KọÈdè: Gamified Mobile Learning for Yoruba Language Acquisition Among Nigerian Children

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ABSTRACT

Language plays a pivotal role in preserving culture, identity, and intergenerational communication. Despite Nigeria's linguistic richness, with over 500 indigenous languages, many of these languages face the threat of extinction due to globalization, urbanization, and the dominance of colonial languages in formal education. This study presents a design case study of KọÈdè, an interactive and culturally relevant digital platform aimed at supporting Yoruba language acquisition among Nigerian children. The study uses an iterative user-centred design. Employing a user-centred design approach, the study developed and tested multiple wireframes and prototypes using tools like Figma and Android Studio. Formative evaluation of KọÈdè revealed the importance of incorporating scaffolding, gamification, and audio feedback to improve engagement and retention among young learners. KọÈdè represents a step toward bridging the gap in child-friendly indigenous language learning tools in Nigeria, offering a tailored and engaging learning experience grounded in culture and everyday language use.

KEYWORDS

User-Centred Design
Language Learning App
Gamification
Digital Language Platform
Language Preservation

1. INTRODUCTION

Language is key for communicating the values, norms and beliefs of a group of people (Yekini-Ajenifuja et al., 2013). There are at least 75 languages in Africa which have more than one million speakers. Research has shown that many African languages face the risk of endangerment. According to Ken Hale (1992), languages no longer being learned by children are moribund and would soon become extinct. A language is endangered when it's not passed to the next generation (Olaifa, 2014). Michael Krauss (2007), a pioneer in the field of endangered languages, defined a language as endangered if children are not likely to speak them in 100 years.

In various reports, it has been noted that parents of this generation have not passed down their culture or language to their children (Chakanetsa, 2021; Vanguard, 2017). Findings from a recent study revealed that 37% of a surveyed group of students aged 6 to 13 from 10 different primary and junior secondary schools in Nigeria are monolingual who speak only English as their first and native language (Uwen et al., 2020). The study further established that the growing preference for English Language is influenced by the pressures from parents, teachers, and peers, as well as the effects of globalization. If this trend continues, the number of English speakers in Nigeria will continue to increase while indigenous languages may become even more endangered.

Marginalization of native languages in Africa has severe effects. According to Basidi (2021), regression of Science and Technology in Africa is mainly caused by the marginalization of native languages. UNESCO (2022) also noted that the use of the mother tongue for class instruction or education aids or enhances learning. It has also been noted that kids are best taught their mother tongue in their formative years (Punch, 2019).

According to Ajani et al. (2024), digital media technology plays a key role in preservation, documentation, revitalization and learning of languages. Other studies such as that of Nanduri, 2024; Palala, 2024 have as well leveraged on digital technology to support indigenous language learning and revitalization in Africa and globally. In the work of Criollo et al. (2024), it was established that technologies such as mobile learning/mobile phones can be used to prevent the extinction of indigenous language. The researchers further noted that the current generation of learners are born into digital world where they grew up with mobile devices, internet and social media and as a result their means of receiving information is linked to technologies. This implies that to effectively support children to learn indigenous language, there is a need to leverage on technology/mobile learning. According to Meighan(2021), there is still need for further research to be carried out with indigenous people to view their perspective on the how they use technology and whether it impacts on day-to-day language usage. In addition, the study of Cassels & Farr (2019) that reviewed 32 different apps designed for the learning of indigenous language noted that more research still needs to be done in this area especially as regards sociolinguistic nature and pedagogical benefits. It is also worth noting that most of these applications reviewed are not for learning African languages and only a few target children. To address the gaps that exist in the literature, we aim to explore how user-centred design principles can be used to develop a culturally relevant mobile application for learning Yoruba among Nigerian children.

2. LITERATURE REVIEW

This section focuses on pedagogy/teaching approaches that support language learning, digital technologies for language education and gamification as an interactive learning method that enhance children's engagement.

2.1. Language Learning Pedagogies

Various pedagogies and learning theories have been identified to support language learning. These include behaviourism, cognitive-code learning, creative construction hypothesis, skill learning, interactional theory, constructivism and social cultural learning (Richards & Rodgers, 2014).

Behaviourism views learning as a process of habit formation through repetition and reinforcement. On the other hand, cognitive approaches focus on the learner's mental processes and reasoning. The creative-construction pedagogy sees error as a way of learning and not signs of faulty learning. Skill learning theory argues that language should be approached as a

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composite of smaller sub-skills, which can be mastered individually and integrated into fluent performance. Interaction theory places emphasis on interactivity and peer collaboration while constructivism stresses the importance of active learning. Social cultural learning/social constructivism places emphasis on scaffolding within a social context (Richards & Rodgers, 2014). Indigenous mobile learning application can be designed on these theories for improved engagement and retention.

2.2. Technology

The use of technology to support learning of languages can be dated back to sixties and seventies where cassette decks were used (Nomass, 2013). With advancement in technology, newer technologies such as NLP, Interactive White Board, Mobile Devices, Games, SMS have been used to support learning of foreign language or language in general (Golonka, 2014; Tolochko et. al., 2019).

2.2.1 Mobile Technology

Mobile phones have recorded a high penetration rate in Africa. This is due to its ubiquitous nature and cheapness when compared to other computing devices such as laptops. Mobile technology is revolutionizing the education sector, as students can now access the classroom and diverse learning resources from the comfort of their home using mobile phones (Rhema, A., & Sztendur, 2013; Sakpere, 2021). Results from various studies indicate that the use of mobile phones improves students' performance (Sakpere, 2019; Sakpere 2021). Various researches have used mobile technology to support the learning of indigenous languages/culture (Tabata et. al, 2009; Criollo-C, 2021). The results obtained indicates characteristics such as the utility and perceived ease of use, positively influencing students to motivate the use of mobile devices in learning a language (Tabata et. al, 2009; Criollo-C et. al., 2021).

Begay (2013) outlines specific design considerations for mobile application targeting learning of indigenous language. These include accommodating language variation (e.g., dialects by region or gender), respecting cultural restrictions (e.g., avoidance of forbidden words, stories, or image), and ensuring the app includes the appropriate textual components such as fonts and native keyboards. Furthermore, Begay emphasizes three guiding principles for effective indigenous language apps: multimedia integration, user-centred interface design, and testing and evaluation for content accuracy.

2.3. Gamification for Child Engagement in Learning

The term gamification simply means the application of game concepts in a non-gaming environment with the aim of enhancing user engagement and experience, change behaviours and support innovation (Caponetto et. al, 2014). Such concepts include badges, point scores, rewards. Gamification has enhanced and motivated learning.

Although gamification has seen widespread adoption in the United States, its integration into African educational systems remains relatively limited. However, its potential is significant, especially for child-centred learning applications. Majuri et al. (2018) found that most gamified learning tools emphasize achievement and progress indicators, while features related to social and immersion-orientation are underutilized.

In summary, the literature suggests that effective indigenous language learning platforms for children must integrate (1) sound pedagogical principles, (2) accessible and culturally sensitive mobile technologies, and (3) interactive, game-based features tailored to young learners. Despite progress in each area, further research is needed to synthesize these components in user-centred, culturally grounded applications for African languages such as Yoruba.

3. METHODOLOGY: PROTOTYPE DEVELOPMENT

3.1. User Research

This employed Voluntary and Snow Balling Samplings. Through a social media post, an open invite was sent out for interested participants/contact to share their experience of how they learnt Yoruba or any indigenous language or that of their children. In addition, some contacts who identified as having interest in Yoruba were reached out to directly. A total of 12 people showed interest in participating in the research at this stage of understanding the problem space/requirement analysis. Participants included Yoruba language educators, parents, and informal language tutors. Requirements were then further gathered from these people using a semi-structured interview. Some of the interview guides are as follows:

i. I have a project on designing a technology that can assist children to learn native language. I know you intentionally assist your child to learn Yoruba. Please can you share your experience in this regard. Do you think an application or technology support would better help children to learn native language? If so, how would you suggest it should be designed?
ii. The project is still in its infancy state. Currently interested in knowing the difficulties you as an experienced Yoruba speaker/instructor have faced in teaching kids Yoruba.

In order to deepen our understanding of the problem, responses from the interview were analysed and grouped into themes. Table 1 summarizes the key insights derived from this analysis.

Table 1: Themes emerging from the User Research

Themes	Explanation
English Dominance	Most parents speak English to them at home. In fact, many of the parents can't even speak well either.
Slow/delayed introduction	Many schools don't get to teach Yorùbá until primary/basic classes and they talk the kids out of speaking Yorùbá language.
Lack of Practice	To learn a new language, practicing it in speaking and writing regularly is very vital but most people I've encountered don't do that so making progress is usually very slow.
Societal Influence	Societal preference for English Language negatively impacts interest and learning
Tone and Pronunciation	Children speak Yoruba with English tonation, missing out tonal accuracy

Following understanding of the problem space, design guides were recommended and a summary is presented on Table 2:

Table 2: Design Insights

Insight	Design Implication
Content over popularity	The focus should not be on user growth as it is in many existing interventions but on linguistic depth
Social Features	An improvement on the currently available apps, will be adding a social connection aspect to it. This will allow leaners connect.
Contextual Learning	Embed words in real-life scenarios/stories to reinforce usage.
Multi-Pronged Learning	Address listening, speaking, and writing as distinct skill areas.
Pronunciation Matters	Include accurate audio taking Yoruba as a highly tonal language into consideration

3.2. Prototype Design

The design of the prototype was iterative and user-centred with constant feedback from users and experts. A total of eight iterations as summarized in Figure 1 were carried out from low fidelity paper prototypes to coded digital implementations.

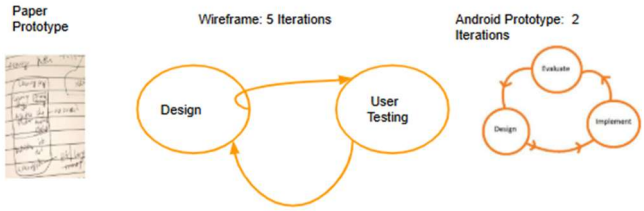

Figure 1: Summary of Iterations of KoEde

3.2.1. Paper Prototype

Paper prototype is easy to use and doesn't necessarily require technical skills (Sakpere & Kayem, 2014). This was indeed helpful to gather initial thoughts. After this it was easier to know how to go about the wireframing. It also afforded the opportunity to easily cross out designs. A major setback was adding colours/making it interactive.

3.2.2 Wireframing

A total of 5 wireframes were done. Each iteration was improved on based on feedback from users. At the initial stage of the wireframing, Adobe XD was used for the initial stages and Figma was used for the latter stage.

The first wireframe was designed using Adobe XD. The 1st UI design majorly had the following features: login, profile set up and learning preference. The profile set-up also included parental support and indication of availability. The learning preference enables learners to be able to set how they want to learn and also understand their personality in order to determine an appropriate learning path. Figure 2 shows the screens of the various features. The first is the welcome page with a placeholder image for the welcome video. The next screen is the sign up, then followed by a notification to show the success of the sign-up. The 4th screen is for profile set up and users can choose their preferred avatar. The 5th and 6th screen prompts are for parental support and seek to get further details/availability of parents. The 7th screen prompts users to enter their learning style and intrinsic character in order to set/determine a unique learning path.

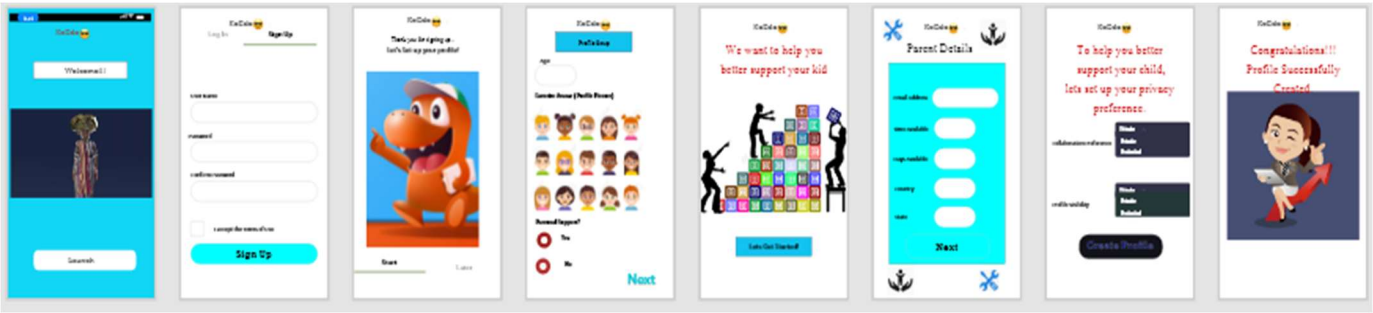

Figure 2: The first wireframe

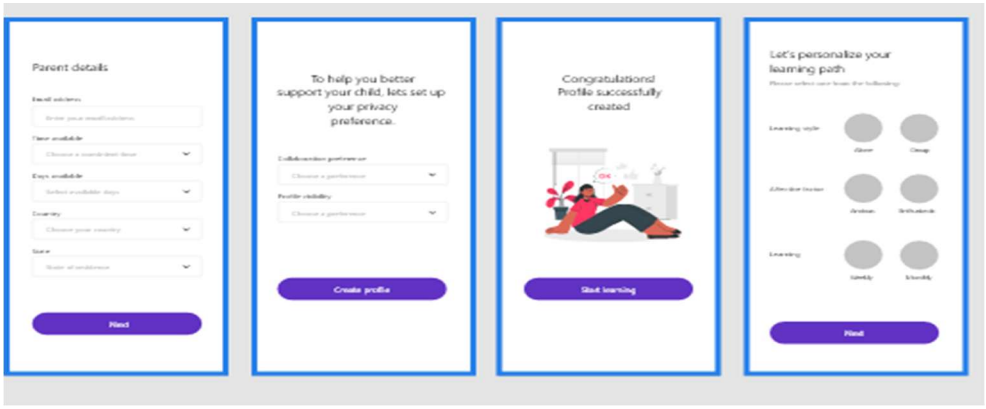

Figure 3: Second Iteration of the wireframe

Figure 4: Puzzle-concept for learning everyday objects in Yoruba

Following expert review, the first wireframe went through a second iteration that incorporated feedback related to visual design principles, specifically improvements in colour harmony, typographic clarity, visual consistency, and interface simplicity. These revisions are in line with established Human-Computer Interaction (HCI) heuristics, particularly Nielsen's usability heuristics, which emphasize the importance of aesthetic and minimalist design, consistency, and user control (Nielsen, 1994).

The second iteration was also influenced by the usability review that the onboarding process specifically the login and sign-up sequence—was overly lengthy and cognitively demanding, potentially leading to user drop-off. This finding aligns with prior research by Alqahtani (2020), which demonstrates that applications with complex or demanding registration processes often experience lower signup rates. The 2nd wireframe is presented in Figure 3.

For the third wireframe, the focus was in coming up with a design grounded in game-based learning principles to enhance motivation and engagement. This phase introduced two interactive learning modules: a puzzle-based activity and a matching game. The design was done using Microsoft Word Drawing tool serving as a low-fidelity prototype. This allowed for rapid ideation and iterative refinement before transitioning the concepts into high-fidelity wireframes for further user evaluation and implementation.

The puzzle-based design as illustrated in Figure 4 has 3 components: Scrambled Letters, Words to search for/trace & image-word association, where in the corresponding image pops up upon correct trace. This design aligns with the constructivism theory which emphasizes active learning as a means of constructing knowledge.

In the puzzle activity, learners are given a particular word and asked to trace/search for it in a puzzle scrambled grid with Yoruba alphabets that is arranged vertically, horizontally, or diagonally. The search/trace is within a time constraint—60 seconds for children above age 10 and 90 seconds for those younger. Correct responses are rewarded with points and trigger the appearance of a corresponding image with option of the audio pronunciation, thereby linking orthographic, phonological, and semantic representations. This design supports dual coding theory which posits that the combination of verbal and visual stimuli improves recall and comprehension.

For the matching game, as illustrated in Figure 5, it's a drag-match interface that consists of 2 columns: the first displaying Yoruba Words and the second showing randomly arranged images. Users are prompted to match/drag each word to its corresponding image in the second column within a maximum number of three attempts for each word. If after 3 trials, the user gets it wrong, a point would be lost. Once a right match has been detected or number of trials met, the image and words would be taken off the list of words/images to learn/match. The matching activity supports active recall and cross-modal reinforcement, both of which are foundation in second language acquisition.

The 4th and 5th are about gamification and re-design of the interface. Following the feedback from the testing of game-based learning concept, learning paths were restructured based on perceived cognitive load. Starting with the Matching Game identified as the most intuitive and culminating in Sentence Formation, which requires higher-order language skills. This revision aligns with scaffolding learning where learners are exposed to concepts in order of difficulty/complexity. This revised wireframe, designed using Figma is presented in Figure 6.

The fifth and final wireframe represented from Figures 7 to 11 is a comprehensive redesign of the entire interface architecture and served as the blueprint for the final coded implementation of the application.

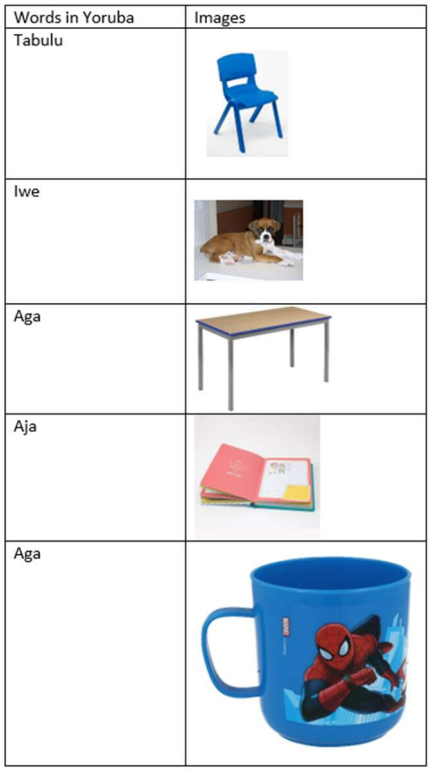

Figure 5: Matching-Game for Learning Everyday Objects in Yoruba

3.2.3 Coded Design

It was difficult to have users interact with Figma design in a dynamic manner. As a result, the coding of the design was done. The implementation was done in Android Studio. VS Code is the IDE used and other SDKs like: Flutter and Android.

The implemented/coded interfaces are still similar to the design of the wireframe. A major difference is that a right trace on the Puzzle would lead to a display of the image of the chosen/traced words. For instance, the Yoruba word, "bata" means shoe. So, a right trace of bata would pop up the image of a shoe. This is to support high retention and learning rate. Also, the interaction of the sentence formation changes. To form a sentence, the coded interface expects a long press on a tile to re-arrange randomly given words. Figure 12 shows the interface of the Gamified Learning Path of the KoEde Android App. Finally, there is a display of a message indicating time up when a user exhausts the given time.

4. EVALUATION, RESULTS AND DISCUSSIONS

This section presents the formative evaluation conducted in two phases to assess the usability and learning potential of the prototype. A mixed-methods approach combining observational studies, walk-through, think-aloud protocols, and post-task feedback was used.

4.1. Phase 1: Low Fidelity Evaluation

Participants: 3 children (ages 2, 4 and 7; 2 males and 1 female), Adults: 2 young Yoruba native speakers (ages 18–22; 1 male and 1 female), 3 UI/UX experts (1 male and 2 females, age range: 20+ to 30+) and a group of 6 upcoming designers participated.

For usability testing, tasks were assigned which entails the match of Yoruba words to appropriate visual objects and trace scrambled words in a puzzle grids. Testing was conducted via Zoom for the children and adults; WhatsApp was used for the Experts Review and the group evaluation was done in-person. Methods consisted of task walkthroughs, direct observation, and focus group presentation/discussion on the concepts behind the

design. Qualitative data were collected through note-taking. Figure 13 shows the picture of the usability testing done via zoom for the low-fidelity porotype.

Metrics measured include Task Completion Time, Perceived Ease of Use (informally rated post-task) - User comments and behavioural observations

4.1.1. Key Findings from the Children Participants:

The age 4 child struggled with the puzzle task, indicating cognitive overload, while the 7-year-old found it engaging and manageable (task times ranged from 26–90 seconds). Both children found the matching game more intuitive, with faster completion times (under 60 seconds). Precisely, the age 4 child spent between 24 seconds and 60 seconds to get the correct match. She found it interesting and easier compared to the puzzle game. The 7-year-old child found the matching game very easy. He spent less than 30 secs for each match. The age 2 child couldn't engage meaningfully, all he did was to observe.

On challenges observed, the first is insufficient age-appropriate categorization. Matching games may be more suitable for children under 7, while older children can benefit from the more challenging puzzle-based learning activities. Secondly, lack of guidance. The need for explicit instructions to guide children through app activities. Finally, auditory Feedback. There is a need for voice or sound feedback when a child presses a word or letter. This will enhance phonetic association and engagement.

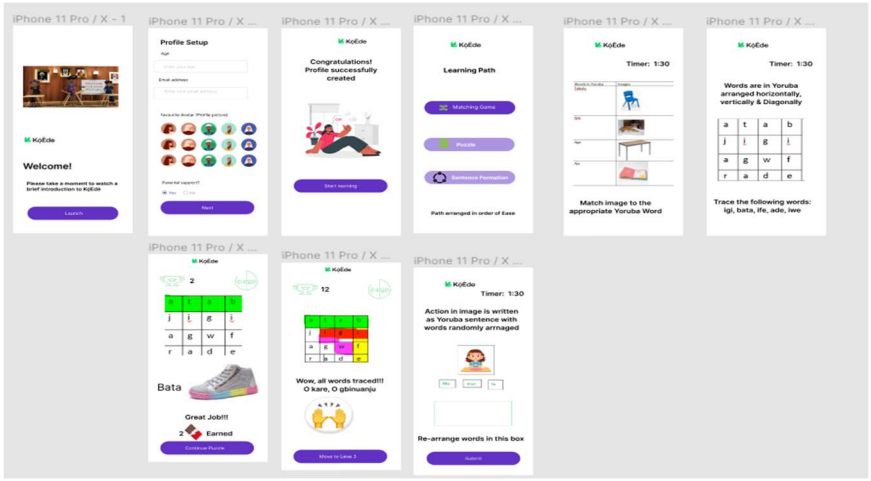

Figure 6: Matching-Game for Learning Everyday Objects in Yoruba

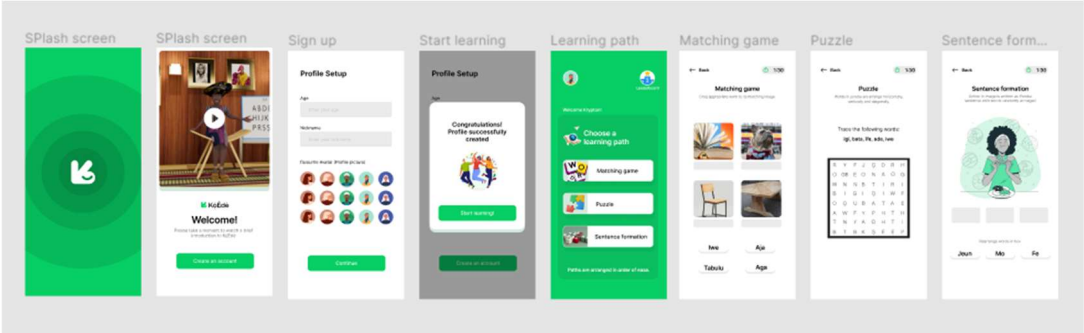

Figure 7: Overview of Prototype 5

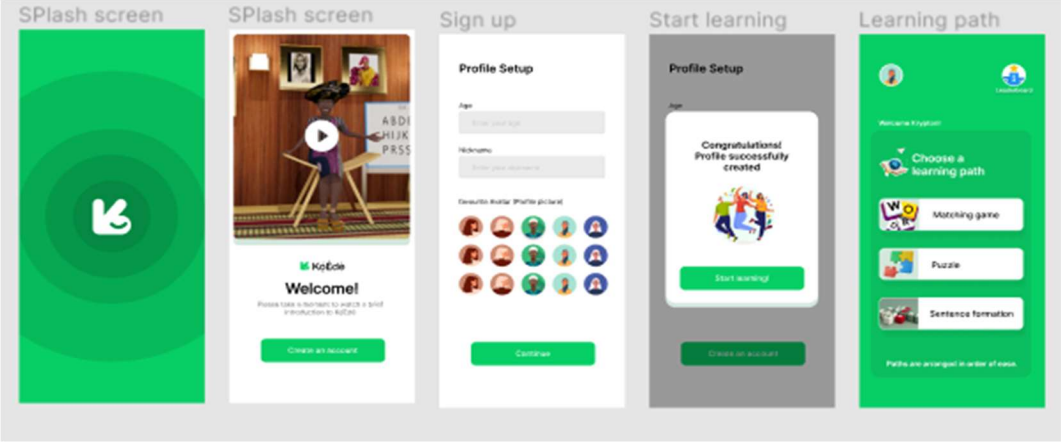

Figure 8: Prototype 5 Login Screen & Learning Path

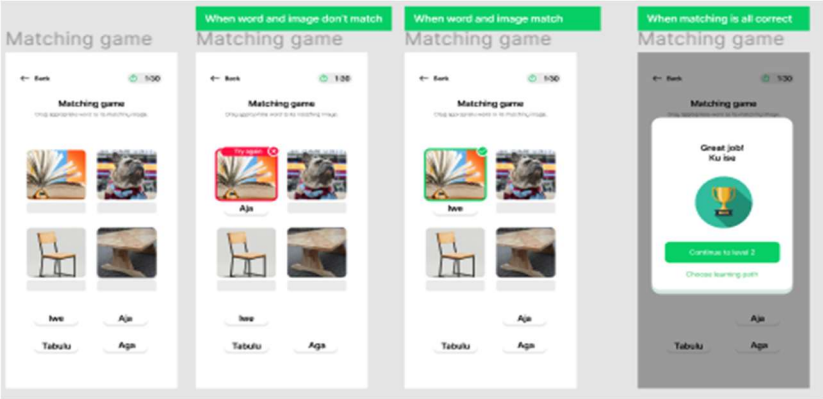

Figure 9: Matching Game Interaction of Prototype 5

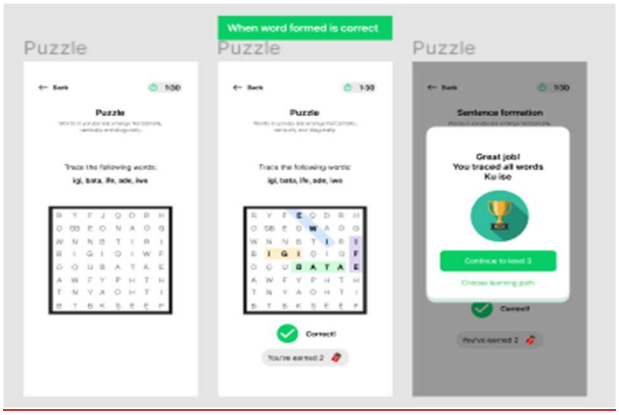

Figure 10: Puzzle Interaction of Prototype 5

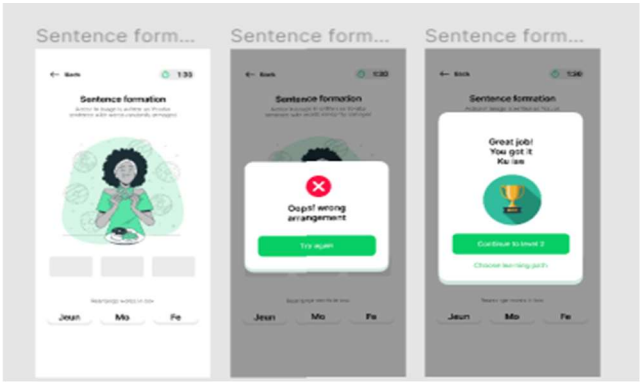

Figure 11: Puzzle Interaction of Prototype 5

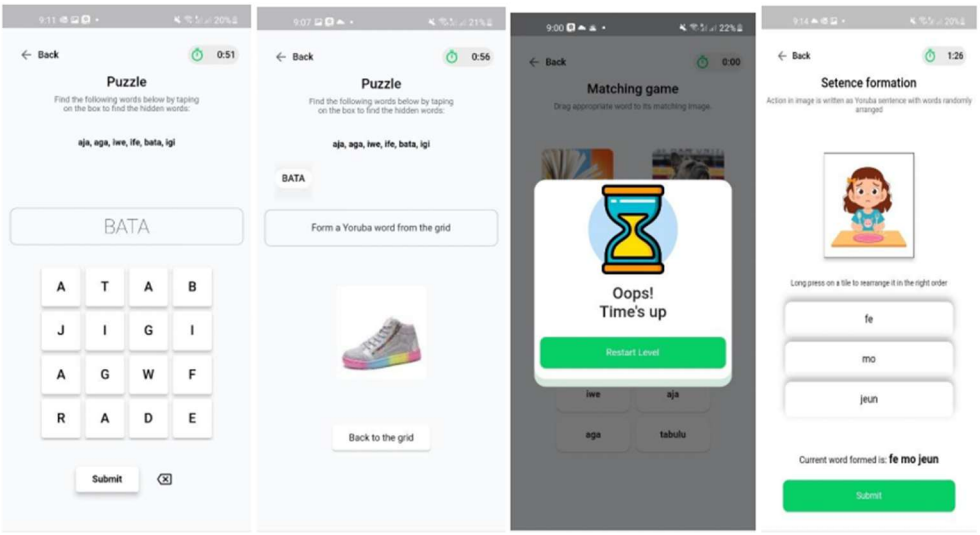

Figure 12: Interfaces of the Gamified Learning Path of the KoEde Android Version

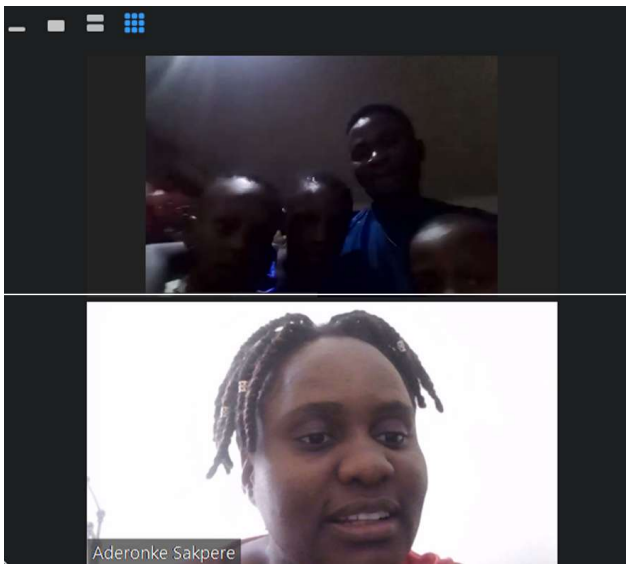

Figure 13: Formative Usability Testing of Low Fidelity Prototype Done Via Zoom

4.1.2. Key Findings from the Yoruba Native Speakers of the Adult Participants:

Three key themes emerged from the qualitative feedback from the adult participants. This is summarized in Table 3

Table 3: Themes from Low Fidelity Usability Testing

Themes	Explanation	Design Implications
Age-Appropriate Content	Activities for younger children (ages 2 - 5) need to focus on rhymes, and familiar concepts of daily words such as days of the week, pronouns, adjectives , noun, food, objects in the house, cartoon, number counting (1 2 3….)	Curate content based on age group group and use audio-visual Learning content should be focused on vocabularies that are used daily and cultural context, this aligns with sociocultural theory
Game-Based Learning Preference	Participants were positively inclined to the gamified learning concept. It was noted that contemporary learners which include children want a fun and engaging experience. One participant highlighted Duolingo as an example of engaging, game-driven language learning.	Reinforce gamification elements Adjust time constraints on the KoEde Game based learning platform on age group (e.g., 60 seconds for younger children). Prioritize intuitive, game-based content for younger age brackets.
Focus on Daily Usage	Learning content should focus more on everyday conversational Yoruba rather than overly formal or academic content taught in school settings.	Incorporate conversational phrases and context-based vocabulary relevant to children's daily environments.

4.1.3. Key Findings from the Expert Reviewers and Upcoming Designers:

The expert team, comprising of experienced UI/UX Designers and emerging designers participated throughout the iterative design process from the low fidelity wireframes to the high-fidelity coded prototype. Their formative feedback is a critical component of participatory design which helped to refine the system's design evolution from iteration 1 to 7 as discussed in section 3. were involved from the 1st wireframe up tunto the coded design/implementation.

4.2. Phase 2: High-Fidelity Evaluation

Participants: 4 adults (ages 20+, 30+, 60+, and 70+), 2 children (ages 4 and 9), 1 UI/UX designer, and 8 technology researchers.

Tasks include Complete profile setup, enrol in and interact with a learning path

Metrics include Task Success Rate, Observed Error Frequency, Usability Issues Identified and Post-task reflections

For procedure, in-person and remote testing were conducted. Participants completed key tasks using the coded Android prototype. Observations and post-task interviews were used to gather insights. Figure 14 shows a picture of the usability testing of the high-fidelity prototype.

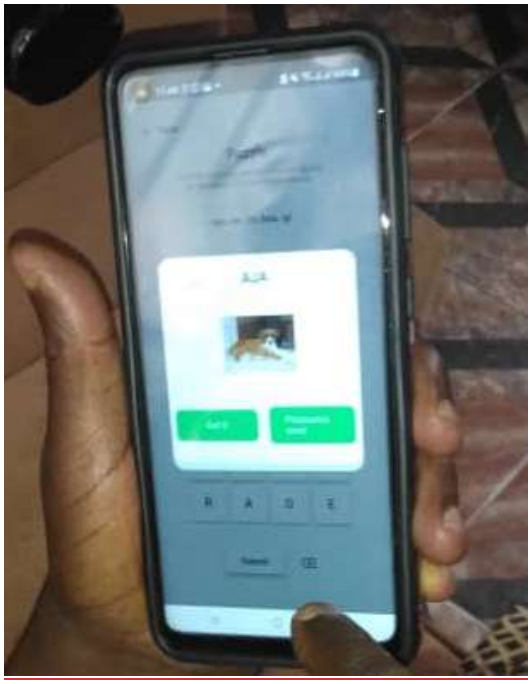

Figure 14: Formative usability testing of the high-fidelity prototype done in person

Overall, the users found the gaming concept endearing, interactive and engaging for learning indigenous language. One mother noted a heightened interest in the app by her daughter who is 3 years old. This demonstrates even possible usage by younger children.

Feedback suggests strong potential for curriculum integration or acceptance in formal setting such as schools, Two participants suggested "It would be nice if the app can be integrated or introduced into primary/secondary school curriculum or support the learning process of indigenous language in the school"

The gaming concept reinforces that the constructivist learning approach where learners actively build knowledge through exploratory interaction is indeed helpful, motivating and engaging for learning indigenous language.

Enhancement Suggestions were given. Participants further gave feedback that could improve the application. Audio feedback was frequently requested to reinforce correct or incorrect actions (consistent with Mayer's multimedia learning principles). Integration of indigenous speech converter was highlighted as a need. The current system uses English-Centric text-to-speech. For instance, the word "ife" can represent multiple meanings based on diacritical marks and tone: Cup - ife; Love - ìfé; City - ifè . One of the users saw the word and assumed

it's the ancient city, because the pronunciation was in English tonation and it confused her. This highlights the need for a localized sppech converted that would take tonal marks and diacritics into consideration.

Time limits were perceived as stressful; participants preferred self-paced learning. Improvement on sentence formation activity is necessary. Participants suggested a bottom-up instructional approach, where individual nouns and objects are introduced and practiced before sentence construction.

4.3. Limitation and future work

The evaluation confirmed the viability of a gamified, culturally relevant Yoruba language learning app. However, the absence of standardized usability instruments (e.g., System Usability Scale) and large-scale user testing limits the generalizability of findings. In addition, the use of social media (WhatsApp) has the primary platform for participants recruitment may have limited participation to individuals within the researcher's network, there introducing biases. While the study was designed as a formative and qualitative investigation rather than a statistically generalizable one, these limitations may affect the broader applicability of the findings. Future research will aim to include a more diverse and representative sample, with clearer justification of sample size and expanded outreach methods.

This study is best viewed as a formative evaluation within an HCI framework, documenting an iterative design journey informed by user-centred and pedagogical principles. Despite these constraints, the work contributes methodologically by demonstrating the value of participatory design, child-centred design for indigenous language learning technologies and user-centred design. Future studies should integrate standardized usability testing protocols, expand sample diversity, and include pre/post testing to evaluate language acquisition outcomes.

5.0 Conclusion

In this study, we presented KọÈdè as a major contribution to the ongoing efforts in preserving and revitalizing Nigerian indigenous languages, particularly Yoruba, through child-centred technology. The development process, guided by iterative prototyping and user feedback, revealed critical features that enhance learning for children—namely, interactivity, gamification, cultural relevance, and progressive scaffolding.

The usability testing provided valuable insights into age-appropriate design elements, the importance of real-life imagery, and the role of feedback mechanisms in promoting engagement and knowledge retention. This study is formative in nature and as a result its limited by the sample size used in the usability evaluation. A larger study with a more diverse cohort of children is needed to validate the design choices and gather more generalizable data on learning effectiveness. In addition, quantitative analysis using System Usability Scale can be employed.

From our formative evaluation, the users highlighted the need to integrate additional learning themes. As such, future work, should consider incorporating elements such as everyday conversational phrases, familiarity with everyday objects, family relationships and indigenous/traditional rhymes. In addition, the need to expand to other Nigerian Indigenous languages may pose a technical challenge such as the need to develop a flexible architectural framework to accommodate diverse grammatical and phonetic systems.

The major strength of this paper is rooted in the design methodology that employs a user-centred approach with iterative prototyping and feedback from low fidelity to high fidelity across a total of nine iterations. This iterative approach yielded a robust artifact and shows the importance of co-design. One of the key lessons learnt is that designing with children rather than merely for them unlocks insights that are often inaccessible through adult-centric assumptions. Indeed, for educational technology to be effective, it must be as enjoyable as instructive. In this way, KọÈdè contributes not only to language preservation but also to the broader discourse on designing culturally rooted, learner-cantered technologies for early childhood education.

ETHICAL CONSIDERATIONS

Ethical clearance for this study was obtained following the initial phase of the project. All participation in the study was voluntary. For child participants, informed consent was obtained from parents or guardians. No personally identifiable information was collected, and all data were handled anonymously to ensure confidentiality and privacy.

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