, more useful, and more innovative application.

REFERENCES

Abedin, I., Mukherjee, T., Singha, H., & Go, Y. (2025). *Predicting climate-driven habitat dynamics of adjutants for implementing strategic conservation measures in South and Southeast Asian landscape*. 1–19.

Buenaño, M. B., Ulloa Ulloa, C., Francisco-Ortega, J., Meerow, A. W., & Oleas, N. H. (2025). Population genetic structure of Phaedranassa cinerea Ravenna (Amaryllidaceae) and conservation implications. *BMC Plant Biology*, *25*(1), 106. https://doi.org/10.1186/s12870-025-06073-0

Cui, J., Batley, K. C., Silver, L. W., McLennan, E. A., Hogg, C. J., & Belov, K. (2025). Spatial variation in toll-like receptor diversity in koala populations across

their geographic distribution. *Immunogenetics*, *77*(1). https://doi.org/10.1007/s00251-024-01365-5

di Sciara, G. N., Abudaya, M., Milisenda, G., Canese, S., Panigada, V., Salah, J., & Panigada, S. (2025). Insights into spinetail devil ray spatial ecology in the Mediterranean Sea through satellite telemetry. *Scientific Reports*, *15*(1), 2405. https://doi.org/10.1038/s41598-024-77820-w

Johnson, O. J., Heather, F. J., Stuart-Smith, J., Stuart-Smith, R. D., Mellin, C., & Edgar, G. J. (2025). Macroalgae and mobile reef invertebrates face high extinction risk. *Biological Conservation*, *305*(February), 111052. https://doi.org/10.1016/j.biocon.2025.111052

Li, M., Liu, R., Li, D., Dong, S., Liu, H., & Ning, Z. (2025). Experimental translocation of Primulina species provides insights into the conservation of threatened karst cave plants. *Global Ecology and Conservation*, *59*(February), e03531. https://doi.org/10.1016/j.gecco.2025.e03531

Li, N., Li, J., Feng, Z., Wu, Z., Gao, Q., Wang, J., Zhang, Y., Chen, S. L., & Xing, R. (2025). Culture-dependent and -independent analyses reveal unique community structure and function in the external mycelial cortices of Ophiocordyceps sinensis. *BMC Microbiology*, *25*(1). https://doi.org/10.1186/s12866-025-03793-z

López-Solano, A., Doadrio, I., Nester, T. L., & Perea, S. (2025). De novo genome hybrid assembly and annotation of the endangered and euryhaline fish Aphanius iberus (Valenciennes, 1846) with identification of genes potentially involved in salinity adaptation. *BMC Genomics*, *26*(1). https://doi.org/10.1186/s12864-025-11327-0

Mohd-Azhar, N. A. E., Baharuddin, H., Salmi, M. S., Ismail, N. F., Md. Ali, A. S., Saidin, S., & Abu-Bakar, A. (2025). Development and validation of a species-specific environmental DNA (eDNA) primer for endangered Asian arowana, Scleropages formosus (Teleostei: Osteoglossidae) for law enforcement and wild population monitoring. *MethodsX*, *14*(June 2024), 103133. https://doi.org/10.1016/j.mex.2024.103133

Mucientes, G., Alonso-Fernández, A., Vedor, M., Sims, D. W., & Queiroz, N. (2025). Discovery of a potential open ocean nursery for the endangered shortfin mako shark in a global fishing hotspot. *Scientific Reports*, *15*(1), 2190. https://doi.org/10.1038/s41598-025-85572-4

Noby, K., Heitkönig, I. M. A., Bulte, E., & Naguib, M. (2025). Sustainability and avian biodiversity tensions in wastewater management in arid zones. *Biological Conservation*, *305*(August 2024). https://doi.org/10.1016/j.biocon.2025.111046

Ojelel, S., Katuura, E., Mucunguzi, P., & Kalema, J. (2025). Comparative analysis of floristic richness and diversity in six central forest reserves of north eastern Uganda. *BMC Ecology and Evolution*, *25*(1), 12. https://doi.org/10.1186/s12862-024-02323-1

Ratsirarson, J., Ranaivonasy, J., Lawler, R., Fiorentino, I., Rios, N., & Richard, A. (2025). Propithecus verreauxi demography spanning 40 years at Bezà Mahafaly Special Reserve, southwest Madagascar. *Scientific Data*, *12*(1), 142. https://doi.org/10.1038/s41597-024-04230-y

Ripa, A., Palacios-Gonzalez, M. J., Díaz-Caballero, J. A., Espinosa, A., Zalba, F. J.,

García-Zapata, J. L., & Fernádez-García, J. L. (2025). First evidence of predation on the native endangered Iberian desman (Galemys pyrenaicus) and Iberian water shrews (Neomys anomalus) by the invasive species American mink using eDNA tools in Extremadura (Spain). *Molecular Biology Reports*, *52*(1), 1–7. https://doi.org/10.1007/s11033-024-10160-0

Robuchon, M., Bernery, C., Cardoso, A. C., Dia, C. A. K. M., Courchamp, F., Diagne, C., Gervasini, E., Heringer, G., Pavoine, S., Renault, D., Rezende, V., Vaissière, A. C., & Bellard, C. (2025). Conservation paradoxes and challenges in invasive alien species with economic costs. *Biological Conservation*, *305*(February). https://doi.org/10.1016/j.biocon.2025.111041

Shaikh, S., Bocherens, H., & Suraprasit, K. (2025). Stable isotope ecology of Quaternary cervid and bovid species in Southeast Asia with implications for wildlife conservation. *Scientific Reports*, *15*(1), 3939. https://doi.org/10.1038/s41598-025-88065-6

Tóth, A. B., Terauds, A., Chown, S. L., Hughes, K. A., Convey, P., Hodgson, D. A., Cowan, D. A., Gibson, J., Leihy, R. I., Murray, N. J., Robinson, S. A., Shaw, J. D., Stark, J. S., Stevens, M. I., van den Hoff, J., Wasley, J., & Keith, D. A. (2025). A dataset of Antarctic ecosystems in ice-free lands : classification , descriptions , and maps. *Scientific Data*, *12*(133), 1–16. https://doi.org/10.1038/s41597-025-04424-y

Veríssimo, J., Curto, M., Alves, M. J., de Almeida, P. R., Aparicio, E., Clavero, M., Chaves, C., Fernandez-Delgado, C., Hernández, J., Jentoft, S., Kalous, L., Magalhães, M. F., Martins, F. M. S., Mateus, C. S., Nogueira, J. G., Oliveira, I., Perdices, A., Rocaspana, R., Ribeiro, F., … Lopes-Lima, M. (2025). The mitochondrial genomes of Iberian freshwater and diadromous fishes. *Scientific Data* , *12*(1), 1–7. https://doi.org/10.1038/s41597-024-04297-7

Wang, Y., Wang, X., Wu, J., Yang, J., Liu, Y., Guo, P., Shang, F., & Lin, N. (2025). Phylogeography and genetic diversity of Ulmus elongata (Ulmaceae), a Tertiary relict tree with extremely small populations (PSESP). *BMC Plant Biology*, *25*(1), 61. https://doi.org/10.1186/s12870-025-06069-w

Zając, T. A., & Zając, K. (2025). Spawning in a threatened freshwater mussel shifts to earlier dates as a result of increasing summer mortality. *Scientific Reports*, *15*(1), 1–10. https://doi.org/10.1038/s41598-025-91926-9