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BioGaea Quest: A Mobile Learning Tool for Strengthening Grade 11 Earth and Life Science Competencies

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Abstract: ***This study aimed to develop and test BioGaea Quest, an offline Android application created to reinforce least-learned competencies in Grade 11 Earth & Life Science. One hundred fifty students from Hagonoy I District were assigned to (i) traditional instruction, (ii) blended instruction plus the app, or (iii) app-only learning. Pre-/post-diagnostic scores rose modestly in the traditional group (17.02-18.69) and in the blended group (10.69-12.96) but surged in the app-only group (10.00-23.73), suggesting that autonomous, gamified practice can accelerate mastery. Quality evaluation via the Mobile Application Rating Scale produced a mean of 4.30 ("good"). This suggests that well-designed mobile tools can meaningfully improve science learning, though larger, longer-term studies are needed to confirm durability and scalability.***

Keywords: Earth and Life Science, mobile learning, least-learned competencies, diagnostic assessment, game-based education

1. Introduction

In 2012, the Department of Education (DepEd) in the Philippines launched the 12 years of basic education called the K to 12 Program. This effort of the Department of Education aims to catch up to global standards and lift Filipino learners' poor academic standing. One of the core subjects in the Senior High School is the Earth and Life Science. As prescribed by the Enhanced Basic Education Act of 2013, the subject must be taken for 80 hours or 20 weeks and taught to non-STEM (Science, Technology, Engineering, and Mathematics) programs in the senior high school.

Despite the significance of science education, learners find the field difficult, leading to low academic achievement [1]. The National Achievement Test and Trends in International Mathematics and Science Studies (TIMSS) 2019 indicate that science subjects remain a challenging field, with the Philippines substantially scoring lower than other participating countries [2]. During the standardized testing in the Philippines, Filipino learners tend to underperform [3].

In the K-12 Curriculum, difficulties of students in every subject are identified quarterly and referred to as Least Learned Competencies (LLCs), which correspond to the lowest degree of skills and knowledge of learners [4]. The identified LLCs must be reviewed to enable the learners master specific competencies. Based on the DepEd Regulation No. 39 S. 2012, it is vital to implement interventions to address the learning gaps effectively.

To remedy learning gaps, educators should leverage advances in technology like mobile learning since it enhances learning [5]. Mobile applications improve the learners' interest due to their convenience [6]-[7]. However, there is less research conducted on the educational use of these applications, particularly in Southeast Asia [8]. Most formal educational systems do not encourage mobile device utilization in teaching [9].

The researcher intends to develop a mobile learning application called BioGaea Quest that will feature e-modules, educational videos, games, and assessment as an intervention for the least learned competencies in the Grade 11 Earth and Life Science subject of Hagonoy I District. The application will be available offline so that learners can access the learning resources easily. This work demonstrates how an offline, context-aware mobile application can mitigate persistent science learning gaps in resource-constrained Philippine classrooms, offering a scalable model for other developing regions.

2. Review Literature

This section will go over the relevant studies surrounding the utilization of mobile learning applications in educational context. The utilization of technology in various fields has become increasingly necessary, and it has been revolutionized in education [10]-[11]. It was revealed that there is an increase in students' learning and interaction and the conveyance of knowledge becomes easy and convenient when using mobile technology [12]. Innovative pedagogy is achieved by combining the suitable teaching and learning methodologies with resources that facilitate interactive strategies that aid teachers in developing the students' learning abilities [13].

In Malaysia, it is being emphasized in the education system the significant role of technology in 21st-century learning, bringing the learning process to a whole new level [14]. Several researches suggest that Science Education can be upgraded by using technology such as mobile applications

[15]. In Africa, using mobile learning applications enhances the collaboration between teachers and students [16].
In the Philippines, Distura developed a mobile application called Scitocin for the least learned competencies in Science 9 and the app yielded a rating of "very satisfactory" [17]. Mobile learning applications are predicted to have positive effects on teaching and learning in the coming years [18]. One prime example of a mobile learning application is the Kahoot app, one of the most prominent game-based learning platforms with over 70 million monthly active users [19]. Kahoot app keeps students engaged by stimulating the learners' sensory and cognitive curiosity [20], and enhances students' engagement, motivation, and learning [21].

Mobile learning apps efficiently monitor the classroom process, supply feedback [22], and support sustainable, situated, authentic, and connected learning-like features [23]. Educators in colleges and schools are increasingly using mobile devices in the classroom to maximize learning and encourage innovative learning [24].

3. Methodology

3.1 Research Design

This study employed a quasi-experimental pre-test/post-test design involving three groups: one control and two experimental groups. In developing the application, a five-phase instructional design model called ADDIE (Analysis, Design, Development, Implementation, and Evaluation) was utilized. The ADDIE model provides opportunity to assess the developed activities in each stage [25].

3.2 Sampling Techniques

A total of 150 Grade 11 students from senior high school tracks and programs in the Hagonoy I District were selected as participants. Each of the three participating schools contributed 50 students, resulting in three groups of 50. While random assignment at the individual level was not feasible due to logistical and scheduling constraints, students were grouped based on their pre-existing class sections with consideration of comparable academic performance during the previous grading period to reduce baseline differences. Group 1 (control) received traditional instruction only. Group 2 (experimental) received a combination of traditional instruction and the BioGaea Quest application. Group 3 (experimental) used the BioGaea Quest application alone.

3.3. Research Instruments

For the purpose of this study, the research instruments used in acquiring substantive data were the competency-based Test and Mobile Application Rating Scale (MARS). A 40-item multiple-choice exam was formulated by the researcher that only focused on the identified least learned competencies. The 40-item diagnostic test was subjected to item analysis to ensure content validity and measurement accuracy. The average item difficulty index was 0.62, and the average discrimination index was 0.45, indicating acceptable levels of test quality. Internal consistency reliability was established using the Kuder-Richardson Formula 20 (KR-20), which yielded a coefficient of 0.86, indicating high reliability. To validate the mobile app, the researcher adapted the mobile validation instrument from the study of Stoyanov called the Mobile Application Rating Scale (MARS) [26]. Its content is based on the app's engagement, functionality, aesthetics, and instructional quality.

3.4. Ethical Consideration

The researcher was accountable for ethical concerns during the conduct of the before and after data was collected. The researcher adhered to ethical consideration. The Research Ethics Committee evaluated and scrutinized the study to ensure that ethical standards are met. The researchers provided consent forms to ensure that the respondents willingly and voluntarily participate. All the respondents were oriented before the conduct of the study to assure them their rights.

4. Result and Discussion

4.1. Diagnostic Tests Results of Different Teaching Approaches

Table 1: Pretest Mean Score Rating

Teaching Method	Mean	Standard Deviation
Traditional Instruction	17.02	6.93
BIOGAEA Quest Mobile App with Traditional Instruction	10.69	3.10
BIOGAEA Quest Mobile App Alone	10.00	3.42

The study revealed that the Grade 11 students have varied diagnostic test scores prior to the exposure to different teaching approaches. Table 1 shows that the control group has a mean score of 17.02, gaining the highest score. The second group combing traditional instruction and BioGaea Quest app scored 10.69, while the group which utilized the app alone scored 10.00.

As stated by Wang, traditional teaching methods, which were prevalent in ancient times, emphasized book knowledge and were teacher-centered [27]. Furthermore, as cited by Tularam, the approach used in traditional teaching is often teacher-directed and the strategies used are conducive to listening and sitting [28]. Following the results, we can conclude that traditional instruction is still effective since it may provide direct teacher-student interaction that reinforces foundational skills and ensures a focused learning environment.

Table 2: Post-test Mean Score Rating

Teaching Method	Mean	Standard Deviation
Traditional Instruction	18.69	6.24
BIOGAEA Quest Mobile App with Traditional Instruction	12.96	3.32
BIOGAEA Quest Mobile App Alone	23.73	10.37

Table 2 shows the diagnostic test mean score rating of Earth and Life Science Grade 11 students after the exposure to the experiment. The diagnostic mean score rating of the control group is 18.69 with a standard deviation of 6.24. This result signifies that the group has a moderate mean performance with some variability and high standard deviation. The

experimental group which employed traditional instruction with BioGaea Quest mobile application has a diagnostic test mean score rating of 12. 96 and 3.32 as its standard deviation. This suggests that the use of traditional instruction and mobile application did not improve the performance of the group.

On the other hand, the group taking advantage of the BioGaea Quest mobile application gained the diagnostic test mean score rating of 23.73, highest among the three groups, with a standard deviation of 10.37. This means that the utilization of the BioGaea Quest application in the classroom has a positive impact in the students' learning. The results affirmed the conclusion of Zydney & Warner that mobile learning application for science education provides technology-based scaffolding [29].

4.2 Development of the BIOGAEA Quest Mobile Application

The developed mobile learning application called BioGaea Quest features e-modules, video lessons, games, and assessment as an intervention for the least learned competencies in the Grade 11 Earth and Life Science subject of Hagonoy I District. In the app's e-modules, learners can be able to read the localized learning resources for the subject as well as accomplish tasks and practice quizzes aligned with the least learned competencies.

On the other hand, video lessons in the BioGaea Quest application serve as additional means of learning the topics and allow the students to have in-depth comprehension about the subject. Moreover, the game in the application offers entertainment to the learners while they master the lessons anchored with the least learned competencies. The results of the development of the BioGaea Quest shows how its works and its components:

Splash Screen. This part of the application (see Figure 1) is the opening interface of the BioGaea Quest Application. It serves as the introductory or landing page of the application.

Figure 1: Splash Screen of the BioGaea Quest Application

Main Dashboard. This part of the application (see figure 2) is where we can choose the medium for interaction. The application has two (2) options: (1) Learn - for reading contents of the e-modules, watching video lessons, and taking quizzes, (2) Play - for playing interactive games for more mastery of the topic.

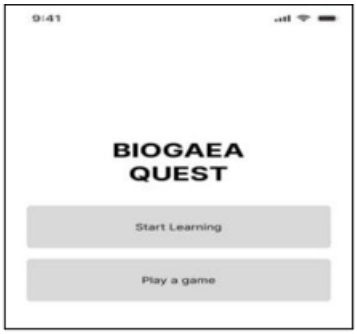

Figure 2: Main Dashboard of the BioGaea Quest App

Read Module. This feature (see Figure 3) contains the e-modules of the topics identified as the least learned in Earth and Life Science. The topics are about genetic engineering, Organ System of Representative Animals, Process of Evolution, and Interaction and Interdependence.

Figure 3: Read Module Dashboard

Watch Video. This part of the application (see Figure 4) where we can see an arrow is the watch video lesson button. All the topics in the application has corresponding video lesson recorded by the teacher as an additional learning material for better learning.

Figure 4: Video Lesson Button

Take Assessment. This component (see Figure 5) is where learners take their quiz after reading and watching video lessons to test their understanding about the topic. After taking each test, your score will be displayed in the screen.

Figure 5: Take Assessment Splash Screen

Play Games. This fun component features games for all the topics in the application. You can choose which game you want to play. All the games are still anchored to the topics in the LLC's.

Figure 6: Game Splash Screen

These vital parts of the BioGaea Quest mobile application not only improve user satisfaction but also enhance motivation, promote sustained use, and crucially contribute to the value of the application in education.

4.3. Evaluation of the BioGaea Quest Application

As indicated in Table 3, the BioGaea Quest Mobile Learning Application was evaluated by experts, teachers, students, and parents. Using the Mobile Application Rating Scale (MARS) by Stoyanov, the application was evaluated according to its engagement, functionality, aesthetics, and information [26].

Table 3: Evaluation results of the application

Criterion Category	Mean	SD	Interpretation
Engagement	4.23	0.497	Good
Functionality	4.34	0.555	Good
Aesthetics	4.31	0.435	Good
Information	4.30	0.435	Good

Based on the data gathered, the mean score rating of the application in terms of engagement is 4.23 with a standard deviation of 0.497 which is interpreted as good. This means that students find the app interactive and stimulates the students' learning. As cited by Kacetl & Klímová, mobile learning apps enhance the student's cognitive capacity, motivation, autonomy and confidence [30].

On the other hand, the mean score of the app's functionality is 4.34 with a 0.555 standard deviation. This suggests that users generally find the app effective and easy to use. The application effectively delivers the content of the lessons and allows users to access valuable learning resources seamlessly. The application also improves students' learning by allowing users to connect with supplementary educational materials.

Furthermore, BioGaea Quest app's aesthetics have received a mean score of 4.31 with a standard deviation of 0.435, suggesting that the users have a positive perception of the app and find the visual design appealing. Among the four criteria of rating the app, aesthetics received the highest mean score. Hence, the low standard deviation indicates that users had the same ratings and consistent appreciation of the app's aesthetics. The aesthetics of the BioGaea Quest application has a high rating, and users appreciate the clean design, intuitive layout, and efficient color scheme. The application's well-designed interface contributes to the ease of navigation, making learning more enjoyable.

Finally, the app's information gained a mean score of 4.30 with a standard deviation of 0.435. This result suggests that the information of the app received a strong positive perception among users.

In general, the app received a good rating. The results are affirmed by Duong Huu Tong et al. that mobile learning application is an important technology in education because of its significant benefits [31].

5. Conclusion

In conclusion, this study explored the impact of the BioGaea Quest mobile application on students' diagnostic test performance compared to traditional instruction. The study revealed that students who used the BioGaea Quest mobile application outperformed those who received traditional instruction, demonstrating the effectiveness of the application, suggesting that digital tools can play a crucial role in improving learning outcomes.

The findings suggest that the BioGaea Quest mobile application could have a substantial impact on learning outcomes, as indicated by the higher mean score in the group that used the app alone. However, combining the app with traditional instruction did not appear to improve performance and may even have been less effective than traditional instruction on its own. This raises questions about how the app integrates with traditional teaching methods, and whether additional training or adjustments to the instructional approach are needed for optimal results.

Furthermore, incorporating mobile applications into traditional learning environments can significantly improve student engagement, providing valuable insights for educators and institutions seeking to integrate technology into their curriculum. The integration of mobile technology into education presents a promising avenue for improving student learning experiences. This study provides a strong foundation for further exploration in this area, paving the way for more innovative educational tools that can transform the future of teaching and learning.

6. Recommendations

While the findings are promising, the study was limited by its sample size and short duration, which suggests the need for further research with larger and more diverse populations to determine if the findings are consistent across different demographic groups.

The BioGaea Quest application can be improved by optimizing storage requirements, quiz reliability, font size, and additional supplementary materials. By addressing these areas, the app can continue to enhance its effectiveness as a learning tool, ensuring an efficient and reliable learning experience for users.

Furthermore, future studies could examine the pedagogical strategies that best complement mobile applications like

BioGaea Quest, providing insights into how educators can optimize technology use to maximize learning gains. Additionally, future research should explore these potential causes in more depth, investigating whether the app's features align with students' learning needs, or if its effects vary across different contexts or student groups.

Moreover, future research could explore the impact of mobile applications on different subjects or educational levels, as well as the long-term effects of technology-enhanced learning on student achievement and retention. Finally, while this study employed a quantitative research design, future research could benefit from qualitative methods, such as interviews or focus groups gaining deeper insights into students' experiences and perceptions of using mobile applications in learning and explore the implications of mobile learning for educational policy, particularly in terms of how schools and universities can integrate technology into their curriculum.

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