

A Survey on Components of a Serious Game for MR-Tawaf Mobile App

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This paper presents the insight components of a Serious Game Mixed Reality for tawaf learning mobile application. This research is focusing on an interactive application that involves six major components; content, mixed reality (MR) technology, serious game (SG), self-directed learning (SDL) method, motivational Flow Theory (FT) and user interactions (UI). The mixed reality environment is chosen in this application to provide a realistic experience especially for the young pilgrims in tawaf learning. Thus, to ensure the MR-Tawaf is beneficial to the umrah pilgrims, the Technology Acceptance Model (TAM) and User Experience Design (UX-D) are applied to develop this app. This paper will highlight the SG components used in the development of the apps. MR-Tawaf is focused only on the involvement of the pilgrim in every step of performing tawaf. It is hoped that the components of MR-Tawaf SG can be referred to as a guideline to those who interested in developing a similar application in a virtual environment for umrah or hajj.

Keywords: Mixed Reality, Serious Game, Tawaf, Serious Game attributes

I. INTRODUCTION

Tawaf is one of the obligatory and pillar of umrah and hajj. Its procedures are complex with many requirements, information, rules, and practical steps that must be in the knowledge of pilgrims. The ritual of tawaf is accompanied by du'a or zikr that will be recited by the pilgrims. In order to understand every detail in performing tawaf, learners (pilgrims) need to attend the umrah or hajj course where the learners will be provided with book, booklets, or slides note. At present, the pilgrims must attend at least one face-to-face course with a well-trained guide/speaker (Ustaz or Ustazah) who mastered the topic. This means that the existing method is much more reliant on the conventional method [1]. Unfortunately, when it comes to the practical part of learning tawaf, the agency will bring pieces of equipment and assembled them to become a Kaabah replica. Another constraint, in existing practice, those pieces of equipment must be borrowed from a certain mosque that owned them. This will cause a problem with the equipment that might have been borrowed by another agency.

Indirectly it will cause no motivation to the learners who have high expectations in learning tawaf.

The popularity of mobile apps nowadays is very influencing many people to perform everyday routine tasks via mobile phones [2]. The existence of new technology developments such as mobile technology, mobile apps, and the virtual world elements have increased interest and engaged users to use them [2], [3] for learning purposes. With the rapid growth of technology, it plays an important role in managing the relationship between people in routine life, social and economic [4], [5], and teaching and learning. Several methods have been introduced to help the pilgrims [1] by using current digital technology. At the moment, mobile application usage is the most popular and prominent [6]. In addition, with its advantages as a mobile device, it is regarded to be very flexible devices, easy to handle, widely owned by many layers of society and used everywhere by the users. With the growth of mobile technology that is nowadays very promising, it is hoped that it could be penetrated in utilization in the umrah and hajj context.

A few years back, many mediums and applications have been developed to ease the learners (pilgrims) to learn how the umrah or hajj worship must be done. These include the 3D tawaf training [7], 3D modelling [8], duá recitation while performing the umrah or hajj rituals, virtual hajj [9], virtual reality umrah [10] and other few examples that will be discussed in the related work section. Unfortunately, none of the existing applications applied the elements of the serious games (SG) which can motivate and engage the learner with the app. Nowadays people amaze with the virtual reality (VR) environment and technology which has grown immensely over elements for learning Muslim rituals. This VR technology provides developers and users with a visualization of real situations - that are hard to imagine, achieve with the coarse eyes or experience in physical reality. Furthermore, it can assist the user in envisaging the intended concepts. Hence, they can create innovative and creative ideas of a situation [11] for the problem they want to overcome. Virtual reality and environment have been implemented in many important applications related to military, health, rehabilitation, safety, and education [9], [12]. This is because it can create an environment that is similar to the real world as it is. There are many existing applications to learn hajj or umrah in the market. Unfortunately, it is unable to engage learners to keep on using the application. In addition, the virtual reality has not been well adapted in the learning technology related to hajj or umrah by the developers.

Hence, the virtual environment must be improved by adapting Mixed Reality (MR) to it so that it could involve the real user experience with the practical part of the area with a Serious Game (SG) components. SG is a computer game built not for entertainment domains [13]. The need for SG is to engage the user in using the app and contribute to the understanding and achievement of predefined objectives [14]. The growth of SG in education can be ascribed to learning where learners can be more engaging with the underlying game to the current situation of learners who comfortable with a digital environment and are familiar with its operation. It is apparent that the delivery and organization of teaching material needs to be changed [14] to accommodate not only the adult learners, but also for young learners and to meet their expectations [15].

The drawbacks of the existing and previous applications serve as the main motivation for us to produce a mixed reality tawaf (MR-Tawaf) as a model to prove that the components of SG and virtual environment applied in this app. The methodology used in developing this app is the User Experience Design (UX-D) and Technology Acceptance Model (TAM) which emphasizes the true user experience that learners have and the perceived of its usefulness.

II. RELATED WORKS

This section is to discuss the related works of the growth of Information and Communication Technologies (ICT) in umrah and hajj application. Until now, scholars have designed and evaluated a number of mobile applications for umrah or hajj. [16] has done a study to investigate mobile applications for tourism and for religious and spiritual services [16], [17]. The researches that have been conducted include building mobile applications for varieties of hajj and umrah services, a guide to Malaysian pilgrims [18] - [21], an augmented reality application to guide pilgrims by [22]. [23], [24] developed a mobile app to ease pilgrims to read hajj and umrah prayers and at the same time understand the meanings by translating them into their language of the pilgrims. [25] has done a research about a mobile app that serve the pilgrims who speak Malay with a dictionary that can translate among languages - Malay - Arabic - English. Meanwhile, [26] have proposed a framework that serves as a crowd-sourcing platform. By using this app, they can define the requirements of pilgrims for services. The app framework uses mobile sensory data. The purpose is to define the context of the users and was used to develop a mobile app for Spatio-temporal services.

In another research, [27] studied the use of a mobile phone as a tracking device. It can be used by the guide (Mutawwif) to detect their pilgrims' movements and determine the location. [28] developed a mobile app for a dynamic signage system to inform pilgrims about the crowd status around the Holy Kaabah and used as an automatic counter for the number of Tawaf rounds. [29] also has developed a mobile app that can be used to guide pilgrims to perform Hajj and Umrah. Her app also functions as a tawaf counter and location tracker. Another mobile app was proposed by [30] for pilgrims' location

identification service during the hajj season, collect information about the location and track the pilgrims.

A recent study has been done by [31] developed a mobile translation application to enable communications between pilgrimages. They developed this application by providing many languages. Voice and text recognition technologies are employed to assist pilgrims to find and translate target words. [31] in his recent study has developed a mobile app for translation aimed to facilitate communications between pilgrimages. This application provided many languages and employed voice and text recognition technologies just to assist pilgrims in finding and displaying the translation of the target words. Whereas [32] has introduced a mobile app named “Al-Hajj” to ease pilgrims in understanding hajj-related matters. This application consists of four interactive features - checklist, map, contact list, and motivational messages. Next, [33] has studied the possibility of using smartphone apps to conduct surveys. This study related to collecting relevant data and information during mass gatherings. This results in how it plays an important role in improving public health by reinforcing knowledge associated with disease prevention.

III. COMPONENTS OF MR-TAWAF

MR-Tawaf is a mobile app that focuses on self-directed learn the tawaf ritual for umrah or hajj by using a mixed reality environment applied with serious game elements. The purpose is to motivate and engage learners (pilgrims) to keep on using this tool of learning the practical part of tawaf. Since all this while learners just attend the face-to-face course and feel difficult to review what they have learned, so it creates a need on having an alternative way of learning tawaf which could help the facilitator or speaker and mutawwif during the tawaf practical learning session. The MR-Tawaf consists of six components namely Self-directed Learning (SDL), Motivational Flow Theory, Serious Game (SG), User Interaction (UI), Mixed Reality (MR), User Experience (UX) and Technology Acceptance Model (TAM). These can be shown in Figure 1 below :

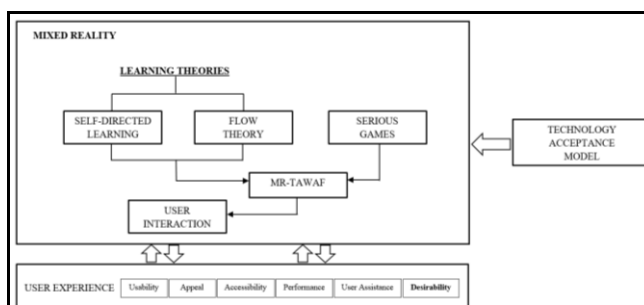


Fig. 1 : MR-Tawaf Conceptual Framework

A. Self-Directed Learning (SDL)

SDL is a self-study method that the learner is learning on her or his own and will not bother anybody. There are two factors important in the development of self-directedness in learning: (1) The feelings of the learner who is being in-charge. Having a genuine impact on the learning situations is crucial for their "desire" to take responsibility, and (2) Responsibility feelings of being in-charge that connected to understand the demands of the learning context, user experience and getting feedback from the system. MR-Tawaf allows learners to feel the process of SDL in which a learner controls their means and learning objectives in order to meet personal goals of learning or the perceived demands of their personal context.

B. Motivational Flow Theory (FT)

A positive qualities are important for all activities including game playing in MR-Tawaf. The enjoyment and knowledge that is applied in the serious games in MR-Tawaf offers are crucial factors in determining whether a learner will engage in the game, enjoy the game and achieve the objectives. This is important because we need to know which kind of motivation elements could motivate and engaged the learners with the games. Since we know that the pilgrims always feel worried about their tawaf or umrah completion, during the optimal user experience, a person will be in a positive psychological state. Learner (pilgrims) is so involved with the goal-driven activity - nothing else seems to matter. The games activity in the apps that produces such experiences is so pleasant that the learners might not notice they are now engaged with the apps.

C. Serious Games (SG)

Serious games in MR-Tawaf are made to help

learners develop efficiently specific skills. The learner will be engaged and enjoy playing the SG in MR-Tawaf and achieve the objectives of the game. SG has the advantage of offering virtual environments. The idea of simulating different kinds of mistakes done by the learners will enforce them to develop their professional skills MR-Tawaf SG also has the power to immerse learners into a world where they have to prepare and think intellectually and mentally to progress the SG, face challenges (due to the mistakes that the learners might do when they perform tawaf) or accomplish seven rounds of tawaf. SG also gives the opportunity to the learners to interact with the app and game dimensions; such as reward, role-playing or challenge.

D. User Interaction (UI)

UI in a social context is concerned with design as a means for creating a meaningful interaction through the use of objects. MR-Tawaf has a systematic approach to understand the dynamics and effects of interaction between the learner (user) and the app. In MR-Tawaf, the app interacts with the learners by giving a checklist for them to check as preparation before they continue with the SG MR-Tawaf. The learners need to respond by clicking the checkbox to highlight that they have done what has been listed. Another example, there is a 2D mutawwif in the app highlighting the learners the total marks they collected after completed every round of tawaf, and also he will appear when learners did a prohibited action while performing the tawaf (in a form of SG simulation).

E. Mixed Reality (MR)

MR is a superset of AR in terms of a “mix of real and virtual objects within a single display. Others consider MR distinct from AR due to the sense that MR involves space, manipulating a scene in which AR could not do. AR is a sub-mode of MR which can provide an augmented workspace by inserting content from the virtual space. Here it will store and interact with the content into a predominantly physical space where we do our tasks. The need for AR techniques is most promising for engaging the learners of MR-Tawaf into augmented workspaces. MR-Tawaf used the approach of mixed reality boundaries which involves joining together distinct virtual and physical spaces by creating a transparent boundary between

them. By implementing this approach, the spaces are not overlaid. It is instead are distinct but adjacent.

MR-Tawaf involves boundary elements; situation. The situation concerns the spatial relationships between the mixed reality boundary, the physical and virtual spaces that it shows to the learners. Segmentation in MR-Tawaf space is a boundary that can be segmented in terms of its floor spatial location. The system will read the floor space with enough light rays of light. These connected spaces provide to some extent a unified frame of reference. It covers the position, orientation, distance, and consistent perspective. The learner may move along the boundary of Kaabah and change their viewing angle. It will still retain the same view (the connected space).

F. User Experience (UX)

User experience (UX) becomes a key aspect of the MR-Tawaf. The aspect of UX is important because none of the umrah pilgrims were agreed to buy the additional devices if we include the Natural User Interaction (NUI) additional components such as AR glasses, 3DRudder foot motion, VR Box II and many more. The task of designing MR-Tawaf requires a very detailed understanding of the context of tawaf itself and the people who will use MR-Tawaf. UX has gained greater attention among people in the industry. These UX design (UX-D) models could guide to improve the design. It also helps to determine the quality of interactive apps. UX is dynamic, subjective and context-dependent. It evolves during the interaction of learners with the system.

G. Technology Acceptance Model (TAM)

Technology Acceptance Model (TAM) is one of the most influential and commonly used theories to describe the user's acceptance of systems. As TAM closely related to the usability of the systems, TAM involves two major variables: Perceive Usefulness (PU) and Perceived Ease of Use (PEOU) to determine the attitudes towards using the MR-Tawaf. PU is the extent to which a user believes that using an information system will improve his or her learning performance while PEOU is a measure of a user's perception regarding a system's ease of implementation. The MR-Tawaf environment could be designed to bridge the gap between theoretical

learning in formal instruction provided in F2F course and the real-life application of the content in the virtual reality environment.

IV. SERIOUS GAME COMPONENTS

Serious games are very potential to help in increasing the effectiveness of learning and training [34]. Many researchers conclude a combination of SG and Information and communications technology (ICT) are accelerating learning, increasing motivation and supporting the development of higher-order cognitive thinking skills [35]. SG could generate engagement and stimulation in most educational environments. The focus must be given to the effectiveness of serious games for learning [36]. The use of SG has extended rapidly to a variety of domains, but still, their design and development remain as one of a challenging process for both developers and trainers [37], [38]. Based on the fact that SG could motivate and engage the learners, MR-Tawaf mobile app applied the elements of SG in its framework.

MR-Tawaf SG is referring to the mini game-shells that allow learners to sense the feeling of ‘presence’ experience. Presence is one of the elements of the motivational FT under a novel MR educational learning framework for both VR and AR - formal and informal learning. The VR (former) allows for the feeling of ‘being there’ in the virtual world. The AR (latter) blends virtual and real elements (learner). This is to enable the 3D virtual elements is registered accurately floor space (MR) in the real world and real experience. Hence, the learners will interact freely via mobile phone displays and follow the instructions accordingly. This approach is to increase learners' interest, engagement, and motivation to continuously use MR-Tawaf. In MR-Tawaf, games were developed using Unity 3D. There are two components in SG that been focused on to attract learners to self-directed learning the tawaf practical :

i. User interface (UI)

UI is used to present visual information or graphical user interfaces. In MR-Tawaf, there are interfaces for 2D (mutawwif) and 3D graphical to represent AR objects (Kaabah, Maqam Ibrahim and Hijr Ismail). These components can either be a standalone object

or linked to a collection of in-game components [39]. These user interface components are organized on an absolute space on the screen or appears dynamically on screen.

ii. In-game component

It represents actor (learner) objects (Kaabah, Maqam Ibrahim, and Hijr Ismail) that are used to stage happenings in a virtual space. The actor is the user himself because of the element of UX in the MR-Tawaf component where the learner wants to experience himself in tawaf practical learning. While objects are represented in 3D graphics, and audio in a form of talbiah recitation (in the early stages of the MR-Tawaf is running) to present their distinctive identities. These components can also possess behaviours to respond physically and act intelligently in the virtual environment according to the degree of realism desired.

Figure 2 below shows the SG components in MR-Tawaf. The components are an evolution of the input-process-outcome game model motivation by [40].

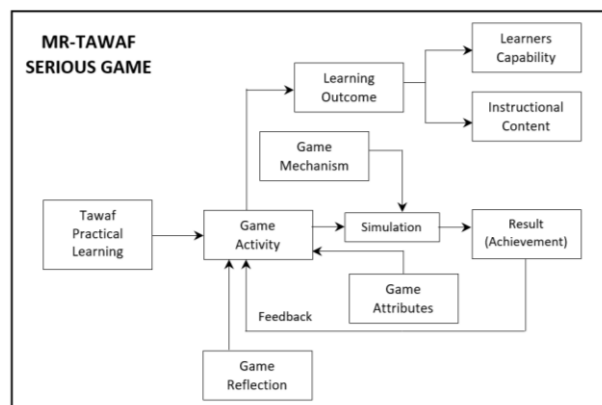


Fig. 2 : Serious Games Components in MR-Tawaf

Learners Capability : In this case, capability refers to the cognitive, psychomotor, and possibly affective skills which the learner should be developed as a result of playing the SG in MR-Tawaf. Here cognitive skills mean the capabilities of recall, analysis, synthesis, and evaluation. While psychomotor skills include the capabilities of well-timed, execution in a proper manner. Affective skills include the capabilities of identifying and valuing appropriate the characteristics, requirements, attitudes and points of view.

Instructional Contents : The instructional contents are the intended subject matter the learner should learn. In this case, is to self-learn the tawaf practical. The detail of the tawaf practical, or the type of important contents that the learner learns, could be a complete list. [41]. It should state that the contents of tawaf practical learning can be classified into four types: facts, procedures, concepts, and principles.

Learning outcomes: It is the goal to be achieved from playing the MR-Tawaf serious game. An intended learning outcome of MR-Tawaf self-directed learning is a particular combination of learner's capability and content. For example, the learner should be able to know the Hijr Ismail part that he or she cannot enter while performing tawaf. The typical examples of learning outcomes are based on the taxonomies of educational objectives. Moreover, with the learner's capabilities, it draws from the psychomotor, cognitive, and affective domains [41]. For example, the learner preview the tutorial before starts the SG to self-learn tawaf practical. Here, by introducing the concept of playing the SG, the learner has performed better in his or her tawaf ritual.

Game attributes : These are those aspects of an SG that support learning and automatically the learner's engagement too. The game attributes include:

- Incremental learning provides the learning materials and introduces the learning activities incrementally. Learners in a face-to-face umrah course will be provided with learning materials before they started to use the MR-Tawaf during the tawaf practical learning session or when they review the content at home. They will review by using the MR-Tawaf SG mobile app.
- Linearity is the extent to which the tawaf practical self-directed learning activities are sequenced by the level in the MR-Tawaf SG mobile app and the extent to which an active learner may be able to follow the instructions, recall what he or she have learned and constructed their own space for AR Kaabah by following the sequence.
- The cognitive processing and short-term memory loads placed upon the learner by the MR-Tawaf SG. The loads need to be carefully calibrated to the target learner who will use the mobile app.

- Scaffolding technique that will support and help provided in the MR-Tawaf SG during the tawaf practical self-directed learning activities.
- Transfer of learned skills of tawaf indirectly supported by the MR-Tawaf SG to enhance the application of previously learned theoretical of tawaf knowledge to other levels of the tawaf SG.
- Interaction is how the game activities require responses and learner's engagement.
- Learner control is how the learner can direct their tawaf learning activities within the SG, providing self-directed learning and self-exploration to suit their own pace. Most importantly, their own experience.
- Feedback is the intermittent response from the app at every MR-Tawaf SG level (at every round of tawaf) and when the learner does certain mistakes, feedback from the 2D mutawwif (the guide) in the app is provided.
- Rewards are arrangements in the MR-Tawaf SG to motivate and encourage the learner to keep on using the app and self-directed learning the tawaf practical so that their motivation is always high.
- The MR-Tawaf SG environment where the learner can relate their learning to their needs and interests in the outside world as if they are in the real environment on how to perform tawaf.

Game activity : Game activity is designed in MR-Tawaf is to keep the learner motivated, engaged, and learned something from the application. The motivation comes from the reward that will be given to the learner for every time he or she success completing the round of tawaf. The deep of the learner involvement or immersion by the learner are depends on the effectiveness of how the tawaf practical content is delivered. A number of methods for constructing learning activities have been suggested by [41] to support given intended learning outcomes. For example, if a learner needs to recall a concept, procedures, the rules, or the steps on how to perform tawaf, the learning activities would include showing the list of rules before performing the tawaf, for example, the checklist or the instructions followed by feedback to the learners.

Game reflection : Game reflection in MR-Tawaf SG here is where the learner thinks about the purpose of learning tawaf activities that have been undertaken. It will reflect the decision of making a strategy to apply during the next round of tawaf. The game reflection should take place within the game so that the learner will not step out of the MR-Tawaf SG. The reflection activity in MR-Tawaf is included within the SG by providing a description, instructions, explanation, feedback of the errors made by the learner, and some corrective suggestions or the possible penalty the learner would face.

Simulation : There are few types of game genres ranging from “beat-em-ups”, open-world sandboxes, strategy games, and simulation. MR-Tawaf SG is under the simulation game type. In addition, MR-Tawaf is developed and applied to the concept of serious games which is adopted for self-directed learning purposes according to game genres.

Game Mechanism : [42] has defined game mechanisms and game rules as the details of the game. In order to design a better SG for MR-Tawaf that suits self-directed learning, the target learner, and the intended outcome, involve the desired learning activities and required instructional content to influence the selected game mechanics.

Game achievement : MR-Tawaf SG provides a reward element in the mobile app. The achievement and reward (the scores) are indicators that the learner has knowledge about tawaf, how to perform tawaf, the rules, steps, and procedures on tawaf before start to self-learn using the MR-Tawaf mobile app. This is because for self-directed learning, what could motivate the learner to be engaged with the medium is to appreciate the effort and give rewards. In MR-Tawaf, the reward is given by award marks to the learner. This will indirectly will motivate the learner to always try his or her best to self-learn and fulfill every single rule and procedure in performing tawaf. So this is a game achievement in MR-Tawaf SG which is the level of learner achievement in playing the game. The reward (the scores) gives the pleasure to the learner. Game achievement indicates the level of learner knowledge while playing games.

V. CONCLUSION

As a conclusion, this paper highlighted how important the components of SG must be studied first before the mobile application is developed. As for MR-Tawaf SG, the relationship between those components shows that how they inter-related each other to achieve the goal and MR-Tawaf SG learning outcome. The MR-Tawaf SG framework has shown the major components applied in the mobile app that could create an effective model for self-directed learning through the use of serious games. Each and every component in this framework has its own role to ensure that learning would take place while playing the game. This has been proposed to MR-Tawaf mobile app as an appropriate foundation for effective SG design. These components for SG provide insights to domain experts what kind of game can be designed to provoke learners' interest, facilitate knowledge construction, motivate learners, and continuously engage with the MR-Tawaf.

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