Enhancing Children’s Learning Experience as a Sustainable Approach through Gamified Application Design

Wildan Ali¹*, Damba Permatasakti¹, La Myra Bening¹ and Dian Sarwono²

¹ Graphic Design & New Media, Visual Communication Department, BINUS Northumbria School of Design, Bina Nusantara University, Jakarta, Indonesia 11480
² Communication Department, Faculty of Computing and Media, Bina Nusantara University, Jakarta, Indonesia 11480

Abstract. The COVID-19 pandemic altered how education was formerly conducted, with a rapid shift from face-to-face to online learning. This situation resulted in a significant lack of student-teacher interaction, which affected particularly lower grade students. However, the pandemic provided an opportunity to develop a more sustainable way of learning due to the increasing use of technologies. This research seeks to improve children's online learning experience through application design in response to online learning conditions. To identify the problem, initial interviews with parents, guardians, and teachers were conducted. Afterward, individual in-depth interviews with primary school teachers were carried out to gain insights on the needs of both students and teachers during online learning. The final app design incorporates gamification elements for both target users. Students follow lessons through interactive narratives based on the standardized curriculum. Teachers can adjust lessons more independently and conveniently using the gamified customization features, such as customizing texts, characters, and media. The effectiveness of the app design was then determined through direct observations with target audiences. The findings show that the application design has the potential to revolutionize and promote sustainability in Indonesian primary school education.

1 Introduction

Education is an individual development of observing socio-cultural conditions and developing positive attitudes towards life. It is aimed to shape worldviews; the foundation needed in the life process can be formed throughout the time. [1] There are three types of education children normally receive: formal, informal, and non-formal. Formal education is typically received in schools or legal institutions that provide predetermined curriculum or program. [2]

Children normally interact with their environments, peers, and educators in formal schoolings, which is necessary for their growth and development. In formal education, teachers play a huge role in motivating children to learn new knowledge or develop their problem-solving skills. [3] Children’s brains are capable of reorganizing and restructuring quickly based on their own experiences, described as “critical experiences”. As they are the most receptive to new knowledge, teachers are encouraged to observe their students' behaviours and provide guidance when they need it the most. [4]

The COVID-19 pandemic proved to be an enormous challenge to the current education systems. Schools and institutions rapidly adopted online learning to curb the spread of the virus. This situation had an adverse effect on children education. It became quite an obstacle for teachers to personally assist their students through online learning. They were unable to directly observe and supervise their students as they do at schools. [5] Moreover, online learning could add stress to both learners and educators. This was due to the increased exposure to digital screens and significant lack of offline class interactions. [6] There was also a significant increase of parental stress during the pandemic that negatively affected children’s well-being. [7] [8] [9] As a result, children were learning less during online classes compared to face-to-face classes. [10]

Despite the challenges, the pandemic also presents an opportunity for sustainable development in Indonesian education sector. Specifically, it could decrease the adverse effects of conventional teaching methods on the environment. Online learning is considered as one of the solutions to achieve such an outcome, as it reduces carbon footprints from various offline activities. [6] In addition, post-pandemic education will most likely incorporate online learning technologies into classes. Many institutions in Indonesia are considering adopting blended or hybrid learning system. [11] A successful example of this classroom setting is, it encourages engagement between both online and offline students. Thus, it creates a more equal and accessible learning environment for remote students. [12]
This research aims to explore the potential of gamified application design to enhance children's online/hybrid learning experience in Indonesian lower primary school education. The project is also intended to support student-teacher interactions during learning process and reduce the burden of transition stress. Moreover, the project works towards helping children more independently and minimizing physical learning resources. This type of technology integration could possibly be a future-proof solution for primary school education in Indonesia, promoting sustainable, accessible, and innovative approaches to education.

2 Literature Review

2.1 Child Development

A child’s mind is akin to a “blank slate” or tabula rasa, which were then written by experiences. [13] These experiences are obtained through social interactions and environments they grow up in. Therefore, children need plenty of enriching stimuli to help with their development. [14] Children typically receive the experiences through learning, both from their parents and teachers in formal education. However, to ensure children truly gain knowledge, it is important to keep children motivated in learning. [1]

There are studies that suggest children learn best through play, as play is a natural activity for children, especially in early years. Play motivates children well, hence, it is the best learning medium to maximize children development. [15] Play emphasizes on what children ‘want’ to do freely instead of being forced to follow or do something. It is very important because children can learn from other people and their environments, extending their concepts of the world. [16]

In formal education, teachers play a huge role in motivating children to learn new knowledge or develop their problem-solving skills. [3] Children’s brains are capable of reorganizing and restructuring quickly based on their own experiences, described as "critical experiences". They are the most receptive to new knowledge during this period. Thus, teachers are encouraged to observe their behaviors and teach them when the children need the guidance the most. [4]

2.2 Online Learning

Online learning is defined as an enhanced interaction between students and teachers through the Internet. It assists both independent and collaborative learning activities. One of the driving forces is advancing technologies, which gradually becomes a bridge between teachers and students through digital media and platforms. [17]

Online learning allows students and teachers to conduct their lessons more flexibly. They can set up classes together upon an agreed time or conduct learning in different times to suit their needs. It also adds more interactivities that traditional classes do not possess, such as video conferencing, automated quizzes, scores, et cetera. [17]

Post-pandemic education will most likely incorporate online learning technologies into classes. Many institutions in Indonesia are considering adopting blended or hybrid learning system in addition to technological advancement. [11] Moreover, the increasingly diverse population demands more personalized learning, which allows more flexibility for learning and teaching spaces. [18] Hybrid and blended learning provide new opportunities of technological advancement in terms of learning methods. A successful example of this classroom setting is it encourages engagement between both online and offline students, while creating a more equal and accessible learning environment for remote students. [12]

2.3 User Interface and User Experience Design

2.3.1 User Experience Design

User experience design is iterative in nature, which the process is similar with design thinking. There are several principles to user experience design, as follows.

1. User as the center
   The core concept of every UX design is to identify humans’ needs and provide solutions. [19]

2. Information Architecture
   Information architecture is how information is organized within digital products. The goal of IA in UX design is to help users understand the information presented in the screen design. [20]

3. Context
   UX design needs context to work effectively. Humans are complex creatures with various habits and problems. Thus, having a context is strongly recommended. [19]

4. Usability first
   Usability is an evaluation to ensure users can use a product comfortably. It is flexible and should be able to adjust to the user’s needs, which can be achieved by conducting user testing. [19]

5. Minimalism
   UX design works best when the product is focused on several features that are most important to the users. Too many elements or features only lose the purpose of a product. [19]

6. Mental models
   Mental models refer to theories that people create mental models to understand how the world works. [19]
2.3.2 User Interface Design

User interface is described as a tool for end users to operate the available maps, the visual end of an interactive product. User experience is broader than interface – it is a two-way communication between digital products and the users. Hence, interaction is dependent as the response is based on the users’ request, and empowering as well, as it gives the user agency during the mapping process based on his or her interests and necessities. [21]

User interface determines the efficiency of the usability of the product. It should be simple enough for users to interact with, and consistent throughout a digital product. It is also encouraged to follow existing platform standards to ensure that users understand the interface elements and commands in the product. [22]

2.4 Four Pillars of Educational Applications

Research by Hirsh-Pasek in 2015 proposed four pillars of educational applications that are potentially more impactful for children. [23]

1. First pillar: active learning
   The first pillar promotes active thinking on children’s mind. It should encourage them to think critically by asking questions, to guess, and evaluate than simply reacting to stimuli on screens.

   The second pillar helps children stay engaged with the learning process, rather than diverting their attention with overwhelming audio and visual elements such as sound effects, flashing ads, and eye-catching rewards.

3. Third pillar: meaningful learning
   The third pillar considers the quality and number of connections between an app experience and children’s external world. It also contains relevant and meaningful contents that enrich children’s learning experience.

4. Fourth pillar: social interaction
   The fourth pillar suggests that an educational app should provide chances to develop social interactions. there are several ways an app can potentially increase social interactions. first, when an app acts as a medium for multiple users to use simultaneously. Second, engaging through screen-mediated interactions such as video conferencing, et cetera. Third, supporting interactions with responsive character design on screen.

3 Methodology

In designing the prototype app, several User Experience (UX) Design Principles were to be applied. By conducting in depth interviews to potential target users, important data and information was to be obtained to ensure the app adheres to the “user as the center” principle. Preliminary interviews would be held with parents, guardians, and primary school teachers to grasp the situation during remote learning. Parents and guardians would be requested to explain how they were assisting their children during the classes, while the teachers inform the researchers about their challenges teaching online and the strategies utilized to overcome them.

![Fig 1. Example of preliminary interview results with parents and guardians.](image)

Subsequently, another round of individual interviews with the teachers was to be conducted to further investigate online learning issues of both instructors and students. They were to be inquired further about their strategies during online learning, specifically when it comes to different grades, important subjects, and whether a new application design would help learning activities further. The resulting data would then be used to help design the Information Architecture in the prototype app.

Insights gathered would then be analysed through user experience analysis methods, such as creating user personas and user journey to identify their pain points. Furthermore, MoSCOW (Must-Have, Should-Have, Could-Have, and Won’t-Have) analysis would be used to determine the app’s prioritized features as the app were user tested for usability as well as the rate of the UX design narrative clarity. As for the user testing, it was to be conducted through in-depth observation with the target audiences due to limitations presented in the research. Below are the user testing metrics to measure the effectiveness of the app design.

<table>
<thead>
<tr>
<th>Table 1. Testing metrics: general onboarding</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feature</strong></td>
</tr>
<tr>
<td>Launch page</td>
</tr>
<tr>
<td>Onboarding Page</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Signup</td>
</tr>
<tr>
<td>Dashboard</td>
</tr>
</tbody>
</table>

- **Press the icons presented in the menu bar**
- **Choose one of the covers**
Table 2. Testing metrics: student's account

<table>
<thead>
<tr>
<th>Feature</th>
<th>Expected Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson menu</td>
<td>User clicks on “Mulai” in any of the sections.</td>
</tr>
<tr>
<td>Multiple choice</td>
<td>User chooses any of the choice sample</td>
</tr>
<tr>
<td>Tutorial page</td>
<td>User waits to watch the tutorial, then clicks next.</td>
</tr>
<tr>
<td>Map game</td>
<td>User attempts to drag the character icon throughout the map.</td>
</tr>
<tr>
<td>Connecting dot activity</td>
<td>User attempts to drag the dots to match the destined answers.</td>
</tr>
<tr>
<td>Interactive physical tutorial</td>
<td>User watches the animation and then follows the movement.</td>
</tr>
<tr>
<td>Spelling activity</td>
<td>User presses the play button and follows along with the spelling.</td>
</tr>
<tr>
<td>Writing activity</td>
<td>User attempts to write the number by clicking on the white space or trying to write</td>
</tr>
</tbody>
</table>

Table 3. Testing metrics: teachers' account

<table>
<thead>
<tr>
<th>Feature</th>
<th>Expected Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson menu</td>
<td>User clicks on “Mulai” or “Edit” or “Assign” in any of the sections.</td>
</tr>
<tr>
<td>Activity Editor</td>
<td>User attempts to explore the page by clicking the menus available</td>
</tr>
<tr>
<td>Character customization</td>
<td>User attempts to explore by clicking on any of the characters and trying to scroll the character choices</td>
</tr>
<tr>
<td>Image and text customization</td>
<td>User attempts to explore by clicking on any of the text spaces available or trying to change the character by clicking (•••) icon</td>
</tr>
<tr>
<td>Dialog customization</td>
<td>User attempts to explore by clicking the text space. V0 choice, (•••) icon on the character box</td>
</tr>
<tr>
<td>Slide mode menu</td>
<td>User attempts to choose any of the menu icons</td>
</tr>
<tr>
<td>Video menu</td>
<td>User attempts to click on any of the space or icons</td>
</tr>
<tr>
<td>Saved activity</td>
<td>User recognized that the activity customized will be saved in Kelas &gt; Assignment Saya</td>
</tr>
</tbody>
</table>

4 Result and Discussion

4.1 Interview Result

The preliminary interview results with parents, guardians, and teachers show that the biggest problem of online learning during the pandemic is the lack of students’ and teachers’ interaction. Teachers face difficulties in observing and engaging with children during online classes, hence it has become a challenge to get their attention and motivate them to learn.

Based on further in-depth the interviews with three primary school teachers, they all agreed that they have adjusted to teaching online. In the past two years, there have been various materials and platforms that were made to support online learning, such as Quizizz and Blooket. However, there are still improvements that can be made. Current technology is still thought to be lacking in assisting students’ and teachers’ interactions. Available platforms do not allow much freedom to customize learning materials, limited only to creating presentations and videos to deliver lessons.

The interviewees also thought that learning platforms between lower grade (1–3) and upper grade (4–6) should be different, as they have a significant difference in learning methods. Younger children mostly depend on audio and visuals, while the older ones should be given more challenge through problem-solving skills.

4.2 Communication Strategy

The project will use application design as its media, due to technological advancement and the shift in learning methods. Moreover, according to the teachers, there is a potential to explore the app mechanism, particularly for lesson customization.

The primary target market for the application is Indonesian children aged 6–9 years old, and the secondary target is primary school teachers. The design should also make the target audience feel good and engaged while using the digital product.

4.3 Design Strategy

This research utilizes user-based approach to identify users’ problems, needs, and opportunities to improve current online learning situation. This project will also prioritize children’s learning experience and teachers' convenience in customizing the materials; thus, the experience in online/hybrid classes can be improved significantly. Since there are different children’s age group for the app, it is important to consider each age group’s learning capability and other users who potentially use the app.

4.4 User Experience Analysis

The results of the analyses were expressed through user personas, user journey maps of the corresponding personas, and features prioritization.

4.4.1 User Persona

Three user personas are created to help identify the users’ behaviors and needs. Anna represents grade 1 – 2 students, Ben represents grade 3 students, and Astri represents primary school teachers.
4.4.2 User Journey Map

User journey maps were created based on these three user personas. The journey maps were aimed to show the users’ emotional journeys and identify their pain points in a scenario, in this case, during an online learning session.

4.4.3 MoSCOW Analysis

Based on previous design analyses, prioritized features are determined as follows.
Table 4. MoSCOW Analysis Result

<table>
<thead>
<tr>
<th>Must Have</th>
<th>Should Have</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onboarding pages</td>
<td>Downloadable content (accessibility)</td>
</tr>
<tr>
<td>Different signups/logins for students and teachers</td>
<td>Submission feature (for children)</td>
</tr>
<tr>
<td>Grade/age filter</td>
<td>Grading feature (for teachers)</td>
</tr>
<tr>
<td>Gamified, interactive content (with children’s interface)</td>
<td>Exploration interaction (for children)</td>
</tr>
<tr>
<td>Progress dashboard</td>
<td>Users’ profile page</td>
</tr>
<tr>
<td>Content customization (for teachers)</td>
<td>Creating teams/classrooms</td>
</tr>
<tr>
<td></td>
<td>Report records</td>
</tr>
<tr>
<td></td>
<td>Progressive tutorial</td>
</tr>
<tr>
<td>Could Have</td>
<td>Won’t Have</td>
</tr>
<tr>
<td>Engaging narratives</td>
<td>In-app AR features</td>
</tr>
<tr>
<td>Guardians’ login/signup</td>
<td>Scanning features</td>
</tr>
<tr>
<td>Payment/subscription</td>
<td>Video conferencing</td>
</tr>
<tr>
<td>Dark mode</td>
<td></td>
</tr>
</tbody>
</table>

4.5 Design Process

This project follows user experience design process which consists of creating the app flow, content design storyboards, wireframes, until high-fidelity prototype.

4.5.1 App Flow

The overall app flow is separated into three major sections, which are starting page, students’ dashboards, and teachers’ dashboard. Each of the flow is designed to guide users find features they would like to access conveniently.

4.5.2 Content Design

The content design consists of the planned storyboard, to give some indications on how the assets should be created or divided, and how the animation or interaction should work. Visuals assisted with voice over is necessary as well for explaining the instructions, texts, or narratives as lower grade children depend heavily on audio.

For the research purpose, the content design was adapted from the “thematic” learning method, which is based on the 2017 revision of the 2013 national curriculum. The source materials were taken from Grade 1 “Diriku” theme. This study chose grade 1 as the sample of the content because younger students need more guidance and attention from the teachers.

4.6 Design Implementation

The application design is created to enhance children’s learning experience and assist students’ and teachers’ interactions further in an online/hybrid setting. Additionally, the project is created to appeal the target market with ease of use and interactive mechanisms.
4.6.1 Student’s account

Student’s account mainly consists of gamified content design, which was inspired from action-adventure games, where players are rewarded by unlocking new narratives, activities, and regions rather than achievement-based reward. It also consists of narrative flow that is told through a series of interrelated activities.

Fig 11. Student’s dashboard

Fig 12. Multiple choice content design

Fig 13. Matching activity

Fig 14. Listening activity

4.6.2 Teacher’s account

Teachers’ account consists of content customization, which was inspired from various editing tools. Teachers will be able to create their own materials using available templates in the app. Customization features for teachers include narrative adjustment, character customization, media uploads, text and listening activities.

Fig 15. Teacher’s dashboard

Fig 16. Activity editor

Fig 17. Character customization

4.7 Usability Testing

The usability testing was conducted with two different target groups: students and teachers. Four children ranging from 6-9 years old participated in the testing. The method chosen was in-depth individual observation to obtain accurate data on participants’ behaviors and organic reactions.

The participant for teacher’s user testing is a primary school teacher with an extensive teaching experience. She has taught schools before and during the pandemic.
The method chosen was a semi-interview approach through online meeting. The authors would like to gain further insights on the app through discussion, in addition to the overall feedback on the navigation.

4.7.1 Student’s testing result

The testing shows that the app is generally intuitive enough for children to use; younger children seemed to not have major problems in navigating the app despite their lack of fundamental abilities. They also recognized that the app is educational instead of entertaining such as a game. The children also seemed to understand the narrative flow of the content as well, as they noted candidly that the main character was going to school then going back home.

The reactions obtained from the tests depend heavily on children’s interests and moods. Some of the children showed immense interest on the app design, even asked the author to create more content for them to explore further. Others appeared to be rather distracted during the testing; they were not patient enough to wait when they encountered errors in the prototype. However, in the end, the children showed positive notes that this approach has a potential to be applied as a learning method in Indonesian primary school classes

4.7.2 Teacher’s testing result

Based on the observation during the testing, the overall app navigation is intuitive to use, as the user did not seem to have major problems navigation from the launch screen until exploring the features. The user even recognized some of the features that are available in another commonly used platform. The customization features seemed to be instinctual as well, as the user recognized immediately the number of customizations, they were capable of doing in the app.

The overall app received a very positive review from the user. She claimed that the project has a tremendous potential to be implemented as future learning method and in various classroom setting, such as online, hybrid, and onsite classes. Schools have started implementing technologies into classrooms as well. Since the chosen medium is a tablet app (touch-based gestures), the user saw the potential as a collaboration tool when teaching in class.

The user seemed excited on the customization aspect, as she stated it would help most teachers greatly in assembling school materials. The current material creation process is quite complex to do, especially for the older ones. In addition to administrative works and teaching, the overall customization is very taxing for teachers to follow. The user claimed that the customization feature provided in the app allows teachers to have fun while working, as she thought that it works similarly to a game, reducing work-related burnout effectively.

5 Conclusion and Recommendation

5.1 Conclusion

This study investigates ways that application design might improve children’s online and hybrid learning experiences as a sustainable learning option. Observational research by Park and Kim [6] suggest that gamification method can be sustainable as it adds learning motivation and facilitates context understanding well. They strongly recommend that gamification in national curriculums should be developed and disseminated to lessen the burdens on both learners and educators. The findings of this study proved that gamified app design has the potential to revolutionize Indonesian primary school educations. Users’ positive receptions of the product opened new possibilities on how learning could be conducted digitally and more sustainably. This learning method is also proven to be future proof, as it can potentially be applied in online, hybrid, and on-site classes.

5.2 Recommendation

There are several limitations in this research project. The design prototype was created in Figma, which limited the usability compared to a fully developed product. Future research should consider collaborating with developers to ensure a more accurate testing result. Simultaneous testing with students and teachers should also be conducted to further prove the effectiveness in all learning situations. Furthermore, since this project only focuses on content design and customization, other functionalities such as class, library, and reward system did not have the chance to be developed. Future studies should explore the opportunities these functions potentially offer to enhance online/hybrid learning conduct.

References


