CS/IT Honours Project
Final Paper 2023

Title: You and Your Baby 2.0: Refactoring and Evaluating an Early Childhood Development Resource Management System

Author: Tariro Banganayi

Project Abbreviation: BBP2.0

Supervisor(s): Melissa Densmore

Category	Min	Max	Chosen
Requirement Analysis and Design	0	20	15
Theoretical Analysis	0	25	0
Experiment Design and Execution	0	20	0
System Development and Implementation	0	20	20
Results, Findings and Conclusions	10	20	15
Aim Formulation and Background Work	10	15	10
Quality of Paper Writing and Presentation	10		10
Quality of Deliverables	10		10
Overall General Project Evaluation (*this section allowed only with motivation letter from supervisor*)	0	10	
Total marks		**80**	

You and Your Baby 2.0: Refactoring and Evaluating an ECD Resource Management Platform

Tariro Banganayi
BNGTAR001@myuct.ac.za
University of Cape Town
Cape Town, South Africa

ABSTRACT

The You and Your Baby platform is a mobile application built for an NGO called the Bhabhisana Baby Project and deployed in 2022 that has seen little uptake and usage from the community of caregivers it was designed for. This failed deployment prevents staff at the NGO from efficiently providing the people they service with curated Early Childhood Development content to support the development of their children. This project used co-design to diagnose the problems with the previous deployment and build a second version of the You and Your Baby application. User and business acceptance testing were used to verify that the new application met the requirements of the NGO it was serving. The project deploys software as well as provides recommendations on how to re-frame the software development process in order to create more usable and acceptable software for African communities.

CCS CONCEPTS

• **Human-Centered-Computing**; • **Human Computer Interaction** → *HCI design and evaluation methods*; • **Software and its engineering** → Software creation and management; • **Networks** → Network services;

KEYWORDS

HCI, evaluation, mobile development, web development, architecture

1 INTRODUCTION

Creating stable, usable software for African communities has long been a concern for the software development community. Even more so when attempting to create software for NGOs. Software creation is an expensive, time consuming activity that requires extensive domain knowledge. This means that NGOs running on tight operational budgets are often unable to harness the benefits of custom software. University led software projects are often a solution to this problem as the research aims of universities often align closely with the objectives of NGOs. This often leads to students creating software for NGOs. However, this can present challenges because although students are a more affordable solution, they often face time-constraints due to a lack of industry experience which can pose challenges when creating good, dependable software. You

and Your Baby (YAYB) is an online platform created as part of a co-design effort between University of Cape Town Honours Students and a Cape Town based NGO called the Bhabhisana Baby Project (BBP). BBP aids children with developmental delays while they wait to access assistance from an overstretched state medical system. The YAYB platform is made up of a web portal and a mobile application that allows caregivers (parents and guardians) to access specially curated content concerning Early Childhood Development (ECD). The platform was deployed by students at the university in 2022 but stopped working soon after the students left. The aim of this project is to diagnose the architectural and usability problems that led to the system becoming ineffective in 2022, fix these problems, and redeploy the system. Additionally, this project aims to provide recommendations on how the software development process should shift to align with the specific needs of African communities when engaging in co-design processes. The methods used in this project include interviews and workshops with caregivers and staff in BBP as well as Sweetwaters, KwaZulu Natal (KZN) . Interviews and code reviews were used to diagnose the original application's problems and a new, improved system has since been built. The result of this project is a new and improved You and Your Baby mobile application with an updated system architecture, a better user experience, and a more reliable, and easily maintainable code base. The project will contribute software towards the mobile health (mHealth) community in South Africa as well as recommendations on the re-framing of software development practices in African communities in the co-design space.

2 BACKGROUND

2.1 CoMaCH

The Co-designing for Maternal and Child Health (CoMaCH) network and project group is a collection of researchers from institutions across Africa, Asia, and Europe who aim to revolutionise the approach to digital interventions for maternal and child health (MCH) by involving the community in the participatory design process of solutions [17]. CoMaCH hase previously worked with the Bhabhisana Baby Project as part of their numerous projects across South Africa [17].This project forms part of the CoMaCH efforts to promote community involvement in the creation of digital solutions for communities in Southern Africa with a specific focus on parental health and child care. CoMaCH partners with businesses and NGOs to develop and implement solutions for pressing maternal and child health problems with many of these solutions focusing specifically on the use of digital technology created through participatory methods [17].

2.2 Bhabhisana Baby Project

The Bhabhisana Baby Project (BBP) is a Cape Town based NGO that provides multidisciplinary support to children with developmental delays in their first two to three years of life. The NGO works closely with caregivers as well as doctors and nurses to provide children with access to life altering physiotherapy, occupational therapy, and speech and language therapy in cases where children are unable to access healthcare from the state [10]. BBP has two members of staff who are responsible for administrative tasks as well as consultations with caregivers and their children. Caregivers and their children see the staff at BBP on a regular basis depending on the specific needs of their children. These consultations can happen anywhere from bi-monthly, to once every two months.

3 RELATED WORK

Digital technology, specifically software, applications, and websites have become increasingly central to the operation and functioning of an NGO [8]. Many NGOs use digital technology to empower communities through education and the distribution of important knowledge [8]. Digital technology allows NGOs to significantly lower operational costs as well as improve efficiency [21].

Early Childhood Development refers to the period of growth and learning that occurs in the early years of a child's life and is critical for the child's physical and mental development as they grow [6]. ECD in South Africa faces significant challenges as many children are born into poverty stricken communities where access to critical healthcare and support are lacking [7]. Children in South Africa are exposed to a significant variation in the quality and access of ECD support with children in lower income communities receiving far worse access than children in higher income communities [7].

There have been attempts to remedy unequal access to ECD support using technology. Notable among these attempts are MomConnect, a Western Cape based text messaging service that aimed to reduce maternal, infant, and child mortality by providing mothers with life saving information and educational resources in the months leading up to, and after the birth of their child [20]. Pregnancy+ is a similar technology that aimed to provide pregnant women with health-related advice during their pregnancy [22]. Milk Matters is a Cape Town based NGO that collects donations of breast milk from new mothers who are willing to donate. Milk Matters has developed a mobile application that allows mothers to better manage their donations as well as communicate better with the NGO [1]. All these interventions are examples of mobile technology being used to reliably support caregivers during the early stages of a child's life.

4 METHODS

4.1 Co-Design Process

The creation of the You and Your Baby (YAYB) platform is a part of an ongoing co-design process with a Cape Town based NGO called the Bhabhisana Baby Project (BBP). This project aims to remedy the failed deployment of the You and Your Baby platform in 2022. We held meetings, both virtually and in person, with staff at BBP to reignite the co-design relationship. The methods employed in the revival of the YAYB system are meant to explore how a mobile application can be designed to address the specific needs and challenges faced by caregivers of children who have developmental delays with a specific focus on architecture and usability. We obtained ethics clearance from the University of Cape Town ethics committee in order to complete our research. Community based research was triangulated across a myriad of techniques in order to minimise the effects of bias from the researchers. These techniques included semi-structured interviews, open discussions, brainstorming sessions, and content creation sessions – these methods were chosen because they allowed the participants to voice concerns, ideas, and opinions freely without interference from the researchers. The open discussions allowed community members to engage each other directly on topics concerning the health of their children and the use of technology, and the brainstorming sessions allowed us to collect and group their ideas for the platform.

4.2 Workshops

We conducted workshops with small groups of caregivers (parents and guardians) at the Bhabhisana Baby Project (Cape Town) and in Sweetwaters (Pietermaritzburg) to find out what participants wanted from the system, conduct usability tests, and brainstorm ideas for the platform. All workshops were conducted within the confines of strict ethics regulations and all participants were given a detailed briefing on the details of the workshop and asked to give written consent before participating. After each workshop quotes and sentiments were tabulated and a thematic analysis was done to group concerns from the participants into actionable software objectives.

4.2.1 Workshop 1 This workshop was a one day workshop held at the Bhabhisana Baby Project offices in Athlone. The workshop was 2 hours long and consisted of semi-structured interviews with users of the application. The demographics of the users consisted of 4 black women, and 1 coloured woman. The participants were remunerated with an honorarium of R80.

4.2.2 Workshop 2 This workshop was a two day workshop held at the Human Sciences Research Council (HSRC) Offices in Sweetwaters, Pietermaritzburg. The first day had 8 participants sourced by leveraging existing connections all of whom were self-reported black women. All participants were mothers with four being under the age of 35 and the other four over the age of 60. The first day consisted of a 4 hour workshop in which semi-structured, round-table interviews were held. The interviews explored mobile technology use, child-care habits, use of technology with children, and data constraints. Next cognitive walkthroughs of the mobile application were conducted. The second day saw 7 out of 8 of the participants returning and the workshop was a 2 hour workshop consisting of a second round of cognitive walkthroughs as well as a content-creation brainstorming activity, followed by a content creation tutorial session. Participants were remunerated with an honorarium of R170 for each day of participation.

4.2.3 Workshop 3 This workshop was a one day, 3 hour workshop with 5 participants. 4 participants were female and 1 participant was male. Race was not recorded for this workshop. The workshop was held at the Bhabhisana Baby Project offices in Athlone. Convenience sampling was used to recruit these participants as they

were the beneficiaries of the BBP program. All participants had children who were either currently enrolled in the program or had recently graduated. The workshop consisted of a semi-structured, round-table interview. The interview explored mobile technology use, child-care habits, use of technology with children, and data constraints. Next, a cognitive walkthrough of the web portal and the mobile application was conducted on the parents' mobile devices. Finally, a content-creation brainstorming activity, followed by a content creation tutorial session was conducted. Participants were remunerated with an honorarium of R80 for participation. User acceptance testing with this group of parents at the Bhabhisana Baby Project was also used as an opportunity to stress test the application.

4.3 Deployment Analysis

The initial deployment of the You and Your Baby platform consisted of a web portal that was built and administered on WordPress and a mobile application that was built with Kotlin in Android Studio by honours students in 2022. We diagnosed the issues in the system in two ways: semi-structured interviews with users of the system in which they were directly asked to list the problems that prevented them from using the application, and a detailed analysis and review of the code base in which any architectural issues of the application were identified. The code base was found to comply with the best practices for the Model View Controller architectural design and so that design pattern was inherited for this project. There were found to be a number of code smells caused by complex methods for downloading and syncing content.We conducted a qualitative assessment of the findings from interviews and code-reviews in order to extract and categorise the requirements for the system. The findings from the previous deployment are explored below.

4.3.1 Insights from structured Interviews

- Difficulty downloading the application
- Interface of the application was confusing
- Content on the application did not load consistently
- Inability to distinguish between different kinds of content
- Desired content not available on the platform
- Performance issues due to old technology
- Forgetting of login details
- Syncing mechanism difficult to use
- No search functionality

4.3.2 Code Review of Previous Deployment **Deprecated libraries with no continued maintenance** was the most pressing issue in the previous deployment because many libraries used in the Android ecosystem are constantly changing. Because the application was designed to be compatible with old versions of Android due to hardware constraints set out by the caregivers, there is an increased susceptibility to deprecated libraries in the code base which would require more frequent maintenance in order to avoid the app breaking. The **Web portal providing "dirty" APIs** is an example of badly matched software between Wordpress and the Android application. The previous iteration of the application sent an API call to the WordPress website on which the content was hosted in order to retrieve the content. The response that was

returned was a JSON file with large amounts of data. String manipulation was needed in order to extract the video links from the API. The previous students were unable to design custom APIs because WordPress was not designed to be a functional API endpoint. An **inefficient, inconsistent, and data intensive content syncing mechanism** was responsible for many pieces of content being unavailable when clicked on in the mobile application. This paired with the fact that all **articles were hard coded into the application** meant that BBP staff were not able to flexibly deliver on their promise to provide content to the users of the application

4.4 Co-Designed Requirements From 2022

The following are requirements for the system that were gathered in 2022 but were used in the redesign of the system in 2023.

Functional Requirements
- Creation and management of ECD Content and Users
- Assignment of ECD content to users
- User authentication
- Display both public and privately assigned content to users
- Provide content in multiple languages

Non-Functional Requirements
- Portability and availability
- Lightweight application
- Responsive an usable
- Display correct information to each user
- Coherent design and branding
- Mobile data efficient

4.5 Co-Designed requirements from 2023

Of these overall requirements those that needed to be re-addressed or added for the second iteration of the platform in 2023 as requested by the participants are as follows:

Functional Requirements
- **Download only what is needed**
  - Users should be able to view all content online and should only have to download onto their device the content that they want. All other content should be available to stream over the internet. This was informed by participants expressing that even though the application was designed not to be data intensive , it was still using lots of data every time they had to sync content from the website onto the local device.
- **All content should be available for use**
  - All content on the platform should be responsive and no content should be unavailable if the user is able to see it. This was informed by participants expressing that many pieces of content that interested them were unavailable on the application when clicked on which made them lose interest in the application.

Non-Functional Requirements
- **Content should be searchable and filterable**
  - Users should be able to search for content by title. This was motivated by BBP staff pointing out that when lots of content is available on the website it will be difficult

to search through the website and find the content that a user is looking for.

- **Improved interoperability between mobile application and web portal**
  - The mobile application should more efficiently fetch content from the web portal and should be able to display that content faster .Additionally, appropriate design decisions should inform the communication protocol between the mobile application and the web portal.

5 SYSTEM DEVELOPMENT AND IMPLEMENTATION

The requirements collected from field work were translated through qualitative analysis, into software objectives that informed the architectural design and system development of the platform. The requirements were categorised and ranked based on their importance to the project and the number of dependencies they introduced into the project. From there, we turned the highest ranked requirements into software tickets that were then listed on our shared ticket board.

5.1 YAYB System Architecture

The You and Your Baby platform consists of two main components: a mobile application and a web portal. The web portal serves as a platform to display videos and articles to users as well as to allow system administrators to manage users and assign content to them. The content is stored within a PostgreSQL database, which is hosted on the Amazon Web Services (AWS) cloud infrastructure. The mobile application serves as a client interface for users to access the content from the website. To achieve this, the application communicates with the website's backend through API calls. Notably, the mobile application does not directly interact with the PostgreSQL database; instead, it relies on the website's API to retrieve and present the desired content to users. This architecture enhances separation of concerns by centralising data storage and management on the website's backend, while allowing the mobile application to focus on delivering an optimised user experience.
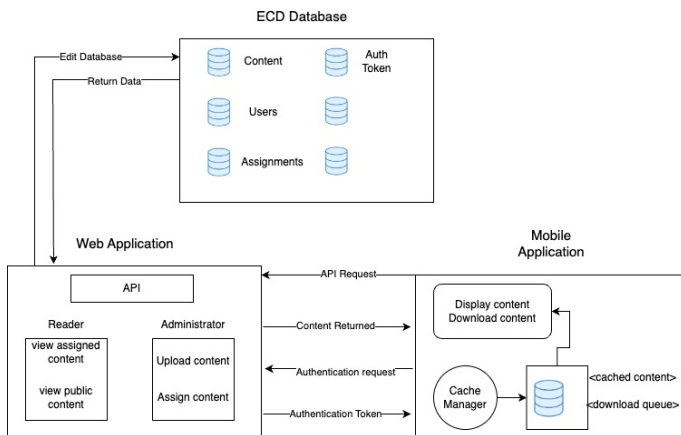

Figure 1: Architecture of You and Your Baby Platform

5.2 Technology Stack

5.2.1 Programming Language The You and Your Baby mobile application was written in Java in Android Studio. The list of libraries used and their purpose can be found in the appendix.

5.2.2 Database Selection The original database design for the system was a MariaDB instance running on an AWS server. This database was unable to connect to the mobile application because of incompatibility issues with database drivers between Android Studio and MariaDB. The solution to this was for us to create a connection between the MariaDB instance and an intermediary Django server. This was unsuccessful due to an inability to compress video files that were stored as BLOBs in the database and transport them over the network. The next solution was to use Firebase as the data storage system for the platform. Firebase is a non-relational database made available to developers by Google. Firebase was successful in storing and servicing content to users on the mobile application and was able to service content with fast response times and little latency. Firebase was used as the primary database during the workshops in Sweetwaters and was successful in allowing users in that location to independently upload their own content to the application. Firebase was eventually removed from the system architecture because it only supports non-relational database functions. This was not suitable because content assignment features require relational mappings between data objects. The final decision was made to use a PostgreSQL database hosted on AWS. This database served content directly to the Web Portal and the application receives the content from the web portal using API requests. The mobile application receives responses in the form of JSON responses that contain an HTTP link to the content. We used HTTP as opposed to HTTPS because it is simpler and faster to implement as there was no need to encrypt or authenticate the static content. The mobile application is then able to stream, display, or download content from this link.

5.2.3 API Centred Design The original You and Your Baby Platform used an architecture that served content to the mobile application via APIs. Because the system was using WordPress the developers had no control over the responses that those APIs gave. In deciding on the justification for using this API centred design for serving content to the mobile application over a direct connection to the database a number of factors had to be taken into account. Those factors as well as their final considerations are listed below:

- Speed of response
  - Serving large content such as video files over the internet using APIs can be very slow and inefficient. We encountered this problem and could not solve it using standard compression techniques. We solved this problem by configuring the API to send the URL where the content was stored instead and allowing the application to deal with downloading that content efficiently using HTTP3 libraries.
- Security
  - Security is a major concern when sending data over APIs. In order to ensure the security of the API calls we ensured that authentication tokens were used and sent with each API request after login which ensures that only registered

users of the system can access any privately assigned information on the system.
– Passwords are encrypted before being sent in API requests as parameters to ensure that a user's personal data remains safe and secure
* Dependency
– One area where using the API centred design does not improve the system is the fact that if the website is down users are unable to access content or log in to the application.

5.3 Mobile Application Architecture

The mobile application uses a standard Model View Controller design-pattern. The mobile application uses three internal storage types: shared preferences to store user authentication data during a session, cache to store media files temporarily during streaming, and internal file storage to store downloaded content. The architecture of the application is displayed below:
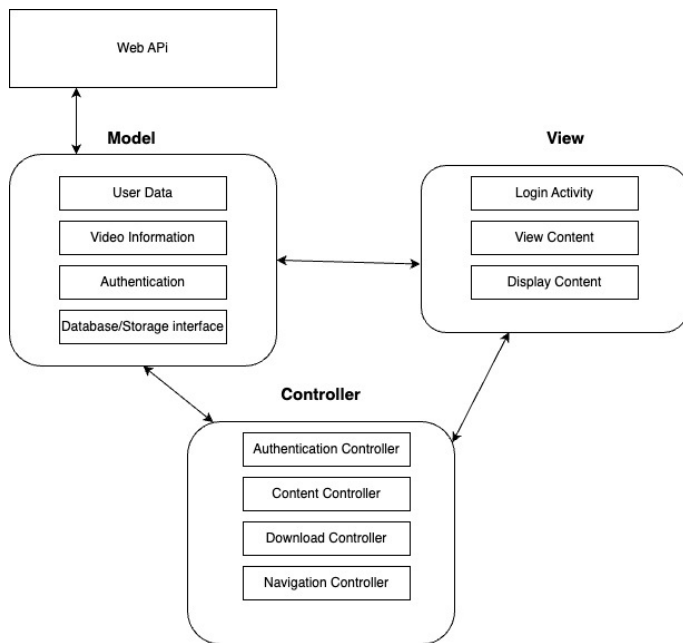

Figure 2: Current architecture of You and Your Baby Application

5.4 Software Development Life-cycle

This project followed a standard Software Development Life-cycle with the key milestones described below:

* Requirements analysis
– Requirements gathering took place as part of experimental design and was used to create a list of functional and non functional requirements for the system as well as to outline focus points that would be important for the development of this second iteration of the You and Your Baby System
* Planning

– A project plan was developed on Jira that outlined dates for sprints and deliverables
– Weekly half an hour meetings with Team members on Microsoft Teams were held in order to plan workshops, provide code updates, and troubleshoot the project.
– Daily check-ins with team members on WhatsApp
– Monthly check-ins with project partners at BBP in order to schedule workshops and visits.
* Design
– The design of the app was inherited from the first version of the application developed in 2022 and designed iteratively with feedback from caregivers
* Implementation
– Strict version control was followed using GitHub to store code with regular commits. All team members were collaborators on GitHub with the ability to make and approve pull requests on code.
– Pair programming was used for code that was highly coupled between the web portal and mobile application. Pair programming was done using Google Meets or in person.
– Code was developed using the Single Pull Request Principle to ensure reviewability, clarity, and ease of testing.
* Testing
– Integration testing was done throughout the project to test that different parts of the code base interacted with each other correctly. Test cases can be found in the appendix.
– User Acceptance Testing was performed with focus groups of parents in the final workshop at Bhabhisana prior to deployment. The test was done in order to decide if the application was ready for deployment. Both alpha and beta testing were carried out for the purposes of this project. Test cases can be found in the appendix.
– Business Acceptance Testing was performed with stakeholders (BBP staff) prior to beta testing to validate the system met the requirements of the business
* Deployment
– A final deployment of the system with all bug fixes and suggestions taken into account is planned for the end of September 2023.

6 FINDINGS

6.1 Application Design Process

This section presents a description of all the events that occurred and findings from those events during the course of this software project. These findings will be split among two categories: application development and user and business acceptance testing.

6.1.1 Application Development The first difficulty in the application development process was understanding the previous system as it consisted of insufficient documentation and a lack of contact with previous developers. Although the system's code was readily available on GitHub, it was difficult to diagnose why the application had stopped working a few months after the previous developers had completed their project. Developing on top of the existing application proved to be ineffective because of the decision to switch the language to Java from Kotlin. It was however beneficial to not have to design the user-journey and screen configuration from

scratch as these could be inherited from the previous application. We found that many of the aspects of the application that required specific algorithms of logic were easy to implement in the new application because they did not have to be conceptualised from scratch, only ported over from the old version of the application to the new version.

The use of new custom APIs as opposed to the API provided by WordPress allowed us the flexibility to only transfer the specific information we were looking for through the API as opposed to sending lots of unnecessary information in the API response.

6.1.2 Database Configuration During development, a major hurdle was connecting to a central storage base to access the ECD Content. Because the content was originally stored as Binary Large Object Data, it was impossible to view it directly in the Android application as the drivers that connected the MariaDB database to Android studio would not allow this data transfer. The decision was then taken to move all the content onto Google's Firebase and use the NoSQL database on Firebase to connect to the mobile application and the web application. This only proved successful for the first minimum viable product of the application for Sweetwaters because this generic version of the app did not require system administrators to assign content to users. Assigning content to users requires relational mapping between data, which Firebase is not capable of. Nevertheless, the Firebase based version of the application performed well in Sweetwaters and received positive feedback with users stating that they enjoyed the flow of the user interface as well as how easy it was to find videos. This version of the application allowed users to upload their own content onto the platform which generated interest from users after they were invited to participate in a content creation workshop.

6.1.3 Content & Assigned Content Upon returning from Sweetwaters we pivoted towards a version that would be compatible with the requirements set out by the BBP. Integration testing on the web application between Firebase and Django failed at this point as Django was unable to work with the non-relational nature of Firebase in order to assign content. This presented a major challenge in the system's development as it meant that Firebase was no longer a viable option for the deployment for the Bhabhisana Baby Project. The first solution was to attempt to connect both the web portal and mobile application directly to a new centralised database hosted on PostgreSQL. This was unsuccessful for similar data transfer reasons as the failed MariaDB connection. The decision was then made to revert to the client-server, API call based relationship between the web portal and the mobile application because this would not disrupt the functioning of the website which had already been deployed and introduced to the BBP staff. Django, which allows the creation and design of custom APIs, allowed for this client-server relationship to exist. The new API based system meant that the mobile application was pulling content straight from the website. This introduced minor performance issues that have not yet been overcome as the API calls to the website can take between 3 and 5 seconds to complete depending on the speed of the WiFi connection. This architecture reintroduced the dependency which meant that the mobile application can only function if the website is up and running correctly.

The content that parents in the different communities wanted to see in the application also varied across locations. Parents at BBP wanted more child health related content on their application as well as content that dealt with the specific developmental disorders affecting their children. Parents in Sweetwaters conversely, were more interested in content that specifically catered to parental health and well being.

6.2 Users and User Testing

The caregivers in Sweetwaters and BBP reported only using their cellphones for communication and light social media use. They all reported that they did not use a wide variety of applications and typically used the same few applications every day.

The website crashed due to service constraints during the test with caregivers because all of its potential users were required to log onto it at once. This rendered the application unusable until we were able to get the website back up. Once the website was up however, users were able to complete cognitive walkthroughs of the application as well as give feedback on its appearance and usability. There were roadblocks in downloading the APK depending on the type of phone that a user was using. The APK was sent via WhatsApp however Huawei devices were unable to install the application straight from WhatsApp in one click as other devices were. Rather, they had to install the APK from their device's file explorer. Findings from specific cognitive walkthrough tests are available in the appendix. Caregivers in Bhabhisana were some of those initially involved in the conceptualisation of the application in previous years. These caregivers comparatively, seemed to have more suggestions for the application than the caregivers in Sweetwaters. The caregivers in BBP had a number of suggestions for the application as listed below:

- Application should use more bright colours such as red, green, and yellow
- Application should have more ECD content that explains medical terms
- Content should be available in more languages and there should be a language filter
- Videos should be downloadable onto the device's local storage for easy sharing

Suggestions from the caregivers in Sweetwaters were as follows:

- Application should use more bright colours such as red, green, and yellow
- Graphical icons are confusing and should be replaced with worded buttons

Caregivers in Sweetwaters did not like the neutral colour palette of pastels and requested that brighter colours be used. Caregivers at BBP wanted to use the Bhabhisana Baby Project logo colour palette as the theme for the application. Users in both Sweetwaters and BBP were satisfied with the overall design of their respective versions of the application. Caregivers at BBP were able to use the application much more intuitively and with less of a required learning curve than those in Sweetwaters. 50% of the participants in Sweetwaters were over the age of 60. These participants were unable to find the 'Download' and 'Search' icons on the application and requested that labelled buttons be used instead. The participants over the age of 60 in Sweetwaters were unable to complete the cognitive walkthrough tasks without assistance.

6.3 Performance

All caregivers at the Bhabhisana Baby Project and in Sweetwaters were using low-end Android devices. The internal storage on these devices ranged from 8GB to 64GB and the devices ranged from 2GB to 4GB of RAM. Performance tests on the mobile application revealed that on average, the application uses 30% of the CPU. The application uses an average of 178MB of memory during runtime. Network related performance tests were also run on the application revealing that each API call used 5KB of data. API calls to fetch all content take an average of 4.6 seconds to complete while API calls to fetch only assigned content take an average of 3.02 seconds to complete. Streaming videos on the application uses between 2 and 15MB per video. Caregivers noted the slow performance when loading content with many wondering if the problem was with their WiFi connection. When the content did load, caregivers noted that the streaming experience was "smooth and fast".

7 DISCUSSION

7.1 Improvements to the Old System

7.1.1 Modularised Architecture To understand why the new version of the YAYB application performs better than the old version we must discuss some of the software changes in more detail and why they are significant. First among the software changes is a move to a more modularised internal architecture of the mobile application. A cognitive attempt was made to modularise the YAYB application so that chunks of code were separated by concern. This was done to make it easier for student developers in the future to change parts of the application without needing to replace the entire system as was the case for this project. This benefit was realised during the development process when we had to replace Firebase with PostgreSQL while not having to refactor any other parts of the application. Modularising technology in this way has many benefits including being able to easily change the software to match different customer requirements [3], this was important because the agile nature of this project meant that requirements were constantly changing throughout the short development period. Different components of the system should share common resources [3], such as can be seen with the single database model servicing both the website and the mobile application. Additionally, because the mobile application does not write to or read from the database directly, its content will always be in sync with the content on the web application. Finally, good communication between entities of different types/languages is important in a modularised system [3] which can be seen in the good interoperability between the mobile application and the web portal.

7.1.2 Programming Language The decision to rewrite the application in Java and to not use Kotlin was taken in the context of this being a student led project. Kotlin was chosen as the language of choice in 2022 because it is more concise and modern than Java. Student led projects are constrained by a lack of time and expertise on the part of the students and so successful projects are those that can be simplified as much as possible. Additionally, student led projects may see many developers and project owners in their lifetime and so the handover across different year groups needs to be as structured as possible [28]. Java best supports this because it is taught at UCT and all future UCT students will be able to read and understand the code-base without the need for extra learning resources - as is not the case with Kotlin. This is corroborated by findings in a comparison between Java and Kotlin that state the benefits of Java include being better for beginners or for people who have a more general computer science background [12]. Additionally Java is preferred because it has a large community of contributors in the form of user manuals and online forums that help to speed up the development process [12].

7.1.3 Client-Server Model Our project corroborates the findings of the previous project in its use of a client-server approach to content distribution in which the web portal acts as a server and sends the content to the mobile application. Although this approach was inherited, it was greatly improved upon in this second iteration. The client-server model is good because many users can have access to the content in the database simultaneously and it also reduces data replication by having all the data stored centrally in one location [23]. The previous year's project had no control over the database they were using as it was embedded into Wordpress. Our server was built on Django giving us absolute freedom to decide how it would send and receive data. Having greater control over client-server communication is an improvement because we can select the data types, storage and hosting options that will give the best performance. Additionally, it means that all APIs are designed from the ground up depending on the needs of the mobile application. This supports the future maintainability of the platform and the application because it allows for future developers who may have different ideas about how the application should function to easily access content in the same manner. Finally, the centralised database acts as a place to store content for the website as well as a central storage unit for the NGO who are now able to centralise the management of all their content in a much more efficient manner. This content can be accessed from the Django API endpoint from a much wider selection of programming languages and frameworks which improves the overall software compatibility of the system. Where this project falls short in terms of its client-server model is the fact that the mobile application is unable to function if the server is down and there are no backup servers in case of emergencies.

7.1.4 API Design Part of the redesign of the whole system was that the mobile application is now serviced by a Django website. This gave us the opportunity to design custom APIs. The APIs were designed in line with the application's functional requirements. Good APIs are specific, readable, easy to understand, and easy to implement [11]. Our APIs are a marked improvement over the API that WordPress uses because the WordPress API returns a non-specific JSON file where additional string manipulation is needed to find the link to the content and then use it to download the content. The API calls to the website are however, quite slow. This is likely due to processing that happens on the side of the web portal that compiles the list of content every time the API is called. This could be improved on the side of the web portal by pre-processing the list of content at regular intervals so that it can be sent immediately as

an API call is received.

7.1.5 Addressing Data Constraints

7.1.5 Addressing Data Constraints Data constraints of the target users was a major constraint in the development of the project. The initial plan involved hosting the system on the iNethi Community Wireless System in an effort to reduce data costs [18] but this was not possible in Sweetwaters and there is currently no plan to install an iNethi NUC (a type of physical network device) in Athlone where the Bhabhisana Baby Project is situated. Instead, we used architectural decisions to try and reduce data usage such as constraining the app from trying to load a video until it was clicked on and also by allowing users to download specific videos that they want to watch later onto the device in a manner similar to most modern day podcasting applications. This hopes to address one of the main data constraints in South Africa which is the affordability of mobile data [19]. We expect more willing usage of the application if it does not incur too many costs for the user. Streaming or downloading a 2 minute video on the application is possible with less than 10MB of data which supports the data efficient non-functional requirement of the system.

7.2 Digital Technology for NGOs

The You and Your Baby mobile application is designed to help parents access specially curated content that will support them and their children through the first 1000 days of their child's life. Although the success of the application is dependent most specifically on whether it meets its requirements, one must also assess whether it meets its broader objective of being a piece of technology that successfully helps an NGO to further its aims. The aims of this specific NGO are to aid children with developmental delays while they wait to access help from state hospitals [10]. In the context of an NGO, technology can aid the NGO in addressing any inefficiencies and frustrations in connection to legacy systems with regards to sending out information [14]. Previously, the staff at the Bhabhisana Baby Project would need to use WhatsApp to communicate with caregivers. If they needed to send content to the caregivers, it would be done in the form of link sharing. There was no centrally managed database with the content on it and therefore the entire process of sharing information with caregivers was, in the words of the staff: "difficult, time-consuming, and unmanageable". Part of the success of the new application is due to the fact that the previous students, as well as ourselves as the researchers, took the opportunity to actively immerse ourselves in the functioning and routines of the NGO so that we would be able to create more meaningful and usable software by having a tangible understanding of the day to day functioning of the users. This supports the notion of 'Action Research' as a means to bridge the gap between the worlds of IT and NGOs [14] by having developers intimately involved in the day to day running of the NGO for whom they are developing software.

In addition to the application's ability to fulfil its requirements, we must look at how the application furthers the objectives of research into mHealth applications. mHealth refers to the branch of digital technology that aims to help the healthcare profession deliver higher quality, more accessible care to patients [24]. Research based projects such as this one often fuel a trend of wasteful proliferation of pilot projects that have no longevity or capacity to scale upwards [24]. Steps taken to avoid this becoming one such project are evident in the project's co-design methodology in which the parents who use the application are encouraged to feel a high degree of 'ownership' over the application because it was through their continuous contribution that the application was built. More work must be done in this research space however to define what 'ownership' means for the caregivers given that they have to rely on student developers to create, implement, and maintain the application.

The YAYB platform was designed to integrate seamlessly into the workflow of the BBP staff and to make the process of uploading and assigning content much easier, faster, and more intuitive. The hope is that by integrating the application with the routine of the NGO, natural uptake of its continuous use will be encouraged. We disagree with the notion that technology should be at the centre of how NGOs deliver services to their dependants [8] which is why the application is scoped specifically to provide supplementary materials and content to caregivers and not any information that is meant to replace the advice of registered medical professionals. We do however subscribe to the idea that technology should at the very least lower the operational costs or improve the efficiency of the NGO [21]. Our findings show that the YAYB Platform does help the Bhabhisana Baby Project function more efficiently given the much shorter time to upload content to the platform, where previously staff had to set aside time to upload content in bulk sessions, they can now do it quickly in between other tasks.

7.3 Re-Framing the Development of Software in African Contexts using Co-Design as a Driving Force

One of the objectives of this project is to contribute to the conversation on re-framing the development of software in African contexts using co-design as a method to achieve better and more usable software for African users. We aim to do this by exploring some of the key factors that make developing software for African communities different than when developing for Western users. The basis of this argument is that much of HCI research on the African continent is done in a manner that is inherently Western in its approach [26] . We propose that a number of the biases and conventions in the traditional, Western software development approach were incompatible with the co-design process when working with culturally African communities and therefore led us as the researchers to adapt our methods on the spot to accommodate the needs of the community. Although the user-centred approach to software development should be lauded for its ability to produce functional software in a short period of time [13], evidence from this project suggests that there are key areas where this approach might hinder a researcher's ability to conduct an effective study.

7.3.1 User Centred vs Community Centred Design The traditional Western software development process follows a user centred design approach that places specific emphasis on the preferences and needs of individual users [5, 16] . The end goal in the creation of software in the HCI field is always to create a product that is efficient and user friendly [25]. Community centred design however must prioritise the needs and values of the entire community over and above the needs of individual users [15]. We believe that in an African context, we as researchers must pay specific attention to traditions and behaviours such as the influence of community leaders and elders in the community - in a way in which one would not be required to do when building software for a Western user base. The software development process when working with communities in Africa must over and above user friendliness and efficiency, evaluate the cultural relevance of the product produced and make explicit considerations for culturally significant symbols and features that would not necessarily be considerations in Western contexts. Our first recommendation in addition to what is present in the literature is that when performing requirements gathering, we believe developers should outline and document explicit cultural requirements for their software above and beyond functional and non-functional requirements. These cultural requirements should be subject to evaluation at the end of the project and developers should be accountable to them in determining the overall success or failure of the project.

The Western approach to HCI software development relies heavily on usability testing and user feedback as its mechanisms for assessing the success of an application [26]. The deployment in Sweetwaters was of specific interest in this regard because the strong African cultural influences of the community members provided great insight into the shortcomings of a strict, traditional, Western approach to software evaluation. Two aspects of this community are of specific interest in proving this point. Firstly the influence of elders in the community. We believe that the software development process from an individualistic perspective does not take into account the interpersonal relationships and power dynamics between users when designing the application for use. These dynamics are important because they can affect the credibility and the subsequent uptake of the technology being implemented. In Sweetwaters, where the participants live in an area with a strong isiZulu tradition, the elder members of the community are revered and thought to be the first point of call for the imparting of knowledge and wisdom. This was of heightened importance in this instance because the application focused on child health and parenting and the elders in this community are regarded as the primary authority on this topic . Similar research in other HCI contexts in South Africa has shown that the dynamics between older members of the community and the rest of the community can have a measurable effect on the outcomes of research in community settings [30]. One can think of the YAYB application in a sense as a challenger to the authority of these community figures. One must wonder whether the introduction of a piece of technology whose functional requirements at their core challenge the power dynamics that already exist within the community would ever have passed a theoretical test for cultural sensitivity and relevance given that the content uploaded on the application was primarily of external origin.

The second example that can be drawn out of the context of Sweetwaters was the suggestion that many of the primary buttons on the application use red and orange as their colours . This finding is interesting because in Western development universal web guidelines and user interface design principles strongly suggest that certain colours should be associated with certain functions because of the semantics and connotations of those colours [29]. This for example, is why buttons with positive connotations (e.g. 'Save' and 'Accept') are green while buttons with more negative connotations (e.g. 'Delete' and 'Cancel') are red. In the isiZulu culture however, the colour red has positive connotations signifying emotions such as love and passion whilst green has negative connotations of illness and envy [32]. We theorise that participants in this community do not associate the meanings of colours in the the same way as their Western counterparts and so would see no problem with having buttons with positive connotations appear as red. On a broader level, this may represent the fact that inherently, standards in software development in the West are informed by the underlying characteristics and values of Western society [4]. It would follow then, that it is not necessarily reasonable to impose those same standards and practices on technology that is implemented in different cultural contexts. This is important because developers and researchers in the university context and in the greater context of the South African IT ecosystem are trained to adhere to these strict Western guidelines without question [5]. We recommend for more research to be done on whether some of the standardised, Western, user facing paradigms surrounding heuristics, user interface and user experience development are indeed transferable to African contexts or if they are simply being accepted because no real inquiry has been made into what works best for Africans.

7.3.2 Agile Development vs Holistic Planning The next consideration speaks specifically to some of the more practical aspects of developing software and how they are affected by developing in African community contexts and over and above that in contexts in under-served communities. In Western development, agile software development methods are used because they emphasise iterative development, quick releases, and adaptability based on user feedback [2]. There is a specific emphasis on formal channels of communication including user surveys, reviews, and usability tests [2, 9]. This is all done in an effort to rapidly build and deploy software in as little time as possible with as few resources as possible. We found this approach difficult to implement in the community context because the co-ordination of entire communities for workshops and user-testing is a slow process. We believe that the co-design process for communities should emphasise a holistic approach to software development where software must be designed to meet a community's long-term goals and cultural values even if it is at the expense of rapidly deploying the software. In Western societies, where developers and researchers cater to a more individualistic way of being [16] , methods of communication being more formal is ideal because it allows people to do things quickly, and efficiently, in a structured and systematic manner.

Community centred approaches in Africa however, may not work

in this same way because in Africa there is a much more informal, community based approach to communication where oral tradition much more supports collective communication in the form of group meetings and collective sit down meetings [27]. The development of YAYB revealed interesting insights in this regard. In both the workshops in Sweetwaters and BBP, the users were almost always opposed to the idea of completing individual evaluation tasks. The cognitive walkthrough, although presented as an individual task, almost always became a group task with multiple members of the community using one phone. A possible explanation for this is that there is a more communal use of technology in community contexts and a certain degree of separation between a user and their device. We base this off claims made by some of the participants who spoke often of sharing mobile devices with friends and family members regularly. The agile process advocates for iterative design where developers regularly push out updates for testing by the users. We believe that iterative development is much more possible in more privileged, affluent contexts where the fast and easy deployment of technology is more commonplace. This is in part due to the issue of data constraint which is a specific problem in South Africa where mobile data is notoriously expensive and coverage in many areas is sub-par [18].

7.3.3 Ownership and Control A question that is yet to be answered in its entirety in this area of research however, is the question of what the full scope of ownership looks like under the lens of co-design. In the traditional western process the software is owned and controlled by the development team and the organisation who owns the software. There is a focus on individualism and making software that is customisable. In the community context however, we want to have a more equitable model of shared ownership where community members feel a psychological sense of ownership over the technology they have helped create [31]. Not only did the community in BBP who had been part of the co-design process from the very beginning have more suggestions for how the application could be improved but on a more qualitative level, their suggestions were more thematically relevant to the core issue of ECD content for children with developmental delays . A limitation in the comparison between Sweetwaters and BBP caregivers in this respect however is the fact that in Sweetwaters, no children were suffering from any explicit health issues. This meant that the caregivers there were from the onset more likely to engage the application only on its ability to provide content that was more generic and less in line with the original purpose of the software as envisioned by the caregivers in BBP who co-designed it.

7.4 Process Reflection

There are some ways in which the process of creating the YAYB mobile application could have been improved. First among these would have been to have a minimum viable product of the application produced earlier in the project timeline and to show it to the participants. This would have allowed us to solve some of the problems that the caregivers had with the application much sooner in the process. Next, it would have been beneficial to include a more rigorous stress testing of the application in the project plan before taking the product to the caregivers. This stress testing should also have included testing the application on devices of different sizes

and devices running different versions of Android. Participant selection in Sweetwaters could have been improved upon by finding participants whose concerns and interests more closely aligned with the issues of maternal and child health as the participants in Sweetwaters came from a close knit community where parents were more likely to seek support and information from each other than from external sources.

7.5 Future Work

We strongly recommend that this project should not be continued as an honours project in the coming years as we believe it has reached a natural plateau in terms of the amount of work that still needs to be done. We believe that caregivers are unlikely to respond well to continued co-design efforts and workshops as those activities may start to become repetitive and un-engaging for those caregivers who have been involved since the project's inception. Instead we recommend that both the website and the mobile application should receive a year-round treatment of incremental updates and maintenance. Future work for the mobile application can look at creating a backup service that allows content to be served in an alternate manner to the database whenever the website is down. Additionally, minor UI improvements should continue at the request of the BBP caregivers and staff but no major re-haul of the UI should be undertaken as this will need to be reintroduced to the caregivers which is a time consuming and expensive activity.

8 CONCLUSION

This project aimed to re-architect the You and Your Baby system in order to improve its underlying architecture as well as make the application more usable. The process involved extensive community engagements in the form of workshops and interviews which led to an intensive development process where the application was rewritten. The new You and Your Baby application is more modular, makes better use of the client-server architecture, and is more user friendly. The overall redesign of the system has improved its maintainability and will make the process of performing updates and bug-fixes much easier for future students. The users of the You and Your Baby application were satisfied with this iteration and noted that it was an overall improvement on the functioning of the application from the previous deployment. We recommend that future students focus on making the handover of the application to new owners easier by facilitating a proper handover of all project related accounts and code to stakeholders in a manner that is well documented and easy to store. We also recommend that continuous communication is upheld with the NGO so that any bugs can be fixed as soon as possible and not left to accumulate. Finally, this project should be used as a case study to show that there is a need for the HCI community to re-assess some of the ways in which we conduct research in African community contexts.

REFERENCES

[1] [n. d.]. Milk Matters. https://milkmatters.org/. Accessed on: August 21, 2023.
[2] Pekka Abrahamsson, Outi Salo, Jussi Ronkainen, and Juhani Warsta. 2017. Agile software development methods: Review and analysis. *arXiv preprint arXiv:1709.08439* (2017).
[3] Ho Seok Ahn, Young Min Beak, In-Kyu Sa, Woo Sung Kang, Jin Hee Na, and Jin Young Choi. 2008. Design of reconfigurable heterogeneous modular architecture for service robots. In *2008 IEEE/RSJ International Conference on Intelligent Robots and Systems*. IEEE, 1313–1318.
[4] Syed Mustafa Ali. 2016. A brief introduction to decolonial computing. *XRDS: Crossroads, The ACM Magazine for Students* 22, 4 (2016), 16–21.
[5] Amollo Ambole. 2020. Rethinking design making and design thinking in Africa. *Design and Culture* 12, 3 (2020), 331–350.
[6] Laurie M Anderson, Carolynne Shinn, Mindy T Fullilove, Susan C Scrimshaw, Jonathan E Fielding, Jacques Normand, Vilma G Carande-Kulis, Task Force on Community Preventive Services, et al. 2003. The effectiveness of early childhood development programs: A systematic review. *American journal of preventive medicine* 24, 3 (2003), 32–46.
[7] Eric Atmore, Lauren-Jayne Van Niekerk, and Michaela Ashley-Cooper. 2012. Challenges facing the early childhood development sector in South Africa. *South African Journal of Childhood Education* 2, 1 (2012), 120–139.
[8] Jonathan Bach and David Stark. 2004. Link, Search, Interact: The Co-Evolution of NGOs and Interactive Technology. *Theory, Culture Society* 21 (2004), 101–117. Issue 3. https://doi.org/10.1177/0263276404043622
[9] JM Christian Bastien. 2010. Usability testing: a review of some methodological and technical aspects of the method. *International journal of medical informatics* 79, 4 (2010), e18–e23.
[10] bhabhisana. 2023. Bhabhisana Baby Project. https://bhabhisana.org.za/.
[11] Joshua Bloch. 2006. How to design a good API and why it matters. In *Companion to the 21st ACM SIGPLAN symposium on Object-oriented programming systems, languages, and applications*. 506–507.
[12] Subham Bose, Madhuleena Mukherjee, Aditi Kundu, and Madhurima Banerjee. 2018. A comparative study: java vs kotlin programming in android application development. *International Journal of Advanced Research in Computer Science* 9, 3 (2018), 41–45.
[13] Adriana Chammas, Manuela Quaresma, and Cláudia Mont'Alvão. 2015. A closer look on the user centred design. *Procedia Manufacturing* 3 (2015), 5397–5404.
[14] Yao-Jen Chang, Rui-Hua Liao, Tsen-Yung Wang, and Yao-Sheng Chang. 2010. Action research as a bridge between two worlds: helping the NGOs and humanitarian agencies adapt technology to their needs. *Systemic Practice and Action Research* 23 (2010), 191–202.
[15] Elizabeth Chen, Cristina Leos, Sarah D Kowitt, and Kathryn E Moracco. 2020. Enhancing community-based participatory research through human-centered design strategies. *Health promotion practice* 21, 1 (2020), 37–48.
[16] Bagele Chilisa. 2019. *Indigenous research methodologies*. Sage publications.
[17] comach. 2023. CoMaCH Network - Co-Designing Community-based ICTs Interventions for Maternal and Child Health in South Africa. https://comach.melissadensmore.com/.
[18] Melissa Densmore, Josiah Chavula, Enock Mbewe, and David L Johnson. [n. d.]. The Case for Localized Content: Strengthening Community Communications Infrastructure. https://awstats.sourceforge.io
[19] Jonathan Donner, Shikoh Gitau, and Gary Marsden. 2011. Exploring mobile-only Internet use: Results of a training study in urban South Africa. *International journal of communication* 5 (2011), 24.
[20] Obidimma Ezezika, Chareena Varatharajan, Shanelle Racine, and Edward Kwabena Ameyaw. 2022. The implementation of a maternal mHealth project in South Africa: Lessons for taking mHealth innovations to scale. *African Journal of Science, Technology, Innovation and Development* 14, 7 (2022), 1798–1812.
[21] Vikas N Honmane. 2013. Technology Enabling NGOs.
[22] Livhuwani Muthelo, Masenyani Oupa Mbombi, Mamare Adelaide Bopape, Tebogo M Mothiba, Melissa Densmore, Alastair van Heerden, Shane A Norris, Nervo Verdezoto Dias, Paula Griffiths, and Nicola Mackintosh. 2023. Reflections on digital maternal and child health support for mothers and community health workers in rural areas of Limpopo Province, South Africa. *International Journal of Environmental Research and Public Health* 20, 3 (2023), 1842.
[23] Haroon Shakirat Oluwatosin. 2014. Client-server model. *IOSR Journal of Computer Engineering* 16, 1 (2014), 67–71.
[24] Christine Zhenwei Qiang, Masatake Yamamichi, Vicky Hausman, Daniel Altman, and IS Unit. 2011. Mobile applications for the health sector. *Washington: World Bank* 2 (2011).
[25] Yvonne Rogers. 2004. New theoretical approaches for HCI. *Annual review of information science and technology* 38, 1 (2004), 87–143.
[26] Muhammad Sadi Adamu. 2021. Rethinking technology design and deployment in Africa: Lessons from an African standpoint. In *3rd African Human-Computer Interaction Conference: Inclusiveness and Empowerment*. 75–83.
[27] Harold Scheub. 1985. A review of African oral traditions and literature. *African Studies Review* 28, 2-3 (1985), 1–72.
[28] Deborah Talbot and Melissa Densmore. 2023. Milk Matters 4.0: Challenges in deploying university-led mobile application development for small NGOs. *ACM SIGCAS/SIGCHI Conference on Computing and Sustainable Societies* (2023).
[29] Harold Thimbleby. 1990. *User interface design*. ACM.
[30] Sarina Till, Jaydon Farao, Toshka Lauren Coleman, Londiwe Deborah Shandu, Nonkululeko Khuzwayo, Livhuwani Muthelo, Masenyani Oupa Mbombi, Mamare Bopane, Molebogeng Motlhatlhedi, Gugulethu Mabena, et al. 2022. Community-based co-design across geographic locations and cultures: methodological lessons from co-design workshops in South Africa. In *Proceedings of the Participatory Design Conference 2022-Volume 1*. 120–132.
[31] Helma van Rijn and Pieter Jan Stappers. 2008. Expressions of ownership: motivating users in a co-design process.. In *PDC*, Vol. 8. 178–81.
[32] Wolfgang Wickler and Uta Seibt. 1995. Syntax and semantics in a Zulu bead colour communication system. *Anthropos* (1995), 391–405.

9 APPENDIX

9.1 Java Libraries

Library Name	Purpose
Exoplayer	Application layer media player
OkHttp	HTTP client for Android
AndroidPDFViewer	PDF viewer for Android
Flexbox for Android	CSS Flexbox layout in Android
Firebase Analytics	Capture usage data
PostgreSQL	Database connection drivers
Retrofit	Turns API interfaces into callable objects
Mockito	Create mock objects for running tests

9.2 Git Repo

https://github.com/BeskarBaddie/ECDapp_2023/settings

9.3 Performance Tests

Performance tests were captured using Android Studio profiler and running identical 2 minute tests with the same tasks.

9.3.1   CPU Usage

Test ID	Peak CPU Usage (%)
1	32
2	26
3	30
4	29
5	27
6	29
7	33
8	31
9	29
10	34

9.3.2   Memory Usage

Test ID	Peak memory Usage (mb)
1	165,2
2	169,5
3	214
4	165,3
5	166,8
6	178,3
7	165,2
8	164,8
9	200,3
10	169

9.3.3   API Call Tests

Test ID	All Content (seconds)	Assigned Content (seconds)
1	4,6	3,4
2	4,6	2,7
3	4,6	2,8
4	4,7	2,8
5	4,7	3,2
6	4,6	3,3
7	4,6	2,4
8	4,5	3,3
9	4,6	2,9
10	4,7	3,4

9.4   Cognitive Walkthorugh Test

Test ID	1 - Mobile Application
Purpose	Users can log in to the application
Instruction	"Please log in to the application"
Task	Insert username and password and press the Login button
Expected Outcome	All users will be able to log in
Actual Outcome	All users and staff were able to log in successfully

Test ID	2 - Mobile Application
Purpose	Users can watch a video
Instruction	"Please play any video"
Task	Click on 'All Content' and click on a video and click play
Expected Outcome	All users should be able to play videos
Actual Outcome	All users were able to play videos without assistance

Test ID	3 - Mobile Application
Purpose	Users can watch videos from assigned content
Instruction	"Please watch a video from assigned content"
Task	Navigate to 'Assigned Content', choose a video, and click play
Expected Outcome	All users should be able to watch assigned content
Actual Outcome	4/5 users were able to watch assigned content

Test ID	4 - Mobile Application
Purpose	Users should be able to download content
Instruction	"Please download a video"
Task	Users should click on a video, and click the download button
Expected Outcome	All users should be able to download videos
Actual Outcome	3/5 users were able to download videos

Test ID	5 - Mobile Application
Purpose	Users should be able to view downloaded content
Instruction	"Please view your downloaded content"
Task	Users should click the 'Overflow Menu' and click 'Downloads'
Expected Outcome	All users should be able to access downloads
Actual Outcome	1/5 users were able to find and access downloads

Test ID	6 - Mobile Application
Purpose	Users should be able to search for videos by title
Instruction	"Please search for a video with 'Immunization' in the title
Task	Click the 'Search' icon and type 'Immunization' and click on the content that pops up
Expected Outcome	All users should be able to search for videos
Actual Outcome	2/5 users manually searched all the content. 3/5 users completed the task correctly

9.5 Integration Testing

Test ID	1 - Video Upload to Firebase
Date	27-06-2023
Status	Failed
Purpose	Test if videos can be uploaded to Firebase from mobile application
Test Action	Click 'Upload Video', select a video from storage
Expected Outcome	Video should upload to Firebase storage
Actual Outcome	Unable to make database connection

Test ID	2 - Video Upload to Firebase
Date	27-06-2023
Status	Failed
Purpose	Test if videos can be uploaded to Firebase from mobile application
Test Action	Click 'Upload Video', select a video from storage
Expected Outcome	Video should upload to Firebase storage
Actual Outcome	Unable to make database connection

Test ID	3 - Video Upload to Firebase
Date	29-06-2023
Status	Passed
Purpose	Test if videos can be uploaded to Firebase from mobile application
Test Action	Click 'Upload Video', select a video from storage
Expected Outcome	Video should upload to Firebase storage
Actual Outcome	Video file appears in Firebase storage

Test ID	4 - PDF Upload to Firebase
Date	04-07-2023
Status	Passed
Purpose	Test if pdfs can be uploaded to Firebase from mobile application
Test Action	Click 'Upload PDF', select a PDF from storage
Expected Outcome	PDF should upload to Firebase storage
Actual Outcome	Video file appears in Firebase storage

Test ID	5 - Exoplayer Test
Date	05-07-2023
Status	Failed
Purpose	Test if the Exoplayer library allows videos to be played and controlled
Test Action	Click on a video and open up the FullscreenVideo activity
Expected Outcome	Exoplayer should load the video automatically and play the video
Actual Outcome	Exoplayer unable to create Media Source

Test ID	6 - Exoplayer Test
Date	05-07-2023
Status	Pass
Purpose	Test if the Exoplayer library allows videos to be played and controlled
Test Action	Click on a video and open up the FullscreenVideo activity
Expected Outcome	Exoplayer should load the video automatically and play the video
Actual Outcome	Exoplayer correctly creates Media Source and plays vi

Test ID	7 - Fullscreen Test
Purpose	Test if phone switches to landscape mode and video fills screen when Fullscreen icon icon is pressed
Date	06-07-2023
Status	Failed
Test Action	Click Fullscreen icon on Exoplayer
Expected Outcome	Phone should switch to landscape and video should fill screen
Actual Outcome	Phone switches to landscape and video does not play

Test ID	8 - Fullscreen Test
Purpose	Test if phone switches to landscape mode and video fills screen when Fullscreen icon icon is pressed
Date	06-07-2023
Status	Passed
Test Action	Click Fullscreen icon on Exoplayer
Expected Outcome	Phone should switch to landscape and video should fill screen
Actual Outcome	Phone switches to landscape and video fills screen

Test ID	9 - Download Integration Test
Date	07-07-2023
Status	Failed
Purpose	Test the download functionality, including starting a download, checking if the file is successfully saved, and verifying the download status.
Test Action	Press 'Download' Button
Expected Outcome	Toast notification should verify download was completed and video should appear in Downloads Activity
Actual Outcome	Toast notification verifies download was completed and video appears in Downloads Activity

Test ID	10 - Download Integration Test
Date	07-07-2023
Status	Failed
Purpose	Test the download functionality, including starting a download, checking if the file is successfully saved, and verifying the download status.
Test Action	Press 'Download' Button
Expected Outcome	Toast notification should verify download was completed and video should appear in Downloads Activity
Actual Outcome	Toast notification verifies download was completed and video appears in Downloads Activity

Test ID	11 - Video Lifecycle Integration Test
Date	05-07-2023
Status	Failed
Purpose	Test how the player behaves during different lifecycle events such as onCreate, onStart, onResume, onPause, onStop, and onBackPressed
Test Action	Exit screen while video is playing
Expected Outcome	Video thread should terminate on screen exit
Actual Outcome	Audio of video keeps playing on screen exit

Test ID	12 - Video Lifecycle Integration Test
Date	05-07-2023
Status	Failed
Purpose	Test how the player behaves during different lifecycle events such as onCreate, onStart, onResume, onPause, onStop, and onBackPressed
Test Action	Exit screen while video is playing
Expected Outcome	Video thread should terminate on screen exit
Actual Outcome	Audio of video keeps playing on screen exit

Test ID	13 - Video Lifecycle Integration Test
Date	06-07-2023
Status	Passed
Purpose	Test how the player behaves during different lifecycle events such as onCreate, onStart, onResume, onPause, onStop, and onBackPressed
Test Action	Exit screen while video is playing
Expected Outcome	Video thread should terminate on screen exit
Actual Outcome	Video thread terminates on screen exit

Test ID	14 Video on own screen
Date	10-07-2023
Status	Passed
Purpose	Videos should open their own unique activity when clicked on
Test Action	Click a video in the recycler view
Expected Outcome	New Fullscreen Activity opens up with the video that was clicked
Actual Outcome	New Fullscreen Activity opened up with the video that was clicked

9.5.1 Login Integration Tests

Test ID	15 Login With Correct Credentials
Date	14-08-2023
Status	Failed
Purpose	API call should be made and Authentication Token should be returned
Test Action	Enter username and password and click Login
Expected Outcome	Authentication token should be returned and dashboard activity should open
Actual Outcome	Unable to connect to server - incorrect endpoint

Test ID	16 Login With Correct Credentials
Date	14-08-2023
Status	Failed
Purpose	API call should be made and Authentication Token should be returned
Test Action	Enter username and password and click Login
Expected Outcome	Authentication token should be returned and dashboard activity should open
Actual Outcome	Unable to retrieve authentication token - incorrect API header

Test ID	17 Login With Correct Credentials
Date	14-08-2023
Status	Failed
Purpose	API call should be made and Authentication Token should be returned
Test Action	Enter username and password and click Login
Expected Outcome	Authentication token should be returned and dashboard activity should open
Actual Outcome	Connection successful but unable to extract authentication token from response

Test ID	18 Login With Correct Credentials
Date	14-08-2023
Status	Passed
Purpose	API call should be made and Authentication Token should be returned
Test Action	Enter username and password and click Login
Expected Outcome	Authentication token should be returned and dashboard activity should open
Actual Outcome	Authentication token returned and dashboard activity opened

Test ID	19 Login With Incorrect Credentials
Date	15-08-2023
Status	Passed
Purpose	API call should be made and no Authentication Token should be returned
Test Action	Enter incorrect username and password and click Login
Expected Outcome	Authentication token should not be returned and dashboard activity should not open
Actual Outcome	NO Authentication token returned and dashboard activity not opened

Test ID	20 Login details stored
Date	15-08-2023
Status	Passed
Purpose	Username and authentication token should be stored in shared preferences
Test Action	Enter incorrect username and password and click Login
Expected Outcome	Authentication token and username should be stored in shared preferences
Actual Outcome	Authentication token and username succesfully stored

Test ID	21 Stored credentials validation
Date	16-08-2023
Status	Passed
Purpose	User should not have to log in if they have already logged in previously
Test Action	Open app after logging in and closing the app
Expected Outcome	If user has already logged in they should be taken straight to the dashboard on app open
Actual Outcome	If user has already logged in they are taken straight to the dashboard on app open

Test ID	22 Exception Handling
Date	16-08-2023
Status	Failed
Purpose	Any API call exceptions should appear in a toast notification
Test Action	Attempt to login while website is down
Expected Outcome	Toast notification should say what the exception is
Actual Outcome	No toast notification displayed. (Not yet resolved)

Test ID	23 Logout
Date	17-08-2023
Status	Failed
Purpose	Pressing the logout button should remove the credentials from shared preferences and navigate back to the Login Screen
Test Action	Press the 'Logout' button
Expected Outcome	remove the credentials from shared preferences and navigate back to the Login Screen
Actual Outcome	Shared preferences removed but did not navigate to the Login Activity

Test ID	24 Logout
Date	17-08-2023
Status	Passed
Purpose	Pressing the logout button should remove the credentials from shared preferences and navigate back to the Login Screen
Test Action	Press the 'Logout' button
Expected Outcome	remove the credentials from shared preferences and navigate back to the Login Screen
Actual Outcome	Shared preferences removed and navigated to the Login Activity

9.5.2 Content Management Integration Tests

Test ID	25 Spinner Selection Test
Date	10-08-2023
Status	Failed
Purpose	Test whether the spinner's selection changes the filtered video list correctly based on the selected topic.
Test Action	Click on the spinner and select a topic
Expected Outcome	Filter all videos by selected topic
Actual Outcome	No response from code

Test ID	26 Spinner Selection Test
Date	10-08-2023
Status	Failed
Purpose	Test whether the spinner's selection changes the filtered video list correctly based on the selected topic.
Test Action	Click on the spinner and select a topic
Expected Outcome	Filter all content by selected topic
Actual Outcome	All content disappears

Test ID	27 Spinner Selection Test
Date	11-08-2023
Status	Failed
Purpose	Test whether the spinner's selection changes the filtered video list correctly based on the selected topic.
Test Action	Click on the spinner and select a topic
Expected Outcome	Filter all content by selected topic
Actual Outcome	Content is filtered by selected topic

Test ID	28 API to fetch content
Date	12-08-2023
Status	Failed
Purpose	Test whether the API call to fetch video content is successful and handles different response scenarios (success, error).
Test Action	API call should be made when 'All Content' is clicked
Expected Outcome	Fetch list of all content and populate recycler view
Actual Outcome	Unable to make API call - incorrect URL

Test ID	29 API to fetch content
Date	12-08-2023
Status	Failed
Purpose	Test whether the API call to fetch video content is successful and handles different response scenarios (success, error).
Test Action	API call should be made when 'All Content' is clicked
Expected Outcome	Fetch list of all content and populate recycler view
Actual Outcome	Only content titles are fetched

Test ID	30 API to fetch content
Date	12-08-2023
Status	Passed
Purpose	Test whether the API call to fetch video content is successful and handles different response scenarios (success, error).
Test Action	API call should be made when 'All Content' is clicked
Expected Outcome	Fetch list of all content and populate recycler view
Actual Outcome	All content is fetched and recycler view is populated

Test ID	31 RecyclerView Display Test
Date	12-08-2023
Status	Failed
Purpose	Test whether the RecyclerView displays the video content correctly after fetching it from the API..
Test Action	RecyclerView should be populated with cards with title, tag, and language
Expected Outcome	ecyclerView should be populated with cards with title, tag, and language
Actual Outcome	Only titles displayed

Test ID	32 RecyclerView Display Test
Date	12-08-2023
Status	Passed
Purpose	Test whether the RecyclerView displays the video content correctly after fetching it from the API..
Test Action	RecyclerView should be populated with cards with title, tag, and language
Expected Outcome	RecyclerView should be populated with cards with title, tag, and language
Actual Outcome	All content is displayed correctly in cards in the RecyclerView

Test ID	33 Search Content Test
Date	13-08-2023
Status	Failed
Purpose	Test whether the search functionality filters videos by name as the user types in the search view.
Test Action	Type the title of a piece of content in the search bar
Expected Outcome	Automatic filtering should happen as the user types
Actual Outcome	All content disappeared

Test ID	34 Search Content Test
Date	13-08-2023
Status	Failed
Purpose	Test whether the search functionality filters videos by name as the user types in the search view.
Test Action	Type the title of a piece of content in the search bar
Expected Outcome	Automatic filtering should happen as the user types
Actual Outcome	Search only occurred upon pressing 'Enter'

Test ID	35 Search Content Test
Date	13-08-2023
Status	Passed
Purpose	Test whether the search functionality filters videos by name as the user types in the search view.
Test Action	Type the title of a piece of content in the search bar
Expected Outcome	Automatic filtering should happen as the user types
Actual Outcome	Filtering occured automatically as user typed in the search bar