Design Of Ezydu'a AR Application as New Media Experience for Children in Informal Education Environment

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Abstract. Ezydu'a is an augmented reality (AR) mobile application tailored for informal education settings to assist children in memorizing daily routine du'a. Recognizing the challenges faced by children in informal learning environments, the app employs a user-centered design (UCD) approach to develop engaging and effective learning experiences. Through iterative design and evaluation, Ezydu'a incorporates interactive AR elements, such as markers and virtual objects, to enhance children's learning process. Formative evaluation findings have guided significant improvements in content, character design, interface, and navigation. By leveraging AR technology within an informal learning context, Ezydu'a aims to make du'a memorization enjoyable and accessible for young learners.

Keywords: AR Mobile Application; Mobile App Design; UCD Approach; Formative evaluation; Children's informal education

1 Introduction

Prayer, or du'a, is a fundamental routine in the life of every Muslim and represents an act of supplication to our Creator. Du'a is uplifting, empowering, and one of the most powerful and effective acts of worship in which a human being can engage. It has often been called the weapon of the believer. Du'a is essentially a submission to God and a manifestation of a person's need for God's guidance [1]. Muslims are taught to recite various types of du'a from a young age. Ideally, du'a is recited in Arabic, so learning and memorizing du'a during childhood provides an advantage, as children's brains easily absorb information, making it easier to recall du'a later in life.

Usually, early teaching of du'a to children occurs in informal setting environment. Informal education encompasses learning that occurs outside formal school settings, driven by personal interests and curiosity. Unlike structured educational environments,

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informal learning is often spontaneous and can happen through experiences like social interactions, cultural activities, and personal exploration, fostering lifelong learning skills [13]. This form of education is especially beneficial in nurturing adaptability and critical thinking, offering flexible, accessible ways for individuals to develop new skills and knowledge [14].

Traditionally, to make the memorization of du'a easier and more enjoyable, teachers or parents use colorful books or other printed materials that can be displayed on walls. In the modern era, du'a has also appeared in various digital forms, such as YouTube videos and other interactive applications. This approach makes du'a recitation more fun and accessible, allowing it to be practiced anywhere and anytime.

The advent of new technologies like Augmented Reality (AR) has been used in various learning settings, including education. AR is regarded as a new medium and an alternative to interactive CD-ROMs [7]. According to Siltanen and Aikala [8], AR has the ability to enrich hybrid media by combining conventional and digital elements, offering opportunities for engaging advertisements [11], short videos, gaming, and more. An AR system combines real and virtual objects in real environments, operates interactively in real-time, and registers objects in two environments simultaneously [2]. It allows users to view things visually by simply pointing a camera at them, with the information presented through overlaying visuals and immersive content on top of the real world. AR provides an effective tool for developing integrated learning environments [12] that support the manipulation of physical objects and the visualization of content, thereby enriching the learning experience [7][10][11]. Furthermore, it makes learning materials easier to understand, which can improve soft motor skills, communication skills, and other fundamental abilities [4].

This technology offers a new potential for enhancing memorization by adding meaningful value to the user experience. Motivated by this potential, we developed a research project titled the "EZYDU'A" AR application. EZYDU'A is a mobile learning app tailored for children aged 4 to 6, featuring simple daily du'as, such as prayers for studying, meals, sleep, and for parents. We aim to explore how combining AR technology with multimedia elements like text, images, and audio can make memorization both easier and more engaging. This article will discuss the practical aspect of design and development of this AR mobile application in detail in the following sections.

2 Design & Development of Eazydu'a Prototype

The design and development of the EzyDu'a application can be divided into two main parts namely AR mobile application and AR Marker. During the design and development, formative evaluation was also conducted in order to ensure that this application fulfils the requirements and functions accordingly.

2.1 AR Design (Marker)

AR app designs into 2 parts respectively. The first part is the design of the marker that will be used to activate the AR content. AR-based markers require a certain marker/label to register a virtual object position that will be displayed in a real-world environment [3]. The design of AR marker architecture has adopted AR-based marker development as shown in Fig 1. Conceptually, the marker is a rectangular card or paper which over the card has a certain pattern or line with different id and code. Thus, a laptop camera or smartphone will detect the position of the AR marker scan on the flashcard and then the virtual element will be generated by the AR software and the virtual object will appear on the screen.

The paper-based marker card is designed accordingly as mentioned in section 2.2. The design has considered a suitable principle that allows the camera to capture the image effectively. Secondly, we also designed the virtual object that will be displayed after being generated by the AR software application. The marker design is explained in detail in section 2.2 as well.

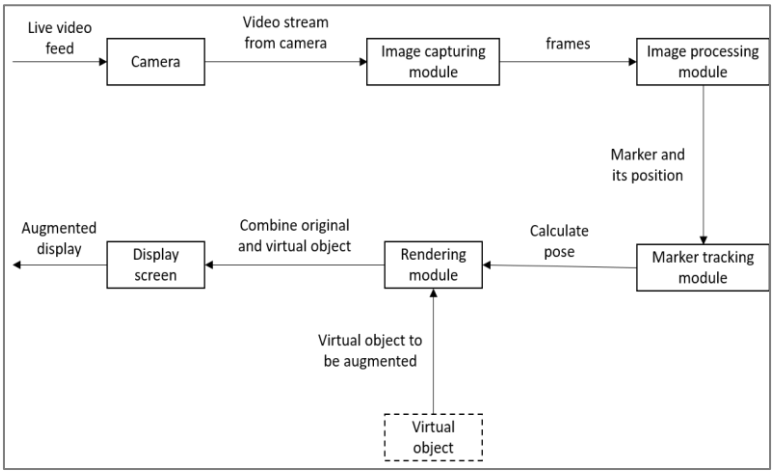


Fig 1. Marker-based AR Development

2.2 Mobile App Design

Generally, EzyDu'a AR mobile app was designed by following the User-Centred Design (UCD) approach. In UCD the design was done iteratively, which allows designers to focus on the users and their needs in each phase of the design process [5]. The design and development have followed suit the UCD phases of the understanding context of a user, specifying user requirements, came out with user solutions and conducted the evaluation/testing (refer to Fig 2).

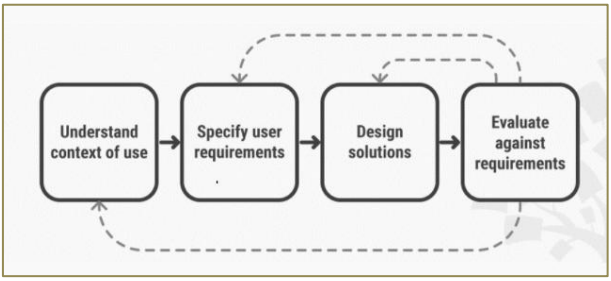


Fig 2. User Centered Design Approach

In *understanding the context of a user*, the mobile app was designed with children in mind and their common daily activities. The early interview with parents has suggested that children follow some specific routine for daily basis activity. Therefore, the app's functions are designed by following these routines such as waking up, entering and exiting the bathroom, having meals, studying, du'a for parents and sleeping.

In *specifying user requirements*, experts such as users and content experts were interviewed to gather the data needed for establishing the user requirements. Experts were asked regarding the application such as the user (in this case we used parents) has indicated the characteristics of children that we need to consider and content expert was validating the du'a in terms of text (wording) and pronunciation (during recitation) to ensure its correctness.

In the *design solution*, there are three important parts: marker design, mobile app design, and virtual object design.

a) Marker Design:
AR markers are visual indicators that trigger the display of virtual information. These markers are standard images or small objects that are pre-trained to be recognizable when placed in front of the camera. The images for the markers need to be chosen carefully, as they will create a tag within the image. The markers were designed using the Visual Studio application, with different markers assigned to different types of du'a. The markers were then saved into the Vuforia application for use with each du'a. Each marker was rated either 4 or 5 stars based on how easily it could be triggered.

b) Mobile Apps:
In the development phase, suitable AR-related software was used to develop the application, along with several other tools needed to complete the task. Images such as icons, illustrations, and text were designed using Adobe Illustrator and Adobe Photoshop. The application was then developed using Unity 3D, Android Studio, and Vuforia, using objects that had been created earlier. This phase involved installing the application on an Android mobile device. The application was published using Android Studio and exported in the appropriate APK format.

c) Virtual Object:

The virtual object is displayed as a result of the AR engine being triggered by the marker. This object consists of static 2D images of suitable illustrations of du'a, Arabic text, and audio of du'a recitation. Eight types of virtual objects were created for this application, each designed to be short to facilitate easy memorization. The virtual objects are also accompanied by audio to ensure the du'a is heard clearly, aiding in memorization for children. The virtual objects were designed using Unity 3D, with some coding required to embed the audio into the application.

2.3 Iterative Design Process

The EzyDu'a mobile app went through an iterative design process to solve problems early, improve usability, and make the development more efficient and cost-effective in terms of both budget and time. Ultimately, this iterative design process will advance the current design and fully polish it based on the feedback received from users.

We were conducting a qualitative formative evaluation in this phase to gather user feedback regarding the design work. There are three respondents involved in early stage and two more involve in later stage. There was one content expert, two user interface designers and two parents. For now, we have not yet involved child participants, as they will be included later during the summative evaluation phase. We used an interview technique in gathering all the data. We focused on four main dimensions to assess the performance of our application: content, interface, character, and navigation. The questions are open ended regarding the four dimensions stated earlier. The interviews were conducted online, where the experts were asked to download the application, use it, and then participate in a video conferencing session via Google Meet at a mutually agreed time. During the interviews, data was recorded and analysed afterward.

Character

An initial attempt was made to design the app to suit both boys and girls, with "Aisha" representing the girl character and "Irfan" (the original Irfan) for the boy (Fig. 3). Children using the application could choose a character based on their gender, and the app would be tailored to their preference. However, during testing, the girl-related design was still under development, so users were unable to visualize it. Consequently, the respondents advised us to focus on just one character, complete the app, and then conduct another round of testing. Currently, the application shows some inconsistencies and incompleteness due to the design catering to both genders.

Based on the feedback, we made modifications to use only the boy character. After several iterations, a new version of Irfan was designed and selected as the main character of the application (Fig. 3). The new Irfan character is now used consistently throughout the mobile app and the virtual objects.

Fig 3. Ezydu'a character

Content

Content testing focused specifically on the virtual objects, particularly the recitation of the du'a. All experts agreed that the audio was clear, correctly pronounced, and paced appropriately for children, making it easier for them to memorize. However, the 2D images were found to be inconsistent in terms of colour and text. Additionally, the illustrations did not accurately depict the content of the du'a being recited. Therefore, changes are needed to make the visuals more memorable and consistent. Each virtual du'a has been redesigned with appropriate environments; for example, the du'a for studying now features a study environment with a desk and book, while the du'a for entering the bathroom shows a bathroom or toilet background (Fig. 4). Both the text and images have been redesigned to ensure consistency throughout the application.

Fig 4. Ezydu'a virtual object

Interface

Paper-Based Marker

Each du'a is associated with a unique paper-based marker, featuring Irfan and Aisha along with a distinct QR code. The markers were made colorful to appeal to children (Fig. 5).

Fig 5. Ezydu'a Old Marker

During testing, users had no issues accessing the virtual objects when the camera was pointed at the markers. However, they raised concerns about consistency, noting that while the markers were different (which was positive), they were also unrecognizable (Fig. 5). Additionally, the colors and designs of the markers needed to be precise for effective printing and to ensure the virtual objects would appear correctly on the screen. In response, we decided to redesign the markers, focusing on the specific du'a (e.g., waking up, having a meal) and using a single color (black) (refer to Fig. 6). This redesign resolved the issues of inconsistency, recognizability, and printing, as highlighted by the respondents.

Fig 6. Ezydu'a New Marker

App design

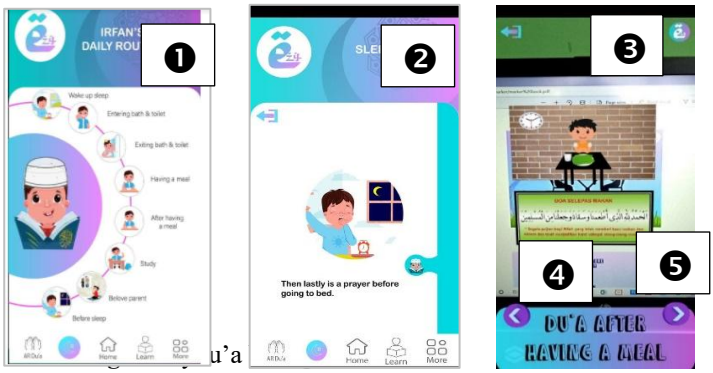
Experts noted that the font, background, and color themes were inconsistently used throughout the application. Different fonts were applied across both the app and the video virtual objects (as mentioned in an earlier section). Additionally, the backgrounds and colors varied from page to page (or type of du'a), which slowed down information processing as users felt they were in a different environment or needed to perform different tasks. Based on the respondents' feedback, the AR mobile application's interface was modified to ensure consistency. The background and color theme were simplified and standardized, adopting shades of blue to align with the boy character (Fig. 7).

Fig 7. Ezydu'a AR Mobile Interface

Navigation

The initial navigation was designed in a linear format, allowing users to recite the du'a according to the routine previously outlined. However, users provided feedback that they found it frustrating not being able to navigate directly to other du'as. Additionally, the navigation buttons were too small, and users expressed a preference for a clicking sound as feedback when interacting with them.

To address these issues, we redesigned the navigation to be more flexible, enabling users to access any du'a from any page. As shown in Figure 8, label 1 indicates the main page where users can navigate to different du'as. Label 2 shows the page displayed when a user clicks one of the icons. Tapping an icon will open the camera, allowing the virtual object to appear when the specific marker is recognized. Labels 4 and 5 provide options to navigate to the previous or next du'a. Label 3 allows users to return to the main page (label 1), giving them the flexibility to choose a different du'a recitation if they do not prefer the previous or next one. This flexible navigation was implemented based on the respondents' suggestions.



u'a

As a result of the iterative design process, significant improvements have been made based on the feedback received. These enhancements have substantially altered the application to better suit the target users. In the User-Centered Design (UCD) approach, formative evaluation supports the iterative process of software development, allowing designers to assess how well the design aligns with the users' context and requirements. This process ensures that the design performs effectively and, most importantly, meets the users' specific needs and expectations.

3 Conclusion

AR opens new possibilities for devices to be useful throughout the day by allowing us to experience digital content in the same way we experience the physical world. As previously mentioned, this article is created to share our journey in creating an AR mobile application. This study is significant in two different perspectives. Firstly, this article explained regarding the design of AR application that mainly encompasses three different elements of AR mobile application, the virtual object and the marker design. Each of it has been described in detail in the respective section. Secondly, we conducted evaluation practices to ensure the application effectively guides children in learning daily du'as. This evaluation is essential to confirm that the app enables children to learn du'as independently at home or in any setting, enhancing accessibility. Moreover, by incorporating AR technology to overlay images, text, and audio, the app aims to support easier memorization and create an engaging, enjoyable learning experience for children.

Before launching the Ezydu'a AR application, a formative evaluation was conducted. Numerous insights were gathered from respondents, helping us understand the current performance of the application. The feedback and suggestions provided by respondents were used as the foundation for improvements. Significant enhancements were made in terms of content, character design, interface, and navigation, which we believe will lead to a better learning and memorization experience. As a result, a revised version of the Ezydu'a AR mobile app has been designed and is ready for a second cycle of evaluation.

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