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Design and Use of a Mobile Application to Prevent Teachers' Absenteeism in a Higher Education Setting

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Abstract—In this paper, we present a digital application developed to prevent teachers' absenteeism in a private university in Indonesia. In particular, we evaluated the development and the application of an Android-based attendance management system (AAMS) to monitor teachers' attendance and their teaching activity at a private university in the capital city of Jakarta, Indonesia. Adopting a design-based research approach, we observed the development procedure and interviewed three end-users of the application, i.e. teachers. The findings of the study revealed the potential use of AAMS as a digital tool to prevent absenteeism among university teachers. The three main challenges were highlighted during the application of AAMS, including the processing time duration and system error, the reporting and analytics issues, and the input manipulation. Furthermore, a recommendation is offered on the basis of the findings.

Keywords—Digital application, attendance management system, teachers' absenteeism, mobile application

1 Introduction

Teacher absenteeism is generally viewed as a teacher's intentional or episodic absence from schoolwork [1], [2]. Teachers are said to be absent if the school administrators are not able to find them in the schools for any cause at the time of a random unannounced spot check [3]. With respect to the reason for teachers' absence, Sagie classified teacher absenteeism into either voluntary or involuntary on the basis of the reasons for their absence [4]. Voluntary absences are led by the teachers' direct willingness to not attend a teaching session at school [1]. This type of absenteeism may be a result of job dissatisfaction and a lack of commitment to the institution [5]. The latter is often caused by particular circumstances beyond the control of the teacher, such as illness or discretionary or other conditions such as marriage, mourning and administrative responsibilities [6]–[8].

A body of literature has reported the negative consequences of teacher absenteeism at school on the students' achievement, school management and school expenses, as well as the school performance. A study conducted by Danteh, Yaboah, Sam and Monkah [9] in Kumasi, Ghana, for example, revealed that teacher absenteeism significantly lowers the students' performance in Basic Education Certificate Examination (BECE). Similarly, Miller, Murnane, and Willett [10] found that a substantial number of the absences are unauthorised, and a larger number of absences lead to significantly lower student achievement in a large urban school district in the northern part of the United States of America. Abayasekara and Arunatilake [11] also reported that student achievement is low in schools when the number of days of leave taken by the teachers is high. This was demonstrated using descriptive statistics which implied that the average number of teacher leave days was 15% of the total number of working school days.

In the context of developing countries, teacher absenteeism at schools has been a critical concern for the governments, educational bodies and, apparently, school administrators. A number of studies (i.e. Davies, 2018; Sabarwal & Sawdeh, 2018; Usman & Suryadarma, 2007) have found a high rate of teacher absences from their school itinerary. Iqbal, Muhammad, and Haider [15] investigated the causes of absenteeism among 100 public and private school teachers in Punjab, Pakistan. The results indicated that the rate of a public teacher's absence in the school was 54% per month, while that of the private teachers was 34%. Family reasons and sickness were observed to be the reasons for the absence of the public school teachers, while work dissatisfaction, job insecurity, and the work atmosphere were the reasons for the private teachers' absence in school. In addition, Mooij [16] conducted a longitudinal study in Pradesh, India, on the voluntary teacher absenteeism level. The findings revealed a high teacher absenteeism level because of poor infrastructural facilities, overcrowded classrooms, lack of motivation and inadequate training to deal with multi-lingual classes. The other reasons were related to the school context, such as the absence of rewards or incentives for the teachers to perform well.

More specifically in Indonesian school settings, McKenzie, Nugroho, Ozolins, McMillan, and Sumarto [17] carried out a large-scale study on the teacher absenteeism in Indonesian schools. The study was considered 880 primary and junior secondary schools across six regions—Java, Sulawesi, Sumatra, Kalimantan, Papua and Maluku, and Bali and Nusa Tenggara—including 8,300 teachers and 8,200 students. The researchers observed the classes and conducted interviews with the principals, teachers and district-level officials. They examined not only the teachers' chronic absence from school but also the teachers who, although present in school, did not attend a class or teach as scheduled. Unfortunately, the findings revealed that the teachers' truancy was generally higher in rural schools than in urban schools because the teachers worked at more than one institution and because of poor physical facilities. The truancy occurred over a loss of control from the district education office, school principals, as well as the students' parents or guardians. Moreover, the principal's contribution to the truancy was critical as they did not attend school themselves nor provided a positive role model to the teachers.

Many researchers have identified several factors contributing to teacher absenteeism, one of which concerns a teacher's low effort to attend class. In a recent study, Sabarwal and Jawdeh [12] explored the issue of teachers' low effort to maintain good class attendance, particularly the concept of 'mental models' that lead to a teacher's absence in school. Examining the data of 16,000 teachers across developing countries such as Afghanistan, Argentina, Indonesia, Myanmar, Pakistan, Senegal, Tajikistan, and Tanzania (Zanzibar), these researchers found that teacher absenteeism was tolerable under certain conditions. The findings also suggested that many teachers considered the following types of absenteeism to be acceptable at school:

- When the prescribed curriculum had been completed
- When the students were left with assignments to complete
- When the teacher was doing something useful for the society.

The study also showed that teachers in these countries believed that being assessed on the basis of the students' learning was sufficient to determine their performance. Sabarwal and Jawdeh [12] argue that teachers might not seem to increase this effort as they might not think they could or should do so. If teachers are enabled to identify their present levels of work as well as efforts to be "socially optimal and contextually justified, then they are less likely to increase effort in response to a change in the accountability and incentive structures" [12, p. 11].

The recent developments in the field of information and communication technology have offered alternative solutions for monitoring employees' attendance in particular organisations, particularly the teachers' attendance in schools (e.g. Duflo, Esther, Dupas, & Kremer, 2011; Ujan & Ismaili, 2011). Many researchers have suggested the use of an attendance management system (AMS), an alternative technology application developed to help an organisation manage manpower notes and analysis, day-to-day monitoring of attendance, maintenance of statutory registers, monitoring of leave records, calculation of overtime and transfer of the relevant information to the payroll system [20], [21]. AMSs can be generally categorised into four application types, namely manual systems, biometric systems, card-based systems, and e-commerce systems [22].

Baffoe [23] investigated a biometric AMS application called Rapid Application Development (RAD) in the rural educational institutions of Ghana. The findings showed that RAD provided the schools with an efficient way of generating reports and retrieving the attendance information of teachers in the rural districts. However, the application of a biometric system to manage the teachers' attendance can unfortunately raise a number of concerns. For example, for user enrolment, the users' fingerprints should meet the requirements of cleanliness, dryness, and a lack of scratches and/or swelling [24].

In addition to the AMS application, an Android-based e-commerce system has been considered an alternative that enables organisation managers to monitor not only the employees' attendance but also their efficiency [22]. Joshi, Shete, and Somani [25] evaluated an Android-based application for AMS for the advancement of institutional and educational systems in India. The proposed project was implemented in applications such as online study material, announcements of events and examinations, academic calendar, online attendance record, performance record, and even parent intimation system using Android applications. The findings of the study showed that the system helped the teachers to maintain their own attendance through a smartphone and to monitor their students with respect to the students' assessments and attendance.

Bhattacharjee, Kundu, Raychaudhuri, and Chakraborty [26] introduced an AMS application compatible with all Android versions starting from 4.2 Jelly Bean. They connected the application to the college server so as to access and update the attendance over the college LAN. The application involved various items such as registration, courses and attendance for various purposes which shall be discussed later. The application allowed the addition of courses by the teacher and the addition of students to the respective courses. When a course was ready, it was visible in the selection area for marking attendance, checking the attendance percentage and even checking the date-wise attendance. After the app integration, the researchers found that the Android-based attendance application operated at a high level of efficiency. It appeared to be safe, easy and less time consuming. The app was user friendly and did not require the user to be close to the main system. Finally, the findings suggested that the storage, retrieval and evaluation of the users' data were performed with minimal errors and within the smallest-possible amount of time.

Investing in a system that keeps teachers present in the classroom should be considered as a priority for school managements, administrators and policymakers. A key part of this effort is to develop an appropriate school system which captures the daily attendance of the faculty members, generates faculty attendance reports and analytics, provides an absence notification system for the faculty members, chairperson and the dean, and includes an immediate communication system concerning the absences incurred [27]. The current study aimed at evaluating the development and application of an Android-based AMS (AAMS) to monitor teachers' attendance and their teaching activity at a private university in the capital city of Jakarta, Indonesia. To this end, the study documented the structure and the development process of AAMS and explored the perceptions of teachers towards the use of such an application to monitor their attendance and teaching activities.

2 Method

The current study was a part of a bigger project evaluating the role of technology to prevent teachers' absenteeism in higher education settings. In the study, we evaluated the development and application of AAMS to monitor teachers' attendance and their teaching activity at a private university in the capital city of Jakarta, Indonesia. To this end, the study documented the structure and the development process of AAMS and explored the perceptions of three teachers about the use of such an application to monitor their attendance and teaching activities in the classroom.

The study adopted a design-based research (DBR) approach to address the research objective. In educational research, Fishman, Penuel, Allen, Cheng, and Sabelli [28] argued that DBR allowed the researcher to design and test a particular innovation within real-world educational settings. The main objective of this research approach is to enable 'the impact of educational research and generate generalisable design principles' [29, p. 16]. To this end, in the current study, we worked closely with IT developers to gain the insights from the AAMS development procedure and observed the application of AAMS at a private university. We also explored the perception of three teachers as the end-users.

3 Narrative Development and Findings

The AAMS considered in the current study was an Android-based application developed to provide a system interface that monitors teacher attendance in classrooms. The interface system, later called U-Mobile, uses a client–server based model to allow engagement between clients and servers [30]–[33]. The system was developed using several tools, including MySQL server database, Apache, Android Apps Native and Application Programming Interface (API). U-Mobile was connected to a phone's GPS which limited the access of the application only to a particular position. This restricted the potential attempts by teachers to manipulate the data input.

To use U-Mobile, teachers were asked to download the application from Google Play Store and install it on their mobile phones. After the installation, the teachers were asked to log in to the application by using the usernames and passwords already given to them by the faculty administration. Figure 1 shows the login page and the welcome screen.

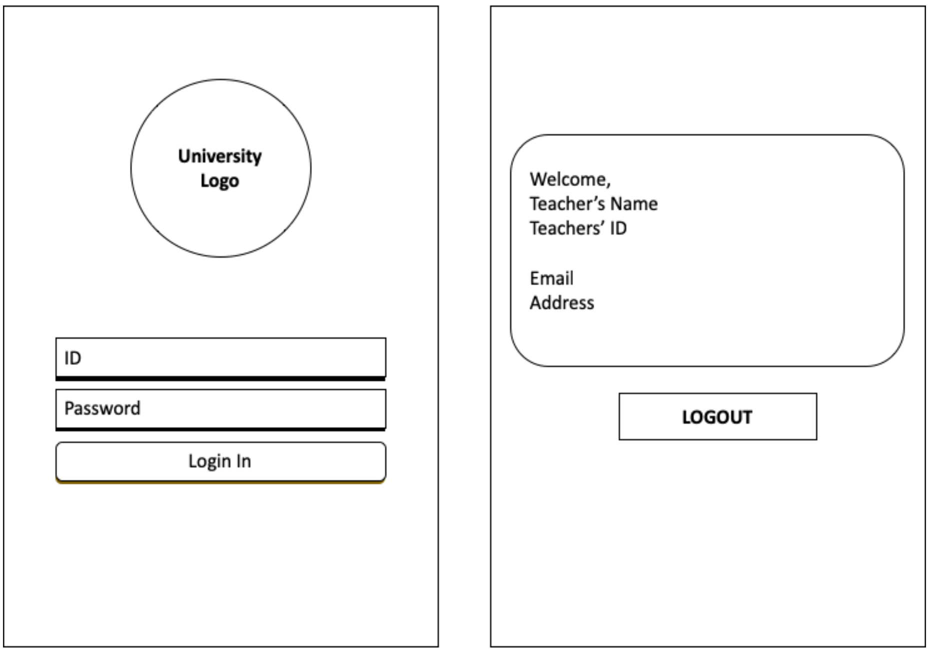

Fig. 1. Login page (left) and welcome screen (right)

U-Mobile features 12 menus, including attendance, teaching schedule, students under supervision (PA), examination schedule (exam), essay, supervisory schedule, information, room, two next menus, chat and help desk (see Figure 2). Unfortunately, six of these twelve menus did not function well or did not work at all (e.g. users were unable to click on information, two next menus, chat and help desk).

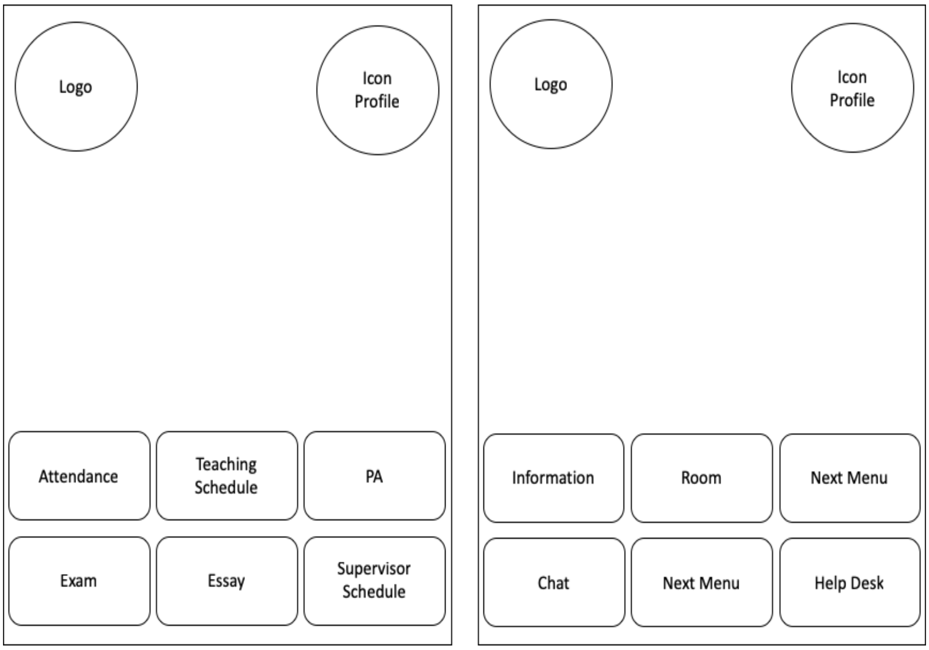

Fig. 2. Screen menu page 1 (left) and screen menu page 2 (right)

Of these 12 menus, the attendance feature was used by the faculty administration to monitor both teachers and students. The feature required the teachers to complete three tasks: check students' attendance in the classroom, describe the topic being taught and save the data to the system (see Figure 3). In each teaching session, first, the teachers had to monitor their students' entry into the classroom and check their name in the application to mark their attendance. Teachers were also required to record the topics that they were teaching at the time and save them to the system. Teachers were counted as present in the class only if they completed these tasks and the save operation was successful.

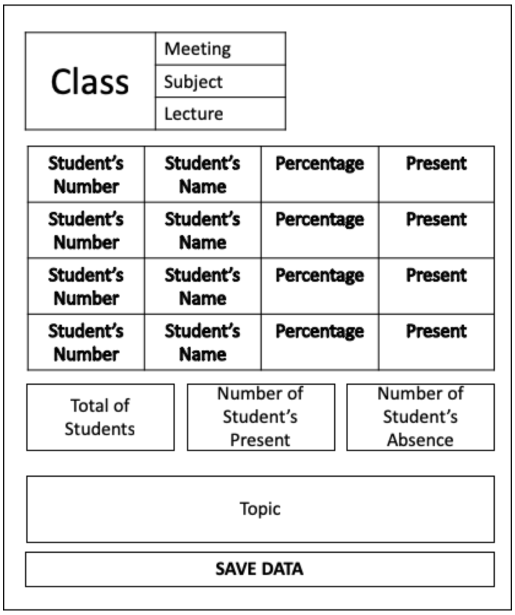

Fig. 3. Attendance menu in U-Mobile

Technically, the U-Mobile application was user-friendly, allowing the end-users to operate the application at their ease. During the pilot, none of the participants reported any technical issues. Instead, they mentioned that the application screen used soft colours in the background which was comfortable for their eyes. They also reported that the icon menus with the accompanying texts provided them with information about how to navigate in the application.

U-Mobile was observed to effectively capture the daily attendance of teachers and record each of the teaching sessions on a day-to-day basis. The data inputs to the system by the teachers were stored directly to two databases: the academic bureau and the faculty administration bureau. This allowed immediate communication to the related parties in the bureaus concerning the absences incurred [27].

However, we identified three critical issues concerning the application, namely processing time duration and system error, reporting and analytics issues, and input manipulation. Each of the issues is discussed below:

3.1 Processing time and system error

The processing time required for the application to store the data into the central database at the faculty administration was considered acceptable. As mentioned earlier, the attendance feature in the application required the teachers to not only mark their attendance but also monitor their students' entry into the classroom. The student monitoring activity had to be performed one by one by checking the students' names in the application to mark their attendance. Note that each marking attempt required 3–7 s for the system to store it into the central database. For a class of 40 students, the marking took approximately 3–7 min. The total time that the teachers spent to complete the tasks in the attendance menu ranged from 5 to 15 min depending on the speed of the Internet connection on the site.

All the participant teachers interviewed mentioned that tasks were frustrating because of a bad Internet connection on many sites across the faculty buildings. They also asserted that the marking menu icon frequently did not function well and displayed the message 'underdefined' (see Figure 4).

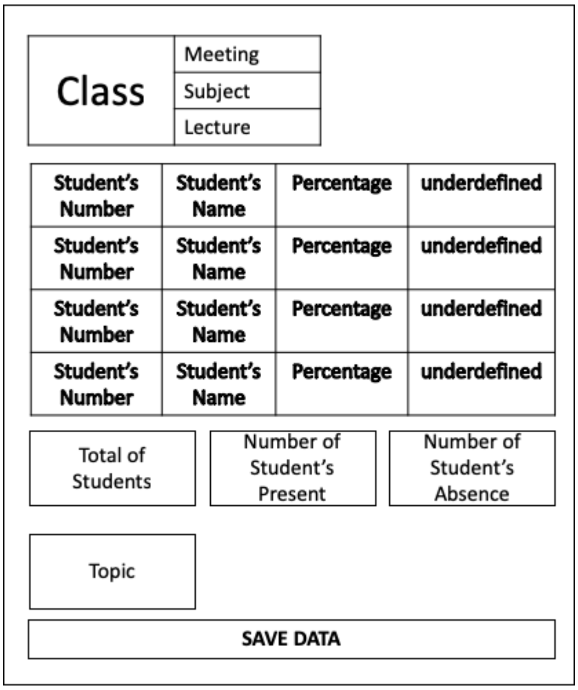

Fig. 4. System error in attendance feature

The effect of the long processing time and the system error was significant for the teachers. The teachers felt that monitoring students' attendance through the application reduced their teaching duration and thus affected their teaching plans. One of the teachers said:

'I tried several times to click on the menu, and it did not work at all. Obviously, this wasted my time. I had two teaching sessions of 100 min, and I spent more than 10 min only for this unsuccessful students' checking.' (Teacher B)

The teachers also reported the negative effect of the system error on their work performance and incentives. They mentioned that the error had caused them to not complete the required attendance set by the faculty administration and thus lowered the financial incentives they received. Teacher A confirmed:

'I lost about Rp. 300.000 (or USD 21) last month because of the system. I thought the system would automatically record my attendance when I marked the students'

attendance in the application. But, in fact, it did not. I tried to clarify this issue to the administration. When I met them, I was told that the system recorded me as not attending the classroom teaching. They told me to also complete my teaching report manually. This was ineffective, really.' (Teacher A)

Many researchers have reported the role of financial incentives in improving teachers' attendance in teaching classrooms [17], [34], [35]. Balu and Ehrlich [35], for example, suggested that financial incentives could improve the teachers' attendance in the teaching classroom. The fact that the U-Mobile system error made it impossible to record the teachers' attendance appropriately might directly affect the teachers' financial incentives and thus would negatively impact the teachers' attendance in the future.

3.2 Reporting and analytics issues

As discussed earlier, U-Mobile benefited the faculty administration in that it helped them record the teachers' attendance on a daily basis [27]. Unfortunately, we observed that the system did not feature the report menu for teachers as the end-users. The absence of reporting menu has restricted teachers from generating their attendance reports and analytics. As in the case of Feature 3, the teachers were only informed about the percentage of students' attendance and the number of students attending the classroom sessions. Such an absence put the teachers at a disadvantage in that they were not given a tool to help them reflect on their participation in classroom teaching.

3.3 Input manipulation

Earlier, we mentioned that U-Mobile was integrated with the end-user phone's GPS system where it was allowed to use the end-user's position data and link it to the central database. This integration enabled the system to monitor the end-user's position and only allowed teachers to input data from a particular position. The findings from the observation and the interviews with the teachers revealed that many of the teachers manipulated their attendance by modifying the GPS data input. Teacher C said:

'I was surprised that I could mark my students' attendance from the traffic light which was more 500 m away from the main building I taught in." (Teacher C)

Although, many teachers believed that the input manipulation was motivated by their personal intention, but because of the U-Mobile system, they could not reliably record their position. Teacher A, for example, asserted:

'I believed something wrong had happened with the application. I was in Building D, but it was strange that the application restricted me from inputting the attendance data.' (Teacher A)

Teacher B added:

'One of my students said to me that he could use the application from home. He showed me an application that allowed users to manipulate their position. I tried to download and install a fake GPS application into my phone. It worked!' (Teacher B)

4 Conclusions

In the current study, we evaluated the development process and the application of U-Mobile as a technological tool to monitor teachers' attendance and their teaching activity at a private university in the capital city of Jakarta, Indonesia. The teachers perceived the use of U-Mobile to monitor their teaching attendance as positive. However, three main challenges were identified during the project implementation, namely processing time duration and system error, reporting and analytics issues, and input manipulation. The further development of U-Mobile should address these three challenges. In this current study, we only involved a small number of participants which accordingly could not represent the overall view of university teachers about the use of U-Mobile. Further research is thus needed to address the effectiveness and the teachers' perception of the AAMS application in higher education settings with a relatively large sample.

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Improved Direct Routing Approach for Mobile IP Systems

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Abstract—The mobile IP communication protocol is a flexible system for mobile connection that is designed to allow the device to be moved between networks while maintaining a permanent IP address. IP datagrams using mobile IP can be routed to a specific mobile station (MS) regardless of its current internet location. However, to facilitate such routable characteristics, the communication with an MS that is visiting a foreign network is intermediate with communication between the home agent (HA) and the foreign agent (FA) which increase the total delay and harms the communication performance, especially when the MS continuously moves from a network to another. Accordingly, to handle the delay issue, this paper proposes a new approach for mobile IP direct routing, based on the "follow-me" principle. The proposed approach depends on sending a new temporary care-of-address (CoA) for the previously visited network as the MS moves to another to keep a reliable tracking–like process with the HA. Accordingly, the agents of all the visited networks play the same principles as the HA role whenever the MS moves from a network to another. The proposed approach influences the delay and the speed of the delivery of internet packets. The simulation showed that the proposed method decreases the delay by up to 50% compared to the direct routing approach.

Keywords—Mobile IP, Routing, Care of address, Home Agent, Foreign Agent

1 Introduction

Mobile IP technology has been developed to ensure that a user of any mobile device can move from one network to another while maintaining a permanent IP address [1]. As a location independent, using mobile IP allows the IP datagrams to be routed by identifying each mobile station (MS) with a home address regardless of its current internet location. Accordingly, if the MS is positioned away from the home network, it is associated with a particular address, known as the care-of-address (CoA), which identifies its current location using the endpoint [2]. Generally, mobile IP is responsible for the registration of the MS with the home agent (HA) and routing the datagrams via the tunnel to the MS. The mobile IP usually maintains the TCP connection between the static and the mobile hosts and reduces the effects that are resulted from the mobility of the device; therefore, it helps to keep the TCP connection intact [10]. As such, mobile IP is often regarded as a communication protocol that is controlled and standardized by the Internet Engineering Task Force (IETF).

MS is associated with two addresses, the care-of-address (CoA) and the permanent home address. For the implementation of the Mobile IP, two main entities play critical roles in the network connectivity; these are Home Agent (HA) and Foreign Agent (FA). HA stores the information concerning the MSs [3], maintains the entries of the MS location in the directory and acts as a router within the home network of the MS. Accordingly, HA ensures the delivery of datagrams through the tunneling technique to the MS. FA stores the information about all the mobile devices that are visiting the network and advertises the CoA [1]. The FA communicate with the MS to deliver and de-tunnel datagrams, which are then tunneled through the HA by the mobile host. In the absence of FA in the host network, the mobile device has to take over the responsibility of advertising and to address itself. In this case, the FA is usually apprehended as a router that offers a routing service and operates within the network that may be visited by various MSs [4]. This mechanism forms a unique architecture for the mobile IP as illustrated in Figure 1.

Mobility management provides seamless connectivity and session continuity between an MS and the network during its movement. HA is a central entity that tracks the movement of the IP address to keep MS connected and anchoring traffic from source to destination through point-to-point tunnels. The mobility challenge in mobile IP technology is growing with the rapid growth of mobile communication over IP, and the traffic in mobile IP technology will exceed wired communication in terms of the traffic load [5]. According to Cisco [6], the traffic load of the mobile data will be increased by a factor of 11 from 2013 to 2018, and 61% of the IP traffic will be dedicated to the routable devices. Accordingly, reducing the unnecessary traffic generated by changing the MS location is necessary to improve the performance of the network and reduce the total delay. Generally, the traffic is duplicated by the routing process in the mobile IP, in which both HA and FA intermediate the communication of a visited MS to facilitate its connectivity.

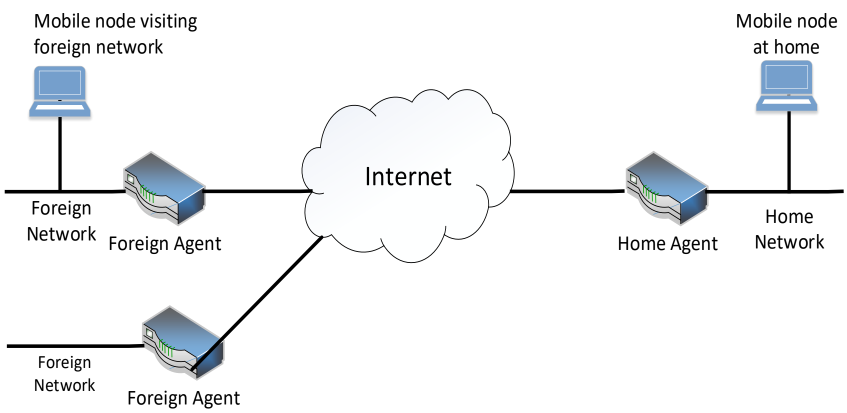


Fig. 1. Mobile IP Network Architecture

Two approaches are used to facilitate the mobile IP routing process; these are direct and indirect. These routing approaches showed robust features in routing the IP datagrams from a correspondent (CN) and MS, yet, each of which has its scalability limitations with routing via the anchor point. This limitation affects the performance of the network in general in terms of delay and transmission rate. Although the anchorless alternative is not possible due to the architecture of the Mobile IP technology, an enhanced anchor-based approach can be implemented by reliable tracking–like process with the HA in order to reduce the communication overhead while the MH is moving from a network to another.

This paper proposes a new approach, referred to as "follow me" approach that decreases the delay and increase the speed of the data transmission by sending a new temporary IP address (CoA) for the previously visited network as the MS moves from one network to another. The proposed approach keep the HA updated with the MS address by sending a temporary CoA continuously. Although updating the HA with MS routing required extra traffic load, it is trivial compared to the extra traffic load added by both the direct and indirect approach via the anchor point. Accordingly, the proposed approach decreases the load and total delay. Moreover, the proposed approach depends on ease the dependence on the anchor point to save the bandwidth. The detail of the proposed approach will be discussed in the following sections. The rest of the paper is organized as follows: Section 2, presents an overview of the direct and indirect routing approaches. Section 3 discusses the related work on mobility management in mobile IP technology. Section 4 presents the proposed work and discusses the technical details of the "follow me" approach. The experimental simulation results are presented in Section 5. Finally, the conclusion is presented in Section 6.

2 Mobile IP Routing: Overview

In the Mobile IP indirect routing approach, the CN sends a packet addressed by an MS's permanent address to the home network. Accordingly, there is no difference in the routing process in case that the MS is located in its home network or is visiting a foreign network. Thus, mobility is entirely transparent to the CN. In the transmission process, the packet is first forwarded as usual, to the MS's home network. Then, the HA interacts with an FA to trace the mobile station's CoA, as illustrated in Figure 2. The HA also looks out for packet arrival that is addressed to the MS whose home network is that of the HA, but that is currently located in a foreign network. The HA receives these IP packets and then forwards them to a mobile station in a two-step process [7]. First, the packet is forwarded to the FA, using the MS's CoA. Second, the packet is forwarded from the FA to the mobile station [8]. The HA needs to address the packet using the MS's CoA so that the network layer will route the datagram to the external network using the traditional routing algorithms. HA always encapsulates the CN's original datagram with a new larger datagram, which is addressed and delivered to the MS's CoA. The FA, who owns the CoA, will receive and de-capsulate the packet and extract the correspondent's original packet from the larger encapsulating packet [3, 9] before forwarding the packet into the MS.

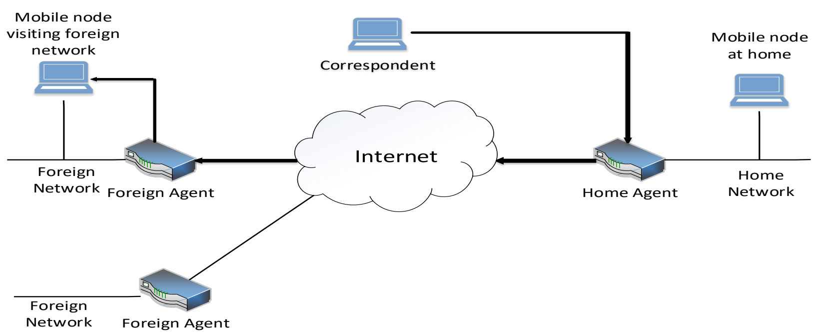


Fig. 2. Mobile IP Indirect Routing

The indirect routing approach suffers from an inefficiency known as the triangle routing problem because the datagrams addressed to the MS must be routed first to the HA and then to the FA. Direct routing of mobile IP is a process in which a correspondent sends the IP packet(s) to an MS without passing through the HA. The route that is adopted by the packet for traveling is called direct route, and the process implemented by such route is called direct routing. In the mobile IP direct routing approach, a CN sends a request to an HA for the address of the MS. After receiving the permanent mobile address or the current CoA of the requested MS, the CN directly forward the packet(s) to the network where the MS is currently located, as illustrated in Figure 3 [10].

Accordingly, the direct approach reduces the dependency of the HA in forwarding the transmitted packets to the moving device, yet, the CN has to request for the address from the MH while transmitting the first packet. While this is small communication overhead, the significant communication overhead results when an MS keep moving from a network to another as packets are addressed to it, leading to another situation that is similar to the indirect approach. A comparison between the direct and indirect approaches based on the responsibility of the involved nodes is given in Table 1 [11, 12].

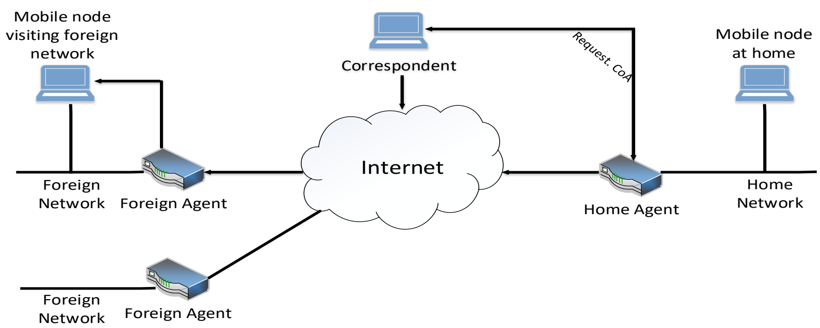


Fig. 3. Mobile IP Direct Routing

Table 1. Comparison between Direct and Indirect Approach

	Indirect	**Direct**
HA	Receives all the transmitted packets and transfers them to the FA.	Receives the first transmitted packet and transfers it to the FA. Receives and provides the CoA.
FA	Receives all the transmitted packets and transfers them to the MS. Traces the CoA of the visiting MS.	Receives the first transmitted packet and transfers it to the FA. Registers CoA to the visiting MS.
MS	Registers CoA with the FA	Registers CoA with the FA
CN	Sends all the transmitted packets to the HA.	Sends the first transmitted packet to the HA and communicates directly with the MS.

3 Related Work

The mobile IP routing approach allows users to move between networks and continue receiving the incoming session requests and support sessions in progress [13]. The previously discussed approaches for routing the mobile IP have disadvantages that have been addressed in the literature. Wong and Leung [14] compared between the performance of the direct and indirect approaches and conclude that "careful design is necessary in order to reduce the signaling and processing overhead for location update." Ho and Akyildiz [15] and Li et al. [16] provided an estimation of cost for the mobility of the mobile nodes across networks. Based on the conclusion of the cost estimation, various approaches for minimizing the communication overhead in mobile IP routing have been proposed. The researches for improving the mobility management have taken different directions, which can be summarized as follows: Estimation nodes' location for cost reduction, decentralization the communication using agents other than the network agent (i.e., HA and FA) for overhead reduction and estimating the closest agent for overhead reduction.

Choi and Tekinay [17] minimize the overhead of the location management process adaptively by predicting the mobility pattern. The adaptive estimation of the mobile location that is moving is only possible if the speed and path information is available and the mobility is taken place at a certain speed on a directed path. Adaptive estimation cannot be used to locate a randomly moving station. Thus, before the location is estimated, the history of the mobile movements are used to determine whether the location can be automatically estimated or not. Accordingly, adaptive estimation eliminates the need for further communication to locate the moving device. Similarly, Taheri and Zomaya [18] proposed an approach based on data clustering algorithm in order to estimate the location of the moving devices. The history of a device movement is used to predict the future movement of the node. The clustering algorithm is used to discover the network topology and automatically determine the routing path.

Zheng et al. [19] proposed an approach that allows the visiting node to use a temporary agent in the visited network. Accordingly, communication is intermediate with dynamic HA (DHA) to reduce the risk of a single point of failure and provide a flexible system. DHA assigns a temporary home address to the visiting node to shorten the distance between the visiting node and the HA, which in turn reduce the handoff latency.

Yen et al. [20] proposed a Global Dynamic Home Agent Discovery (GDHAD) that allows the visiting node to use the nearest HA through anycast protocol that discovers the closest HA to every node. This approach reduces the cost and delay of registration with the original HA. Cuevas et al. [21] proposed another distributed HA-based approach to reduce cost and latency. The proposed approach is based on peer-to-peer HA discovery. The proposed approach depends on overlay peer-to-peer networks formed by multiple HAs. Each HA has information about the location of the other HAs. An MS sends its current location to the current HA continuously and the current HA lunches a discovery process to find the closest HA to the MH. The current HA sends the MH the IP addresses of the closest HAs, who in turn connect to one of these HAs. Motoyoshi et al. [22] proposed a similar approach for locating the closest HA. The MH sends a registration request to the current HA, who maintains the path and history information of the MH and the distributed HA. The current HA finds the most suitable HA based on the history maintained and starts the delegation procedure with the selected HA. The current HA sends an acknowledgment to the HA as the delegation completed. Chen et al. [23] propose a mobility management approach to reduce the cost of communication using a Markov process that analyzes the tracking cost of the device mobility. A mobile subscriber (MS) grouping and equivalent quadrangular area are used to reduce the communication overhead with the stations. A summary of the reviewed literature is given in Table 2.

Table 2. Comparison between Mobile IP Routing Enhancement Approaches

Approach	Goal	Approach Description
Choi and Tekinay [17]	Estimation nodes' location for cost reduction.	Adaptively predicting the mobility pattern to determine the location.
Taheri and Zomaya [18]	Estimation nodes' location for cost reduction.	Estimates the location of the moving devices using network topology analysis.
Zheng et al. [19]	Decentralization communication using agents other than HA.	Allows the visiting node to use a temporary HA in the visited network.
Yen et al. [20]	Estimating the closest HA	Allows the visiting node to use the nearest HA through anycast protocol.
Cuevas et al. [21]	Estimating the closest HA	The proposed approach is based on peer-to-peer HA discovery in overlay peer-to-peer networks.
Motoyoshi et al. [22]	Estimating the closest HA	HA maintains the path and history information of the MH and the distributed HA to find the suitable HA.
Chen et al. [23]	Estimating the closest HA	Uses a Markov process that analyzes the tracking cost of the device mobility and finds the best HA.

Although the existing literature addressed the problem of delay and communication overhead by locating and communicating with the HA of the visited network, the solution to the cost of registration and intermediate communication are still challenging the mobile IP technology. Accordingly, a new approach for mobile IP routing is required to solve this problem, which will be addressed in this paper.

4 The Proposed Approach

A new approach called *Follow me* is proposed by improving the commonly utilized direct routing approach for mobile IP. The proposed approach depends on sending a new temporary IP address (CoA) for the previously visited network as the MS moves to another network. Besides, the mobile node also registers its new CoA in its home network to keep a reliable tracking–like process with the home agent (HA).

4.1 The "Follow me" CoA registration process

A mobile station (MS) in mobile IP can be moved from a network to another. Accordingly, a mechanism for CoA registration is required with the HA and FA. *In follow me* approach, when the MS moves from its home network to any foreign network, the foreign agent (FA) of a host network immediately sends a new temporary IP address (CoA) for the visiting MS. The MS then registers its new CoA in its home network. Then, when the MS leaves the visiting network and moves to another, the previous CoA will be discarded, and a new CoA from the current network's FA will be received and registered with the HA and the previously visiting network's HA. Accordingly, if no transmission process is being implemented while the MS moves, a correspondent will ignore the old CoA immediately after receiving the new CoA. However, if a transmission process is implemented while MS moves, the agent of the previously visiting network will receive the packets and transmitted them to the MS based on the recently received CoA. Then, after the internet session between MS and a CN is terminated using the TCP 3-way handshaking, the CN will use only the MS permanent IP address for the future connection with the underlying MS. To explain the process of CoA registration for the proposed system, an example of an autonomous network system is illustrated in Figure 4.

As given in Figure 4, the MS left the home network and moved towards a foreign network (FN_1). After a while, the MS moves to FN_2, FN_3, FN_7 and finally to FN_n. Each time it moves, the MS receives a temporary address, which is then registered with the home network of the MS and is sent directly to the previous FN. Assume that the MS receives CoA_1 from FN_1 for T_1 period when it moves to the first foreign network, where T_1 is the time the MS will remain in the network associated with FN_1. A session was in progress with a particular CN when MS moves from HN to FN_1. The MS sends its new temporary address CoA_1 to the HA and to the CN to ensure the internet session remains in use. Then, when the MS leaves FN_1 and moves towards FN_2, it will lose CoA_1 and receive a new temporary IP address CoA_2 from FN_2. The MS will send CoA_2 to the FN_1 and the HA. During the mobility of MS, when it will move through *FN3*, the same process of CoA registration will be repeated using CoA_3 from FN_3 then CoA_4 from FN_7 followed by CoA_5 from FN_n. Accordingly, the MS always sends the new CoA to the previously visited network to notify it about its current address. Thus, if a packet is being transmitted while the MS is moving, the notified FA will direct the packet into the address that is sent by the moving MS. In such a way, re-transmission is avoided in all cases, which reduce the delay and enhance performance. The process of registering and distribution of the MS for the example that is given in Figure 4 is illustrated in Figure 5.

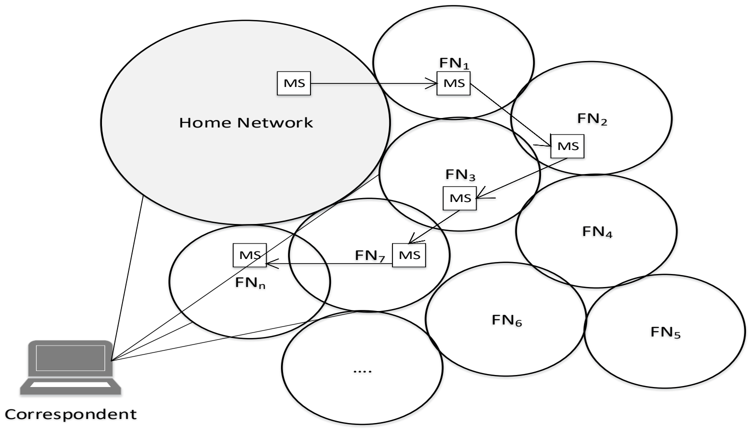


Fig. 4. Example of a Mobile station Mobility process

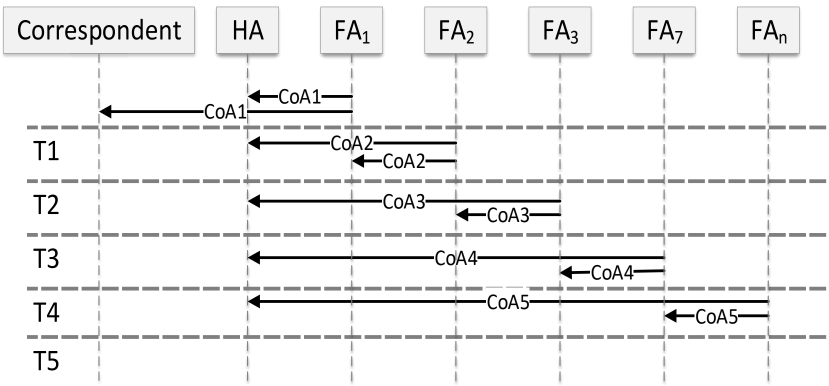


Fig. 5. Mobile IP "follow me" Direct Routing CoA Registration

4.2 The "Follow me" packet delivery mechanism

Packet delivery mechanism in the proposed follow me approach is implemented based on the location of the MS. The first scenario occurs when the MS is located within the home network. In this case, the CN will directly send a packet to the HA using the traditional internet routing techniques, taking into consideration the fact that the destination IP address of the packet is the mobile's permanent address. As the mobile is located within the home network scope, the packets will be directly forwarded to the desired MS. The MS then receives the packet and gives the required responses as requested. While when the MS is located within a foreign network, the MS will have a temporary address that was obtained from the foreign network and registered with the network agent(s). The CN transmits a packet to the MS, based on the CoA according to the following scenarios:

- The CN directly sends the first IP packet to the HA who will encapsulate the packet and forward it to the last visited network. After that, HA sends a particular service packet that contains the CoA to the CN that enable CN to send packets directly to MS without referring back to HA.
- The CN sends a request to the HA to inquire whether the current IP address of the MS is MA or CoA. After receiving the address, the corresponding network forwards the packet directly to the MS that is located in a visiting network.
- The CN sends a request to the HA to inquire whether the current IP address of the MS is MA or CoA. After receiving the address, the corresponding network forwards the first packet directly to the MS that is located in a visiting network.

The most critical scenario occurs when CN is transmission packets while the MS is moving to another network while. The previous FA forwards the packet from CN to the first network, and the previous FN will inform the CN about the new CoA for the MS. Accordingly, using the proposed packet delivery mechanism, the end to end delay will be enhanced, and the reliability of the transmission will be improved through the prevention of packet loss that may occur due to the movement of the mobile station in the visiting networks. The proposed mechanism minimizes the communication with the HA, as the correspondent refers to the HA only if the transmission is failed. Moreover, the FA will also have less overhead as the MS is responsible for acquiring the CoA once.

Example of the packet delivery mechanism in the proposed *follow me* approach compared to the traditional direct approach is illustrated in Figure 6. Assume that the CN sends the first packet directly to the MS that is located in R12. The MS moves to R9, and the packet from CN to R12 is not delivered. In the traditional direct approach, the CN will contact the HA for new CoA for the moving device then the packet will be sent again from the CN to R9. In this case, the total delay will be the end-to-end delay plus the encapsulation and de-capsulation process time for the two transmission attempts. While in the proposed follow me approach, R12 will inform for the CN about the new CoA for the moving device and the packet will be forwarded from R12 to R9. Accordingly, the time consuming double transmission will be eliminated using the *follow me* approach.

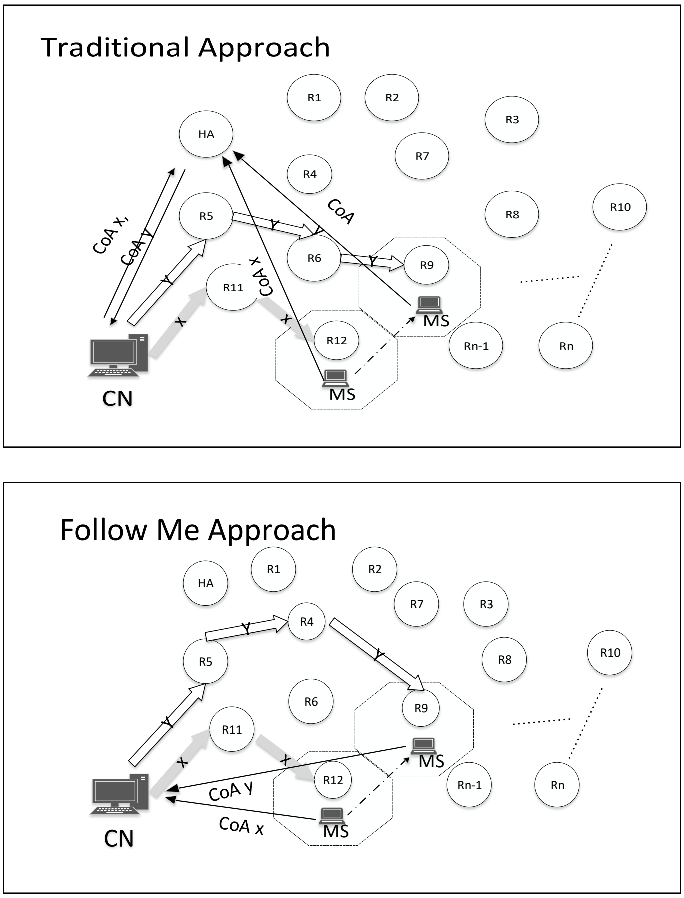


Fig. 6. Packet Delivery Process in Follow me and the Traditional Direct Routing

5 Comparison, Simulation, and Results

Numerical analysis and simulation are conducted to evaluate the performance of the proposed approach. Accordingly, six scenarios are implemented for the mobility of the devices, and the total delay at each scenario is calculated. A summary of the scenarios is given in Table 3.

Accordingly, there are three different delays in any of these scenarios; these are transmission delay (Ds), Encapsulation and de-encapsulation delay (Den) and CoA transmission delay (DCoA). These different forms of delay based on the depicted scenario will be evaluated using numerical simulation and mobile simulation. In the numerical analysis, without loss of generality, we assume that the transmission delay is identical regardless of the identity of the sender and the receiver nodes. Accordingly, we also assume that the transmission delay and the CoA transmission delay are identical. Accordingly, the delay of each of the depicted scenario is calculated as given in Table 4.

Table 3. Comparison between the Direct Approach and Follow me Approach

Scenario		Direct Approach	Proposed Approach
Located Node in the Home Network	First Packet	S1: Total delay is equal to the transmission delay as the packet is sent directly.	
	Other Packets		
Located Node in a Foreign Network	First Packet	S2: Total delay is equal to the transmission delay from CN to HA and HA to MS plus the encapsulation delay.	
	Other Packets	S3: Total delay is equal to delay of sending a particular service packet that contains the CoA to the CN after the first packet and the transmission delay from CN to MS plus the encapsulation delay.	
Relocated Visiting Node	First Packet	S4: Total delay is equal to the transmission delay from CN to HA and HA to departed network and the encapsulation delay. Besides, the delay of encapsulation and re-transmission delay n-times, to n-networks that are visited by the MS while the packet is transmitted.	S5: Total delay is equal to the transmission delay from CN to HA and HA to departed network and the encapsulation delay. Besides, the delay of re-transmission delay between n-times, to n-networks that are visited by the MS while the packet is transmitted.
	Other Packets	S6: Total delay is equal to delay of sending a particular service packet that contains the CoA to the CN after the first packet and the transmission delay from CN to MS plus the encapsulation delay.	

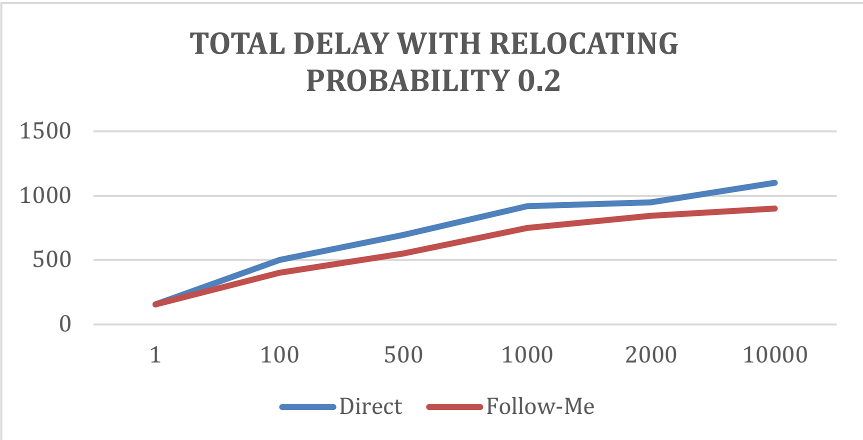
Table 4. Representation of the Total Delay in the Direct Approach and Follow Me Approach

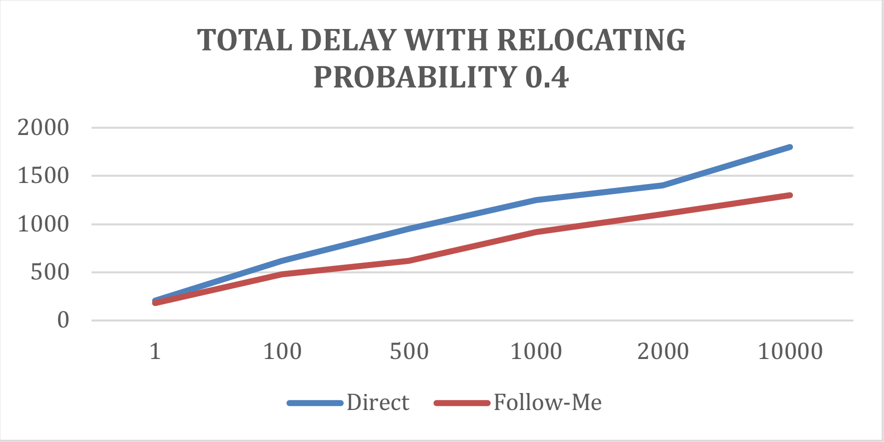
Scenario	Equation	Unity Measure
S1	$D_{total} = Ds$	1
S2	$D_{total} = Ds_{CN-to-HA} + Ds_{HA-to-FA} + D_{en}$	**3**
S3	$D_{total} = Ds_{CN-to-HA} + Ds_{HA-to-FA} + D_{en} + D_{coA}$	**4**
S4	$D_{total} = Ds_{CN-to-HA} + (\sum_{i=1}^{n} Ds_i) + (\sum_{i=1}^{n} D_{coA\,i}) + D_{en}$	**2n + 2**
S5	$D_4 = Ds_{CN-to-HA} + \sum_{i=1}^{n} Ds_i + D_{coA\,i}$	**n+2**
S6	$D_{total} = Ds_{CN-to-HA} + Ds_{HA-to-FA} + D_{en} + D_{coA}$	**4**

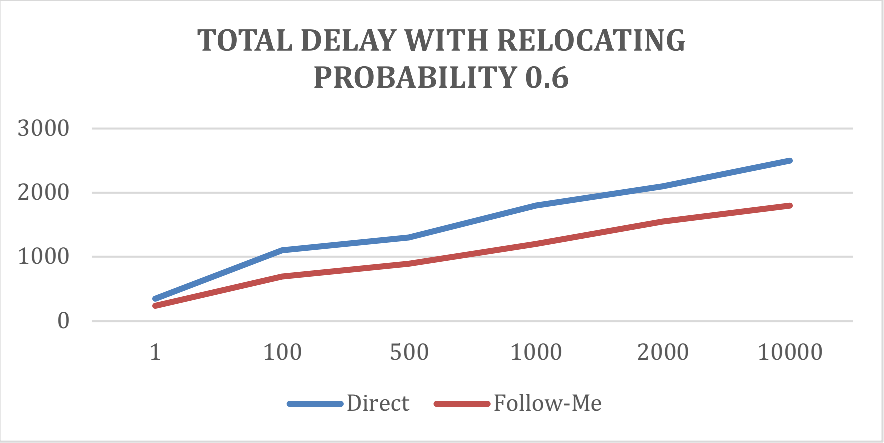
Accordingly, the apparent delay occurs when the MS is moving continuously from a network to another forming the first-packet scenario repeatedly. Accordingly, if the relocating of the MS occurred with each packet transmission with a probability of 1, the direct approach delay will be almost double the delay in the *follow me* approach. The variation in delay between the two approaches decreases as the probability is decreased till the variation reach zero with moving probability of 0.

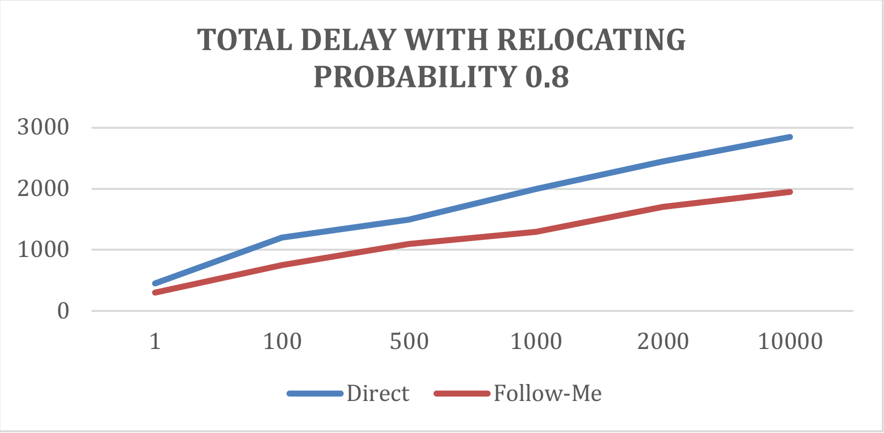
A mobile IP system was simulated using Java with four types of agents; these are HA, FA, MS, and CN. A set of functionalities with various frame types were developed to facilitate communication within the simulated environment. The mobile node can send a message, register with HA and deregister with FA. CN listen to incoming messages are reply accordingly. The HA initiate a communication with the CN and with the FA to send messages to MS. The HA inform CN about the newly registered nodes and communicate messages with nodes and FA. The FA register MS nodes and communicate with CN. According to the simulated system, the direct approach and the follow-me approach were simulated based on different relocated probability which creates different scenarios according to the discussion above with different packet numbers and the total delay in a millisecond was captured and compared as illustrated in Figure 7.

As the results illustrate, the total delay of the follow me approach is less than the delay of the direct approach. The resulting gap is increasing when the relocating probability increase, in which the number of relocating of MS occurred more often. In the probability of 1.0, the total delay of the direct approach is almost double for the follow me approach. As noted in the results, the total delay variations are increased among the compared methods as the number of communicated packets increases, which clearly illustrates the benefits of using the proposed approach in reducing the total delay in real communication, in which the number of transmitted packets are substantially huge.




TOTAL DELAY WITH RELOCATING PROBABILITY 0.4
2000
1500
1000
500
0
1
100
500
1000
2000
10000
Direct
Follow-Me


TOTAL DELAY WITH RELOCATING PROBABILITY 0.6
3000
2000
1000
0
1
100
500
1000
2000
10000
Direct
Follow-Me


TOTAL DELAY WITH RELOCATING PROBABILITY 0.8
3000
2000
1000
0
1
100
500
1000
2000
10000
Direct
Follow-Me

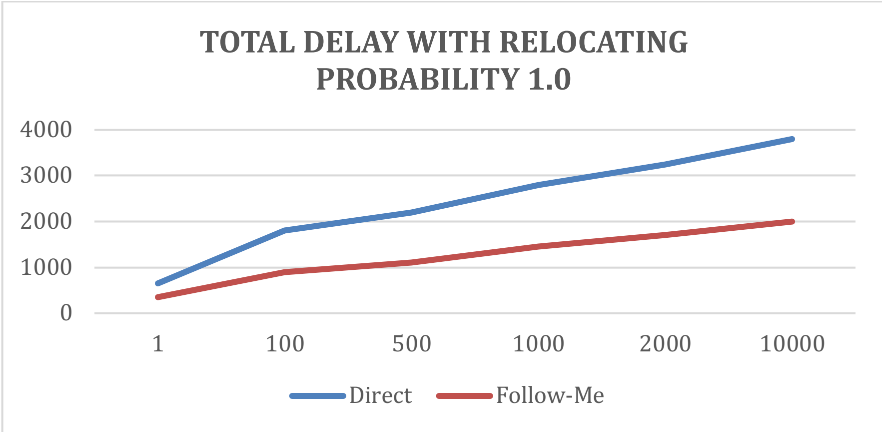


Fig. 7. The total Delay of the Direct Approach and Follow me Approach with different Relocation Probability and Packet Number

6 Conclusion

The mobile IP direct routing approach has become a popular method for mobile routing. However, it suffers from the problem of re-transmission as the mobile agent relocated from that network to another. Accordingly, in this paper, a new approach, which is referred to as 'follow me", is proposed to manage the direct routing of mobile IP. The proposed method depends on informing and allowing the agent of the previously visiting network to transmitted packets to the MS based on the received CoA. Accordingly, the proposed approach minimizes the communication with the HA, as the correspondent refers to the HA only if the transmission is failed. Moreover, the FA will also have less overhead as the MS is responsible for acquiring the CoA once. The simulation results showed that the total delay could be reduced up to the half in the case with a probability of mobile relocating of one.

7 Acknowledgement

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Quiz Tool Within Moodle and Blackboard Mobile Applications

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Abstract—The development of a course is measured through Assessments. Tests and Quizzes measure performance and quality of course progress as well as student understanding of course contents. Most of Learning Management Systems (LMSs) provide a built in quiz tool to help instructor to design a quiz and obtain students records. Nowadays, LMSs companies provide versions (applications) that are compatible with mobile handheld devices. In this paper, we will investigate features available within quiz tool within the open source LMS Moodle and the proprietary LMS Blackboard.

Keywords—Quiz, Assessment, Moodle, Blackboard, Mobile, Application, Online, E-assessment, LMS, Learning

1 Introduction

Handheld devices such as: Laptops, Personal Digital Assistants (PDAs) and smart phones are becoming popular among people as they are portable and affordable wireless microcomputers with handwriting recognition technology. The evolution and continuous expansion of mobile devices has arisen the integration between the educational environment and the modern mobiles. The term mobile learning (Mlearning) refers to the use of handheld IT devices in training, learning and teaching [22]. It facilitates learners to access knowledge anytime and anywhere as well as to merge their learning experiences in a shared collaborative environment. It provides mobility of technology, Mobility of learners, and Mobility of learning [4]. M-learning is developed as an expansion of E-learning (Mobilearn 2003) and considered to be one of the newest trend in education application [29].

Currently, Learning Management System(LMS) is the core of e-learning. LMSs are deployed within institutions and organizations that are involved in education and training. LMS is supposed to support student learning and faculty teaching. Three main LMS vendors are available: Proprietary LMSs, Open-source LMSs, and Cloud-based LMSs [3]. The main differences between the three LMSs are summarized in Table1 [3] [16].

As mobile technology is being improved and expended, most of LMSs provide mobile application in addition to the desktop system to be used by student and instructor. Mobile application can prevent drawback of using web based learning [26].

LMSs mobile applications include built-in tool to benefit of using computer base exam [24]. It is known that e-assessment is important to develop learning method and enhance teaching strategies [18]. Different Quiz tool features are available in different LMSs mobile applications. In this paper, we will investigate features available within quiz tool in open source LMS Moodle and the proprietary LMS Blackboard.

This paper is structured as follows: Section 2 review the definition of mobile learning, section 3 introduce online mobile exam, section 4 examine Quiz features in Moodle mobile LMS and section 5 examine Quiz features in Blackboard mobile LMS, finally discussion and conclusion in section 6.

Table 1. Differences between the three LMSs

	Proprietary LMS	**Open- Source LMS**	**Cloud-Based LMS**
Cost	Vendors charge a license fee license fee and support is expensive	If not free, OS LMSs are cheaper than proprietary LMSs. No need to pay for maintenance and support	Very cost-effective cost is based on usage. No need to pay for maintenance and support
support and service	Vendors provide Customer service support for each license.	Lack of support and service. Heavy dependency on the online community	Depends on tools you choose.
Authentication	Authentication to software is usually by a Username and password	Authentication to software is usually by a Username and password	Authentication might be an issue: depends on tools you choose but mainly use Username/ password
Code and Innovation	Vendors hold possession of the code.Vendors do not allow users to view or alter the source code.	Vendors share the code with their users. Users have the freedom to share and update the software without restriction.	Vendors hold possession of the code. Vendors do not allow users to view or alter the source code.
Availability	Available through companies that own the rights to the packages. Free trial is available to try before buy.	- These are freely available to download directly over the net.	Free social applications are available online. Free trial is available to try certain tools before buy.
Installation	Certain LMS tools require special Hardware/Software installation to access and use it.	Certain LMS tools require special Hardware/Software installation to access and use it.	No need to install additional Hardware/Softwar e to access and use it.

2 Mobile Learning

Mobile learning (M-learning) is another type of education technology; students can study anywhere and anytime; it is the adoption of mobile technology with pedagogical education [8]. M-learning is defined as the use of handheld computer and wireless transmission for learning and education [17]. [21] showed that the mobile learning starts through using SMS in dissemination of educational Information in Russia.

The basic features that distinguish mobile learning from traditional learning method is the ability to acquire knowledge, collaborative learning phases, the ability to combine learning content, instant need of learning and the mobility of learning [9].

According to [2], M-learning is divided into three types: formal, informal and well-directed. The formal type includes some reminder like short message or notification.

The informal type as Facebook include exchange message and feedback to get data, and finally well-directed type uses media like video.

M-learning is a subset of Distance learning (D-learning). D-learning is term used to describe the ability to support learning for those in different geographical place [13]. M-learning is also a subset of e-learning that use electronic material in learning like internet, CDs, audio and video. The relationship between three learning system view in figure 1 [5].

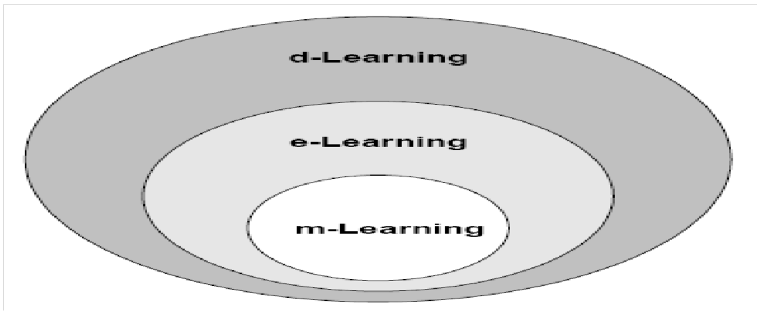

Fig. 1. The Place of M-Learning as Part of E-Learning and D-Learning [5]

M-learning is more preferable due to flexibility to access course content, download lesson notes, submit an assignment, quiz and any other learning activity at any time from mobile devices [10] [1]. In order to design a good mobile learning project, five points are considered: Technology should be accessed anytime and anywhere, holding the technology, connecting to internet via mobile phone connectivity or wireless connection, integrating mobile learning by combining some features, and finally the education institution must support good course content suitable with mobile format [14]. In addition, availability of a mobile learning tool is a must which is a tool specifically designed for mobile learning [23], and mobile learning platform which include wireless network, resource platform and mobile device [30].

[25] designed an android platform application that is integrated with Moodle, the project includes design and implementation for tool in m-learning depending on Moodle, the proposed project is more flexibility, mobility and convenient than traditional e-learning method.

3 Online Mobile Exam

Online exam has spread rapidly in education institution, due to benefits of using computer base exam for both student and instructor such benefits are: reduce cost, reduce errors, and reduce stress when have online exam [24]. Online exam known as online assessment or/and computer based exam mean the use of a system to evaluate student achievement in the course. The objective for using e-assessment is to develop learning method and still enhance teaching strategies [18].

M-learning also include an assessment tool as part of their application. Many projects were designed by researchers to provide Online exam mobile application. Quizzler, M-quiz are quiz systems used in both PCs and mobile. These systems were developed by Victoria University of Wellington. CosyQTI developed by university of Piraeus,and C-POLMILE developed by the university of Birmingham for multiple choice question [20] . Mobi-exam is another example of such applications, it was used by [28] study to achieve mobile exam, the study focus on the development of online exam applied in mobile devices or PCs. The study showed that using such applications provide more flexible, simply, quickly online exam technique. [11] produce a prototype system called MES Mobile Exam System that is available for IOS and Android.

[27] proposed a model for e-exam in mobile devices named Time Adaptive for Mobile E-Exam(TAMEx). The researchers handled the time factor during the exam. This model is based on wireless connection (WLAN IEEE802.11) and RSSI that help to give student extra time if any loss of connection happens during exam, according to result: this model increase reliability of e-exam.

Another application called HTML5 application is used for mobile test; the application depends on Sencha Touch framework. It is suitable for IOS, Android, windows phone and Blackberry. The design of HTML5 app is based on MVC (Model View Controller) [6]. iQuiz tool proposed by [19] and adopted with Moodle to apply quiz, they try to solve limitations in Moodle quiz and iAssign package which supported by Moodle. The limitations as they mention are authoring not simple, iAssign integrated with Moodle without questionnaires, quiz database and questionnaires data not integrated in search tool. iQuiz add new question types, the ability to share and reuse the quiz resources.

Online mobile exam has drawback concentrated in security [12] and cheating. The Moodbile project created by [7] to enhance security of exam in mobile learning. Many weakness point that effect exam security were considered to achieve security in open source learning management system.

[15] Proposed a theoretical model for smartphone devices to authenticate the identity of students before and during the e-assessment session. The proposed model combined biometric techniques (fingerprint and facial recognition) to control the process of student's authentication.

In this paper we will consider Moodle and Blackboard mobile applications and study quiz features within these two applications.

4 Quiz Features in Moodle Mobile LMS

One of the most famous open source LMS is Moodle, with 143,205,877 users in 228 countries [Moodle, 2018]. Moodle is a free open source learning management system application that is adopted by international education institutions. It is available in 35 languages. Moodle provide a blended learning approach. Due to the revolutionary of mobile technology, Moodle provide a mobile application that is compatible with IOS and Android platforms. Through Moodle mobile, student and teacher can easily access course material, easily upload file with different types, view forum discussion, glossary and course plan, reminder and notifications are also available, Moodle app also deliver quiz and assignment. Moodle is an HTML5 web application, need internet connection to provide their services while its provide some offline features. (Moodle,2018). Moodle mobile app works on devices running Android 4.4+ and IOS 6+. The Moodle mobile quiz require Moodle 3.1 onwards. Or install required plugins for older versions. Plugins are Templates generated when user open the plugin in app, Templates downloaded when user login, or Pure Java script plugins. The Moodle mobile app is an application used by both students and instructors. The design of a compatible quiz in Moodle mobile app is performed with Moodle desktop platform only, the ability to create a quiz using Moodle mobile app is not supported yet. It is important to highlight that quizzes in Moodle mobile app are not supported in safe browsers. Quiz features available in Moodle mobile Quiz activity module are described below:

4.1 Question types

The Quiz activity module is used to design quizzes with question types compatible with mobile app. Standard Question types are suitable for mobile access and can be graded directly, such types are: (Calculated, calculated multi-choice, calculated simple, Drag and drop into text, Drag and drop markers, Drag and drop onto image, Description, Essay, Matching, Embedded Answers, Multiple choice, Short Answer, Numerical, Random short-answer matching, Select missing words and True/False). Essay questions which require uploading a file from student are manually graded.

Third-party questions are not compatible for mobile app quiz such as: Combined, and STACK types which need plugins to be installed. Also, the image is not supported in Moodle mobile quiz.

4.2 Question bank

The question bank or bool is available in Moodle mobile quiz to help instructor to assemble a record that contains all questions divided in categories. Question bank can be used to help instructor to select all or part of these questions when creating a quiz. The quiz will not be available in Moodle mobile app, if the quiz is designed by using a Question bank that has an incompatible mobile question type. In this case, the quiz must be performed through Moodle desktop.

4.3 Question layout

The design of a compatible quiz in Moodle mobile app is performed with Moodle desktop platform only. The Moodle mobile quiz support the ability to determine number of questions per page, as well as support reshuffling and randomizing the appearing of question. The attribute that prevent student to move to next question if the current question is not answered known as blocked question is not available in Moodle mobile quiz.

4.4 Quiz attempt

The ability to validate the duration of online quiz attempt is supported. Instructor can determine the quiz duration from start-date/time to end-date/time. The quiz can be attempted after the start date/time only and must submitted before finish date/time. Instructor can determine number of times a student can attempts the quiz. Also, the time of quiz attempt is supported as well as the option to save for later and continue from last attempt. A massage will appear if the user tries to submit when connection lose or not connected to internet.

A remarkable feature is available which is the ability to download and attempt the quiz later offline. This is applicable if no time limit is set and no network address is required. Offline quiz is available through enabling the option "allow quiz to attempt offline in mobile app". When using offline the following options are not compatible: timer, access restriction by password or subnet, and the deferred feedback with or without CBM (Certainty-based marking).

4.5 Quiz grade and rubric

Both instructor and student can view grade for a quiz or for all course. Instructor can view the submission of quiz/assignment. also, student can see grade as weight and percentage, the total contribution of grade from all course are supported. Standard Question types are suitable for mobile access and can be graded directly except essay questions which require uploading a file from student and manual grading. For offline attempt; student can view the grade later since student can't submit the quiz offline, massage "finish but not submitted to the sit" is presented.

The instructor can write a feedback for student mark present in grade book, also the correct answer can be presented for students. A statistical report is provided for instructor for each question and the percent of answer for each choice made by students. Moodle mobile app provide an advance grading method; however, it does not apply a rubric to a mobile quiz. Rubrics are not yet supported.

4.6 Quiz authentication

Beside the course password, Instructor can create a password for the quiz to allow students to access the quiz. This process is performed during the design of the quiz. For security reasons, and to make sure that quiz is attempted from a certain network; IP network addresses will be considered. Quizzes in Moodle mobile app are not supported in safe browsers.

5 Quiz Features in Blackboard Mobile LMS

Blackboard is a proprietary LMS that support interactive teaching and learning across 90 countries reaching approximately 100 million users in over 30 languages (Blackboard, 2018). Blackboard provide two mobile applications designed for student and instructor. Students use Blackboard app to view course content and material, achieve assignment, quiz, interact with other student via massage or via discussion forum with the ability to receive notification and reminder. while Blackboard instructor app is available for teacher to view course material, grade of assignments, upload file and send massage to student.

The Blackboard app and instructor app are available on IOS 4.0+, Android 2.2+, and Windows devices. For best used, it is advisable to upgrade the application with the latest updated version for without any extra fees, if Blackboard is deployed by the institution.

The Mobile quiz is created by using Blackboard desktop environment only and can be accessed through mobile and /or browser desktop, till now you can't create the quiz through mobile device or via Blackboard instructor app (Blackboard 2018). Quiz features available in Blackboard Mobile Quiz activity module are described below:

5.1 Question types

Blackboard mobile quiz support many types of questions, such as: true/false, multiple choice, short answer, essay, Hot spot, File Response such that only image file types will be accepted by the Blackboard Mobile Learn app. We noticed that images in test questions are not displayed. Incompatible mobile questions within the quiz require either to open the test in a desktop browser or in the in-app browser. When you include incompatible mobile question types in a test, the app treats the test as mobile incompatible and a browser is needed. If all the questions in quiz are compatible, then the randomize of question and the answer are supported.

5.2 Question bank

Instructor can create, preview and update question in database and then instructor can use all or part of them. Question bank or bool questions can be reused in other quizzes. However, question bank or pool are supported in Blackboard mobile application if and only if it includes questions with supported types. Otherwise, quiz attempt will be performed using Blackboard learn environment in in-app browser or desktop browser.

5.3 Question layout

The Mobile quiz is created by using Blackboard learn desktop environment only. If all questions in quiz are mobile compatible, then randomizing of questions and answers is supported. Mobile appearance of questions in test; "One at a time question presentation" option that allow one question per page is not compatible in mobile quiz.

5.4 Quiz attempt

The ability to set the duration of online quiz attempt is supported. Instructor can determine the quiz duration from start date/time to end date/time. The quiz can be attempted after the start date/time only and must be submitted before finish date/time. Instructor can determine number of times a student can attempt the quiz especially if it is self-assessment quiz. Timer option is not compatible with mobile quiz. However, the option "save for later" and continue from last session is available. The message " you can't save for later" will appear, if instructor prevents this option and requires submitting quiz with the first quiz attempt.

In Blackboard, attempting quiz offline is not supported. Student can view course contents, grades, feedback offline but cannot download quiz for offline attempt.

5.5 Quiz grade and rubric

Grade for overall course or for each quiz with feedback is supported. Blackboard app does not support feedback as attached file, new-box view annotation which is an inline grading comments, nor the response for each question answer feedback, these options are available only through desktop browser. The score of each question in quiz (correct or not) is not supported in mobile quiz.

Instructor can choose to enter the grade via grade forum discussion or individual discussion, and then student can see his/her grade with instructor feedback.

In the app, quiz rubrics are supported. Instructor can associate a rubric with the quiz. Student can view the rubric, but they need to access the course on a web browser to see the scores the instructor selected for each criterion.

Blackboard instructor app provide the summary of number of students submitted and overall class average, results can be viewed in graph. Details of assessment is available, like number of attempts and if a rubric is used. Other options are provided like ready to grade, ready to post, posted grade and not submitted grade. However, grading test is not supported with instructor app. Instructor need Blackboard environment for grading. instructor can add comment for students as feedback for quiz when post grades.

5.6 Quiz authentication

Beside the course password, Instructor can create a password for the quiz to allow students to access the quiz. This process is performed during the design of the quiz.

6 Discussion and Conclusion

Blackboard applications and Moodle application are widely used in mobile learning. This paper is concentrated on quiz tool available in these applications based on features mentioned before. Blackboard have separate mobile applications for student and instructor while Moodle have one application for all.

Both of the mobile applications share many quiz criteria: Moodle and blackboard have question bank for supported type of questions, Moodle app support more question types than Blackboard app. Moreover, layout feature is available for both under some restriction, and both support an unlimited time of attempt. if student did not finish the quiz the feature “save for later” is also supported in both mobile LMS. In addition, notification massage is used to remind students of a quiz is supported in Moodle and Blackboard, password for authentication is utilized in both applications.

Toward designing a quiz, instructor need to use desktop platform version for both Moodle and Blackboard. Unsupported questions in Blackboard app force student to open the quiz in app browser or desktop browser.

It is important to point that Moodle mobile quiz is not supported in safe browser. For un supported questions, student need to open desktop browser to complete the quiz.

Offline quiz feature is supported in Moodle app quiz; this feature can be defined as the ability to download a quiz to answer it later offline. this feature available only if the instructor activates the option "allow quiz to attempt offline in mobile app" when create a quiz, with offline quiz some features not work like timer, password, and the deferred feedback. The offline quiz not supported in Blackboard app.

Moodle app need to use plugins, which include 3 different types: Templates generated and downloaded when the user opens the plugins and Pure Java script plugins. The first type the template of plugin will be generated and download when user open the plugin in app. The second type Templates downloaded on login and rendered using JS data. Finally; Pure Java script plugins, this type need when you use feature like capture link in apps. If there is a question in quiz require a plugin not supported in the student's device the quiz will not work. While the users of blackboard apps do not need any plugins since they must use the latest edition.

In this paper, we have presented the relation between mobile learning, electronic learning and distance learning, and highlighted the features of quiz tool in Moodle app and blackboard app.

It is important to mention that cheating cannot be controlled in both apps unless the quiz is held in a closed room. Using mobile devices means that students are able to access downloadable course material and use them to answer the quiz. For future; we need to handle this issue to assure accurate quiz results.

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User-Centred Design in Content Management System Development: The Case of EMasters

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Abstract—Including users in design and development of an interactive product is crucial to achieve high level of usability. Content management systems have two categories of users, content creators and content consumers, and designers of these systems have to considers the needs of both user groups. In design of interactive learning systems, special attention has to be given to the process of learning, which means that functional, accessible and usable interface has to serve the purpose of knowledge acquisition. Designing for mobile learning brings additional challenges due to the small screens of mobile devices. The paper describes the process of utilization of user-centred design in development of a simple content management system for learning called EMasters. The aim of the EMasters is to enable teachers to easily create and organize courses which will be delivered to students to facilitate web-based and mobile learning. According to the user-centred design approach, teachers and students are involved in iterative process of design, implementation and evaluation of EMasters. Evaluation study used complementary methods and provided quantitative and qualitative feedback. The usability score reached good level and the guidelines for redesign of the system interface are drown. According to the obtained results, proposed framework is confirmed to be applicable in user-centred design of content management systems in general. In addition, the directions for adjustment of the framework for specific cases are provided.

Keywords—Mobile learning, user-centred design, user interface, content management system, usability, rapid prototyping, user testing

1 Introduction

The concept of learning anywhere anytime is rather old. If we consider textbooks as the first mobile learning devices, as suggested by Searson [1], then learning anywhere and anytime begins with the students reading textbooks on the bus on their way to school. Contemporary digital learning environments support this concept since they are typically web-based and therefore available by any device connected to the Internet. In addition to learning, they bring new affordances such as online testing, communication with teachers and collaboration with peers. The pervasive owning of smartphones, tablets and other mobile devices allow learners to move freely while learning and to communicate with peers faster than ever before. Furthermore, the emerging paradigm of ubiquitous learning brings the dimension of "anyhow" to the plethora of benefits of mobile learning [2], [3], [4]. Recent trends in digital education also include adaptive learning systems, serious games and virtual environments. Research in intelligent and adaptive user interfaces enabled development of personalized learning environments that address user individual differences and deliver individually tailored content and learning paths through the course [4], [5], [6]. Introducing gamification elements into digital learning resources keeps students more focused and engaged in learning [7]. In simulated game-like environments such as 3D virtual worlds, serious games and virtual reality environments, learners can face real situations and learn directly from these first-person experiences [8], [9], [10], [11].

The common goal of all technological interventions in learning, including above-mentioned trends, is to increase the ease of use of learning applications and to improve the learning outcomes of learners. These applications are usually highly interactive thus keeping the focus and motivation at learning. All these desirable features are results of application of the principles of interaction design and learner-centred design [12].

Considering specifically mobile learning, today learning applications are competing with prevalent usage of mobile phones for chatting, music, videos and social networks. Learning is no more a single process that is closed in controlled environment such as for example virtual worlds or virtual laboratories [9], [11]. Instead, learning activities are frequently interrupted with notifications from various applications that distract student while learning. Thus, besides the fact that uncontrollable usage of mobile phones leads to decreased learning performance of students in general [13], in case of mobile learning the process of learning is directly affected by the events at the same screen on which the learning occurs. In those circumstances, the importance of good design of learning applications for mobile devices becomes crucial. If the student is frustrated by the learning application he is currently using, the chances that after responding on a chat he will get back to learning are probably lower than in case of pleasant and meaningful learning experience. This fact raises the need for further research on finding more efficient ways of using mobile phones for learning.

The paper presents the process of design and development of a simple content management system for learning called the EMasters. The system is responsive i.e. adapted to small screens of mobile devices such as laptops, tablets and smartphones. The development cycle is an iterative process which is conducted by the principles of user-centred design.

The paper is structured as follows. After explaining the rationale for the study in the introductory section, Section 2 provides a theoretical framework with short review of online educational systems, their strengths and weaknesses. The theoretical section continues with definitions of the terms and methods used in the study. Section 3 briefly presents the key points in design and development of the EMasters. Section 4 describes the procedure of conducted evaluation study and the results follow in Section 5. In Section 6 the obtained results are discussed, and the implications of findings are brought. Section 7 provides closing remarks.

2 Theoretical Background

2.1 Online educational systems

Many academic institutions and private organizations make continuous efforts and invest significant resources in providing online learning opportunities for their students or employees and network technologies continuously develop new possibilities for successful utilization of online leaning for personal growth [14]. Therefore the pool of learners is now expanded from the „traditional“ students to a much broader scope which includes employees in a company or self-motivated learners who choose to attend some courses in their free time for individual development. The most common forms of online education in institutional settings are Massive Open Online Courses (MOOCs) [15] and Learning Management Systems (LMSs), e.g. Moodle [16] as a category of Content Management Systems (CMSs) specially indented for learning. Despite the different definitions and basic functions of these systems, as explained in [17], they aim to provide high-quality education to the cohorts of students in a cost-effective manner. They are widely implemented in high academic institutions, public and private organizations, either to support blended learning or to provide fully on-line education. These solutions are convenient for large institutions because teachers and management have control over learning achievements of the participants. In addition, they may obtain numerous reports on learning analytics, which is the basis for development of new policies and strategies and for progress of the institution.

However, researchers suggest that these institutional systems still do not succeed to meet the requirements. Some of frequently reported weak points are: high costs of development and continuous maintenance; user interface is often non-responsive, i.e. not adapted to small screens typical of mobile devices; students sometimes oppose to mandatory software, while teachers, who are expected to design learning content, are sometimes not ready to take this new role of course creators [18], [19], [20]. As a part of an answer to these challenges, small e-learning applications or microlearning applications have appeared lately as an alternative to learning content in typically large e-learning systems [21]. Microlearning as a novel type of digital instruction can contribute to interactivity in learning experience due to a very easy form of application and the ability of simple integration into online educational systems and virtual environments [21].

The common feature of all these forms of educational applications is that teacher/instructional designer need not to have any programming skills to be able to successfully create learning content. According to the definition of the CMSs, which are in focus of this paper, teachers are provided with tools and features for creating the content of online courses and for moderating interaction with their students [17].

2.2 User-centred design

User-centred design (UCD) is covered by ISO standards related to a broader scope of human-centred design and usability [22]. ISO 9241-210:2010 describes requirements of human-centred design principles and activities that are related to the usage of computer systems. The standard concerns with ways to enhance human–system interaction through usage of both hardware and software components of interactive computer systems. The standard is intended to be used by professionals who manage the design and development of interactive systems. Figure 1 shows typical stages of UCD according to ISO:

- Plan the UCD process
- Understand and specify context of use
- Specify user requirements
- Produce design solutions
- Evaluate designs against requirements
- Design solution meets user requirements

In iterative process of designing, implementation and evaluation several phases are reoccurring as many times as needed to reach the final stage in which design solution meets user requirements to a great extent.

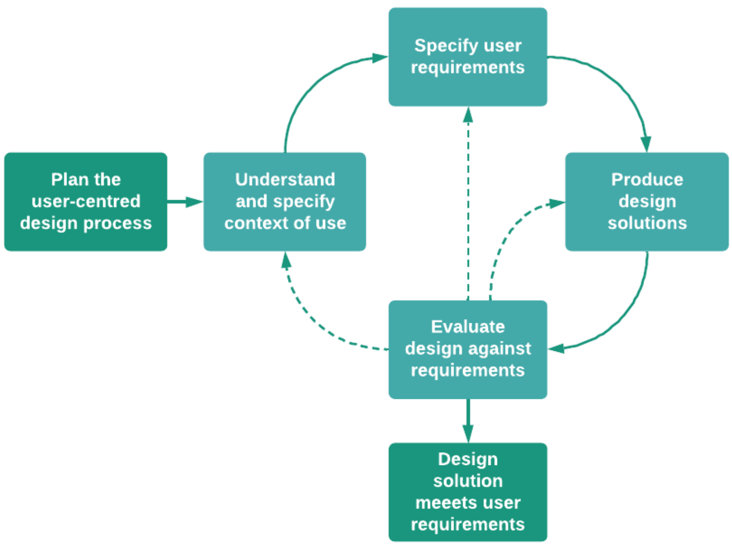

Fig. 1. The user-centred design process according to ISO 9241-210:2010

For software designers building interactive learning applications, Quintana, Krajcik, and Soloway [23] extended the traditional definition of UCD approach and proposed a definition of learner-centred design. They have considered three dimensions of interaction in learning systems: the audience (users vs. learners), the addressed problem (using tools vs. learning work) and underlying approach (supporting action vs. supporting learning). When designed for learners, educational software must address several unique needs of learners as users: the concept of learning by doing, individual differences and different levels of motivation [24].

Specifically, when designing CMSs, two categories of users have to be considered, namely the content creators and the content consumers. In interactive learning systems, content creators are teachers or instructional designers while content consumers are learners who use delivered content for knowledge acquisition. To ensure that system will be adopted by the users, both user categories must be engaged in the process of system design. The users expect to be able to control the interaction and user enrolment in design process is crucial to achieve this goal. This is especially important in informal learning where there is no institutional incentive or requirement for using specific software. To be adopted and really used, an application for both institutional and informal learning has to provide appealing user experience for teachers and learners.

The UCD approach is focusing on usability [25]. According to ISO [22] usability is: " extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use". Recently published new ISO Standard for Usability, Usability Reports and Usability Measures, ISO 9241-11:2018 extend this definition and explains that usability should not be considered as a property of a system but as an outcome of use [26].

Usability evaluation is regularly conducted during the evaluation phase of UCD process described in Figure 1. Moreover, evaluation and design are closely integrated in this process and some of the same methods are used both in evaluation and in the phase of specifying user requirements [12]. Methods of usability evaluation include [27]:

- **Usability testing** – an evaluation process with users doing real tasks on a prototype or real system, while carefully observing their behaviour and emotional response during the interaction; also called user testing;
- **Usability inspection** – method in which usability experts evaluate the interface according to a set of usability guidelines, with no user involvement;
- **Usability inquiry** – method of gathering user feedback after the interaction with the system, usually through surveys, interviews of focus groups.

The methods differ in nature and in number of participants. Expert inspection requires significantly smaller number of participants compared to methods that involve end users. Since it may be very hard to find five usability experts to do the evaluation [28], user testing and usability inquiry are more frequently applied. However, to get different perspectives on the interface, research suggests triangulation of methods when possible [12].

Qualitative methods are usually conducted through formative evaluation to check the compliance with user requirements and to provide guidelines for interface redesign [29]. On the other hand, quantitative methods are more often used as a part of summative evaluation to confirm that design has reached high level of perceived usability [12], [29]. In the rest of the paper, we will explain in details the methods which are chosen to be applied in usability evaluation of EMasters, namely the thinking aloud protocol as one of user testing techniques followed by several questionnaires and an interview used in post-session usability inquiry (see Chapter 4).

3 Design and Development of the EMasters

The aim of the EMasters is to enable teachers to easily create and organize courses which will be delivered to students to facilitate web-based and mobile learning. Teachers register to the system, make courses and organize their content. As part of the course, they may write text and import other objects such as pictures, videos and microlearning applications. Besides learning content, the teachers can make quizzes for evaluation or self-evaluation of knowledge acquisition process. They can update and delete any piece of the course they have created. The application also has a forum section in which both the teachers and the students can start a discussion on a topic and reply to previous comments. In addition to these two user groups, the application has an administrator who is in charge of the system and controls the proper entry of all data.

The first design of the EMasters was made as a wireframe e.g. paper prototype for desktop, web-based and mobile interfaces. In a simplified process of UCD, that involves iteration of design, implementation and evaluation, the pilot testing of the first design was carried out with five students of University in Split, Croatia, Faculty of Science. Three participants tested the wireframe in teacher`s role and two participants in student's role. According to the feedback from pilot testing, the second wireframe was made. Redesign included several changes in teacher's interface and student's interface. For example, buttons for updating and deleting a chapter in teacher's interface were replaced with hyperlinks. This feature is shown in Figure 2, as developed later in the implementation phase. In addition, the forum page, which shows a topic, was redesigned in a way that the field for entering the reply is enlarged and the button for submitting the entry is red instead of green. Figure 3 shows the forum page with the theme "Regular expressions" which is a topic in the "Unix" course.

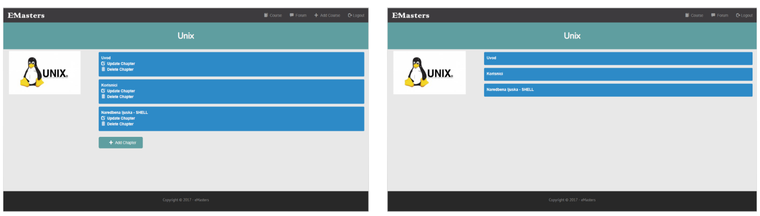

Fig. 2. Homepage of the UNIX course in EMasters as displayed for teachers (on the left) and students (on the right)

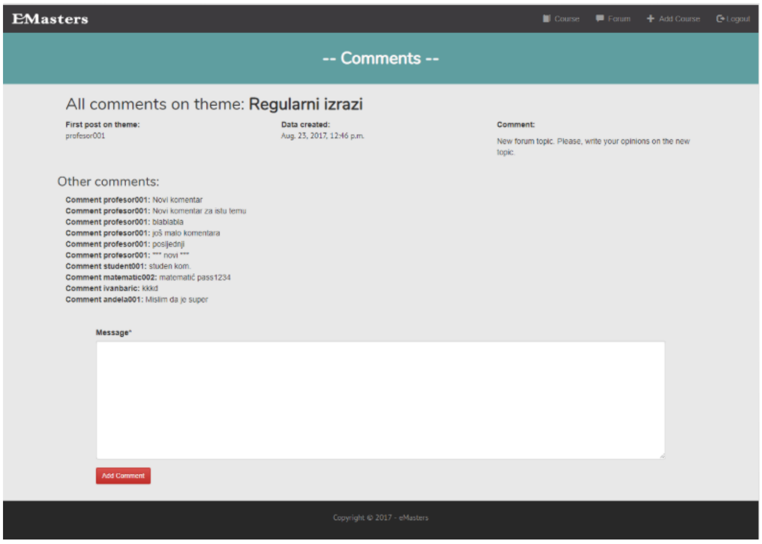

Fig. 3. Screenshot of a forum topic on theme "Regular expressions" in EMasters

The EMasters application was created in Python programming language using Django framework [30]. Django makes use of Model-Template-View (MTV) application architecture as presented in Figure 4. Model is linked to a database where the data is being stored or retrieved from. This layer contains all the information regarding data storage, data connections, entry limitations, mandatory or non-mandatory data, etc. Template is a presentation of the model, i.e. HTML webpage that contains data with instructions on how the webpage should be displayed. The View in MTV architecture serves as a bridge between the other two layers. The user accesses the server using a web browser, after which Django ensures to open a specific view at the user's request. Finally, the database is accessed, and the data are used to display the webpage in the browser according to the request.

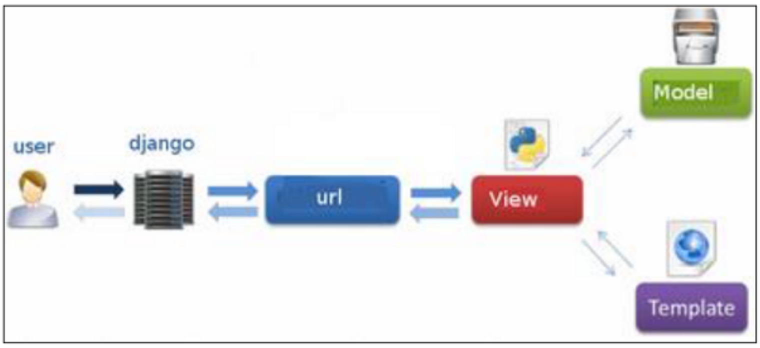

Fig. 4. Model-Template-View (MTV) software architecture [28]

To adapt the interface to devices with different screen sizes, Bootstrap is used as a front-end framework. Figure 5 shows responsive design of a typical content page for teacher, displayed at laptop and iPhone6/7/8. Layout of the same page for students does not have hyperlinks for updating and deleting existing objects nor the hyperlinks at the bottom of the page that enable adding new content and creating a quiz.

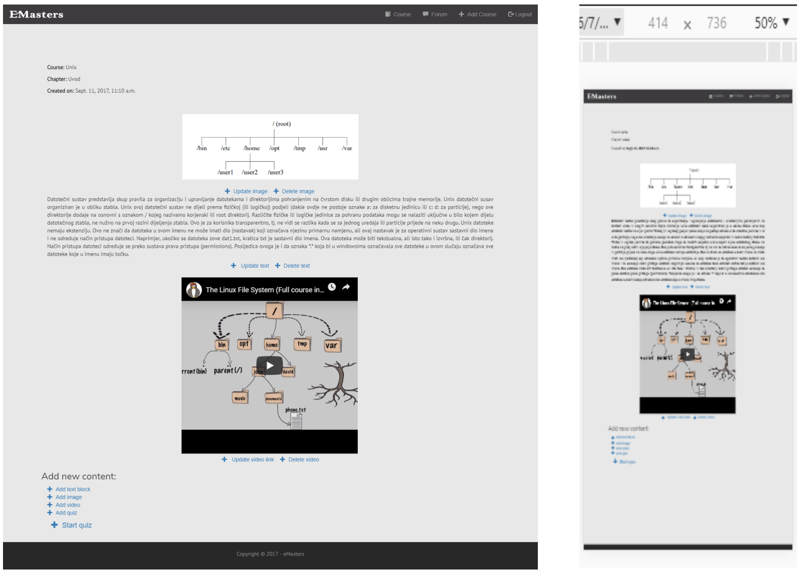

Fig. 5. Responsive design of a typical content page for teacher/course creator in EMasters

4 Usability Evaluation

Evaluation study was conducted in several individual user sessions with slightly different procedures for participants who accepted the role of teachers and the ones who took the role of students. The study begins with teachers' sessions. The students' sessions are conducted after all the teachers have finished creating their courses in the EMasters. Thus, the students were free to choose a course from the pool of courses delivered by the system. All participants followed the same method in the evaluation study but with different instruments according to their role. The evaluation procedure for each participant begins with user testing technique called thinking aloud protocol, which is conducted with teachers in the processes of course creating and later again with students in the processes of learning in the EMasters. The following steps involve usability inquiry methods (see Chapter 2.2.), namely post-session survey and semi-structured interview. Figure 6 briefly presents procedure of usability study with the steps of individual sessions carried out with teachers and students.

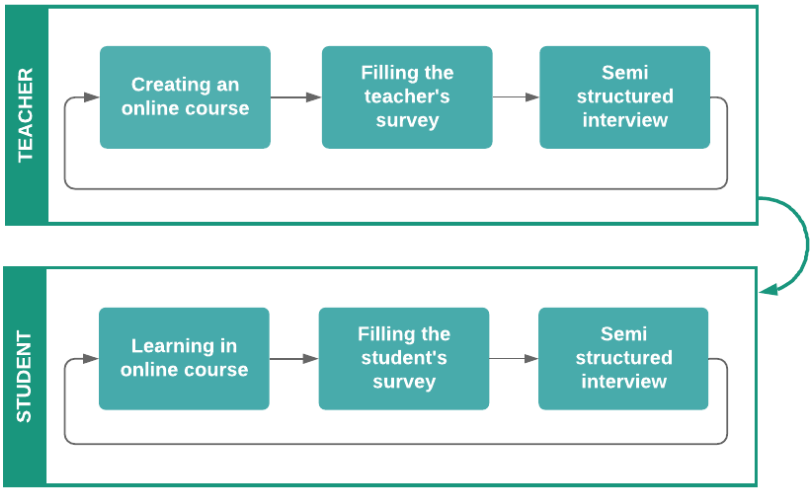

Fig. 6. The method of EMasters usability study

Users who accepted the role of teachers were asked to register in the EMasters and to create an online course on a topic of their choice. They were instructed to make learning content with minimum two chapters and a quiz. They were allowed, but not explicitly told, to import different types of external files, such as images and videos. The structure of the course was not precisely set. However, the teachers were suggested to follow the ADDIE model of instructional design [31] in the phases of course design and development. The teachers were able to review developed course by taking the role of student.

In the learning session, students were invited to register in the system and to select one of the actual learning courses. They were free to explore the content and take quizzes at their own pace and in order they prefer. They were also asked to find the forum and write a comment regarding one of the topics.

Both teachers and students were encouraged to think aloud while doing their tasks. The supervisor of the study observes the user behaviour in real time. He notes the user`s comments as well as key aspects of the interaction such as unexpected steps or mistakes the user makes in the process of course creating or learning. The supervisor does not help the users in achieving their goals. After all users' sessions are completed, the evaluator's notebook becomes valuable resource of potential usability problems of both teacher's and student's interface.

4.1 Post-session survey

Following the procedure presented in Figure 6, after individual hands-on session in the EMasters, each participant was invited to fill in a survey. The post-session survey was hosted on Google Forms and included three sections: SUS questionnaire, qualitative feedback section and background section. Questions in the first two sections were the same for both of the user roles, while background sections were specifically designed to be different for teachers and students.

The SUS [32], [33] is a standardized questionnaire for measuring perceived usability of the system and is used worldwide for overall usability evaluation of different systems [34], [35]. The reliability, validity and sensitivity of the SUS was confirmed in numerous studies as reported by Lewis and Sauro [36]. In the same paper they have provided a curved grading scale to interpret the overall SUS score and this scale will be used in our usability study. Although Brooke initially limited the interpretation of SUS to the overall score [32], Lewis and Sauro conducted a comprehensive psychometric analysis of the SUS and suggested that SUS results could also be interpreted by individual items [36]. Based on regression analysis they have provided item benchmarks related to overall SUS scores. Table 1 in the Results section of the paper shows all the SUS questions.

The second section of the post-session survey is designed to obtain qualitative feedback from the users. It included open-ended questions: What did you like the most in the EMaster system? What are the flaws? What improvements do you suggest? The users' subjective opinion about their experience in using the EMasters application can reveal major flows in design and help us develop guidelines for redesign of the system interface.

Finally, in the background section of the survey, we obtained demographic data of the users who participated in evaluation study. There were several multichoice questions, related to the role of the participants. The background section in the teacher's survey collected age, affiliation and the level of previous experience in using e-learning systems as well as in creating online courses. On the other hand, in survey for students, the background section asked their age, time spent in online learning and specifically in mobile learning as well as previous experience in using e-learning systems.

4.2 Semi-structured interview

Semi-structured interview is carried out as an addition to qualitative feedback obtained from thinking aloud protocol and the post-session survey. The interview was conducted individually with each participant, immediately after they filled in the survey. The interview usually begun with several questions related to the answers that user provided in the survey and then continued in form of free dialog. The users had the opportunity to review their experience in using the system and to explain what improvements of the interface they would suggest and why.

Using complementary methods of usability evaluation, namely quantitative and qualitative methods, we can get deep insight in usability issues of the system being developed. The SUS gives us the score which reveals the severity of usability problems while qualitative methods may provide initiatives and concrete guidelines for interface redesign which is supposed to reduce recognized problems in interaction and increase the overall usability of the system.

5 Results

The study was conducted in the autumn semester 2018 at University in Split, Croatia, Faculty of Science. To obtain potentially wide scale of usability issues, the participants were recruited from students, pupils, teachers and general population. The results are presented separately for teacher's and student's interface.

5.1 Teacher's interface

Seven participants volunteered to use the application in the role of teacher/course creator. Age of participants ranged from 24 to 45 with the mean of 37.17 and standard deviation of 7.97. One participant was a student of educational vocations, two participants were high school teachers and one high school pedagogist. Since the application is intended to be used in informal learning, three participants were recruited from general population. Previous experience in creating online learning content ranged from novices (3 participants) to experts (1 participant).

All participants successfully created a course on a topic of their interest. The SUS items along with the mean scores and standard deviations for teacher's interface are shown in Table 1. The scores are ranged 0 to 4. It has to be noted here that even numbered questions have reversed polarity and their score is calculated accordingly, as described in [32], [33]. This means that for odd numbered questions the score in Table 1 represent the level of users' agreement with the statement while for even numbered questions the score represents the level of users' disagreement with the statement. Thus, for example, the score 2.71 on item no. 2. "*I found the system unnecessarily complex*" means that users rated simplicity of the interface with 2.71 or 67.75%. As a result, the higher score in Table 1 always stands for higher level of perceived users' satisfaction with the EMasters.

Table 1. SUS results for teacher's interface

SUS question	Mean	SD
1. I think that I would like to use this system frequently.	3.00	0.82
2. I found the system unnecessarily complex.	2.71	1.38
3. I thought the system was easy to use.	3.14	0.38
4. I think that I would need the support of a technical person to be able to use this system.	1.86	1.07
5. I found the various functions in this system were well integrated.	3.00	0.82
6. I thought there was too much inconsistency in this system.	2.86	1.35
7. I would imagine that most people would learn to use this game very quickly.	2.71	0.49
8. I found the system very awkward to use.	3.14	0.69
9. I felt very confident using the system.	2.86	0.69
10. I needed to learn a lot of things before I could get going with this system.	3.14	0.90

Overall SUS score for teacher's interface is given in Table 2. The obtained value means that satisfaction of participants who took the role of course creators is 71.1 %.

Considering individual ratings from participants, the minimum individual grade is 2.2 (55%) and the maximum 3.4 (85%).

Table 2. Summary of the SUS for teacher's interface

N	Mean	SD	Min	Max
7	2.84	0.93	2.2	3.4

In the qualitative feedback section of the post-session survey six of seven participants wrote positive impressions. Most of them appreciated the simplicity of the interface. The comments also included the "ease of use", "nice and intuitive design" as well as highly functional interaction. Five users reported that have experienced some flows of the EMasters system. They were not satisfied with: restricted possibilities in design of page content i.e. the positioning of objects on a page; the absence of data on students' usage and achievements; and the fact that quiz allows only multiple-choice type of questions. These issues were clarified in individual interviews with each participant. In addition, a user suggested that teacher should be able to edit only his/her own courses.

5.2 Student's interface

In the role of student, 14 volunteers took part in the study. Mean age was 28.28, with standard deviation of 10.15, minimum age of 12 and maximum age of 43. Two participants were primary school pupils, two high school students and one university student. The rest were adults with various backgrounds. Prior experience in using computers and mobile devices for learning was almost equally distributed in the sample (rare, sometimes, often, very often, regularly).

All participants registered in the system, took time for learning and taking the quiz on selected lesson. All of them succeeded in finding a forum and leaving a comment. The SUS results obtained from students are presented in Table 3 and the overall SUS score is given in Table 4. Overall students' satisfaction is 68.9%. The lowest individual student's grade is 1.6 (40%) and the highest grade is 3.8 (95%).

Table 3. SUS results for student's interface

SUS question	Mean	SD
1. I think that I would like to use this system frequently.	2.43	1.16
2. I found the system unnecessarily complex.	2.86	1.17
3. I thought the system was easy to use.	2.79	1.42
4. I think that I would need the support of a technical person to be able to use this system.	2.50	1.40
5. I found the various functions in this system were well integrated.	2.50	0.65
6. I thought there was too much inconsistency in this system.	2.86	1.23
7. I would imagine that most people would learn to use this game very quickly.	3.07	1.14
8. I found the system very awkward to use.	2.57	1.34
9. I felt very confident using the system.	3.43	0.76
10. I needed to learn a lot of things before I could get going with this system.	2.57	1.60

Table 4. Summary of the SUS for student‘s interface

N	Mean	SD	Min	Max
14	2.76	1.22	1.6	3.8

In the post-session survey, we obtained various feedback from users in the student's role. Four participants did not write comments regarding positive aspects of the application. The same users wrote that they did not experience difficulties in interaction and they had no suggestions for improvement. Six participants liked the ease of use and several students like the aspects that are more related to learning content than to the user interface. Considering users' opinion on shortcomings of the application, most of the students referred to weaknesses in learning content (too much text, not enough images, videos etc.) while two students had difficulties in reading because of the small letter size. Reported usability issues and suggestions for improvement from student's perspective were discussed in post-session interviews with each participant. As opposed to content pages, the users had no objections to the usage of quizzes and forum.

6 Discussion

According to the interpretation scale for SUS [36], where average grade (C) stands for SUS scores 65.0 -71.0 and slightly above average grade (C+) stands for 71.1 -72.5, we can conclude that users rated the EMasters application as good for course creation (71.1%) and learning (68.9%). Qualitative analysis also confirmed that the application is generally perceived as easy to use for both course creators and learners. Participants of the study appreciated the simplicity of the interface, clear design, availability of the content and the possibility of communication through forum. Discussing the weaknesses of the application, we collected significant number of comments. The obtained feedback is used to decide what comments are relevant for the interaction and can provide guidelines for redesign that could improve usability of the system. For example, enlarged letter size can be used for the text in content pages, or we can provide users with an option to set the letter size to desired value. It is important to communicate all reported issues with the users to reach the final decision on redesign. Thus, the issue of inability to manipulate the position of objects on a content page is considered as less relevant when compared to risk of a possible bad layout on small screens of mobile devices.

Conducted evaluation study revealed some concerns that are not usability problems but also demand consideration. They are particularly related to handling the quizzes and managing the course and its participants. In quizzes, the feature of displaying scores immediately after taking the quiz can be added. Major improvements of the system could include features for teachers such as administering the students, tracking their progress through the course and analyse their achievements on quizzes. Still, the initial incentive of the EMasters was to facilitate informal learning so these major improvements could be considered if the purpose of application is to be used in institutional settings.

Considering the procedure of conducted study, we have to notice that some of the results regarding student`s interface may be the consequence of a poor design of learning content in some courses. Several users that took the role of course creators are not familiar with the principles of instructional design and did not apply any of them. Although these users can contribute in usability evaluation of teacher's interface, especially when developing applications for informal learning, their courses may have major flows related to content quality. On the other hand, the study shows that students who evaluate the interface in learning process sometimes have troubles identifying which problems are related to the usability and which to the content quality. This limitation can be overcome in a way that poorly designed courses are excluded from the second part of the study. This approach requires evaluation of developed courses by instructional design experts prior to the usability study of student's interface. Another solution is to engage only teachers or instructional designers to create online courses in the first phase of the study. Both options support the initial idea of the EMasters to be available for all, which means that everyone can create a course for interested audience on a topic of their own choice. Both solutions also ensure that the high usability level of the system will reinforce the process of content creation and of learning.

7 Conclusion

The paper, describing the case of design and development of simple learning CMS called the EMasters, presents an iterative process of user-centred design. The process begins with rapid prototyping and pilot testing of the first design. The second design is made according to the users' feedback and the implementation follows. To evaluate developed system, a comprehensive usability study was carried out. The evaluation method combined several well-known and reliable techniques of usability testing and usability inquiry. Quantitative results show that usability score reached a good level. Qualitative user feedback revealed several usability problems as well as other issues related to the content quality. The outcomes of the study provide guidelines for improvements which can be implemented in the next iteration of UCD for EMasters.

According to the obtained results, the evaluation framework confirmed to be suitable for iterative process of user-centred design of CMSs. The study shows that usability evaluation can be successfully applied in design process in a quick and cost-effective manner. In addition, the framework can be further adjusted and refined to fulfil the requirements of specific CMSs developed for the purpose of learning thus contributing to the researchers and practitioners in the field of design and development of learning CMSs.

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The Efficacy of MALL Instruction in Business English Learning

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Abstract—The existing technological expansion has transformed pervasive revolutions in modern civilization, with continuing innovation of services and products. Nowadays people are having different channels of communication. Currently, mobile learning (M-learning) is being used extensively in teaching and learning foreign languages which further widens the mobility of learners. The usage of mobile instruction can lead learners towards a real interruption to learn effectively when used inappositely. The current study is an attempt to explore the potential usage of M-Learning in English for specific purpose (ESP) classes. For this intention smartphones were used in the ESP context for teaching Business English at College of Business Administration at a public sector university in Saudi Arabia. A questionnaire was distributed to 21 participants of the present study after 5 week exposure to M-learning activities in formal classroom. The findings revealed that ESP learners acknowledge M-learning as a prompt source of feedback in ESP. The results of this study also indicate that incorporation of M-learning in ESP learning with conventional classroom can support learners to develop their learning proficiency. Moreover, learners showed significantly positive attitude in mobile instruction in formal classroom.

Keywords—M-Learning; ESP; Mobile instruction, MALL Technology

1 Introduction

1.1 Background

The use of technology is practicable from global world to formal classrooms and it has combined education with the need of learners to a great extent. Successful language instruction requires the enthusiasm and creativity to motivate learners as well as to keep the teaching alive in language classrooms (Beatty, 2013; Patel & Jain, 2008; Pinter, 2017). The use of optimal instructional technology is a part of the provision of suitable learning environment and opportunities to connect the requirements and principles of language learning. Therefore, it is the basic requirement for EFL teachers to get required awareness of technology usage that will develop and foster learning effectively (Yang & Chen, 2007). The moderate use of technology is fundamental aspect of inculcating technology as learners will face problems to grasp the positive usage of technology particularly in language classrooms. Moreover, right choice of technology is also mandatory for the achievement of desired goals as simple integration of technology cannot promise the learning enhancement in formal or informal classroom (Vrasidas & Glass, 2005).

Learners acquire language informally by the means of availability of recourses. With the instant growth and persistent availability of digital handheld and mobile devices, technology has widened the access to learning material, which offers various learning expansion since early 1990s (Littlejohn & Pegler, 2007; Warschauer, 2004). These readily available opportunities have vivid capacity to transform the mechanism of learning and in favor of this informal instruction can be easily initiated to impede the process of learning in conventional classrooms. Macfarlane and Ottewill (2013) asserted that these technology oriented openings can also expedite more shared and interactive learning environment for learners, which are radically distinctive from conventional and informal learning setting that includes the traditional methods of watching television and reading newspapers. The use of technology is beneficial when it is used for the development of academic goals of the syllabus and classroom activities instead of devising instruction for the better usage of technology and its skills. Similarly, the integration of technology in language classes also requires the careful planning to address the learners' needs and usability for language learning tasks. This assertion is also confirmed by the Levy and Stockwell (2013) as computers are meant to perform the role of teacher, tutor and tool conveniently. This sort of formal learning is typically directed by an instructor, while informal learning is predominantly learner-centered and self-directed (Ehlers, 2009; Hirumi, 2002; Marsick & Watkins, 2015). As a result of the growing attraction of smartphones, digital technologies and the division between formal and in formal learning environment, is considered as immaterial (Bradwell, 2010).

Currently, android and smartphone technologies, as a platform for information and communication, have got a significant boost in the field of education recently and attracted the attention of various institutions to use it as instructional technology. This enormous familiarity has been guided by the development and availability of fast speed Wi-Fi, working habits, transformation of lifestyles and community standards (Salz & Moranz, 2013). Hutchins (2014) also highlighted this fact that the expansion of internet is growing by the usage of personal computers and smartphones in different educational and normal life settings. Likewise, the rise of the usage of mobile learning in education in Saudi Arabia is also accelerated in recent years (Alsuwayed, 2017). However, the expansion of smartphone devices has been mirrored in numerous countries around the globe, principally due to its manifold function. So, there is increase in smartphone technologies for the experts in the field of education to adventure the digital transformation which includes the practicality of expanding the use of technology and android applications as a supplement to foster the language acquisition and learning sequence (Armstrong, 2016; Dingli & Seychell, 2015; Penny, 2017).

1.2 Research Questions

The present attempt tries to explore the answers of the following questions:

1. Do ESP learners reflect the mobile phone integration as an efficient way to learning English for Specific Purposes?
2. Do ESP learners recognize mobile phones as a useful technology in learning language?
3. What sort of language learning activities do learners employ in on their mobile phones?

2 Literature Review

2.1 Mobile Learning

Broadly speaking, mobile learning includes any sort of leaning intervened by the means of using mobile phone devices (Wishart, 2017) which can happen anytime, anywhere and at suitability of the user. The viability of smartphones urged scholars, teachers, practitioners and researchers to turn the focus of their consideration to emergent technologies and their probability as language teaching instrument. Several attempts have been made to explain the term M-learning, and mostly it is referred and dedicated either on intervening technology or on learners' flexibility. Page (2014) refers mobile learning as an indication of the prospective development in learning other researchers regarded it as closely associated to M-learning as subset of E-learning (Anderson, 2008; Motiwalla, 2007). Park and Heidemann (2011) refer mobile learning on the usage of mobile phone devices or wireless devices for perseverance of learning at any place.

The arena of mobile learning is persistently developing and equally current and past studies attempt to explicate the characteristics and elements of mobile learning. The main focus of major researchers (Guy, 2010; Melhuish & Falloon, 2010; Stockwell, 2007, 2010a; Stockwell & Liu, 2015; Wan, 2013) was to develop consensual interpretation, pedagogy and framework that can be appropriately integrated in the shift of latest technologies, distinctive prospects and mobility of learners in formal and informal education framework. Therefore, sufficient understanding of the term of M-learning is essential for the best use of this technology. The most prominent mobile devices comprise of android smartphones, laptops, tablets, MP3 players and small portable PCs, all of these have capability to facilitate and develop the process of learning (Pereira & Rodrigues, 2013). Contemporary expansions of social networking and social software have given smartphone devices more ubiquitous than in previous times, particularly it is more common amongst youth. M-learning software application should be guided by the instructors, irrespective of hurdles because of global change in the usage of software to attain its full benefits. The process of learning can occur well when it is aided by the usage of smartphone, that may be one of the key benefits of the learning (Zhang, Wei, & Burston, 2011). In a meta-analysis Chee, Yahaya, Ibrahim, and Hasan (2017) also found a profound progression in developing learning skills of leaners. Most researchers (Al-Asmari & Rabb Khan, 2014; Badwelan, Drew, & Bahaddad, 2016; Fida, Farouq, Alamawi, & Kamfar, 2017) also acknowledge M-learning as positive instrument in developing learning process in Saudi Arabia.

2.2 Technology Integration in ESP Education

The global business setting is currently controlled by the practice of English related to business, which subsequently is heading to a growing involvement about teaching English for specific purposes. The existing technological advancement has determined profound variations in society in the shape of availability of new inventions and facilities, and new modes of communications universally (Stehr & Ruser, 2017). The prevalent usage of smartphone devices nowadays also provided appreciated place for teaching business English learners who have ample access of mobile devices, as it offers them supple and easy way to study their own. Because of the viability and availability of potable software and mobile phone devices is currently expanding and way there is also drastic change in teaching methodologies (Hadland, Borges-Rey, & Cameron, 2017). M-learning offers learners the possibility of exceling the restricted atmosphere of conventional classroom to create an attractive learning self-sufficiency. So, this wide range of business English applications for the development of learners' ability has also advanced in recent years.

The association between information and communication technology and ESP stays well in a strong effect of Computer-assisted language learning (CALL) with the advancement in linguistics and language learning (Shih, 2010). Technology integration in ESP classes can be seen in the shape of various digital and smart tools, access to the high speed internet to engage the leaners in developing their understanding. Like other modes of language learning ESP also requires learner-centered apps for the experience of technology with conventional classroom teaching to make teaching atmosphere interested. The role of technology in ESP is to support the learners to access to reliable material that has been utilized as an additional help for learning purposes (Nekrasova-Beker & Becker, 2017). It has also further developed the ways of organizing related language task from outside of the classroom to the traditional classroom setting by persistent use of WhatsApp, Snapshot and many other smartphone applications. Therefore, integration of technology advances the visualization process of language learning effectively, when it comes to ESP context, it can be used as for the content and development of business related vocabulary. The usage of technology in ESP teaching has modernized the methods and material for ESP students (Bloch, 2013).

Researchers (Alemi, Sarab, & Lari, 2012; Tayan, 2017) have indicated that learning backgrounds which are associated with enhancement of technological motivation for the learners, are more beneficial as compared to other methods of language instruction. McDonough and McDonough (2014) proposed that ESP requires a different approach and activities and it has also separate schema in the field of applied linguistics platform. Moreover, it has its own teaching methodologies and ways of engaging learners as well as its interdisciplinary in research. Thus, it is a great delusion that findings of technological integration in EFL context can also be generalized to the finding of ESP teaching. In rapid revolutionizing instructive education environment, the potentials of technological learning are developing and they can be replaced to obsolete traditions of learning environment.

The result of Falloon (2017) identified the importance of the associating MALL with traditional classrooms. The function of handheld devices and scaffolding helped learners' to construct their understanding and link their experiences positively. Similarly, the use of MALL approach result in developing self-determined techniques outside the conventional classroom boundaries, where virtual connections and mobile phone devices bump into developing the goal of target language conversation requirements and benefits (Kukulska-Hulme, Lee, & Norris, 2017). The current attempt is also a part of modern technology to understand the process and need of integrating MALL technology in Arabic speaking ESP learners of accounting section of a public university of KSA.

3 Methodology and procedure

3.1 Methodology

The present study used the quantitative method for collecting data. Quantitative method allows researchers to be more reliable and objective in the results (Brannen, 2017). In order to quantify the results a questionnaire was adopted after analyzing previous studies in the filed relating MALL studies. The use of questionnaire is a useful and operative way of collecting data and information on the perceptions and attitudes of study participant on a given field or subject matter (Brown, 2001). All the learners were given 15 minutes after the formal classroom to engage in MALL activities. Learners were allowed to use their smartphones freely for the discussion about the taught topic. Learners were exposed to use their smartphones in the last part of their class for five weeks. For this purpose a WhatsApp group was created by the researcher and all the learners were asked to practice their exercises in this group. They shared their classroom activities by using WhatsApp. The data was collected in first academic semester of 2017.

3.2 Participants and Instrument of the study

21 ESP learners from College of Business Administration of a public university of Saudi Arabia participated in this research study. They study ESP as part of their syllabus for a period of one semester. All of the learners were assumed to have a similar level of English as they were placed in groups after a university placement test at the time of registration. The first language of learners is Arabic and they use Arabic as means of communication in campus. All of the learners have smartphones with fast data connection but they didn't have any past experience of using smartphones as an aid in

learning in the classroom. However, for current study they were exposed to use their cellphones during their classes regularly for a course of one semester.

Quantitative method was employed to gather the related information for the current study. The researcher inspected different prominent specialists in order to adopt questionnaire for collecting data. Moreover, the selection of classroom activities was also analyzed to check the recognition for the need of mobile learning in ESP classes. A questionnaire was adapted mainly from two different previous studies (Gaudreau, Miranda, & Gareau, 2014; Palalas, 2011). In the first part, seven elements on the usage of effectiveness were chosen to gauge the learners' understanding of-learning. Learners were asked to respond to these elements on the 5 point Likert scale from strongly disagree to strongly agree about the instruction of M-learning for ESP classes. The second section of questionnaire was related to learners' usage of M-Learning in conventional classroom setting. This part consisted of six elements where learners had to mark their understanding on the basis of 5 point Likert scale from never to very often frequency. In the last part of the questionnaire, advantages and disadvantages of mobile-based instruction in classroom were analyzed. Learners had to choose from already selected advantages and disadvantages from Palalas (2011).

4 Data collection and Results

After five weeks of the exposure of using smartphone, learners were asked to complete the questionnaire. They were asked to complete the questionnaire in their class time. The questionnaire was administered to preform intact group of 21 students of College of Business Administration faculty. After getting responses from the learners, data was evaluated descriptively by coding means and the percentages of the replies from the students. The remarks were separately collected and calculated in the final outcomes, therefore covering more individual awareness and learners' perception on the use of mobile phones in ESP classes. Moreover, data were also collected and analyzed descriptively on the prelisted advantages and disadvantages of smartphone integration in formal ESP classes.

4.1 The use of Smartphones in ESP classes

All the students were inquired to appraise their usage of smartphones after 5 weeks of smartphone instructions during conventional classroom on Likert scale from 1 to 5 (Very often=5; often = 4; rarely= 3; very rarely=2 and never; 1). Table 1 explains the usage of smartphone usage in typical classroom as an aid to their formal classes.

Table 1. The use of Smartphones in ESP classes

The use of smartphones in ESP Classes					
	Never	***Very Rarely***	***Rarely***	***Often***	***Very often***
Searching supplementary material using Mobile	0	25%	35%	40%	0
Sending emails using Mobile	0	59%	51%	0	0
Navigating Educational websites	0	14%	67%	19%	0
Note taking on the phone in the class	0	17%	43%	40%	0
Use of social media	0	17%	43%	40%	0
Use of phone for taking pictures	9%	55%	27%	9%	

Adapted from (Gaudreau et al., 2014).

This is obvious form the results that highest numbers of the learners were engaged in browsing internet to look for the supplementary material related to their formal classroom instructions and sending emails by the means of using smartphones. It is obvious from the above results that 59% students used smartphone for sending emails and 40% of students employed their efforts in finding supplementary material in classroom. Moreover, highest percentage of students indicated that they rarely used their smartphones for the searching class-related material as compared to 19% who used smartphones for this purpose. However, it is also noteworthy that a considerable number of students utilized their smartphones in browsing social network page in the class. The purpose of using smartphones for social networking can be further investigated. The minimum percentage was noticed for taking pictures during their classroom.

Effectiveness of Mobile Instruction in ESP Classes. To evaluate the efficiency of learners' development after using smartphones during the class time, learners were asked to gauge the effectiveness of smartphone instructions. They had to evaluate smartphone instructions on the identical scale ranging from 1-5 (Strongly Agree=5; Agree=4; No opinion= 3: Disagree= 2; strongly disagree=1). The table listed below explains the responses of ESP learners. The items of this part of questionnaire were adapted (Palalas, 2011).

Table 2. Mobile Instruction in ESP classes

MALL Instruction in ESP classes					
	Strongly Agree	***Agree***	***Neutral***	***Disagree***	***Strongly Disagree***
MALL offered an effective way of learning language	12%	67%	19%	2%	0
Developed English Learning Proficiency	3%	87%	10%	0	0
MALL offered Learners' centered learning	18%	52%	17%	10%	3%
MALL provided and easy and fun way of learning	11%	69%	8%	12%	0
I learned better with smartphone	2%	34%	28%	36%	0
I would use different apps for learning English	87%	9%	4%	0	0
Smartphones are a distraction in class	0	13%	10%	59%	28%

Adapted from (Palalas, 2011).

Students' responses indicate that M-learning is most operative part of learning. The data presents vital indication of improvement of learners' proficiency in learning English. 87% learners approved the instruction of smartphones develop learners' proficiency effectively. Moreover, a considerable numbers of leaners also agreed that mobile learning is an easy and enjoyable method of ESP learning. Similarly, 87% leaners also should their inclination towards the usage of smartphones applications for self-directed learning for ESP classes. However, some learners also identified that smartphone may cause distraction in classes but this percentage languished below the considerable number. Some learners showed indifference in integrating smartphone software in ESP classes. Nevertheless, many learners have marked smartphone integration as a fun way of learning.

4.2 Advantages and disadvantages of smartphone instruction in ESP Classes

Students were asked to mark prelisted advantages and disadvantages of smartphone immersion in formal classes that apply to their situation in the last section of the questionnaire. They were allowed to choose as many as they think comply with their situation in formal classroom teaching. The responses of students are listed below:

Table 3. Advantages of Smartphones Instruction in ESP classes.

Usefulness of smartphones instruction in ESP Classes	
Learning Material is readily available	73%
Ubiquitous Learning	52%
Pronunciation development	28%
Fun way of Learning	39%
Source of instant Feedback from instructor	88%
Offers collaborative learning	41%

Table 4. Disadvantages of smartphones Instruction in ESP classes.

Disadvantages of smartphones instruction in ESP Classes	
Small screen size	58%
Data connectivity	89%
Material surfing is time consuming	20%
Lack of interactivity	30%
Technical problems	40%

This is viable from the responses collected from students, the immediate and instantaneous availability of accessible data; prompt feedback from peers or instructors are undoubtedly the prime advantages of smartphones instruction in formal ESP classes for the development of learning process. Most of the students indicated it a beneficial method of getting required information or details of certain responses whenever they need to look for online material. Furthermore, receiving and delivering instant comments is also regarded to be specifically helpful and productive way. Similarly, several students from the targeted group also contemplate it as collaborative learning in the possibility to get required aid when required and less numbers of students regard smartphone instruction as fun way of learning in class. Contrarily, students also indicated smartphone instruction as problematic in learning process because of the lack of free access to Wi-Fi or data in the class. A remarkable number of students marked battery that glitches in using their smartphone for effectiveness of ESP instruction in the classroom. Some students also labeled the typing problem on small screen and duration of time for downloading material as it may create lack of connectivity and interaction is ESP learner exposure. However, it is noteworthy that time consumption percentage is languished at 20% which is important factor in formal classroom because of the time constraint of schedule.

5 Conclusion

No one can deny the fact of the ubiquitous presence of smartphones in our surroundings as chief source of communication in particular and an effective teaching aid for the progression of educational methods in general. The present study was an attempt to measure the potential of the M-learning integration in ESP context. The results of this study are in line with previous MALL studies (Badwelan et al., 2016; Macfarlane & Ottewill, 2013; Stockwell, 2010b) by creating different diverse learning opportunities. Due to its ubiquitous presence, this technology has a great role in language learning and teaching process. Owing a smartphone allows individuals to associate and develop coordination without any time constraint. Neglecting this proficiency of smartphones, in fact, is refusal of adopting modern methodologies. Like EFL teaching, ESP teaching also demands the attention of teachers to boost the possibility of mobile phones integration to get the benefit of this hand-held device. Therefore, the target of ESP teachers should be maximizing the utility of smartphones in typical and informal teaching situations. The goal of using technology should be the development of teaching process; not the usage of smartphones but in the way as these gadgets can assist learning accordingly. The findings of the data of present attempt indicated that usage of technology in ESP classroom need careful handling and management of this approach.

The integration of smartphones in this study fostered the process of provision of feedback effectively in ESP classes. A language instructor or a teacher can monitor the group activities as well as he can trace the performance of learners easily even if the number exceeds than the set standards. Similarly, it is an effective way of finding a solution of encountered problem by learners themselves. The result is self-directed learning and development of confidence among themselves. Moreover, from learners' perspective, smartphones are useful source of inducing constructivist –based background that can also affect the motivational level, collaboration and individualized engagement in learning process. Furthermore, the results of this study also indicate that integration of M-learning in ESP learning in traditional classroom can assist learners to develop their learning proficiency. In addition to the persistent benefits of M-learning, it is also important to consider the effective and purposeful usage in classroom. If the M-learning activities are not planned carefully, this technology can be real distraction and mere wastage of time. So, careful handling and planning for developing learning process is essential part of devising M-learning classroom environment.

6 Implications and Limitation of the Study

It is commonly known fact the MALL is now indispensable learning asset and previous studies had established its positive effect on English language learners impressively. The present study suggests some implications of M-learning implementation and providing applied advantages of this learning tool efficiently. Firstly, it is valuable to integrate such learning tools in ESP language teaching by using already developed technological soft-wares programs to facilitate learners with attractive and motivating learning system inside as well as outside of the formal classroom setting. Moreover, curriculum developers and ESP instructors need to encourage learners to use this technology purposefully and for the sake of progression of their language learning. In addition the incorporation of this useful technological tool by the instructors provides opportunity of self-directed learning to great extent and learners' language learning efficiency can be developed by the means of interaction and communication with peers and instructors. The result is scaffolding effect on the ESP learners' learning ability. This enables leaners to share, discuss, correct, expand and assign responsibilities during the course of communication with teachers (Boettcher & Conrad, 2016).

Additionally, MALL is newly developed approach in teaching and learning process in education particularly in second or foreign language learning. Principally it signifies the practice of hand-held smartphone devices and tablets to learn and advance their language learning skills both in EFL and ESP context effectively. Literature is abundant with the studies that have been carried out in the recent past globally as well as in Saudi Arabia (Al-Asmari & Rabb Khan, 2014; Al-Masrai & Milton, 2012). In addition to numerous advantages, it also facilitates learners to be independent in learning process at the ease of the utility of time and background.

Like other research investigations, this study has also some limitations. The current study is limited to one section of a public university in ESP learning field with limited number of participants. Therefore, the findings of this attempt cannot be generalized to the other aspects of ESP learning as different subject matter requires different methodology. Moreover, if the study includes large number of students, more profound understanding of M-learning can be attained precisely. In addition, if the mobile instructions for classroom usage are given to participants better results can be gathered. Irrespective of less number of participants and M-learning usage in formal class current attempt is a solid foundation for further experimental research in this arena.

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The Relationship between Segmentation and Question Location within Mobile Video Platforms for Enhancing the Ability of Recall

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Abstract—The current research aimed at identifying the relationship between segmentation of video clips (Segmented Video (SV) / Non-Segmented Video (NSV) and Question location (Pre-questions Preq / Post question Postq) through Mobile Video Platforms on affecting the Recall ability among some students of the College of Education. The semi-experimental approach was used as based on the factorial designs (2 × 2). The research sample consisted of (63) female students from the College of Education at the University of Jeddah and randomly distributed to the four specified research groups. A Recall test has been developed. Analysis of variance (one and two) (ANOVA), Partial Eta Squared, and Schiff's post hoc comparison were employed to analyze data. The results showed the effectiveness of the segmented videos as compared to the non-segmented videos, and of the pre-questions as compared to the post questions, it also showed the priority of the fourth treatment of the interaction between segmented videos and pre-questions locations as compared with other experimental treatments.

Keywords—Mobile Video Platform, Segmentation, Question Location, Recall**.**

1 Introduction

Mobile Platforms are interactive online services that allow students and teachers have the access to digital content, interactive tools, and online resources to support and manage the learning and teaching process [1, 2]. Mobile platforms are also secure educational networks that give teachers simple ways to create and manage classrooms across the web, and provide a productive environment for interaction between teachers and learners, regardless of place or time [3]. Recently, several mobile video platforms have begun to emerge, allowing classrooms to provide the teacher with a variety of strategies that control the presentation of videos, and to offer some interactive features that were not available with video applications deployed across networks over the last few years. Among the technologies provided by Mobile video platforms is the possibility to split up one video for more than one segment in addition to the ability to add various questions within videos [4-6], An example can be at some platforms available at web and mobile like Edpuzzle (https://edpuzzle.com/), and Educanon platform (http://www.educanon.com/).

Videos are the main component of mobile platforms, but studies related to the examination of technical variables for digital video or the tools associated with these clips did not have the chance to be researched and studies [7]. This is consistent with what has been mentioned in literature that the design process for delivering videos across the web is in general limited and needs further examination and study [8, 9]. However, when talking about the video variables that are associated with the mobile video platform system, the segmentation variable becomes one of the most important video variables associated with controlling the pacing of instruction and reducing the excessive cognitive load, leading to the release of knowledge resources and an increase of working memory capacity in encoding new learner information for learners [10]. The principle of segmentation is based on the assumption that the educational program that allows the learner to control the speed of learning through tools that allow him to stop and follow while reading video presentations is more effective than the presentations that run from start to finish without interruption [11]. This is because digital video segmentation gives the learner the opportunity to stop the flow of information when necessary, and allows him to process information more precisely, thus promoting the learning process [12]. Although a large number of studies in literature supported segmented instruction (SI) versus non-segmented instruction (NSI) [10, 13, 14], the comparison between segmented and non-segmented remains one of the variables that need to be studied within a context that necessitates interaction with other variables [15].

Learning from videos across the web should not only be limited to viewing; however, the viewing process should be linked to a set of questions related to the video content [16, 17]. Regardless of the number of segments of a video - whether one or several - it is important to determine the best location for the questions that relate with each part of the video. Are the questions located before the beginning of each part? or are they placed at the end of each part? The use of questions within the videos is one of the important variables that need to be studied, especially that it has a strong relationship to the learner's ability to remember and retrieve [18]. Research in studies that focused on the placement of questions, whether before or after the learning content, leads us to the fact that most of the benefits that can be obtained from linking questions to videos comes from studies that have raised questions after viewing the content, while there is little knowledge about the potential benefits of questions being raised before viewing the content, although previous content questions help students encode subsequent information and improve memory performance [19]. In addition, the pre-questions that precede each part of the video may also be important and can be considered as a key tool that guides students to what they will learn and draw their curiosity for learning. It can also be used as a tool for Metacognition [20]. While some believe that pre questions may not enhance or even hamper the learning process because in this case they serve as a selective indicator for the learner's information that the learner should pay attention to what follows in content, thus ignoring other information that are not covered in pre questions [19], others believe that the importance of questions at the end of each part of a video comes as an indicator for having the learner complete watching all the video content and ensure that being exposed to all the key content contained in the clip [16]. It also tests what the learner watches in the videos and helps him apply his new knowledge and however enhance the learning process [21].

The researcher was interested in the groups that handle video as based on segmentation and question location as one of the approaches that aimed at finding solutions to the problem the researcher encountered when teaching the e-learning course for students of the College of Education, especially that the in-classroom learning activities are based on a review of some of the available web-related videos of the course topics, that is followed by a discussion based on the review to the content of these clips. However, the researcher noted an inability to recall the contents of these sections, which are displayed free of charge through some sites and applications that do not have any characteristics based on the segmentation or locating questions, such as (YouTube) and (Vimeo). The researcher went on to try to know the effect of segmentation and the question location in the video clips to enhance the recall capabilities of the students of the College of Education in the e-learning curriculum.

Based on what have been mentioned above, the current research aims to determine the effect of video segmentation (segmentation vs. non-segmentation) and the location of questions through segmented videos, that is, before (prequestion) or after (postquestion) in developing the recall skill within the mobile platforms that are employed in teaching some subjects related to the e-learning course of students of the College of Education, University of Jeddah.

Therefore, the present research attempts to answer the following questions:

- **(RQ1)** What is the effect of segmenting videos (segmentation vs. non-segmentation) across mobile platforms in developing the recall skills of students?
- **(RQ2)** What is the impact of question location within the video (pre-question or post-question) across mobile platforms in developing the recall skills of students?
- **(RQ3)** What is the impact of the interaction between video segmentation and question location across mobile platforms in in developing the recall skills of students?
- The current research also tries to validate the following hypothesis:
- **(H1)** There is no statistically significant difference at the level of ≤ 0.05 between the mean scores of the experimental groups in the post measure of the recall test; due to the effect of segmentation.
- **(H2)** There is no statistically significant difference at the level of ≤ 0.05 between the mean scores of the experimental groups in the post measure of the recall test; due to the effect of question location.
- **(H3)** There is no statistically significant difference at the level of ≤ 0.05 between the mean scores of the experimental groups in the post measure of the recall test; due to the effect of the interaction between segmentation and question location.

2 Literature Review

2.1 Mobile video platforms

The e-learning revolution has produced a variety of systems that can be relied on in various learning and teaching processes, including mobile Platforms which have become dependent on unconventional tools in managing educational situations [22, 23]. mobile platforms have become one of the active tools in developing cooperation and creative thinking among learners [24, 25], and has proved reliable in the development of student engagement and responsible learning processes [3, 26].The design variables of the mobile platforms have also created motivation and stimulation for learners to complete learning tasks [27], and improve learning through active participation in discussions and tasks [27]. Recent popular platforms include video-based platforms, including the edpuzzle platform which succeeded in providing interactive tools such as adding questions in various formats (right and wrong, multiple choice, and open questions). It also allows segmenting video clips so that each clip can handle specific subject area. Other features for these new platforms include anti-skipping to ensure that the student views all the contents of each section of the clip, with a choice that allow the student to re-view specific parts [28]. In addition, these new platforms accept adding subtitles to the clips and using them as a translation bar. They activate content aggregation feature that allow viewing available digital web-based sources next to the video clip through the platform [4].

The main content of the video platforms, which are the video clips themselves, and considering redesigning them so that learners can recall their contents again is an important issue [29]. It is essential for the instructional designer to keep in mind that large videos which exceed 10 minutes may result in the learner not completing the video content [30]. Some cognitive studies have shown that after 10 minutes the learner's stimuli gradually disappear, which means that the learner may not complete the video and then seek new videos immediately [31].

Other studies suggest that it is better to have an average video length of (6) minutes per clip [32]. However, when a video for one lesson is segmented for more than one part, the total parts of all videos should not exceed 20 minutes [33]. In addition, the presence of the teacher in these sections and the use of body language to emphasize some important information increases the student's interest in content areas where a teacher is present [34]. It may also be better to employ tools that allow discussion and comments on the contents of sections that are broadcasted to learners, so that the teacher can support learners who need some guidance when they study outside the classroom and respond to them within a short time rather than waiting for the scheduled class time [16, 35].

2.2 Digital video segmentation

Video segmentation is based on a premise that these presentations provide fast and continuous information flows, and each flow of information needs to be processed in the working memory. Therefore, when not giving the learner enough time to process this information, it is likely that he/she may replace a new information with a previous one regularly without having them stored in the long-term memory [36]. That is why the process of segmentation work to divide the video into successive meaningful clips [37] by adding pauses between these parts that allow the learner to move from one part to another after pressing a follow button [38]. This helps reduce the cognitive load, organize new knowledge, address pre-stop content, control learners' speed of learning, and enable understanding of complex information and content [36, 39-41].

Segmentation also gives learners an opportunity to learn how to extract important information from a specific part before moving on to the next, as well as analyse the visual spatial structure of the content on the screen, which can be difficult to do when the display is constantly changing [42]. Several studies that were interested in segmentation processing versus non-segmentation processing have shown that segmentation process is very effective in developing the ability to acquire knowledge, apply new strategies [10], solving problems [14], enhance performance and conduct cognitive processes [43], and enhance the ability to recall [44].

The segmentation process can be considered as a form of temporal cueing [36], where the segmentation process allows a better focusing on the mini and magnified events within a single video clip [45]. Some have attributed the failure of some digital media - including video - in making a change in learning outcomes to a media design that lacks time organization; this time organization allows the learner to easily process web-based content. This makes segmentation one of the important design factors that should be taken into consideration when designing learning materials, especially that is a key tool that control the timing when processing the educational content [43]. However, segmentation is very important even when the learner does not have control on moving from one part to another withing the digital medium. This was made clear in the study of Spanjers [15] which pointed out that the automatic stop for (2) seconds that is followed by a display of information without any control on the part of the learner has positive results when compared to the display that goes without any stops.

2.3 Question location within digital video clips

Examining the optimal placement of questions within digital videos whether before or at the beginning of the segment means looking at the ideal design to employ questions as an instructional tool within the mobile video platforms, rather than simply looking at questions as tools for measurement and evaluation [19, 46]. This trend and orientation encourage having a good number of mobile video platforms that provide a variety of tools to manage the set of questions across videos [6, 47]. Questions that are presented at the beginning of learning process are called pre-question, while the questions that are presented at the end of the section are referred to as post-questions, and the various positions of the questions in the learning materials have multiple effects on the learners, so it is important to examine the optimal position for the placement of questions with regards to learning outcomes [48]. Some argue that the reliance on pre-questions means simply an activation of the prior knowledge, and an increase of the learners' concentration on the educational materials that will be presented later [19], while the post-questions are more related to the idea of retaining the impact of learning and raising the rates of remembrance [49]. Some studies have shown the effectiveness of the instructional materials that are preceded by questions as compared with other educational materials that are not preceded by any questions for memory development [50, 51]; this can also be found in the study of [19] that targeted a comparison between two groups. First is the experimental and it answered the pre-questions before watching the videos, the second is a control group that watched the videos without pre-questions. The results have shown that the performance of the experimental group was better than the control group, which means that there are positive effects when including pre-questions in videos. While other studies have indicated that there are limited effects of pre-questions; these effects are limited only to information that focused only on pre-questions [52, 53]. As an example, [52] presented a series of multiple-choice questions in three positions, one before explaining the lecture, the second at the end of the lecture, and the third before the unit test. The results indicated an improvement in the performance of students who got pre-questions in the two groups, although they did not recall the pre-questioned information in the same way they recall non pre-questioned information. Hence, more than one study has pointed out that a failure to answer pre-questions by learners does not affect the positive advantages that pre-questions offer, especially that their primary role is coding the subsequent information [53, 54]. When some criticize the pre-questions for their influence in directing the learner to pick only information related to questions [46], it can be noted that video presentations may not face this challenge because they have the ability to control the frequency of information display, allowing the learner to watch all information included in the presentation [46]. Some argue that the post-questions that come at the end of learning processes may have a significant role in improving the understanding of the content of previous questions, especially when these questions focus on inferences and the main ideas that relate to the displayed content, where this kind of question is considered in this case as Adjunct Questions [55]. In a study by [56] that compared the post-questions with the questions generated during learning or learning without questions, the results have shown the effectiveness of the post-questions in improving the efficacy of the recalling skills of the main ideas and factual details.

2.4 The ability to recall

The recall is the individual's ability to restore the information stored in his memory, and it is also the ability to remember information when instantly needed [57]. This recall may be a serial recall, in which the material must be remembered in a particular order, and there is also another kind of recall called free recall, through which the information can be brought in any order, and there is also an ordered recall where the learner must recall the words as requested and he/she should identify the sequence or the location of the words that he remembered. Another kind of recall is the caused recall where the learner is given certain information that could help him mention the requested topic, such as the first letter of the word [58-60]. Moreover, recall is one of the components of a broader process called retrieval; it contains two major elements: recognition and recall where recognition is a form of memory, and it is easier than the recall because it depends on the existence of previously learnt stimulus. Recognition means that what the individual sees or hears in the present is part of a prior knowledge, while recall is concerned with remembering events and experiences that were learned in the past without an existed stimuli or situations that led to learning [61]. Recall requires two types of activities: first is to search the memory to determine the required information, and second is a simple examination to identify whether the information is familiar or not.

Segmentation can affect the learner's ability to recall information due to the ability of segmentation in organizing the encryption, processing, and storing of information in memory and recalling it from memory. This ultimately affects the memory capacity to perform the recall processes [38]. In addition, questions location significantly affects the ability to recall because pre-questions give indicators for a focus on subsequent content, which means paying more attention and encoding it. On the other hand, post-questions are certainly related to a previously presented information and a training to recall a content that relate to this type of question [52]. The video is also generally an effective tool in addressing the problems of recall as well as its active role in enhancing recall and has great ability to handle the recall errors [62]. The general characteristics of mobile video platforms support anti-oblivion and the ability to recall and remember. According to the decay theory, the main reason for obliviousness is the lack of use or practice of the acquired experience and the theory emphasizes the need to practice and use information from time to time to help retain them and keeping them vivid in memory [63].The mobile video platforms that are based on segmentation and adding question solutions for dealing with obliviousness by allowing the learner to see each part of the content more than once and get trained to recall and encode information more than once, which ultimately enhances the learner's ability to recall [22, 23].

3 Theoretical Framework

Presenting the content at a rapid pace and in continuous flows without any interruption may exceed the cognitive ability of the learner and thus lead to a cognitive overload [12]. This means that instead of displaying videos in continuous flows, it is better to display them in segments by adding stops within the video through which the learner can moves from one part to another according to his desire and speed in acquiring information [36]. This comes in line with Richard Mayer's Cognitive Theory of Multimedia Learning (CTML) which recognizes the principle of segmentation. It is one of the basic principles of a theory that relates to how information is handled. The principle indicates that learning is best done when presenting content in parts to allow the learner to move between them at his/her own desire rather than continuously displaying them automatically [12]. Working memory performs three things at once: processing information related to external stimuli in working memory, keeping new information in working memory, retrieving information from long-term memory. The working memory capacity is in normal condition limited, and in case the cognitive demands of an educational task exceed the memory capacity, it leads to Cognitive Overload. However, using segmentation in this case is one of the solutions through which the amount of information processed by the learner can be controlled without any cognitive overload [10, 44].

The Event Segmentation Theory (EST) recognizes an important principle that states that individuals recognize and perceive any activity in the form of separate events through a process called mental segmentation which happens by setting boundaries between events so that current information get perceived, attention processes become organized, and knowledge be stored in the long-term memory. This happens through a procedural process in which the person forms models of the event in his working memory on the basis of sensory information and prior knowledge. Based on these models, predictions are made of what will happen at the next moment and are then compared with what actually happens according to the new sensory information received, and when a difference exists between the expectations and the new sensory received information, a new event model will be constructed for the next part, and in this case the so-called event boundaries are distinguished [64]. There is no doubt that the principle of video clips segmentation provided within the digital video system platforms comes in line with the theory of the event by dividing video clips into separate events which make it easier for the learner process and understand the events' components.

According to Cognitive Load Theory (CLT), the more diverse are the sources of learning and the more varied are the relationships between these sources, the more cognitive burden it puts on the learner, and this makes the subject becomes more difficult in the learning process. However, one of the solutions that must be taken into account to solve such a problem is to provide sufficient time for the learner to be able to handle all elements of learning and draw up relationships between these elements [65].Therefore, segmentation is offered as one of the solutions, which is compatible with the cognitive load theory, in providing the learner with enough time to process web-based educational presentations, which includes a diverse number of educational elements and topics [36, 66]. It is also important to take into consideration that segmentation may expand the time needed for learning due to the provided pauses through digital videos. However, cognitive load and learning outcomes do not improve with the span of time regardless of how long it is; rather, segmentation is the key factor in improving learning outcomes and in preparing the cognitive load for the learner to receive and process new information. This can be illustrated by Hassler and his colleagues, who have demonstrated the effectiveness of segmentation in all conditions under which the learning time was unified [67].

In normal educational environments, questions and tests are often considered tools for evaluating students' knowledge. It is an annoying event for both students and teaching staff; it is carried out at specific times of the academic year to assess knowledge and efficiency. However, questions are deeper than merely a measure of knowledge, they are effective tools for memory development and retention of what has been learnt; a phenomenon known as testing effect, which in other words mean to what could questions contribute to the survival of the learning effect [49]. Thus, the use of questions within digital stems from a rule that considers questions as a strategy to acquire knowledge rather than a test or measure of learners' knowledge, and that the questions as unit is one of the learning events that has an effectiveness in the development of learning outcomes. This effectiveness may go beyond the direct study of a content that does not include any questions [53]. Questions are therefore one of the learning tools, and if any education system has a core set of tools that assist its learning process, questions should be considered as one of the most important tools.

4 Methodology

4.1 Design

This research is based on the semi-experimental approach. It relies on the factorial design (2 × 2), which is used to measure the effect of independent variables, segmentation, question location on the dependent variable Recall that is related with the study of some of the topics of the e-learning course by the students of the College of Education at the University of Jeddah, and the following table (1) illustrates the experimental design of the research.

Table 1. Research Experimental Design (2×2)

	Segmented video (SV)	**Non-segmented video (NSV)**
Pre-Questions (PREQ)	Group (1): A segmented video that consists of five parts; each part is preceded by questions	Group (2): A video that consists of one part and preceded by questions
Post-questions (POSTQ)	Group (3): A segmented video that consists of five parts; each part is followed by questions	Group (4): A video that consists of one part and followed by questions

4.2 Sample

The current research sample consisted of 63 female students from the College of Education at the University of Jeddah in Saudi Arabia who are studying an "E-Learning" course. Students who were good at using the platform and who have the desire to participate were nominated. The selected students were randomly assigned into four groups, (PREQ + SV) which includes (17) students; the second group (PREQ + NSV) and it includes (16) students; the third group (POSTQ + SV) includes (15) students; and the fourth group (POSTQ + NSV) includes also (15) students.

4.3 Measures

The research sample students' ability to recall was evaluated by an open-ended test, in which the students answered two main questions, each was divided into four parts, which stimulated the recall of what was explained on the platform. The participants answered each question by writing their answers in each of the four question boxes; each box is allocated to one part of the four question arts. Each student's response was evaluated by two teachers (interrater reliability, r = .88). The total value of the recall test scores was (46), which goes as follow: (23) degrees for each question where (3) degrees were assigned for the classification part; (3) degrees for the types part of; (6) degrees were also assigned to the characteristics part; (6) degrees for the tools part; and (5) degrees for the development cycle part. Recall Test Appendix (A)

4.4 Procedures

The procedures of the current research have been implemented according to the phases of educational design, specified in (5) basic phases as follows:

4.5 The analysis phase

During this phase, the basic to-be implemented task across the mobile video platform in the current research was analyzed. The educational tasks were based on the study of educational platforms and Web 2.0 applications which are one of the main topics of the e-learning course at the College of Education, University of Jeddah.

Each topic covered 5 main themes: concepts, types, characteristics, tools, and development cycle. The characteristics of the sample students were analyzed with regard to the previous use of mobile platforms. 77% of Students indicated that they use some platforms like Edmodo, and Edpuzzel. In addition, more than one mobile video platform were analyzed, such as Edpuzzel and Educanon, and the Edpuzzel platform was developed because it has all the potentials and characteristics associated with the research variables, and because of the popularity of this platform among the sample students. In addition, this platform (Edpuzzel) has the following features:

- A choice to upload or recall videos from video sharing sites such as YouTube.
- A free download of clips with a capacity of (1) Giga.
- An ability to create more than one chapter, with each having its own independent properties.
- Pauses and segmentation for videos are available.
- Each section can be re-viewed separately.
- A skip feature is available for any part of the video.
- Statistical information about whether or not the student is watching the video, the last time a video was watched, and the total percentage of students completing the video all can be provided.
- A control for the amount of time made available for viewing videos is also available.
- A choice to add questions within your videos and receive answers.
- A choice for sharing video with students through their various accounts.
- A choice to identify the number of students viewing each videos independently.
- A feedback on student inquiries and questions can be provided.

4.6 The design phase

During this stage the video platform and segmentation variables were designed and placed as follows:

Designing Educational Objectives: The educational objectives were based on (10) basic objectives related to the subjects of educational platforms and Web 2.0 applications.

Designing a Presentation for Digital Video: Two visual presentations were designed for educational platforms and Web 2.0 applications, each displaying the five core topics identified in the learning tasks. the learning objectives were also identified in the previous step, then a re-recording of the presentation has been made through one of the screen cam programs (SnagIt), and the video time range has been made not to exceed (10) minutes, so as to guarantee that the learner stay concentrated during the whole period of the video display.

Segmenting the Digital Video Clip: There are two modules for the digital video, which were designed as follows:

Segmenting Video (SV): Video clips were segmented in this module into five parts; each part includes one of the previously mentioned educational subject areas. The balance between these parts was taken into account with regards to time range, and the segmentation was performed using the Add Questions tool within the platform which will be provided with questions – both Pre and Post -in the next stage.

Non-Segmented Videos (NSV): In this processing, the video is played without any segmentation, which means that the video is only made of one part with a duration of 10-minute with no pauses.

Designing Question Location: Post and pre-questions were designed as to have the same formulations, but the only substantive difference between them was in the specific position of each question. The researcher was keen on directing a question for each of the content areas which are identified in five areas.

Designing Pre-question Location: Regarding the position of the pre-question within the segmented videos, a question was added before each of the five parts of the video. Question (1) starts at the first second of part one of the video presentations. In addition, each added pause contain a pre-question of the next part; while for non-segmented videos, (5) questions were added at the first second of the video presentation.

Designing Post-question Location: Regarding the position of the post-question within the segmented videos, a question was added after each of the five parts of the video. Question (1) starts at the end of pause for part one. In addition, each added pause contains a post-question of the previous part; while for non-segmented videos, (5) questions were added at the end of the last minute (minute 10) of the video presentation.

Fig. 1. Illustrates the patterns of video segmentation and question location within the four experimental groups

Figure 1 Segment videos and question locations according to the experimental design

Specify the time period for viewing the video: Using the (Due) tool, one day was only allocated before the final application of the recall test.

Prevent Skipping: The "prevent skipping" option has been activated to prevent skipping of any part of the video before viewing it.

4.7 The development phase

At this stage, the teacher's account was activated through the Edpuzzel platform. Four semesters were also created; each one is assigned to an experimental processing. The code of each group was obtained. The structural evaluation of the platform was also carried out.

4.8 The application phase

At this stage, the equivalence of the groups was confirmed, the learning process was launched and the tasks performed via the digital video platform, the final post-implementation of the recall test was then carried out.

5 Results

The results of the four experimental groups were analyzed for Recall among the research sample students in relation to the Mean Scores and Standard Deviations, and with regards to current search variables, Segmentation and Non-segmentation(SV, NSV), Question location (Preq, Postq) Explains the results of the analysis. Table (2) illustrates the results of the analysis.

Table 2. Mean scores and standard deviations of the four research groups

Question location	segmentation		Total
	SV	***NSV***	
PREQ	Mean=42.35	Mean=30.94	Mean=36.82
	SD=1.32	SD=1.95	SD=6.02
	N=17	N=16	N=33
POSTQ	Mean=37.07	Mean=23.33	Mean=30.20
	SD=1.33	SD=1.11	SD=7.09
	N=15	N=15	N=30
Total	Mean=39.88	Mean=27.26	Mean=33.67
	SD=2.98	SD=4.17	SD=7.30
	N=32	N=31	N=63

The two-way ANOVA was conducted on the students' recall scores according to the segmentation (SV, NSV) and question location (PREQ, POSTQ) to identify significant differences between groups. Table (3) shows the results of two-way ANOVA.

Table 3. The two-way ANOVA on the students' recall scores according to the segmentation and question location

Source	Sum of Square	df	Mean of Square	F	Sig.	ŋ2
segmentation	652.50	1	652.499	302.92	0.00	.837
Question Location	2483.58	1	2483.581	1153.00	0.00	.951
segmentation * Question location	21.10	1	21.098	9.70	0.00	.142
Error	127.09	59	2.154			
Total	74711.00	63				

A summary of the main effects and interactions are presented in the three sections that follow:

5.1 Effects of video segmentation

The results have shown that there was significant difference on the main effect for the segmentation [$F_{(1,\ 63)}$=302.923, P=0.00]. Results indicated that (SV) students [M=39.88] significantly outscored (NSV) [M=27.26] in the recall scores. When estimating the effect size (Partial Eta Squared) to quantify and explain how much better the effect was, the results showed that the effect size was large for this interaction ($\eta 2$= 0.837), and so this result has practical implications for instructional designers of video.

5.2 Effects of question location

The results have shown that there was significant difference on the main effect for the question location [$F_{(1, 63)}$= 1153.004, P=0.00]. Results indicated that (Preq) students [M=36.82] significantly outscored (POSTQ) [M=30.20] in the recall scores. When estimating the effect size (Partial Eta Squared) to quantify and explain how much better the effect was, the results showed that the effect size was large for this interaction ($\eta2$= 0. 951), and so this result has practical implications for instructional designers of question location.

5.3 Effects of interaction between the video segmentation and question location

The interaction between the segmentation and question location has shown significant difference [$F_{(1, 63)}$ = 9.795, p=0.003]. When estimating the effect size (Partial Eta Squared) to quantify and explain how much better the effect was, the results have shown that the effect size was noticeably large for this interaction ($\eta2$= 0. 142). Result of Schiff's post hoc comparison indicated that (SV+PREQ) students [M=42.35] significantly outscored (NSV+PREQ) [M=30.94] [LSD=11.41, P=0.00], (SV+POSTQ) [M=37.07] [LSD=5.28, P=0.00] and (NSV+POSTQ) [M=23.33] [LSD=19.02, P=0.00] students in in the recall scores. Also results showed that (SV+POSTQ) [M=37.07] significantly outscored (NSV+PREQ) [M=30.94] [LSD=6.13, P=0.00], and (NSV+POSTQ) [M=23.33][LSD=13.74,P=0.00] in the recall scores. The results have also shown that (NSV+PREQ)[M=30.94]significantly outscored (NSV+POSTQ) [M=23.33] [LSD=7.61, P=0.00] in the recall scores.

6 Discussion

6.1 Effects of video segmentation

The result that indicated the effectiveness of segmentation versus non-segmentation of digital video in developing recall can be traced back to the ability of segmentation to organize learning subjects, and to place each cognitive unit in its own part; this helped learners understand the details of each part, process it and store it in their memory. The process of segmentation sets a dividing line between each cognitive unit and the unit that follows, thus giving the learner an opportunity to manipulate the content, and not be affected by the successive frequency at which the subsequent presentation can erase what was presented in the previous presentation. The process of segmentation helped to reduce the cognitive burden on learner and free his knowledge resources in a way that helped the sample individuals encode the majority of the information presented in the videos. The process of segmentation thus equipped the learners with greater ability to retrieve the acquired content. The real value of segmentation as compared to non-segmentation lies in the fact that it gives each learner enough time for a flexible handling to all learning contents. So it is the learner who decides when to step forward and to what extent he can wait in this part; the learner can also watch the video again and again which is constantly reflected on the learner's recall-related capabilities. The current result is consistent with the cognitive theory of multimedia learning that recognizes the principle of segmentation in which learning is more effective when presenting content in the form of parts as it allows students to move between them. Segmentation rates according to the cognitive theory of multimedia learning may be one of the solutions that help control the amount of information that the learner handles without any additional knowledge burden. This finding is again consistent with was stated in the theory of segmentation, which pointed out that individuals are primarily aware of ongoing information in the form of separate events, and that segmentation gives the learner greater opportunity to deal with the presented events through what is known as mental segmentation. There is a consistency between the result of this research and the results of a large number of studies that targeted segmentation; the results of these studies have shown that segmentation are the best solution for the learner's coding, processing, and retrieve, which is ultimately reflected positively on what is called the recall [15, 36, 38, 68].

6.2 Effects of question location

The result that indicated the effectiveness of the placement of pre-questions as compared to post-question in the development of recall ability can be traced back to the fact that the placement of questions initially before viewing the information can provide signs to the cognitive content that must be focused on within the video. This state of alerting to the subsequent content of the videos, which makes the learner in a state of constant attention to search for information that matches the questions presented at the beginning of the content. However, pre-questions in this case act as wake-up stimuli of the coming video content, which makes the learner in a state of constant attention ready to search for information that matches the questions presented at the beginning of the content. In addition, the nature of the place in which the pre-questions are located makes it able to encode the basic themes of information, which makes the learner able to retrieve them again in more than one situation. Pre-questions can also be considered as orientation keys to a testable content, which makes the learner highly focused with a content that relates to the presented questions, and thus can easily retrieve it later. Unlike post-questions, pre-questions can be considered as a planning tool for the following learning events and activities. When learners are presented with questions before watching the video, they become in an organized status for all the content details that he/she must learn. Learners' attention is at its highest level at the beginning of any educational situation and it begins to diminish over time. This may explain the strong influence of pre-questions as compared to the post-questions where the learner usually gives less attention to pos-question as compared to pre-questions. In addition, post-questions can be considered as a confirmation of the already raised information and do not have a role in coding knowledge, unlike pre-questions. This finding is consistent with what has been pointed out that pre-testing are effective tools in memory development and ani-obliviousness, especially when the learner succeeds in answering these questions. It is also a strategy that helps acquire knowledge rather than being an assessment tool for knowledge. This means that pre-testing can be used as a reliable educational tool within videos clips to organize coding, processing and storing information, and then retrieve it again. This result corresponds to previous studies that indicated the effectiveness of pre-testing [19, 50, 51, 53].

6.3 Effects of interaction between the video segmentation and question location:

This finding which states that the highest recall rate was for the group that used a segmented video with pre-questions can be traced to the fact the video segmentation helped students organize their learning and gave them the opportunity through various offered pauses to observe what was raised by pre-questions. Pauses also helped students to practice linking pre-questions with what was subsequently presented to them. It can also be said that video segmentation has contributed to enhance appropriating videos for the schematic role that pre-questions play. The success of the group who used video segmentation associated with pre-question over the third group who used segmented videos associated with post-question can be attributed to the fact that the handling done with the third group lacked the guiding and orienting role that pre-questions could play; the third group relied on the post-questions that played an affirmative role on prior knowledge. The success of the handling done by the first group over the handling done by the second and fourth groups, which included non-segmented video clips, can be traced to the fact that the handling of the second and fourth group faced additional cognitive burden because the clips did not have pauses that could enable the learner handle the already presented information and knowledge. The handling done with the second and fourth group lacked having intervals between the main themes of the content which reduced the learner's chances of an in-depth handling for each learning theme.

7 Conclusion

The current research focused on some design variables for web-based digital videos. These variables were based on segmentation, question location, and their relation with the recall ability. The research concluded that segmented videos have an advantage over non-segmented videos, pre-questions also have an advantage over post-questions, and that there is an advantage for the handling that includes interactions between segmentation and pre-questions. In the opinion of the research team that future research associated with mobile video platforms may be directed towards studying the relationship between some of the design variables of videos and the cognitive approaches of learners. Due to the importance of the role of the teacher in the process of learning, it is possible to study the degree of the teacher's presence through digital videos. Although the segmentation variable has been studied in more than one study, video segmentation rates still require further studies. Mobile video platforms need to be developed so that to become compatible with specific categories of special needs people and addressing this issue is recommended by research orientations.

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Fully Automated Classroom Attendance System

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Abstract—This paper is based on the study and the implementation of the pilot project for customized, automated, highly secured class room management system known as fully automated classroom attendance system. In this research paper, the strategies, design, development and implementation of a pilot project for class room attendance management systems is explained in detail. As a pilot project, mobile app is built on Android platform using Xamarin programming. Prototype of proposed system provides high level of authentication by embedding face recognition and biometric verification together with radio frequency identification system (RFID) system. Though given model features are specially designed for our college needs, but this model can be modified for general usage and can be applied for all academic levels i.e. school, college, universities. Among the other features of system, one important feature is selection of system to work in smart mode in which system closes after predefined time.

Keywords—USB RFID proximity sensor, RFID Cards, attendance management system, mobile application, smart mode system, face recognition, thumb verification.

1 Introduction

In recent time, technology trend is to switch from typical traditional system to fast, smart and interactive system which can be linked to some web application, so that users can access the system at any place at any time. Radio frequency identification system abbreviated generally as RFID has proven its self-one of the secured, inexpensive and fast emerging technology. RFID application area includes access management, location based services, smart homes, airports, super markets, tracking vehicles for road pricing and speed controlling [1-4]. This technology transformation of system into RFID system has been adopted in attendance systems and different models have been proposed [5].In some models, RFID system is integrated with fingerprint [6].In some models along with RFID, other parameters like face recognition are also applied [8].In most of the systems models, focus is on systems which can detect false and bogus attendance, an undeniable requirement, but in this paper a system model is proposed which can be able to do pre and post attendance requirements, the proposed system model implementation is based on Jubail Industrial college defined protocols for student attendance, and the system is able to address and comply all college procedures related to student attendance smoothly and efficiently. With recent advancement and technology trend toward IOT, it is preferable that system should be able to access anywhere at any time.

2 Background

In this section college rules regarding student attendance system are discussed. As like most of academic intuition, academic semester consist of sixteen weeks, before starting classes, faculty member prepare their attendance file, contains all student list for both theory and lab. For attendance teacher call students name one by one and mark their attendance in a paper. The students coming after certain minutes (in Jubail Industrial College 3 minutes) are considered late and students coming after five minutes are considered marked as absent. All these steps are done manually. Teachers spend their valuable time for taking attendance and needed to be attentive to observe who is coming late or who is absent. In addition to that, if student goes outside classroom for some reason he should return within 5 minutes, in case if he takes more than 5 minutes he will be marked absent for this period. Currently in JIC, after taking the attendance manually, the teacher will be entering the attendance manually to a data base known as SIS (Students Information System). In the Proposed system, each student will be issued a separate RFID card, or a RFID tag can be embedded in the existing student ID card. The students are supposed to come with RFID cards to the classroom. For avoiding using of card by other student every RFID card is linked with database, where student biometric thumb impression and face recognition can be verified by using designed app options. Implementation of the idea proposed in this paper enhances the competitiveness in the current world of IOT. As a pilot model mobile app is designed named “JIC CMS”. Jubail Industrial College Class Room Management System.

3 System Design

In the whole scenario explained above, it was required to design such an efficient and smart system which would be able to solve all problems is required. For this an RFID based system with specially designed app has been developed. App name is “JIC CMS”, Jubail Industrial College Classroom management system. This app is designed on Xamarin platform. In our designed system every faculty member will have its RFID Reader and mobile with installed application. Technical detail of RFID reader is mentioned in table 1.The operation of App starts from staff account generation which includes staff personal details, department details etc. App screen shot is shown in Fig 1. After creation of account new window with three options will be available, Enrolment, Attendance and Report as shown in Fig 2

Table 1. RFID Reader Specification

Specification	Specification Value
Supply Voltage	DC 5V
Maximum working current	< 10mA
Card sensing speed	less than 200ms
Encoding	Manchester 64-bit,modules 64
Operating temperature	-10'C ~ +70'C
Operating frequency	125KHZ
Baud rate	9600Kbit/s
Support Card Type	EM4100, TK4100
Read Range	5 cm
Dimensions	63 × 18 × 8 (mm)
Output format	10 digit decimal

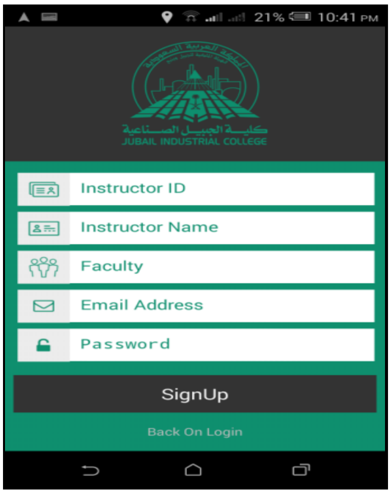


Fig. 1. Faculty Personal Information window screen shot

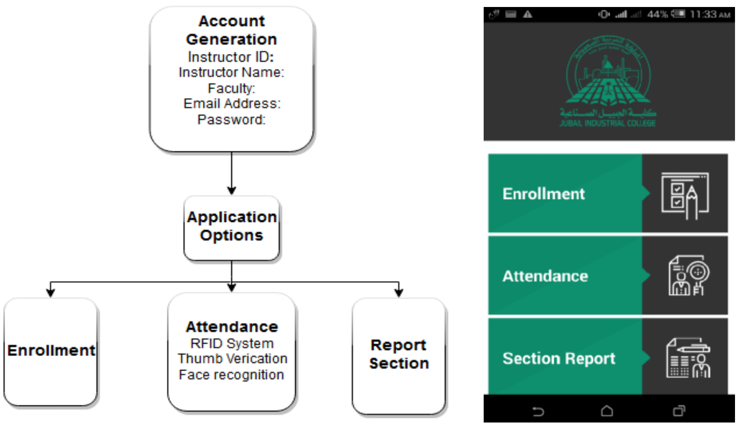


Fig. 2. JIC CMS App option

4 Enrolment Section

In the enrolment screen teacher can upload the name of student, student id number, course details, activity details, section details etc. available at the beginning of the semester. This uploading should be done only once at the beginning of each semester for each course.

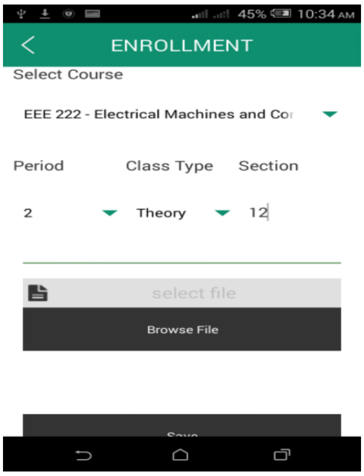


Fig. 3. Enrolment section screen shot

5 Attendance Section

In this section regular attendance system that is based on RFID is defined. For identification of bogus attendance and to provide higher level of verification thumb verification and face recognition can be embedded in customized mobile app in attendance section option. This bio metric identifiers verification is extremely applicable during examination for ensuring smooth conduction of exam. Details of implementation and working algorithms are also part of this section. Figure 4 shows flow chart of attendance section.

5.1 RFID identification system

In our designed system it is assumed that every faculty member will have its 125KHZ RFID Reader and mobile with installed application. Every student is provided with an RFID card. 10 digit unique card numbers are assigned to each RFID card. RFID Card number is mapped to student Identification number in RFID database. Low frequency (125 KHz) is used which can be detected with RFID reader with distance of 5 cm. Faculty member connect USB stick to his mobile and open app “JIC CMS” and open concerned section. As the students enter to the classroom mark their attendance by simply showing the RFID tag to the card reader, students can just keep the RFID in the line of sight distance. If the student comes within first "3" minutes, he will be detected and marked as present as shown in figure 5. After three minutes present option will convert automatically into late and will be valid for next two minutes, within this duration i.e. Three- five minutes system will be marked as late entry. Similarly according to the college rules a student coming after five minutes will be treated as an absent as shown in figure 6. All this features are implemented by linking the student entry to the system clock.

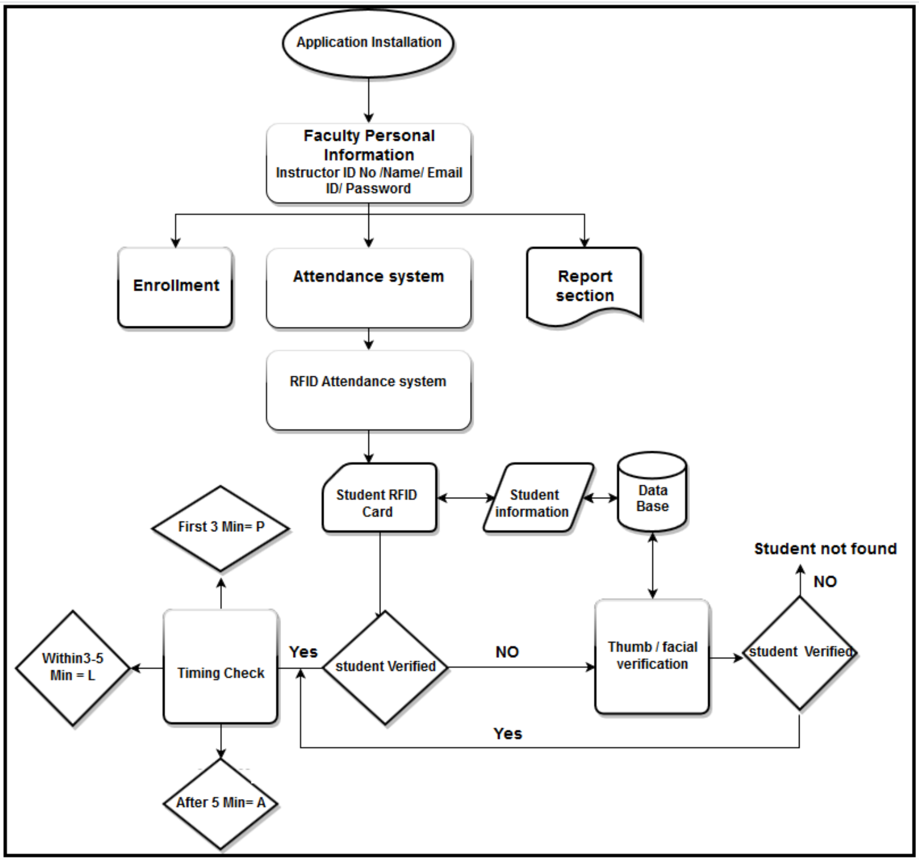
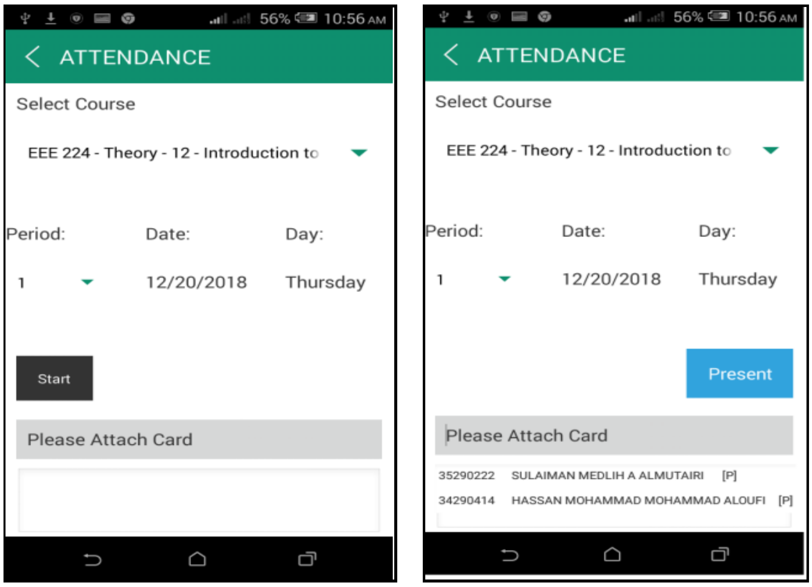
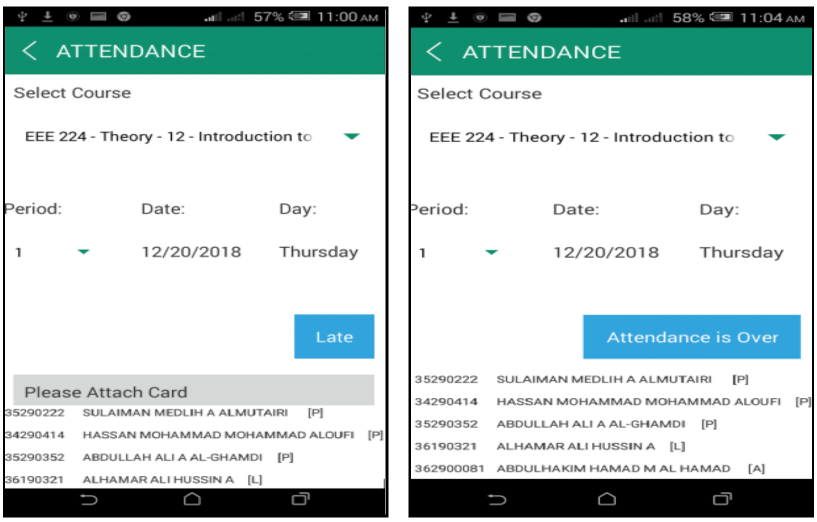


Fig. 4. Attendance section flow chart



(a) (b)

Fig. 5. Automatic Attendance system Screen shot (a) Before pressing start (b) Within "3" Minutes Marking Present

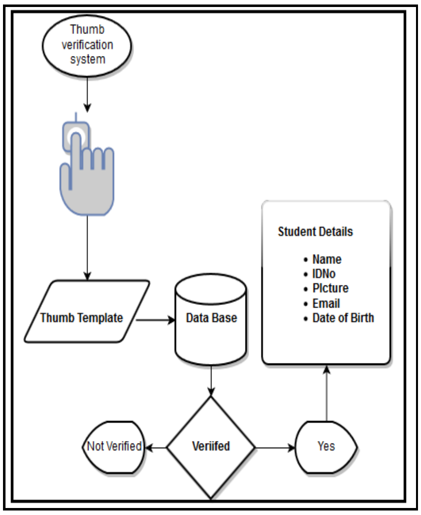


(c) (d)

Fig. 6. Automatic Attendance system Screen shot (c) Between"3-5" Minutes Marking Late (d) After "5" Minutes Marking Absent

5.2 Thumb verification system

In this section implementation of thumb verification system together with working algorithm used in mobile app designed by Xamarin will be discussed. Framework of biometric authentication system is shown in Figure 7. At the time of admission, student thumb templates are extracted and stored into the database. During the thumb verification process, using app option the system applies the same technique for thumb matching process. After matching thumb impression system generates student details like ID no, student picture, can be seen in screenshot on figure no 8.



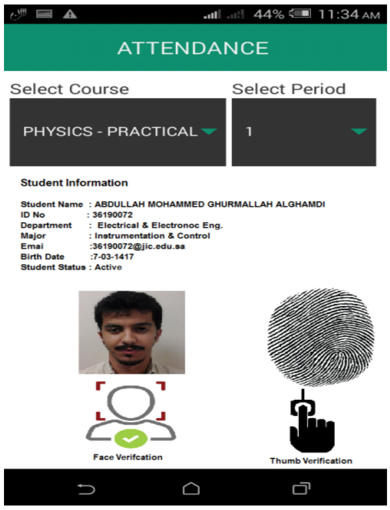
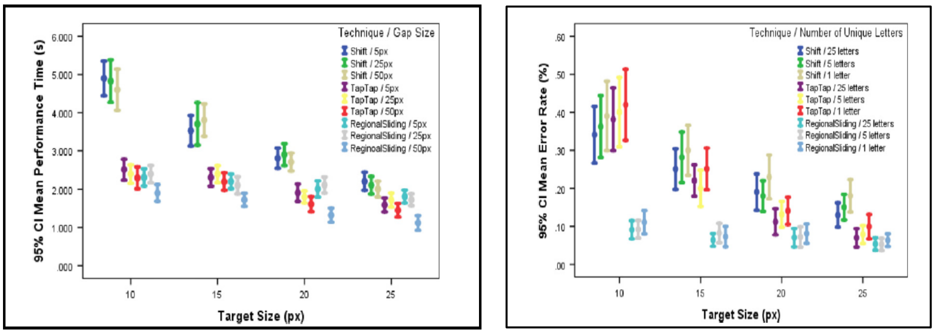


Fig. 7. Thumb Verification flow chart **Fig. 8.** biometric impression Screen shot

Regional sliding Technique*:* Selection of correct template on touch screen mobile devices is one of the important aspects. There are several difficulties like unconscious slipping of finger while pressing, occlusion of thumb more than the target size, etc. Substantial research shows that target size which is one of the critical factors affects user, must be near to 9.6mm. Although number of techniques like tap tap, shift, thumb pace, escape are available. In all these techniques named before have issues of targeting not only the selected area but also surrounding area. Based on these facts designed and implemented our app on Regional sliding technique for sensing and target selection during target selection. Research shows Regional sliding performs in shorter time with lowest mean error rate and also less effected on small target. Fig. 9 shows comparative analysis of Regional sliding with shift and Tap Tap techniques as stated in [16].



(a) Mean performance time (b) Mean Error rate

Fig. 9. (a) Mean performance time (b) Mean Error rate

Face verification system: To provide higher level of security, face verification option is selected. It is assumed at the time of admission and enrollment high quality image has been stored in data base for verification purpose. For face verification in real time it was required to implement some algorithm. Face Recognition process consist of face detection, preprocessing and finally application of any face Recognition algorithm. Face detection is implemented by using HOG, histogram of oriented gradients algorithm. Typical steps involved are defined in block diagram figure no 10

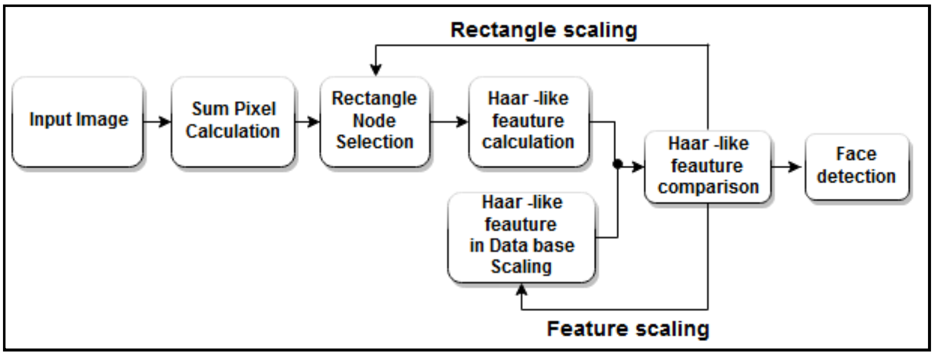


Fig. 10. Block Diagram of Histogram of oriented gradients algorithm

Selection and application of suitable face detection algorithm was one of the prime task. In smart phones either android or IOS platform based, face detection implementation is easy after the availability of open CV. Open CV (Open Source Computer Vision) is an open source library for image processing and computer vision, originally developed by Intel and free for both commercial and non-commercial use. The face recognition is made easy by the Face Recognizer in Open CV. Figure 11 shows comparison of different algorithm .Substantial research shows all algorithms are relative accurate but open face shows more accurate and results are more reliable over other available algorithms. Open face is based on deep convolutional networks (CNNs) technique. Figure 12 shows implementation of open face using CNNs. Figure 12 is divided into two parts. Left side is using for extraction of features, needed to perform only once. On the right side images are extracted from dlib's pre trained detector working on HOG algorithm, after certain pre-processing send to convolutional neural network. CNN use these features which are obtained from deep neural network, for predicting person image is passed through right part, and the person classification will be given out.

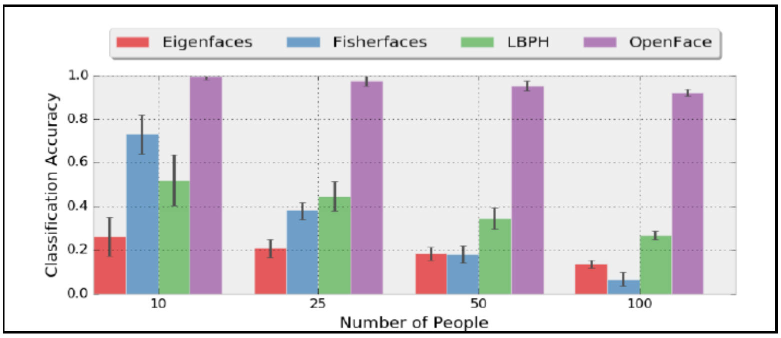


Fig. 11. Comparison of Open face and other algorithm [XII]

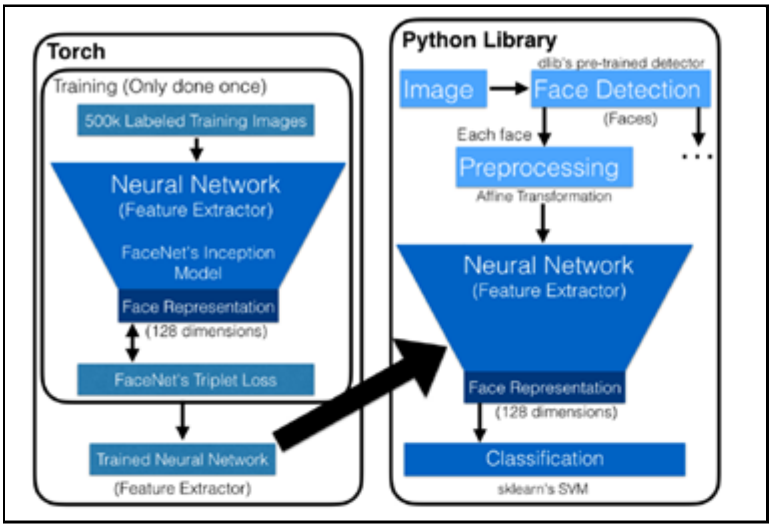
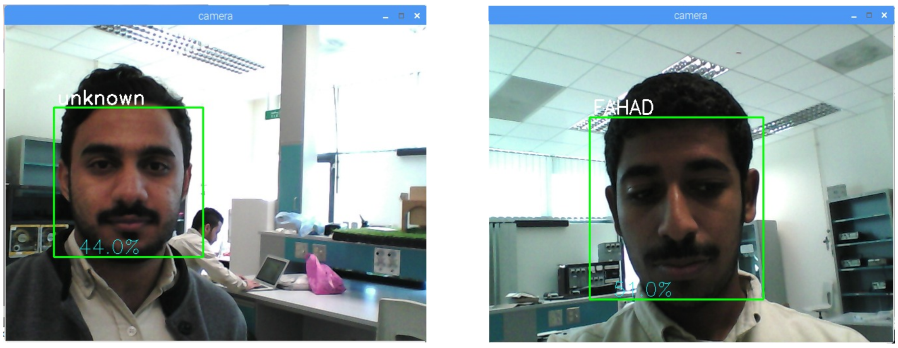


Fig. 12. Open Face's project structure (B, AmosAmos, B., LB.,, 2016)



(a) (b)

Fig. 13. Face Recognition using open CV for JIC CMS: **(a)** 44% accuracy Unknown **(b)** 51% accuracy Recognized

6 Report Section

In this option of JIC CMS app any students Presence reports (weekly, monthly or for any specific duration) can be seen. In addition to report generation, special privilege option is available to perform manual modification in case of special need.

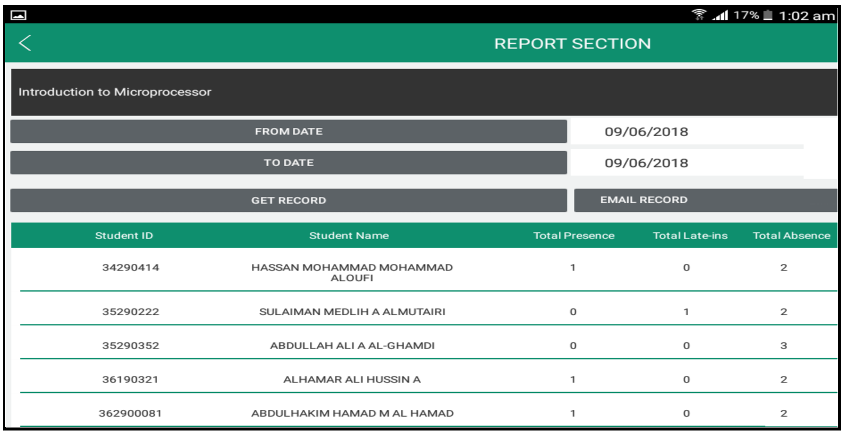


Fig. 14. Screen Shot of Report Section.

7 Conclusion

The implemented system offers number of befits over traditional system includes freedom of delivering lecture with full focus without notifying student timing. As it is fully automated, the chance of error in the attendance entry is NIL. Options of biometric identification make system invincible. Although designed app options are customized to college rules but concept of application is applicable to any academic level or organizational level. Application of thumb/ face recognition reduce misuse of RFID card. Linking this app with student information, which student use to see their attendance, will drastically save faculty time and resources as well.

8 Future Work

Although proposed model gives an idea of smart class but still improvement place is there. RFID reader range can be increased by replacing high range RFID reader. During our study of this project it was found that instead of using Xamarin, using of other mobile development tools like Ionic, React Native will lead to better application result at the cost of time and resources.

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The Effect of Mobile Digital Content Applications Based on Gamification in the Development of Psychological Well-Being

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Abstract—The aim of this research is to design a proposed model for Mobile Digital Content Applications Based on Gamification and measure its effectiveness in the development of psychological well-being among the graduate students of King Abdulaziz University who are challenged with issues related to the nature of postgraduate studies, which may affect their levels of psychological well-being. Research sample consisted of (62) students, partdicularly those who are students of the postgraduate programs at King Abdulaziz University. The study has applied the semi-experimental approach that is based on two group design. The experimental group used an application version called "My Academic Advisor", which was developed according to the proposed model, while the control group used a version that did not include any methods or tools for gamification. A measure of psychological well-being was built through the mobile digital content applications. The measure in its final version consisted of 6 themes that included (36) indicators of psychological well-being; 6 indicators for each theme. The results of the application showed the effectiveness of the proposed model of the gamification in the development of psychological well-being among the experimental group students compared to the students of the control group.

Keywords—Gamification; Mobile Digital Content Applications (MDCA); Psychological Well-Being (PWB).

1 Introduction

Gamification is a trend in research that recently has become popular in educational. It refers to applying attributes and elements of games in educational contexts that are not play-based, that is, to bring fun and motivation to the educational environments, and to turn monotony and stereotyping learning events into an enjoyment experience [1, 2] Gamification in educational environment means raising challenges within the educational context. There are tasks that must be carried out by the learner who is given points, badges and passes through different levels depending on the way he/she performs these tasks. Moreover, learners or users are classified according to their achievement rates [3, 4].

Gamification is primarily based on external stimuli which sometimes has a negative impact on self-motivation. People who perform activities due to external incentives, once removed, they become less willing to perform learning tasks and activities [5-7]. However, some research studies that aimed at analyzing performances and tasks implementation that are stimulated by external incentives as compared to those not stimulated by any incentives have shown that the effectiveness of the performance and task implementation is in favor of the group that was supported by incentives, as indicated by study [8] that examined 12 different studies which aimed at running (25) comparisons; these comparisons included incentive assisted performance vs performances that did not receive any incentive at all. The results have shown an effect degree of (0.6) in favor of groups that obtained additional external incentives, which means that it is difficult to develop an educational system without considering the motivational system involved in this system.

[9], With regards to MDCA that has been developed to deliver content for learners, McLoughlin believes that these applications are very important because they support dynamic technologies that provide the learner with an opportunity of education that has greater control, self-autonomy, and make the learner more connected to learning events because most of them are adaptive to their characteristics and meet the learner's needs. Digital content applications also make the learner more interactive because the content is formulated in accordance with the learner's perspective and the way he/she processes information. Therefore, it is important to study the structure of digital incentives through applications of digital mobile content and determine the mechanism of implementing and managing them in a way that optimizes the use of these applications, especially under the confirmation of a variety of studies that the use of methods and tools for mixing in digital environments needs further studies [10, 11].

Postgraduate students face challenging situations that make them in need of enhancing a feeling of well-being, and thus avoid any negative feelings. This invites researchers to search for reliable tools that could enhance the psychological well-being. However, some studies have shown an existence of a positive relationship between the mobile digital content media and applications and the psychological well-being; this means that it is possible to rely on the mobile applications gamification incentives for enhancing psychological well-being [12, 13]. In fact, the current research is trying to investigate this issue by studying the relationship between the gamification of the mobile digital content and psychological well-being among postgraduate students.

The current research thus tries to answer the following questions:

- **(RQ1)** What are the themes and indicators of Psychological Well-being that could be obtained through Mobile Digital Content Applications?
- **(RQ2)** What is the proposed model of the mobile digital content gamification for the development of PWB among postgraduate students?

- **(RQ3)** How effectiveness is the proposed model of the mobile digital content gamification for the development of PWB among postgraduate students?

1.1 The current search also tries to validate the following hypothesis:

(H1) There is no statistical difference at the level 0.05 between the average scores of the experimental group; the one who uses a mobile application based on gamification, and the average scores of the experimental group; the one who uses a mobile application without any methods of gamification in the post measurement of PWB through mobile digital content application, due to gamification tools influence.

2 Literature Review

2.1 Gamification

Generally, gamification is a term that is closely related to Games, and not Play. This is because playing offers more freedom and a bit of restraints, unlike games that mean constraints, challenges, competition, and goals to be pursued and realized [2, 14]. Gamification is known to be the use of game design elements in a non-game contexts not depending on playing" [15], also known as Using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems [16]. In a more in-depth look at the concept of gamification, four terms that are relevant to the concept of gamification can be emphasized [15, 17]:

- **Game as a Term**: Refers It refers to a presence of the following components: a goal to be achieved, rules to determine how to reach the goal, feedback system that provides information on the level of progress towards the goal, and finally voluntary participation.
- **Element as a Term**: It helps distinguish between the concept of gamification and serious games which are used as whole games but for non-recreational purposes. Gamification refers to the explicit use of certain elements: points, badges, leaderboards, progress bars that are used in non-gaming contexts.
- **Design as a Term**: It means the use of Game Design instead of game-based technologies. This is because gamification invests in the design elements and not the technologies and programming that are used in developing digital games.
- **Non-gaming Contexts as a Term**: The field of applying gamification is very broad and not limited with restrictions, and as mentioned before, gamification is used in non-gaming contexts.

2.2 Mobile digital content applications (MDCA)

Anderson believes that MDCA are e-services that connect a group of individuals who share common characteristics and interests in a frame of human relationships. Anderson sees mobile digital content applications as "a more interactive, participatory and social development of the forms and tools used across networks"[18]. This happens through a growing set of tools that learners use to gather information and interact in appropriate ways [19-21]. Here MDCA succeed to make a big move in web technologies rendering them as more creative and attractive, [22], through a philosophy to maximize collective intelligence among a group of users which added value to every user participating with a dynamic information [23]. Mobile social applications are tools that provide unique opportunities to socially exchange all kinds of information and multimedia through synchronous and asynchronous communications that encourage interaction and sharing of different knowledge production [24, 25]. This means that MDCA are comprehensive services in which people interact usin their mobile devices, and however allows learner to share activities and interests, make friends, and look for interests and activities adopted by other learners.

When talking about the characteristics of MDCA, it can be emphasized that it is not a standard or technology per se, but a framework for delivering shared applications via new user interfaces [22, 26, 27] . The MDCA are based on a basic philosophy which says that unique content is more important than the program, because unique content is able to attract learners and provide a variety of creative and inventive opportunities, as well as keeping content as digital objects instead of pages (as understood previously) that are easy to exchange and interact [24]. Digital content applications are based on the concepts of interaction between learners that facilitate thoughtful and critical discussion in order to acquire basic knowledge; digital content applications are not simply an application to achieve a goal but rather a tool for shaping knowledge within a framework of an ongoing process of construction in which the learner is mainly involved [10]. As a result, digital content applications have changed its role from the transmission, availability and distribution of learners' educational materials and use to the idea of participating in the production of these materials, so that digital content applications become educational sources and portals rather than being objects of specific categories [28-31].

2.3 Psychological well-beings (PWB):

PWB can be defined as a set of behavioral indicators that generally display high levels of individual satisfaction, and can be identified with reference to six main factors as follows [32-35]:

- **Autonomy**: Refers to an individual's autonomy and his ability to make decisions, resist social pressures, and control personal behavior during interaction with others.
- **Environmental Mastery**: Refers to the ability of an individual to organize conditions and control varied activities, benefit effectively from surrounding conditions, and to provide suitable environment and personal flexibility.
- **Personal Growth**: Refers to the individual's ability to develop his abilities, increase his effectiveness and his personal competence in different aspects, and enhance a sense of optimism.

- Positive Relations with other: refers to the individual's ability to form friendships and social relationships with others on the basis of friendliness, empathy, mutual trust, understanding, influence, friendship, and the willingness to give and take.
- Purpose Life: refers to the ability of an individual to define his goals in life objectively, and to have a clear goal and vision that direct his actions and behaviors, together with perseverance and insistence in order to achieve his goals.
- Self-Acceptance: refers to the ability of self-realization, positive attitudes towards one's personality and past life, and acceptance of various manifestations of the self, including positive and negative manifestations.

There is a clear relationship between gamification and PWB, where the systems give the user an independence of decision-making and freedom of choice, which is one of the basic components of PWB. Gamification helps the learner to control the implementation of activities, tasks of learning, and personal flexibility, which is reflected on the environmental capacity of the learner. Gamification considers the development of gradual levels of challenges; therefore it contributes to the development of the learner and his sense of optimism, which leads to the process of personal development, and through the joint-working groups provided through the gamification, the learner build positive relationships with others which contributes positively to the improvement of PWB. Gamification also depends on specific clear set of goals that every learner seeks to achieve through various stages, which makes the learner's life purposeful. In addition, gamification and the tasks it included, through which the learner moves using self-supported external motives, make the learner satisfied with himself and all its reflective manifestations [36-38].

2.4 Theoretical framework

Among digital content applications, gamification usage is supported by the Self-Determination Theory (SDT) indicating that the learner's move toward tasks execution is driven by a set of intrinsic motivations that do not work mechanically because they require appropriate support and feedback by the environment, which is noticed through the incentives provided by the gamification system [4, 39-41].

In the learning environment, gamification usage has a correlation with the Motivation Theory (MT) definitely in the part related to extrinsic motivation, which can compensate the difference between internal incentives and the learner's actual level. It is possible that learner may have an internal desire to be high achiever in learning but may fail due to his weak scientific and cognitive abilities; therefore the external incentives have a significant role in motivating the learner to reach the desired level [42].

The basic psychological Needs Theory (BPNT) refers to the existence of a set of factors that make any activity fun and motivational to intrinsic motives, these factors are: Autonomy, Competence, and Relatedness as provided by gamification systems that stimulate independence by giving the learner a sense of willing and freedom when it comes to the implementation of tasks, It stimulates competence by giving the learner a sense of effectiveness in the accomplishment of tasks and influencing the environment in which they are present. Finally, they encourage the competence generated by the learner's social relationships with his peers within the learning environment and the involvement he felt in his capacity as a member of the groups formed during the task's implementation [10-12]

Flow Theory (FT) is one of the theories that supports gamification usage, although it is highly concerned with internal motives as a necessity for the state of flow; however, the incentives provided through the gamification system to push flow processes leads to a greater sense of well-being, and encourage continuity, through which learner know that he is right, which help him keep in line with the flow processes to reach the desired goal [43, 44].

The design of the proposed application is based on these theories so that the application work on supporting learners with incentives that meet their basic needs and compensate for the difference between their internal incentives and the desired level. In addition, it guarantees having the learners present in a continuous flow of learning through digital content applications.

3 Methodology

3.1 Design

The two group-experimental designs are used by the research team. The first group used my "academic advisor" application developed by the research team, which does not include any use of the gamification methods, while the second group is the experimental one used the application developed in line with the methods of gamification. Table (1) illustrates the experimental design of the research.

Table 1. Research experimental design

Research both groups	Independent variable	Dependent variables
Experimental group (1)	Applying “My academic advisor” application without gamification	Psychological Well-Bing through mobile digital content application
Experimental group (2)	Applying a gamification-based application of “My academic advisor”	

The independent variables, as shown in the previous table, were based on the applications of a gamification-based digital content. The dependent variables were based on the PWB through the digital content applications.

3.2 Sample

The study sample consisted of (62) students out of (91) students who are studying a course named "Learning Technologies and Resources", at the General Diploma Program of Education, King Abdul-Aziz University, in the academic year 2016/2017. The sample was assigned through two stages. In the first stage, the sample individuals were chosen intentionally as per two criteria: the first was a technical criterion in terms of possession of suitable mobile phones by the sample individuals, in addition to using some social applications available through these phones. The second criterion was related to the consent of the sample individuals to join the research experiment, while in the second stage, sample individuals were distributed randomly with (31) students in each group.

3.3 Measures

In the current research, PWB is linked to indicators of well-being that happen as a result of learning through certain applications of digital mobile content. However, to prepare the scale of PWB through the applications of mobile digital content, more than one scale of PWB, including (Ryff's scale of psychological well-being, 1989), and the Psychometric Well-being Scale were developed [35]. In accordance with the nature of well-being themes as found in the previous scales, in addition to the nature of learning through MDCA and the nature of postgraduate students in the current research, the scale of PWB was developed through MDCA. The scale includes six themes:(1) self-independence (2) environmental enabling (3) personal development, (4) positive relationships, (5) purposeful life, (6) self-acceptance. The measure contains all in all (36) individuals, distributed on the six measure themes by (6) items for each theme: (3) positive, and (3) negative. The scale was presented to a group of arbitrators to verify its validity and relevance to the postgraduate students (education field). Students were asked to evaluate each item with reference to the five-scale evaluation (strongly agree, agree, neutral, disagree, strongly disagree), and degrees from 1 to 5 respectively are given in the case of positive expressions and vice versa in the case of negative expressions (items are coded based on a 5-point Likert type scale (from 1 = strongly disagree to 5 = strongly agree). The measure stability is ensured before application, where Cronbach's α (= 0.769).

3.4 Procedures

The procedures of this research study have been implemented as compatible with the stages of the specified educational design through five main stages as follow:

Analysis stage: The educational tasks, in this stage, to be executed through the proposed model, where the current research focused on the educational content tasks and activities within a course named "educational Techniques and Learning Resources" for general diploma students (education), where (8) educational tasks related to the research and theoretical study on the educational technology innovations are determined. Nevertheless, the learner’s characteristics related to using the mobile technology were analyzed. A result indicates (76.6%) of the sample individuals own android-based mobile phones, and (93%) of students use the mobile phone to access the internet. (88.6%) of Students use mobile social applications, both public and private. And through applying the scale of PWB through applications of mobile digital content, the researcher showed a significant decrease in the PWB indicators in the research sample.

Design stage: Through this stage, the proposed model is designed to use gamification in MDCA, according to the following:

Designing an Educational Objective: The educational objectives, under discussion, were related to the curriculum of educational techniques and learning resources, especially the Unit of Educational Technology Innovations. Accordingly, a list of educational objectives was established which included (18) objectives.

Designing Tasks: 8 step-by-step tasks have been designed, the first level includes two tasks for the analysis of the technical innovation characteristics and for the collection of information in multimedia model; the second level includes (3) tasks that contained recorded videos about innovations, preparing technical projects, and developing innovation visual channels.

Designing Mechanisms: An illustration has been made to each of the following: the nature of the challenges in each task, the additional opportunities that each student can receive as a result of his communication with the teacher about the tasks, the mechanisms of positive competition, how to cooperate, the timing of the feedback. It is essential to determine a list of rewards that each person can obtain, the status of every person according to the number of points and badges he collected, the announcement of the final winners according to the leaderboards, and how every student expresses himself and achievements.

Designing Gamification Tools: It has relied on (3) tools, presented as follows:

- **Points:** The numbers of points are assigned in each task, with total of (100) points, in accordance with table (2).
- **Badges**: (5) Badges were designed as follows: one for a student collaborating with his colleagues; a full grade-badge that is awarded to a student who obtains full grade in one level; the level champion badge that is given to the student who completes the level and receives all points and gets into the pride of place in terms of time; the task accomplishment badge which is given to student who completes each task separately; and distinctive badge that is provided to the person who achieves (90%) of the total points.
- **Leaderboards:** They are designed to identify the order of the students according to the number of points and badges obtained by every student, as per the performance of the various tasks across the three levels identified.

Table 2. Tasks points in accordance with the graduated levels

First level tasks		**Second level tasks**		**Third level tasks**	
Number of tasks	***Task points***	***Number of tasks***	***Task points***	***Number of tasks***	***Task points***
2	5	3	10	3	20
Total of 10 points		Total of 20 points		Total of 60 points	

Digital content application design "academic advisor": The proposed application includes (3) basic components:

1. Guidance tools (including 4 tools): Study Programs, Your Guidance Services, Set an Appointment, and Send an Inquiry

2. Content tools via social media channels (including 4) tools: YouTube, Twitter, Blogger, and Instagram
3. (gamification tools "3"): Rewards, Tasks, My Rewards, News. The application tools can be displayed as follows:

- Study Programs: Through which the student learns all the basic information about graduate programs (general information about the program, program vision, program message, program objectives, program outputs, study plan, course descriptions, and program admission).
- Your Guidance Services: under which the student recognizes all guidance services that can be obtained through the application.
- Set an appointment: Through this tool, every student asks an appointment with teaching board member charged with the academic guidance.
- Send an Inquiry: every student has any query regarding the content, sends a direct inquiry to the academic advisor.
- Content (social media): digital content, through this tool, is accessed using social media applications and four main channels are identified for content delivery, including the YouTube video application, Twitter), the application of Blogger, and (Instagram).
- Rewards Regulations: Through this Regulation, the student can identify the regulations governing the complaints, the tasks required and the mechanism to obtain rewards for each task.
- My Rewards: Each student can recognize the rewards he has received as a result of his / her performance. The rewards are set in 3 types: points, badges, and leaderboards.

Fig. 1. Reward page with the proposed application

- News: you will be able, through this tool, to identify the latest news about the program, all news, and information about the winners of the various competitions.
- Application Interface: The application's main page, including all components of the application as described in the following figure No (2):

Fig. 2. Main interface of application

Educational content organization: Content is presented constructively so that the learner will be able to access the main ideas of the content through channels of social communication identified in channels (4), which were mentioned previously, and linked to the developed application.

Educational strategies design: Several strategies have been adopted, including: competitive learning, collaborative learning, participatory learning, research learning, problem solving, and project-based learning, in a manner such strategies can suit the gamification system.

Development stage: At this stage, the overall structure of the application was produced by android studio, and the three components of the application were developed, which included guidance and counseling tools, content tools and gamification tools, as well as the production of some digital media that would be used in the digital content application.

Implementation stage: Under digital content application, prior application of gamification well-being scale was implemented, then launching the process of learning and implementation of tasks through application, Implementation of the learning strategies identified during the implementation of the educational tasks, then considering the post-application of PWB through MDCA.

4 Results

4.1 The scale of PWB through (MDCA):

The PWB scale, as presented in the theoretical framework, and the procedures carried out in the preparation of the search tool, included (6) various themes: autonomy, environmental enabling, personal development, positive relationships, purposeful life, Self-acceptance, and the scale composes of (36) vocabularies, were distributed on the six themes, 6 vocabularies for each theme.

4.2 The proposed model for (MDCA) Based on gamification:

The mobile digital content application gamifications suggested model is reached as discussed in the research procedures. The Model (3) included basic components for MDCA, model (10) covers characteristics of gamification using the mobile digital content application, (7) characteristics of mobile applications in general, (10) diverse mechanisms, (5) dynamic elements of gamification, (4) theories forming the basic principles of the gamification system, (3) gamification tools, (3) principles for managing incentives, and Figure (3) below illustrates the components of the proposed model and Details.

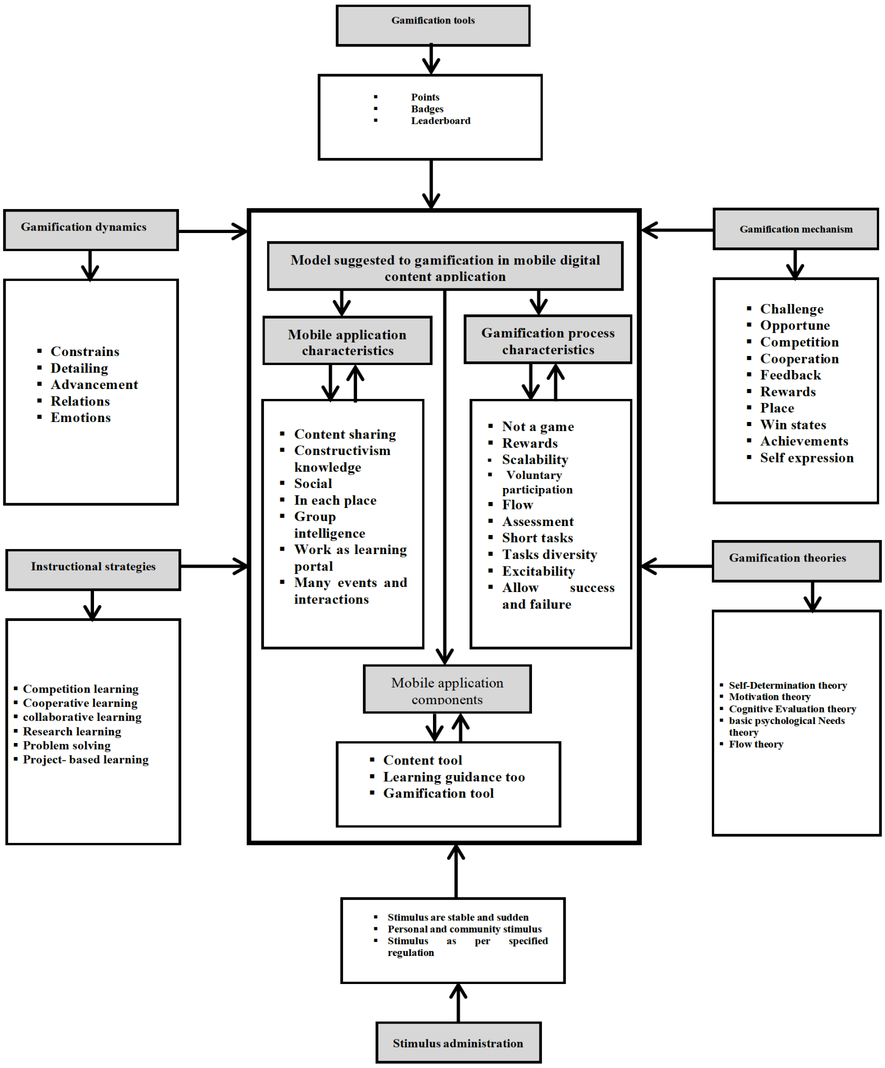

Fig. 3. The proposed model for (MDCA) Based on gamification

4.3 The effectiveness of (MDCA) based on gamification in the development of (PWB)

T-test was used to recognize the significance of difference between the experimental group (1) and experimental group (2), to verify the validity of the first hypothesis of the comparison between the first group that used the application of the developed digital content without relying on the gamification system and the second group that used the proposed model for MDCA based on the gamification system.

Table (3) shows the results of the T test for the research both groups individual degree averages

Table 3. The arithmetic mean, standard deviation, and t-test with regard to the research both groups individuals degree average

Group	N	Mean	SD	t	DF	Sig
Group (1) MDCA without gamification system	31	125.71	2.39	44.70	60	0.000
Group (2) The suggested MDCA based on the gamification system	31	169.62	3.81			

There are statistically significant differences, as shown in the previous table, between the experimental group (2) using the proposed application based on the gamification (M = 169.62, SD = 3.81) and the first group that used the application without the gamification system (M = 125.71, SD = 2.39) (t = 44.70), (p = .000). Therefore, the hypothesis can be modified to mean that "there are statistically significant differences in the mean score of 0.05 between the mean scores of the experimental group (1) students (using a mobile application based on the methods of gamification) and the mean of the first group (using a mobile application without any methods of gamification).

5 Discussion

The above-mentioned result, which has led to the effectiveness model proposed for gamification and the role of which in the development of PWB through applications of digital mobile content in comparison with MDCA that do not rely on methods of gamification, is based on the fact that the gamification system has contributed to create the highest motivation among the learners of the sample. This great motivation has contributed in placing the learners in an active and motivated mood, this led them to exercise all their tasks independently and control the digital mobile environment, as well as the desire to overcome the educational challenges facing them to improve the personal growth of their learning-related skills, and to successfully complete the learning tasks. The experimental group was able to build positive relationships among learning groups individuals. Such positive relationships are reflected on the learners' ability to build level goals and an ability to achieve success in each of these levels, which makes them feel self-satisfied. All previous factors were reflected on the total indicator of the PWB of the experimental group, which was higher than that of the students of the traditional group [34, 45-47].

Gamification incentives also contributed to a rising state of well-being that led learners to complete their learning tasks. Each incentive represents the beginning of a new rise in the well-being indicator. According to Skinner theory of reinforcement, rewards greatly stimulate the continuation of positive practices, and guarantee that these practices do not fade with time [45]. According to the flow theory, providing positive incentives at varying intervals of time is relevant to the human nature which is largely based on internal motivations stimulated by external obtained reward [43] This corresponds to the study of [7], which suggests that Reward-based Intermittent Reinforcement is one of the most reliable types of gamification systems, as it emphasizes the learner's autonomy and does not affect the learner's internal motivations. In addition, they provide the learner with a state of joy and fun. The flexible adaptive tasks that have been used have supported the learner's personal flexibility in carrying out tasks, moving between the graduating levels of a challenge, and stimulating the building of positive relationships to maintain continuity of the flow state. This supports the processes of environmental empowerment and learner's personal development and the practice of all activities and tasks under clear and specific goals, which eventually led to a rise in the indicators of learner's PWB [37] [38]. The current study results are consistent with a large number of studies that have indicated the effectiveness of gamification in the development of various learning outcomes such as [48], which demonstrated the effectiveness of learning to increase student productivity. And a study by [49], showed that digital badges are effective in increasing the amount of learners' participation,[47], showed the effectiveness of gamification in developing cognitive achievement, [50] demonstrated the effectiveness of gamification in developing motivation for achievement. [51], demonstrated the effectiveness of gamification in reducing the dispersion of learners.

6 Conclusion

The current research is one of the researches that focused on the design elements to develop gamification systems through digital content applications, through which gamification systems can be applied. The research aims at determining the relationship between the applications of digital content based on the gamification and the PWB of postgraduate students through these applications. The best applications depending on gamification on the PWB compared to applications without methods of gamification have specified. In the opinion of the research team that future research related to the employment of gamification through e-learning environments may be more oriented towards study of the intensity of elements of games that can be used within the relevant environment, in addition to finding a clear relationship between the components of visual and verbal games. Nevertheless, study of gamification through electronic learning is of high importance. The research team, also, believes that it is necessary to have a new research trend that aims at establishing a clear framework for the digital environment- gamification for people with special needs such as deaf or blind. Also, linking the gamification to the augmented reality is one of the research issues to be studied.

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Diagnosing Adoption to Mobile Learning

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Abstract—This study was undertaken to address the need to modernize the modes of teaching and learning pedagogy by taking advantage of the proliferation of electronic gadgets and mobile devices since, as counted there are more computers than the people in the world [1]. This research found out how learning in the new platform could be adopted by teachers and students. In addition, it tested the different variables involved in the use of mobile in learning by faculty and students of Centro Escolar University (CEU) to determine factors that made implementing technology a success or a failure.

To attain the set objectives, this study made use of descriptive and inferential method to the data gathered from respondents via stratified random sampling. Specifically, it employed frequency, mean, standard deviation, t-test, analysis of variance and multiple linear regressions for the treatment of data derived from the survey questionnaires. To complete the triangulation approach and for consistency of findings, observation and interview were also conducted.

Subsequently, in order to determine adoption to mobile learning the modified Unified Theory of Acceptance and Use of Technology (UTAUT) model was employed. This model shows relationship of moderating variables which are age, gender, voluntariness of use and experience from independent variables like performance expectancy, effort expectancy, social influence, facilitating conditions, anxiety and self-efficacy.

After all the statistical treatments were applied, Anxiety, Self-Efficacy, Effort Expectancy, Performance Expectancy and Facilitating Condition contribute to the success of the introduction of technology to the organization, while social influence was excluded as the reasons why users adopt it.

Keywords—Mobile learning, technology adoption,

1 Introduction

A new breed of era started when mobile devices landed on peoples' hands. These technology savvy individuals find ways on how to use these gadget to their advantage. With the recent studies [2], [3] it revealed that by 2020 the number of things connected to the internet will reach 50 billion and by the year 2019 there are 5 billion smart phone and tablet users.

Looking at the spread of these gadgets, this will make an impact in all fields. From industrial to manufacturing to agriculture, this phenomenon could be an enabler to more advanced things or could disrupt existing traditions and processes. Education will not be spared from it. In fact Daniel Burrus, chief executive officer of Burrus Research Associates Inc., predicted that mobile learning represents an amazing disruption and opportunity [4].

The use of innovative technology in the classroom has a positive impact on students learning [5]. As a way of embracing changes, it is interesting to note that schools and universities are coping up by searching and introducing new platforms. They are working towards improvement and innovation, knowing that classroom-based lessons and other approaches may not suffice to the growing mobile users and fast paced development in technology. The availability of these gadgets combined with creativity of teachers, this tool can be used to deliver quality teaching and amazing learning experiences among students.

However, implementing mobile learning is still not as easy as *abc*, aside from learning the technicality to use this state the of the art technology, human factors in order to adopt it, needs to be studied as well. What are the factors that will make teachers and students adopt mobile learning? If there are studies that show people reject new technologies when they replace humanity while embraces them when they support human desire for purpose, challenge, meaning and alignment with nature even if these technologies are unwieldy, expensive, time-consuming to use, and constantly break down [6].

In fact, when smart phones and tablet landed on the hand of teachers and students and a number of website offers on-line education at no cost, there was an assumption that adopting to it will take a leapfrog. However when Edx was launched even Harvard faculty argued on its impact to its current system [7]. Moreover, since technology gadgets can influence the socio emotions of students, balancing and controlling the use of it are needed [8]. This is one of the evidences of human's resistance to adopt to changes. An illustration that even technological advances offers a modern way on how to do things there are barriers for its implementation.

Since financial investment is at stake in implementing mobile learning, identifying variables on user adoption to it is deemed necessary. This study gives light on which factors to address and the challenges administrators are facing in enhancing teaching and learning through technology. When all these where identified and considered, adoption will no longer an issue if in the future new technology for improvement and sustainability are introduced.

2 Background of the Study

Currently, Centro Escolar University is considering a new learning management system (LMS) as an enhancement to its various learning modalities for its diverse learners that can be accessed in mobile. In the context of this study, mobile learning includes the use of LMS in mobile devices. Since both technologies offers features that when adopted could provide a brand new way to conduct classes as well as increase teachers' productivity and enrich classroom experiences to the students, this study was conducted. This study determined the adoption of mobile learning using Unified Theory of Acceptance and Use of Technology (UTAUT). Using this model, it could determine teachers' and students' attitude, preparedness and concerns with regard to mobile learning adoption [9].

3 Statement of the Problem

1. What is the profile of the respondents in terms of:
   (a) age;
   (b) gender;
   (c) experience;
   (d) voluntariness of use and
   (e) mobile devices ownership?
2. How do the respondents assess mobile learning based on the following determinants of user intention?
   (a) Performance Expectancy (PE);
   (b) Effort Expectancy (EE);
   (c) Social Influence (SI);
   (d) Facilitating Conditions (FC);
   (e) Anxiety(AX) ;
   (f) Self-Efficacy(SE);
3. How do the respondents assessments of mobile learning in terms of performance expectancy, effort expectancy, social influence and facilitating conditions compare when grouped according to age, gender, voluntariness of use and experience?
4. Among the determinants of behavioral intention, which are the factors that will make the teachers and students adopt mobile learning?

4 Hypothesis

The factors that will make the teachers and students adopt mobile learning will not be determined by the use of UTAUT.

5 Methods and Procedures

The Sloven's Formula was used to identify the number of respondents needed in this study. The questionnaire was composed of two parts. The first part is for demographic profiling that served as moderating variables which includes the age, gender, voluntariness of use and experience. Part II is patterned to the UTAUT model that made use of determinants of behavioral intention namely performance expectancy, effort expectancy, social influence, facilitating conditions anxiety and self-efficacy. A marked of .957 or excellent verbal interpretation when the questionnaire was checked for internal consistency using Chronbach's Alpha. 461 questionnaires were distributed among the students and employees in CEU. These were tested and treated using Statistical Packages for Social Sciences (SPSS) application. The following statistical method, frequency distribution, percentage, mean, standard deviation, T-test, Analysis of Variance (ANOVA) to come up with the needed answers to the question posted.

5.1 Theoretical framework

This study is anchored at The Unified Theory of Adoption and Use of Technology. This theory explores the different factors that make adoption to the technology a success. UTAUT is consists of moderating variables such as age, gender, experience and voluntariness of use. These variables when relate to dependent variables performance expectancy, effort expectancy, social influence and facilitating condition factors on the use and adoption can be identified. These identified factors are useful to make necessary adjustment to ensure success in implementation. In the case of this study, all moderating variables were tested to the different dependent variables and on the additional factors, anxiety, self-efficacy and attitude towards using technology thereby increasing the scope on what to consider.

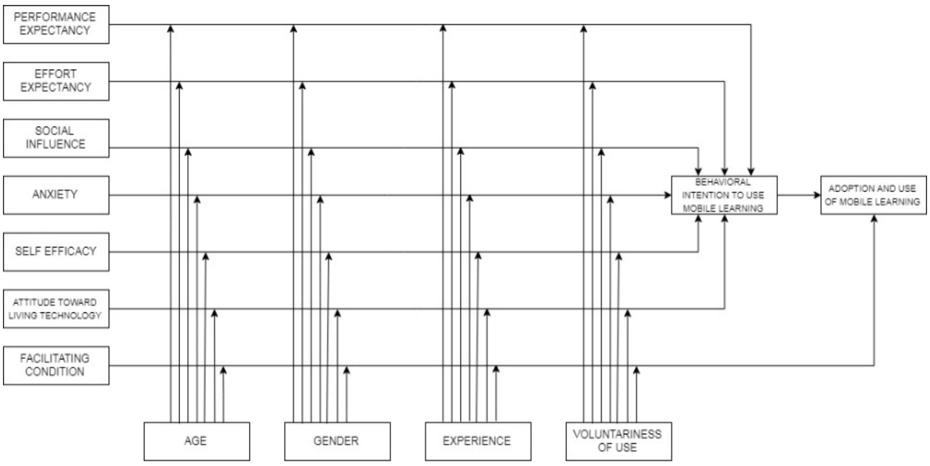

Fig. 1. Modified Unified Theory of Acceptance and Use of Technology (UTAUT)

5.2 Profile of the respondents

Out of 461 respondents, majority of it is within the age ranges from 19 to below or 65.9% percent. The respondents were mostly female or 63.4%, which is in the third year level and consider using mobile in learning as voluntary. A number of respondents answered smartphones as the device they use for mobile learning which is 76.8 percent while tablets and netbooks scored 34.5% and 9.3 percent respectively.

6 Results and Discussions

In assessing the different determinants of user intention a five-point Likert scale was used.

The Assessments of Mobile Learning in terms of Performance Expectancy is presented on table1. The respondents agreed that learning from mobile is useful to his/her work or study *(x=4.25).* It enables them to accomplish the task quickly *(x=4.18)*, increases productivity *(x=4.13),* and increases the chance of getting good grades or good performance in their job *(x= 4.02).* The overall mean *(x=4.48)* strongly suggest that learning from mobile help them attain gain in study/job performance. Performance expectancy has direct effect on the adoption of web based training [10] [11].

To take advantage of the results presented, teachers could use mobile devices in enriching the teaching and learning experience of the students within or outside the campus by creating activities because students will surely take interest on it.

Table 1. Assessments of Mobile Learning in terms of Performance Expectancy

Performance Expectancy				
	N	***Mean***	***Std. Deviation***	***Verbal Interpretation***
Learning from mobile is useful to my work/study.	460	4.2478	1.3331	Agree
Using mobile devices enables me to accomplish task more quickly.	460	4.1826	1.3008	Agree
Learning from mobile increases my productivity.	458	4.1332	1.2715	Agree
Learning from mobile increases my chances of getting a good grade/good performance rating.	459	4.0261	1.2466	Agree
Performance Expectancy	461	4.478	1.2094	Agree

As seen on Table 2, on the Assessments of Mobile Learning In Terms of Effort Expectancy. The result on effort expectancy connotes that both students and faculty do not have a hard time to use mobile devices in teaching and learning. The overall mean (X=3.65) suggests that respondents exerted less effort to use the system to achieve his/her goals in using mobile to learn/teach. Based on the rating, respondent's claimed that it is easier for them to use mobile in the learning/teaching(x=3.59) as well as to become skillful (x=3.87). On the other hand, the rating on the use of mobile devices (x=3.62) and connecting to internet (x=3.51) using their gadgets were easy for them as noted on the results. Effort expectancy confirms that when a technology is easy to use and require less effort is one of the reasons why user adopts a system [12].

Social Influence as defined by Venkatesh is the degree to which an individual perceives that people who are important to him/her believe that he/she should use the new technology which the overall mean of (x=3.92) implies as reflected on table 3.

People who influence respondent's behavior (x=3.87) and those that are important to them (x=3.82) think that they should teach/learn through mobile. The support to use mobile devices is also seen in their classmates and colleagues, in fact respondents claimed they have been helpful in the use mobile in the teaching/learning (x=3.92). However, the results minimally agree was yielded when the respondents were ask on the university's support on the use of mobile in teaching/learning (x=3.09). On the interview with the respondents in investigating on why the aforementioned results were derived, the policy on mobile use inside the classroom as well as the low wi-fi signal in the campus are the two common reasons. People adopt technology to blend or connect to other people [13]. However, after the user used the technology social influence is no longer significant [14].

Table 2. Assessments of Mobile Learning In Terms of Effort Expectancy

Effort Expectancy				
	N	***Mean***	***Std. Deviation***	***Verbal Interpretation***
Using mobile to learn/teach is easy for me.	461	3.5900	1.19920	Agree
It is easy for me to become skillful through mobile learning/teaching	461	3.8698	1.12113	Agree
Mobile devices in teaching/learning is easy for me.	461	3.6291	1.20467	Agree
Connecting to internet for mobile learning is easy for me.	460	3.5087	1.20182	Agree
Effort Expectancy	461	3.6497	1.05943	Agree

Table 3. Assessments of Mobile Learning in terms of Social Influence

Social Influence				
	N	***Mean***	***Std. Deviation***	***Verbal Interpretation***
People who influence my behavior think that I should teach/learn through mobile	461	3.8655	1.07102	Agree
People who are important to me think that I should use mobile devices in teaching/learning	461	3.8265	1.09358	Agree
My classmates/colleagues have been helpful in the use mobile in teaching/learning	460	3.9174	1.15363	Agree
In general, the university has supported the use of mobile in learning.	461	3.0954	1.18119	Minimally Agree
Social Influence	461	3.9262	.99850	Agree

On facilitating condition as seen on table 4, the overall mean score of 4.14 shows the respondents' belief that an organizational and technical infrastructure exists to support the use of mobile in the teaching and learning. The ratings on the table reflected that availability of resources exists in CEU (x=4.23) and respondents have the necessary knowledge (x=4.34) to use mobile devices in teaching and learning. The respondents also agreed that their mobile device is always compatible with other systems they use (x=3.95) and in case they need assistance there is a specific person or group is available (x=4.04). Financing, skills, capacity and infrastructure are examples of challenges encountered when implementing technologies [15].

In the case of CEU, the Teaching and Learning Technology Department (TLTD) and Information Communication Technology (ICT) are the departments responsible in facilitating the use of modern technology. The former is responsible in implementing technological advances in the teaching and learning process while the latter is on implementing such infrastructure needed to modernize CEU.

Table 4. Assessments of Mobile Learning in terms of Facilitating Condition

Facilitating Condition				
	N	*Mean*	*Std. Deviation*	*Verbal Interpretation*
I have the resources necessary to learn from mobile	461	4.2321	1.13842	Agree
I have the knowledge necessary to use mobile in learning	460	4.3413	1.12354	Agree
My mobile device used in learning is always compatible with other systems I use.	460	3.9565	1.18370	Agree
A specific person (or group) is available for assistance with my mobile device	459	4.0414	1.15805	Agree
Facilitating Condition	461	4.1421	.98192	Agree

Anxiety and Self efficacy are the additional variables tested in this study, this test that aside from perceived usefulness other factors are being considered by users before adapting to new technology [16]. Anxiety questions measure the degree of an individual apprehension or even fear when he/she is faced with the possibility of using mobile devices in teaching and learning is reflected on table 5. All indicators of anxiety level were rated minimially agree, from respondents apprehension (x=2.91), security issues (x=2.76), fear of making mistakes (x=2.59), down to the feeling of being intimidated (x=2.61). The overall rating of (x=2.72) suggests that anxiety in using mobile devices is not a matter to consider when in using mobile in the teaching and learning.

Table 5. Assessments of Mobile Learning in terms of Anxiety

Anxiety				
	N	*Mean*	*Std. Deviation*	*Verbal Interpretation*
I feel apprehensive about using mobile in learning	459	2.9107	1.07303	Minimally Agree
It scares me to think that mobile learning is not safe	460	2.7630	1.09780	Minimally Agree
I hesitate to use mobile in learning of fear of making mistakes I cannot correct.	458	2.5939	1.09750	Minimally Agree
Mobile learning is somewhat intimidating to me.	459	2.6144	1.08054	Minimally Agree
Anxiety	461	2.7178	.96465	Minimally Agree

Table 6 shows the result on self-efficacy of the respondents. Self-efficacy refers to an individual's belief in his or her capacity to execute behaviors necessary to produce specific performance attainments [17]. The capacity of the respondents to use mobile in the teaching and learning is high as seen on the different indicators of self-efficacy. This means that respondents believe in their own ability to succeed in accomplishing task. Students will use technology when it is capable of increasing their efficiency [18].

The overall rating of 3.29 translated to as minimally agree when ask whether the respondents could perform the task when there is someone around to tell them what to do while working (x=4.30), calling help desk for oral instruction(x=3.24), plenty of time and resources are provided (x=3.35) and instruction readily available (x=3.26) are not necessary for them to complete their job or task.

Table 6. Assessments of Mobile Learning in terms of Self Efficacy

Self-Efficacy				
	N	***Mean***	***Std. Deviation***	***Verbal Interpretation***
I can complete a job or task using mobile:				
If there is someone around to tell me what to do as I work.	461	4.3080	1.16120	Minimally Agree
If I can call to help desk for oral instruction	460	3.2391	1.04130	Minimally Agree
If I have a lot of time to complete the job and resources are provided.	461	3.3536	1.09084	Minimally Agree
If I have the instruction readily available	461	3.2646	1.09912	Minimally Agree
Self- Efficacy	461	3.2914	.98283	Minimally Agree

Table 7 presents the comparison of respondents' assessments of mobile learning technology in terms of performance expectancy, effort expectancy, social influence and facilitating conditions when grouped according to age bracket. Looking at the table age of a person yielded a very significant variable in the results of performance expectancy, effort expectancy, social influence and facilitating conditions when analyzing the adoption of an individual to technology. An F value of .949 with a mark of 001with a verbal interpretation of very significant was observed on pair 19-below VS 30-39, connotes that in terms of performance expectancy, older respondents tend to adopt the technology more compared to younger respondents. This means that technology will be adopted more by older individuals if this will help them excel in their performance or help them in their task or job compared to younger individuals. Therefore, performance expectancy has positive impact to older individuals when compared to younger individuals on mobile learning.

On the other hand, effort expectancy has positive impact to younger individuals when compared to older individuals. An F value of 9.117 with a mark of .001 with a verbal interpretation of very significant was observed to pairs 19-below VS 20 – 29, 19- below VS 30 – 39, 19- below VS 40 -49 and 19- below VS 50-above in terms of effort expectancy. This data connotes that young ones exerted less effort in mobile learning compared to older people.

Influencing younger individuals on the adoption to mobile learning is much easier compared to older individuals. The data prove this because an F value of 5.823 with a mark of .000 with a verbal interpretation of very significant was observed to pairs 19-below VS 20 – 29, 19- below VS 30 – 39, 19- below VS 40 -49 and 19- below VS 50-above in terms of social influence. Opinions of the people who are important to them are much regard and by young ones compared to older people. Therefore social influence in mobile learning has positive impact to younger compared to older individuals.

When it comes to facilitating condition, there is a positive impact on older individuals on the adoption to mobile learning compared to younger individuals. An F value of 5.9775 with a mark of .000 with a verbal interpretation of very significant was observed to pairs 19- below VS 30 – 39, 19- below VS 40 -49 and 19- below VS 50-above was the basis of this analysis. Older persons have more positive views that organizational and technical infrastructure exist to support mobile learning compared to younger individuals. This shows that older persons are more aware that in the organization there is a unit that will assist them on the use of mobile learning. This difference suggest that adults put emphasis on facilitating condition compared to younger person [19]. Using this finding older people will look for someone to assist them on their technology needs.

An F value of 2.963 with a mark of .016 and a verbal interpretation of significant was observed to pairs 19 - below VS 50 above, 20 - 29 VS 50 above, 30 - 39 VS 50 above and 40 - 49 VS 50 above yielded from Anxiety. The data connotes that younger individuals exhibit a positive emotional reaction towards mobile learning compared to older persons.

It is safe to say that self-efficacy of the respondents when related to age is not significant in the adoption of mobile learning, an F value of 1.504 with a mark of .200 as seen on table. Understanding age difference is beneficial on the use of technology [20].

Among the determinants of user intention, facilitating condition and self-efficacy were found to have a significant difference when the respondents are grouped according to gender. The scores for facilitating condition in female respondents(x=3.0234, SD=.98717) and male respondents (x=3.3159, SD=.94511) with a value of =3.096, p=.003) suggests that male respondents have higher belief that organizational and technical infrastructure such as hardware, software and people resources exists in CEU for mobile learning compared to female respondents.

In terms of self-efficacy, the results show that female respondents(x=3.1750, SD=1.02900) and male respondents (x=3.4835, SD=.86999) with a value of =3.259 p=.001). Male users' belief in his capacity towards mobile learning is greater when compared to female respondents. This suggests that male users are more independent in doing task related to mobile learning and that male are more users of technology compared to female. This findings relates to that male students has higher self-efficacy in computing than the male students.[21]

However in table 8, there is no significant relationship when respondents' assessments of mobile learning in terms of performance expectancy, effort expectancy, social influence and anxiety when grouped according to gender.

Table 7. Comparison of Respondents' Assessments of Mobile Learning Technology In Terms Of Performance Expectancy, Effort Expectancy, Social Influence and Facilitating Conditions When Grouped According To Age

		Mean	SD	F	Sig.	V.I.	Pair
Performance Expectancy	19 below	4.01	1.19	.949	.001	Very Significant	19- below VS 30-39
	20 - 29	4.24	1.21				
	30 - 39	4.80	1.05				
	40 -49	4.5	1.30				
	50-above	4.91	1.14				
	Total	4.14	1.22				
Effort Expectancy	19 below	3.53	0.99	9.117	.001	Very Significant	19- below VS 20 - 29 19- below VS 30 - 39 19- below VS 40 -49 19- below VS 50-above
	20 - 29	3.60	1.00				
	30 - 39	4.19	1.13				
	40 -49	4.39	1.48				
	50-above	4.84	1.16				
	Total	3.65	1.06				
Social Influence	19 below	3.83	0.98	5.823	.000	Very Significant	19- below VS 20 - 29 19- below VS 30 - 39 19- blow VS 40 -49 19- below VS 50-above
	20 - 29	3.88	0.99				
	30 - 39	4.45	0.83				
	40 -49	4.39	1.07				
	50-above	4.75	1.18				
	Total	3.92	0.99				
Facilitating Condition	19 below	4.02	0.95	5.977	.000	Very Significant	19- below VS 30 - 39 19- below VS 40 -49 19- below VS 50-above
	20 - 29	4.22	0.91				
	30 - 39	4.54	1.04				
	40 -49	4.56	1.16				
	50-above	4.98	1.16				
	Total	4.14	0.98				
Anxiety	19 below	3.7803	0.94302	2.963	.016	Significant	19 - below VS 50above 20 - 29 VS 50 above 30 - 39 VS 50 above 40 - 49 VS 50 above
	20-29	3.7323	0.94102				
	30-39	3.5081	1.02161				
	40-49	3.625	1.07626				
	50 above	2.8409	1.10834				
	Total	3.7178	0.96465				
Self-Efficacy	19 below	3.2281	0.9947	1.504	.200	Not Significant	
	20-29	3.4066	0.91584				
	30-39	3.5806	0.86936				
	40-49	3.375	1.03682				
	50 above	3.0682	1.33272				
	Total	3.2914	0.98283				

Table 8. Comparison of the Determinants of User Intention When grouped according to Gender

Group Statistics						
	Gender	***Mean***	***Std. Deviation***	***t value***	***Verbal Interpretation***
Performance Expectancy	Male	3.1921	1.24308	.759 p=.448	Not Significant
	Female	3.1024	1.19989		
Effort Expectancy	Male	2.7605	1.13387	1.842 p=.066	Not Significant
	Female	2.5718	1.00489		
Social Influence	Male	2.9686	1.02718	.815 p=.415	Not Significant
	Female	2.8893	.98506		
Facilitating Condition	Male	3.3159	.94511	3.096 p=.003	Very Significant
	Female	3.0234	.98717		
Anxiety	Male	2.8009	1.01366	1.480 p=.139	Not Significant
	Female	2.6623	.93250		
Self -Efficacy	Male	3.4835	.86999	3.259 p=.001	Very Significant
	Female	3.1750	1.02900		

Table 9 presents the results on the comparison of the respondents' assessments of mobile learning in terms of performance expectancy, effort expectancy, social influence and facilitating conditions when grouped according to experience. Among the determinants of user behavior, experience when related to self-efficacy has no significance. This was based on the yielded data 1st Year (x=3.30, SD=0.86), 2nd Year (x=3.54, SD=0.99), 3rd Year (x=3.17, SD=1.037), 4th Year (x=3.47, SD=1.093) and Employee (x=3.48, SD=0.98) with a value of =1.601 p=.158).

Significant findings were found between pair 1st Years and faculty On the assessment on performance expectancy, the mark of 1st Year (x=3.05, SD=1.11) and faculty (x=3.95, SD=1.19) suggests that employees adoption to mobile learning is higher because they believe that this will help them in their work compared to students' rating. The same findings are on effort expectancy 1st Year (x=2.55, SD=0.94) vs Faculty (x=3.51, SD=1.00) , social influence 1st Year (x=2.88, SD=0.97) vs Faculty (x=3.43, SD=1.06) and anxiety 1st Year (x=2.87, SD=0.90) vs Faculty (x=2.13, SD=0.98). These data suggest that there is a higher tendency for the faculty compared to 1st Year students to adopt mobile learning if the use of such technology is easy and effortless, influenced by their peers to use and a worry free adoption.

Table 9. Comparison Of The Respondents' Assessments Of Mobile learning In Terms Of Performance Expectancy, Effort Expectancy, Social Influence And Facilitating Conditions When Grouped According To Experience

		Mean	**SD**	**F**	**Sig.**	**V.I.**	**Pair**
Performance Expectancy	1st Year	3.0525	1.11944	3.294	.011	Very Significant	1 VS 5
	2nd Year	3.4645	1.24428				
	3rd Year	3.0127	1.20667				
	4th Year	2.9265	1.31626				

	Employee	3.9464	1.13162				
	Total	3.1085	1.19753				
Effort Expectancy	1st Year	2.5543	.94596	4.152	.003	Very Significant	1 VS 5
	2nd Year	2.6968	1.01341				
	3rd Year	2.4552	.98122				
	4th Year	2.7500	1.12152				
	Employee	3.5179	1.31728				
	Total	2.5675	1.00756				
Social Influence	1st Year	2.8804	.97094	2.564	.038	Significant	1 VS 5
	2nd Year	3.1330	.95104				
	3rd Year	2.7690	.94394				
	4th Year	2.9265	1.07079				
	Employee	3.4286	1.0620				
	Total	2.8800	.97122				
Anxiety	1st Year	2.87	0.90	4.927	.000	Very Significant	1VS5 2VS 5
	2nd Year	3.03	1.00				
	3rd Year	2.69	0.93				
	4th Year	2.41	0.78				
	Employee	2.13	0.98				
	Total	2.72	0.95				
Self-Efficacy	1st Year	3.30	0.86	1.601	.158	Not Significant	
	2nd Year	3.54	0.99				
	3rd Year	3.17	1.037				
	4th Year	3.47	1.093				
	Employee	3.48	1.096				
	Total	3.29	0.98				

Comparison Of The Respondents' Assessments Of Mobile Learning In Terms Of Performance Expectancy, Effort Expectancy, Social Influence And Facilitating Conditions When Grouped According To Voluntariness Of Use. In terms of respondents' assessments of WI-FI technology when grouped according to voluntariness of use compared with the different determinants of user intention no significant finding were yielded. Free will is not a factor to consider in adopting mobile learning.

Table 10. Predictor of the User Intention to adopt mobile learning

Determinants	R square (Coefficient of Determination)	β (Beta Coefficient)
Facilitating Condition	36 %	
Performance Expectancy	44%	
Effort Expectancy	48%	
Self-Efficacy	51%	
Anxiety	53%	

Excluded

Determinants	R square (Coefficient of Determination)	β (Beta Coefficient)
Social Influence		

Between determinants of user to adopt mobile learning, anxiety top the rank (53%), followed by self-efficacy (51%), effort expectancy (48%), performance expectancy (44%) and facilitating condition (36%) as the last factor. Excluded from the factor is social influence. This explains that among the determinants of user intention respondents' anxiety is a good predictor in adopting mobile learning while influences from their peers will not contribute its success.

7 Conclusion

Anxiety, self-efficacy and effort expectancy are the top three identified factors in the use and adoption of mobile learning using UTAUT model. There is a need to mitigate faculty and students findings of apprehension, fear, hesitation and intimidation. Increase the confidence of the faculty and students by providing training workshops and demonstration on the use of mobile learning is necessary. A comprehensive program to implement to develop skills needed in shifting on the use of technology in the teaching and learning process. Since self-efficacy was also identified as one of the factors inclusion of criteria in their performance ranking and on grading system on mobile learning can be a scheme to make adoption a success. Moreover recognizing the effort on the use of technology could also be a strategy. Hence forth in the future anxiety, self-efficacy and effort expectancy will no longer be a factor why adopting to new technology will fail.

8 Recommendation

As an initial action to address anxiety on the adoption to mobile learning, training of users, provision of technical assistance to faculty and students and readily available manuals and guidelines should be drafted to ensure success in mobile learning implementation.

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A Systematic Review of Tablet Technology in Mathematics Education

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Abstract—In 2019, the mobile learning body of knowledge is extensive and much is known about the technology impacts and affordances of mobile devices in educational settings. A particular focus has now shifted toward specific technologies in specific subjects. Mathematics is one such subject and tablets are one such technology that is gaining attention. This systematic review representing the latest generation of tablet technology within the tablet-mediated learning in mathematics body of knowledge sought to derive evidence that supported questions into (a) what math sub-disciplines were covered, (b) what technology (application/hardware) was utilized, and (c) what pedagogical approaches were deployed in educational settings. This included analysis of the (d) advantages and (e) disadvantages present in those elements. Thirty-nine relevant articles were collected from various academic technology and educational databases. The results demonstrate that tablets are being predominantly deployed in various sub-disciplines such as Arithmetic, Computation, and Geometry with the iPad as the dominant choice for tablet hardware/applications. Pedagogical approaches lean heavily on game-based learning, environment interaction, and special needs support. Technological advantages include increased collaboration and mathematics engagement enabled by tablet mobility and a high potential for customization of solutions. Developers, teachers, and researchers need to be informed of potential challenges in designing content for tablet technology deployments in mathematics.

Keywords—Tablets, evidence, mathematics, systematic review, mobile learning, tablet-mediated learning

1 Introduction

The impact of technology on mathematical education and the importance of tablet-mediated learning is recognized as an important area of study [1]. Mathematical skills and competencies are seen as key life competencies and are crucial for "active engagement in all aspects of life" [2 p.1]. Since the launch of the current generation of tablets in 2010, the development of tablet hardware technology has reached a mature state [3]. This allows for more stable platforms for applications to be developed for educational use. The popularity of tablets has led to an increased interest in educational applications, especially in schools [4]. A major driver toward this development of tablet technology is the adoption of said technology within mathematical faculties. Many global governments have introduced procurement programs for schools to enable purchase and supply of tablets to their faculty and student bodies [5] [6] [7]. The development of such programs is a direct result of the combined efforts of the academic community in the last eight years within the field of tablet-mediated learning.

Because use of tablets has the potential to enhance learning, researchers during the last years have become interested in the tablets' affordances in the learning process and their effects on students' achievements [2]. In their review of tablet use in schools, [4] highlighted several affordances of tablets that contribute to improving learning. They include: i) high usability and integration of multiple features (e.g., built-in cameras, accelerometers, and microphones) within one device, ii) easy customization and supporting inclusion, iii) touch screen, as well as iv) availability and v) portability. Furthermore, the authors pinpoint that applications developed for tablets may be "*simpler and more "intuitive" to use than their counterparts used with technologies such as laptops […] because tablet-based application are designed to work with a range of screen sizes and as they often lack the notion of opening and closing applications*" (p.10). In comparison with most computers, tablets that incorporate touch interaction make possible manipulation that is similar to how children manipulate physical objects and exploit their natural sensorimotor form of interaction [8] [9].

Moreover, in contrast to computers and mobile phones, tablets' touch screen supports the interaction of two or more students as the same time which makes them especially suited for collaborative work [10]. After all, the small screen size of mobile devices is an obstacle to learning, especially because of the difficulty in collaboration with shared digital displays [11]. Tablets have also been shown to support multimodal learning, i.e., the use of different and combined modalities (e.g., text, sound, video and pictures) to support learning and meaning-making and to support learners to become both producers and consumers of knowledge material [12].

However, certain technologies are considered to be more suitable for chosen tasks than others. In relation to tablets' use, keyboards, larger screens and special software may be needed to support some specific tasks, for instance, mathematical constructions and computer programming [4]. Furthermore, the results of the research on the affective aspect of learning indicate that tablets contribute to students' engagement and sustain their interest (e.g., [13] [14]). Also, [15] found that students preferred learning with tablets compared to text-books.

2 Background

Previous meta-studies and reviews within tablet-mediated and computer-supported learning in mathematics education have focused on: (1) technological impacts on learning effectiveness (high, medium, low) [16]; (2) learning outcomes/gains from usage of tablet technology (positive, neutral, negative) [1] [17]; (3) educational spaces, as classrooms and laboratories [18]; (4) effective educational programs, such as classroom management, motivation, and supplemental tutoring programs [19]; (5) instructional improvement strategies (technology and nontechnology curricula, manipulatives, and technology tools) [20]; and (6) educational cohorts (K-12, higher education) [16] [17]. Each of these studies either focuses purely on the broader application of computer technology in mathematics or where tablets were the focus, mathematics was not due to a broader overall learning approach.

Furthermore, tablet-mediated learning can be seen as a part of the mobile learning research field. Although there is much debate on what comprises and defines mobile learning in its entirety, there is a growing consensus that the subcategory of 'tools' is one such included factor within the technology area (e.g., [21] [22]). Hence, several relevant reviews focusing mobile learning in mathematical education rather than tablet-mediated learning per se have been conducted (e.g., [23] [24] [25]). In these studies, tablets are largely considered as one of many other mobile devices, without any particular focus on their specific affordances and/or characteristics in terms of user interaction patterns. One of the recent reviews of mobile learning for science and mathematics school education [23] emphasized the review of empirical evidence. However, similarly, the authors have not focused and/or examined specific affordances of tablets compared to other mobile technologies used. In the same vein, [24] reviewed mobile learning in mathematics only reported that tablets, in relation to the types of mobile devices used, were next in frequency (31%) after mobile phones (38%); no analysis of the differences between tablets and other mobile technologies has been presented.

With the high-level understanding of where tablets are located within the mobile learning body of knowledge, it is important to reflect upon previous research where these tools are concerned. In addition to a host of individual journals on the subject, several previous systematic reviews have examined research where tablets have been employed in education. Firstly, [18] analyzed the iPad's instructional benefits in educational settings. Despite finding 'tempting technology features' and 'ease of use' as drawing factors toward using the iPad as an educational tool, they could not conclude that the iPad had any positive academic effect in respect to tablet-mediated learning outcomes – emphasizing a lack of pedagogy-wide and long enough research works. Secondly, scholars reviewed relevant research focusing on the use of iPads in higher education, with a focus on student and teacher perspectives [17]. In line with [18], they found that students' learning outcomes were not improved when using tablets. Some benefits for teachers were pinpointed in respect to information dissemination, academic administration and professional development support [17]. A key finding in respect to technology in the form of tablet applications suggests that no up-to-date research that evaluated the use of apps within the subject of mathematics was conducted. Thirdly, another review [1] evaluated the use of tablets - not just iPads - amongst primary and secondary students concerning learning outcomes. The results indicate that the knowledge base was fragmented and lacked rigorous studies sufficient enough to draw any firm conclusions. When discussing technological affordances, it was noted that in consideration of tablet technology, keyboards, larger screens, and specialized software may be needed to support specialized tasks such as mathematical constructions [1]. Finally, one of the latest reviews investigated *if*, *when* and *how* using tablets impacts on learning outcomes [4]. Based on the analysis of 33 studies, including those that were performed in a mathematical education context, they conclude that overall tablets have significant potential for enhancing learning, but "the most important element remains the teacher, and their classroom practice" (p.115).

In summary, the results of the research mentioned above suggest that the tablet-mediated learning body of knowledge in education overall lacks the pedagogical sense. Besides, a limitation to complete understanding is that these studies do not specifically address tablets in mathematics but tablets from a broader perspective.

Largely the above-mentioned studies lack the combined focus on tablet-mediated learning in mathematics and do not offer thorough insight into the pedagogical practices, the specific affordances of tablets' use that aid students' learning of mathematics, implementation advantages and specific challenges faced by end-users, teachers and developers.

This study thus aims to fulfil this gap by presenting a systematic review of the literature comprising the tablet-mediated learning body of knowledge with a focus on mathematics.

2.1 Research questions

The purpose of this systematic review is to investigate how tablet technology is utilized for mathematics learning and what pedagogical practices tablets support. This is addressed through the following research questions:

- **RQ1:** In what math-disciplines are tablets used?
- **RQ2:** What kinds of tablet technology are used?
- **RQ3:** What kinds of pedagogical practices are enacted?
- **RQ4:** What are the advantages of tablet-mediated mathematics learning?
- **RQ5:** What are the challenges of tablet-mediated mathematics learning?

3 Methodology

To investigate how tablet technology has been utilized for mathematics learning and what pedagogical practices tablets support the existing body of knowledge surrounding tablet-mediated learning in mathematics has been assessed and analysed. Methodological considerations are thus concerned with analysing an aggregate of single research projects that have been conducted in this area and timeframe.

3.1 Data collection

Database searched: Evidence articles were collected from the technology and education-based databases described in Table 1. Databases were selected from an aggregate of those used in previous tablet-mediated and mobile learning systematic reviews (e.g., [1] [17] [18] [22]).

Table 1. Databases searched

Database	Link
ACM Digital Library	http://dl.acm.org/
EBSCO host Research Databases	https://www.ebscohost.com/
ERIC	DB included in EBSCO and ProQuest Searches
IEEE Xplore Digital Library	http://ieeexplore.ieee.org/Xplore/home.jsp
ProQuest	http://www.proquest.com/
ScienceDirect	http://www.sciencedirect.com/
Elsevier Science	DB included in ScienceDirect search

Supplemental manual searches – Journals, In order to ensure subject matter coverage of mathematics in education, manual searches were also conducted in for the following journals: *Computers & Education*, *Journal of Computer Assisted Learning, Computers in Human Behavior, British Journal of Educational Technology, Journal of Educational Technology & Society*, and *the International Review of Research in Open and Distance Learning*.

Search terms: Three different categorization of search terms and potential variations within those categories were derived from a combination of previous tablet-mediated learning systematic reviews by [1] and [17]:

- Tablets: 'tablet' or 'iPad' or 'Android' or 'Windows' AND;
- Education: 'education' or 'pedagogy' or 'learning' AND;
- Mathematics: 'mathematics' or 'math'.

Selection of papers for inclusion in the review: In respect to timeframe, the scope of this study only included evidence gathered between January 2010 and January 2018.

For assessment of the relevant academic body of knowledge, conference proceedings, articles, and journal publications consisted of the evidence articles collected.

The criteria mentioned above, as well as the following inclusion and exclusion criteria, are adapted from previous systematic reviews [1][17][18]. In addition to the specific criteria stated above, evidence articles were included according to the criteria presented in Table 2:

Table 2. Inclusion Criteria

Inclusion	Rationale
Focused on any mathematical sub-discipline	In order to address RQ1, studies that cover such sub-disciplines (non-exhaustive) as geometry, algebra, fractions, arithmetic, calculus.
Reported use of any tablet hardware	This includes iPads, Android and custom platforms. In order to address RQ2.
Reported use of tablet mathematical applications	In order to address RQ2 for the understanding of what applications are deployed in mathematics.
Described pedagogical practices deployed	Concerning RQ3.
Written in English Peer-reviewed original articles	Self-explanatory limitation of the researcher.
All educational cohorts	From junior kindergarten to higher learning. Mathematics is a subject covered at all levels.

In addition to the specific inclusions stated above, evidence articles were included after exclusion evaluation according to Table 3.

Table 3. Exclusion Criteria

Exclusion	Rationale
Non-academic sources	In order to assess the academic body of knowledge, evidence sources such as news, websites, and other non-peer reviewed articles were excluded.
Mobile learning technology papers that do not concern tablet technology	Mobile learning technology is a broad topic and tablets is a subset. It is important to include mobile learning technology papers where tablets are concerned yet exclude the rest.
'Grey Literature' [1]	Excluded due to non-academic nature or does not fully meet inclusion criteria. Includes technical writings, white papers, feasibility studies.
Duplicates	Individual searches from databases may yield duplicate returns.

Coding and categorization of articles: Evidence articles that meet the inclusion criteria were subject to coding by reviewing each article's full text and categorizing the evidence based on the prescribed categories. The categories were derived from the research questions, which were in line with methods used in previous systematic reviews [1] and [18]. Articles in the chosen sample were categorized according to the following non-exhaustive dimensions:

- Math Discipline [RQ1] – The specific math discipline that is the focus of an individual study.
- Utilized Technology [RQ2] – Tablet hardware or software deployed.
- Pedagogical Practices [RQ3] – Commonly identified learning practices applied using technology.
- Advantages [RQ4] – Clear benefits realized from tablet technology.
- Challenges [RQ5] - Commonly documented challenges within evidence articles.

To assess inter-rater reliability concerning the coding of the papers, a sub-sample of 20 of the 39 papers (50%) was coded independently by the authors. The inter-rater reliability (r) was *.89*, showing good agreement between the coders.

4 Results

4.1 Evidence articles identified by search terms

Table 4 presents a record of the search query syntax in the form of Boolean strings constructed from the defined search terms. It also includes various notes important to each search that were applied as refinements based on inclusion criteria and the dates that that searches were run. The total number of articles returned from the searches (275 in a six-year period before exclusions) suggests that there may be a limited interest within the area of tablet-mediated learning in mathematics.

4.2 Evidence articles selected using inclusion criteria

Table 4 also tallies the number of papers each database yielded as well as how many articles were selected based on the inclusion criteria. The ProQuest search generated the most usable results (21 articles), as it also included the ERIC (Education Resources Information Center) databases. In total, 39 relevant articles were found and serve as evidence for this systematic review. A full overview of the reviewed articles is presented in Appendix 1.

4.3 Categorization results

Math discipline [RQ1]
RQ1: In what math-disciplines are tablets used?
Of the 39 articles in the final set:

- Nine articles were related to Arithmetic;
- Six articles were related to Computation;
- Five articles were related to Geometry;
- Nine articles covered multiple disciplines and;
- Algebra, Fractions, Trigonometry, Calculus, Logic and Common Core was also math disciplines of focus.

Arithmetic - Which includes simple addition, subtraction, multiplication, and division - is frequently studied within the tablet-mediated learning mathematics body of knowledge. There is a clear distinction of its use within elementary school levels [26] [27] [28] [30] [31], special needs [32] [33] and even where more advanced equations (and costs) are concerned [34] .

Computation: Evidence articles that reported on the computation sub-discipline are concerned primarily with counting, skip counting, and matching activities [35] [36] [37]. More complex computation activities such as subitizing, quick number judgments [38] [39]; cardinality, number of elements in a number set; relative magnitude, size of a number compared to another; and composition/decomposition, breaking numbers into ones, tens, one hundreds and vice-versa [40] are similarly present.

Table 4. Databases searched

Database	Query Syntax	Note	No. of Articles	No. of Articles Meeting Inclusion Criteria
ACM Digital Library	RcordAbstract:(tablet iPad android windows) AND (education pedagogic learning) AND (mathematics math)	Refinements: Published since 2010 Published to 2018	56	6
EBSCO host Research Databases	(AB (tablet OR iPad OR android OR windows)) AND (AB (education OR pedagogy OR learning)) AND (AB (mathematics OR math))	Published Date:20100101-20180431Source Types: Academic Journals, Reviews, JournalsLanguage: English	85	3
IEEE Xplore Digital Library	(("Abstract":tablet OR "Abstract":iPad OR "Abstract":android OR "Abstract":windows) AND (p_Abstract:education OR "Abstract":pedagogy OR "Abstract":learning) AND (p_Abstract:mathematics OR "Abstract":math))	Year: 2010-2018 Content Type: Conference Publications, Journals	39	4
ProQuest	(AB(tablet) OR AB(iPad) OR AB(windows) OR AB(android)) AND (AB(education) OR AB(learning) OR AB(pedagogy)) AND (AB(mathematics) OR AB(math))	Date: From 2010 January 01 to 2018 April 31 Source type: Scholarly Journals Language: English	67	21
ScienceDirect	pub-date > 2009 and TITLE-ABSTR-KEY((("tablet" OR "ipad" OR "android" OR "windows") AND ("education" OR "pedagogy" OR "learning") AND ("mathematics" OR "math")))	Date Range: '2010' to 'Present'	28	5
		Total	275	39

Geometry: A more complex math sub-discipline than arithmetic and computation, geometry applications take advantage of tablet technology when interacting with environments through camera and compass functions. This is demonstrated in learning situations by capturing angles and distance measurements of real-world images [41] [42]. More advanced geometric activities include i) spatial geometry, consisting of points, lines, polygons [43], ii) translation, reflection, and rotation [44]; and iii) 3D Geometry where users can manipulate shapes in the third dimension using hand gestures and touchscreens [45]

Multi-discipline articles: There were multiple articles where a specific math sub-discipline was either not mentioned. These covered the broader topic of mathematics yet discussed either important pedagogical/technology approaches [10] [15] [46] [47] [48] or multiple math sub-disciplines were researched. In cases where multiple sub-disciplines were discussed, geometry mixed with fractions [49], geometry mixed with computation activities [50]; and mathematical problem solving [51] [52] was identified.

Other math disciplines: More complex math sub-disciplines require more specialized applications that potentially reach smaller educational audiences than foundation level sub-disciplines such as arithmetic and computation in elementary settings. The least complex fractions [53] [54] and algebra [55] [56] accounted for two evidence articles respectively. At the more complex end of the math spectrum, calculus [57] [58] and trigonometry [59] [60] also accounted for two findings each. A sole article researched mathematical logic [61].

4.4 Utilized technology [RQ2]

RQ2: How is the tablet technology used? What kinds of hardware/applications are utilized?

Of the 39 evidence articles in the final set:

- 26 articles were based on the iPad tablet;
- Six articles were based on the Android platform;
- The remaining articles' hardware was either not named or purely custom solutions;
- Frequently studied applications included Motion Math *and*
- Many custom apps were studied.

Tablet hardware technology: Collected evidence supports the notion that Apple may have the educational market covered as 67% of articles deployed iOS based tablets such as the iPad (e.g., [15] [31] [45] [46] [49] [50] [55] [61]).The Android platform has less evidence in support. Many companies develop tablets that run Android, yet the Samsung Galaxy Tab is the only device specifically researched [27] [43] [59]. Other articles present an Android solution but do not specifically state which manufacturer has supplied the tablet [34] [36] [56].

Seven articles do not specifically state what the underlying hardware technology solution is, thus focusing purely on the application itself (e.g., [28] [29] [44] [51] [52]). These kinds of studies are important because they can help explain whether it is the hardware or the software side of technology that impacts other researched factors (i.e., pedagogical approaches).

4.5 Pedagogical practices [RQ3]

RQ3: What kind of pedagogical practices are enacted?

Of the 39 evidence articles in the final set:

- 16 articles were based on Game-Based Learning;
- Five articles were based on some form of Environment Interaction;
- Four articles were customized for Special Needs Learning;
- Other frequent pedagogical approaches included: Feedback, Scaffolding, Drill and Practice, and Reciprocal Peer Tutoring.

Game-based learning: It is no surprise that there is a large volume of evidence in support of game-based learning as a pedagogical practice. The logic is somewhat simple too: games are fun. Therefore math-based games can be fun too. They engage the student in what can be seen by some as mundane math topics presented in a fun way [15] and one case potential for distraction [48]. So, researched was game-based learning as a pedagogical approach that multiple articles focused purely on it [27] [39] [53] [54] [61] [62]. Other evidence combines game-based learning with other pedagogical approaches, such as i) environment interaction, where the tablet technology interfaces with the real world [38] [57]; ii) feedback, where results and comments or positive reinforcement are immediately communicated to the user/student [28] [40]; and iii) immersion through flow experience, i.e., being in the zone [26] or through repetition of math levels [56].

Environment interaction: Utilizing tablet hardware features such as cameras, gyros, GPS and compasses, they can easily interact with the outside environment. This is especially true where geometry apps are concerned. Angles and shapes can be extrapolated from pictures, location data from GPS and other such measures can be inputs from the student's environment. As a pedagogical approach, using the real-world environment makes understanding practical applications easier for the learner [37] [42] and can even bring learning into the third dimension which is more difficult on paper [45].

Special needs learning: Since tablet technology is extremely customizable, special needs pedagogical approaches are customized. Physical disabilities can be accounted for through a specialized touch-input system that removes previous limitations of pencil and paper and enables learning to draft complex trigonometric equations [59]. Combined with environment interaction, game-based learning, and drill & practice pedagogies, down-syndrome [36] or autism [32] students can also be taught mathematics. Scaffolding, or level of support given during learning, is also combined with special needs learning [30] to offer a customized pedagogical approach.

Other pedagogical approaches: Feedback and scaffolding are also commonly utilized in pedagogical approaches. They have been used within games [38], as standalone approaches [46] [47] or in combination with a virtual tutor [34] [50].

Drill and practice, a traditional pedagogical approach where apps provide well-designed learning based on repeated drill-and practice [33] are also frequent approaches. Such approach was found to be combined with tech and test - another traditional approach - to validate the repetition for average [43], as well as special needs students [36].

Another pedagogical approach to be mentioned is that of reciprocal peer tutoring. This is identified to be enabled by network and real-time communication features where learners can solve math problems within an app but also use the same app to demonstrate and teach other learners through video [44] and visual communication [41] [52] [60].

4.6 Advantages [RQ4]

RQ4: What are the advantages of tablet mediated mathematics learning?

Collaborative learning: As one of the primary affordances of tablet technology is its collaborative features (e.g., network and email), there is strong evidence in support of the advantages with respect to collaborative learning. Scribing, peer assessment, learning by teaching or "show and tell" are collaborative advantages whereby students can draw, build, and/or solve mathematical equations, diagrams or representations that subsequently can be visually shown to other students and teachers. This enhances mathematical communication of all involved as students are motivated to clarify and reflect their ideas (e.g., [10] [31] [41].

Mobility: Since tablets are lightweight, wireless, and have long-lasting batteries, there is evidence to support that mobility of the devices is an advantage that is exploited in mathematics learning [44]. The mobility of the devices can lead to arguments against using PC or laptop technology. Laptops are too unwieldy for two students to compare work. Putting two tablets side-by-side is more practical than laptops [57]. Such kind of mobility also leads to the creation of engaging learning environments beyond the traditional boundaries of a classroom: the mobility of tablets result in altering the physical structure of the classroom as well as promoting a classroom environment is more conducive to learning mathematics [61].

Level of customization: The sheer volume of presented in the chosen sample custom math applications is a testament to the seemingly infinite number of ways that tablet technology can be customized. The most researched type of customization was when usable interfaces are designed to the specific needs of the end users – creating an easy-to-use interface. Whether it regards special needs [36] [59] or a more standard interface [37] [49] [54], students need to be comfortable with how they interact with their devices.

Customization of apps with respect to digital tutors or other kinds of built-in-feedback was shown to lead to a lowered requirement for direct teacher support [32]. Additionally, apps were shown to serve as teaching tools or purely learning tools [27], as well as tools used for measurement of teaching effectiveness [40].

Mathematics engagement: Games, visuals, and rewards lend themselves to students being more engaged in mathematics. Overall, the most important factor in mathematics engagement is that math apps are fun [28]. Learners and teachers are most engaged when they are having fun. As outlined by [56], the video game was able to provide entertainment and at the same time was contextually relevant. Even compared to traditional methods such as "chalk & talk," levels of engagement and focus are much higher when tablet technology is used [44]. It is even demonstrated that highly engaged or even variably engaged students to achieve learning gains when utilizing tablets [62].

4.7 Challenges [RQ5]

RQ5: What are the challenges of tablet mediated mathematics learning?

Design/Content: One of the major challenges when it comes to deploying tablet technology in mathematics is getting the design of the solution correct which includes having the right content for the learner/teacher end users. Potential design issues include but are not limited to blurred images from cameras [44], light sensitivity settings [45], inadequately accounting for personal disabilities [59], poor user interfaces [29] [59], and at the most extreme, "inadequacies in representing the accuracy and richness of the mathematics content" [47]. Failure in design and content can lead to costly re-design or abandonment of the solution altogether by the students or teachers as extreme examples. Minor design failures can lead to an increased need for technical support or maintenance teams to be onsite [31] [32] [40] [58].

Solutions to this challenge have been suggested in various application design approaches such as user-centered design [55] and ethnographic design [34].

Cognitive load: The cognitive load placed on students is also a definite challenge as new technology, interfaces, and new math applications first need to be learned themselves before students and teachers can capture the full potential of the learning experience [36] - the brain can only process so much. It has been demonstrated that "extraneous cognitive load can interfere with learning" [48] and lead to distractions within the learning environment. Cognitive load can lead to an increased need for technical training (cost) in addition to learning the math subject being taught [42].

This potential for 'information overload' is a challenge for designers as solutions tend to be based on hardware where potential users already have a technical ability due to ownership at home or elsewhere in an attempt to address this challenge [37].

Another possible solution presented is the use of pre-task instruction in order to alleviate potential high cognitive load that can lead to "digital interface performance deficits" [43].

Hardware vs. Software: A challenge to researchers is represented in the difficulty of "disentangling the exact features of the software and hardware" that defines a given study or intervention as successful [50]. This is a product of the fact that software cannot operate without a hardware platform. An attempt to overcome this challenge was an intervention with three groups: one with a tablet and math app; one with a tablet without the app; and a control group representing a traditional classroom without technology [46]. Even then, deciphering whether it is the hardware or the software that benefitted learners or teachers or resulted in some form of technological limitation remained a challenge [58].

Comparison against traditional methods: Another important challenge that needs to be addressed is the comparison between traditional teaching methods or pedagogical approaches versus those that are enhanced by tablet technology. Comparing enhanced learning environments to the traditional will set a benchmark to measure the effects of tablets within mathematics learning [56]. Unfortunately, there is limited evidence available to support that research is conducting these kinds of comparisons in order to alleviate this challenge [35] [53].

Novelty: The most interesting challenge and a question on researchers' minds are that of novelty. What happens when games are no longer fun or technology is no longer exciting? It "is commonly found in learning processes, the gains attributed to the novelty of a new approach may eventually become attenuated over time" [62]. More evidence is required to support the notion of novelty, and it impacts on tablet mediated learning in mathematics [10].

5 Discussion

This systematic review aimed to investigate how tablet technology is utilized for mathematics learning. In particular, it focused at the understanding of in what math-disciplines tablets were used; what kind of tablet technology was employed; what pedagogical practices were enacted, as well as at the understanding of advantages and challenges of tablet-mediated mathematics learning.

5.1 Foundational mathematics is the dominant math discipline

The results show that there is a clear focus on foundational level mathematics in elementary school settings. Arithmetic (addition, subtraction, multiplication, and division) and computation (counting, number sorting/ordering, and subtilizing) are simple mathematical teaching concepts and lay the groundwork for more complex topics such as geometry, algebra, trigonometry, and calculus. Thus foundation subjects that tend to reach a wider audience of learners will be subject to application development and deployment on tablet hardware in educational settings in higher volume and frequency than more complex applications dealing with, for example, 3D geometry.

5.2 Pedagogical approaches

The most used pedagogical approach, either standalone or combined with others is game-based learning. Tablet technology opens the door for mathematical games to be designed that are touchscreen based, networked, visually and audibly stimulating and most of all fun. The ability to make complex and boring math subjects into fun and engaging experiences are strongly desired by teachers and learners. Except for game-based learning, the reviewed studies either specifically targeted pedagogical approaches or inferred the existence of approaches used. Such table features as cameras, GPS, WiFi, and compasses enable unique opportunities for students and teachers to interact with their environments. Pictures of houses can turn into geometry lessons, and wireless network connections can ensure that students can collaborate and teachers can provide real-time feedback or scaffolding to assist teaching efforts. Special needs pedagogical approaches also not only include games, feedback, environmental interaction, and scaffolding but can be customized depending on physical or mental disability. Students who have lost the use of their hands for example can have custom interfaces developed which limit the impact of the physical disability when interfacing with tablets. These approaches, as well as traditional drill and practice or teach and test, can be programmed and deployed on top of tablet technology. Tablets allow teachers and students to customize their learning by selecting pedagogical approaches relevant to an individual student and/or a specific mathematical subject.

5.3 Advantages of deploying tablets

The affordances of tablets are widely researched and generally accepted in mobile learning circles. Coincidently, the evidence gathered in this review identifies some of the main advantages of tablets deployed in mathematics learning and directly links to tablet affordances [4]. For example, the collaborative affordances of tablet technology - related to, e.g., Wifi, graphical output, and document sharing - translates into math classrooms in which increased levels of collaborative learning is manifested where students can act as peer-tutors and use tablets to solve math problems but also teach and gain peer feedback from other students. Students and teachers also take advantage of the portability and mobility of the technology when setting up unique learning experiences outside of the traditional classroom settings. These advantages, coupled with gaming pedagogical approaches lead to increased levels of mathematical engagement of students when compared to traditional classrooms and tools [63]. Perhaps the prevalent discovered benefit is the level of customization that tablet technology can bring to the student learning experience. Not only can applications be customized to include various pedagogical approaches, but apps can also be tailored toward the specific mathematical sub-disciplines being taught. Lastly, hardware can be customized to interact with external environments or even provide usable interfaces to accommodate special needs students.

5.4 Challenges faced by researchers, teachers, and students

While this review has mainly focused on the positive aspects of tablet technology, there is evidence to suggest that a few key challenges are also present. Design and content challenges plague not only developers but also teachers: how to best design the app for its intended audience and ensure that content is not only relevant but easily understood and navigated by learners is a constant challenge. Development of math apps can take multiple iterations and testing using classroom interventions of variable design. Teachers also face the challenge of how to design effective learning experiences that not only incorporate tablet technology but also apt mathematical pedagogical approaches.

Design and content challenges also need to consider the cognitive load challenge, i.e., interfacing with tablet technology should not put an extraneous cognitive load onto teachers and/or students. Time spent learning how to use an app or tablet interface can negatively impact mathematic teaching, as more time can be spent with technology learning than the subject at hand. The results also show that where there is a demand for high cognitive load, there is also a requirement for increased levels of technical support/maintenance from IT experts for teachers and students – which suggests a financial and time cost.

5.5 The novelty factor

When analysing other minor challenges one less frequently spoken of, yet very interesting and potentially high impact disadvantage came to the forefront – that of novelty. It is yet to be determined whether the novelty of technology fades over time and student/teacher engagement becomes less fun or less exciting as a result. The majority of evidence in this review seems to support the premise that tablet technology in iOS-based teaching is primarily deployed, and perhaps most effective in elementary school levels. That being said, it opens the door to further investigation to determine when the novelty of tablets essentially runs its course as students' progress in grades (potentially leading to disengagement and boredom) or improve other learning outcomes.

5.6 Limitations

This systematic review has several limitations. The first of which is a common limitation facing all systematic reviews – building the snapshot in time of the body of knowledge around tablet mediated learning in mathematics. Necessary conditions of this limitation include

- The exact search parameters represented by the Boolean strings
- The databases searched and choice of inclusion criteria; and the exact time the searches were performed, as well as the time period sample

Since in 2018, we are in the "late majority" maturity level of tablet technology, not only was this potentially a good time for a snapshot but this was also dependent on the almost commonly accepted notion that 2010 was the beginning of the latest generation of tablet technology.

Lastly, the databases themselves and the searches within them were limited to English only results. It follows then that all evidence and findings are limited to one language and not a representative extrapolation of the entire global body of knowledge for tablet mediated learning in mathematics.

6 Conclusion

This systematic review representing the latest generation of tablet technology within the tablet-mediated learning in mathematics body of knowledge sought to derive evidence that supported questions into what math sub-disciplines, what technology and what pedagogical approaches were deployed in educational settings. This included an analysis of the advantages and disadvantages present in those elements.

The most notable finding was that with a low volume of evidence articles in support of tablet-mediated learning in mathematics, the overall body of knowledge requires much more academic development. Researchers going forward should focus on specific mathematical sub-disciplines such as calculus, algebra, trigonometry and mathematical logic with a comparative look into which pedagogical approaches are effective in more complex math vs. foundational math subjects. Comprehensive end-to-end studies that look at tablet technology and pedagogy are needed.

A potential disadvantage discovered also requires more research into the impact of novelty over time. It is plausible to suggest to novelty is not infinite and game base learning or tablet technology may become less interesting in older learning cohorts or even in corporate learning situations and be viewed more as a tool rather than a novel device.

What this study has shown is that despite almost eight years into this generation of tablet technology, the body of knowledge in respect to tablet-mediated learning in mathematics is still limited. Most research to date has focused on broader topics of mobile learning. In closing, it is hoped that this review will serve as a guide and a tool for tablet technology developers, teachers/students and researchers in the field of the tablet- mediated learning in mathematics.

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Mobile Application Based Modified Screening and Assessment Tools for Children with Autism

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Abstract—The researchers have focused on mobile application of screening tool to profile a child according to the degree of autism as per Indian Scale for Assessment of Autism (ISAA) with some modification. The work also emphasizes on practical implementation of various educational assessment tools viz. Indian Portage guide, BASIC-MR (Behavioural Assessment Scales for Indian Children with Mental Retardation) Part A, (FACP) Functional Assessment Checklist for Programming to assess children with autism in form of mobile application. The aim of this study is to enhance easiness, to improve accuracy, to monitor the child's progress and to make the whole process a time efficient one.

Keywords—ISAA, FACP, Indian Portage guide, BASIC MR (Part A), assessment tools, mobile application, ASD

1 Introduction

In an era where `inclusive development' is being emphasized as the right path towards sustainable development (Disabled-persons-in-India-2016) [1] as every student can learn just not on the same day or in the same way, focused initiatives for the welfare of persons with disability are essential.

In the disability spectrum about 1% of the global population suffers from Autism Spectrum Disorder (ASD). 1 in 68 Indian is affected with this neuro developmental disorder that onsets at an early age & limits the child's interaction with the world. It is extremely essential to diagnose or measure autism at the earliest. Childhood Autism Rating Scale (CARS) [2] is the commonly used scale for rating the severity of autism for the children more than two years of age. The scale lacks the information about the disability percentage. NIMH (National Institute for Mentally Handicapped) developed the Indian Scale for Assessment of Autism (ISAA) for diagnosis and measuring the severity of autism in 2009 [3].

As an assistive tool TOBY (tobyplaypad.com) a play pad application is developed to teach children with ASD by a group of scientists in Deakin University, Curtin University, Australia [7,8] . It acts as a technical support to an early intervention program for children with ASD between diagnosis and commencement of formal therapy.

Children with ASD exhibit individual learning abilities and disabilities. Hence educational assessment is very useful to identify their strength and weakness. Some commonly practiced standard educational tools applied on Indian population are Indian Portage guide developed by CBR network, Behavioural assessment scales for Indian Children with mental retardation (Basic-MR) (Part A/B), Functional Assessment Checklist for Programming (FACP) etc.

Our initiative adds easiness and simplicity to the process to classify a child according to the degree of autism as per Indian Scale for Assessment of Autism (ISAA) with some modification. This work also helps educator to visualize and analyze periodical assessments which may help them to design Individualized Program (IEP).

2 About the Tools

2.1 ISAA

ISAA is a screening tool for persons with Autism. Experts closely observe the person, clinically evaluate the behaviour, test by interacting the subject and seek information from parents and care givers to diagnose autism. The assessment period is about 20-30 minutes.

ISAA consists of 40 activities rated on a 5-point rating Likert scale ranging from 1(never) to 5 (always). The 40 items of ISAA are categorised under six domains viz.

1. Social relationship & reciprocity
2. Emotional responsiveness
3. Speech language & Communication
4. Behaviour Patterns
5. Sensory Aspects
6. Cognitive Component.

All qualitative data are further quantified for providing percentages to indicate the frequency, degree & intensity of behavioural characteristics that are observed. The categories depending up on the occurrence of the activity observed are associated with numeric score.

- Rarely (up to 20 %) Score 1
- Sometimes (21-40 %) Score 2
- Frequently (41-60 %) Score 3
- Mostly (61-80%) Score 4

- Always (81-100%) Score 5

ISAA reports the levels of autism and disability percentage of a person. ISAA is a standard psychometric tool for making diagnosis of persons with autism and is reliable and valid in Indian population.

2.2 Indian Portage Guide to Early Childhood Education

Portage is an international program on holistic child development. It provides knowledge on understanding the current development and plan early intervention making optimum use of potential in every child. Portage guide developed by CBR Network (South Asia) is very useful for professionals and parents invoked in the care and development of 0-6 age group children with or without special needs.

Children with autism in India often are assessed and evaluated by Portage guide developed by CBR network, India [4]. The guide considers cognitive development, language and communication, motor development, self-help skills and social development area of a child and determine the child's ability level in various academic areas. This phase is necessary before a child receives special education and related services.

Each functional area covers numerous age-related activities. The activities are rated on a 6-point rating scale (0-5) based on the levels of responses.

2.3 Behavioural Assessment Scales for Indian Children with Mental Retardation (BASIC MR)

The Behavioural Assessment scales for Indian children with mental retardation has been developed by National Institute for the Mentally Handicapped (NIMH) [5] in 1992 to extract systematic information about the current level of behaviour of preschoolers or school going children (3 to 16 years) with mental disorder. BASIC MR has been designed in 2 parts. - Part A and Part B.

Part A: The items included in Part A of the scale helps to assess the current level of skill behaviours in the child. The part A consists of 280 items grouped under the following seven domains viz.

1. Motor
2. Activities Daily Living (ADL)
3. Language
4. Reading-Writing
5. Number Time
6. Domestic-Social
7. Pre-Vocational-Money

We have implemented only Part A in our application as the part appropriately assess the functional areas of a child with autism during early intervention process.

Scoring of BASIC-MR (Part A): Each child with mental blockage may show different levels of performance on every item in part A. There are six possible levels of performance under which each item can be scored. The appropriate score obtained by the child are converted into domain wise percentage and cumulative percentage. And finally, the progress profile is plotted on graph. The Assessment is done initially and before starting the teaching program of a child with autism called baseline assessment. During teaching quarterly assessments are done. At the end of teaching program evaluation is done using this tool.

2.4 Functional Assessment Checklist for Programming (FACP)

The Department of Special Education, National Institute for Mentally Handicapped, Secunderabad, introduced a series of Checklists to facilitate programme planning in each child with mental handicap. [6]

There are positive checklists in this series. Each checklist considers different levels of child's functioning namely pre-primary (3-6 years of age), primary I (7-8 years of age), primary II (8-14 years), secondary group (11-14 years), prevocational-I & II (15-18 years)

The checklist covers the following areas: - Personal, Social, Academic, Occupational, Recreational. The checklist is activity based rather than skill based as the activities require multiple skills. Moreover, an activity is easier to observe and measure the progress in the given area. In addition, this tool is flexible regarding the inclusion or deletion of activities in any given area.

Scoring of FACP: Activities performed by occasional cuing or independently are counted as a point while calculating percentages. Achievement of 80% of items in the checklist is considered for promotion of the next higher level. Recreational activities are evaluated by grade system.

The tool follows the evaluation scheme followed in mainstream education system i.e., the child's progress is periodically monitored, quantified and promotion or detention is decided logically.

3 Design of the Proposed Application

Our goal is simple: to help special educators, parents during the stressful time of diagnosis & commencement of formal therapy. In this work, we have implemented ISAA tool in form of mobile app for classifying a child according to the degree of severity of autism. Each item of ISAA is assessed and rated based on intensity, duration and frequency of the characteristics. In our application a special educator must input the levels of each activities based on keen observation and information supplemented by parents or care givers. ISAA tool reports the degree of autism of a child and the percentage of disability as per the score. We added a new feature i.e., domain wise degree of impairment. This may be beneficial to identify the strength and weakness of the child in a particular domain. This information may act as a guideline during baseline assessment done prior to a formal intervention program.

The standard practice in the special education setup surveyed is as follows:

1. When child with autism comes to join a special school, he/she is keenly observed by the educators.
2. For some days (3-7days). Student's cognitive development, social development etc. are assessed.
3. Various standard educational assessment tools are consulted viz. Indian Portage guide developed by CBR network, Behavioural assessment scales for Indian Children with mental retardation (Basic-MR), FACP (Functional Assessment Checklist for Programming) (Part A/B) etc.
4. Based on the assessment, Individualized Educational Plan (IEP) is designed by the educator for each student.
5. Student is assisted with appropriate teaching learning material.
6. Periodic evaluation of their progress is done & revised IEP is designed.

It is also aimed to represent the performance data in intelligible way using summarisation, visualisation & interactive interfaces which will help educators /caregivers to visualize and analyze the ongoing activities of the students. In this work, we have also implemented few frequently practiced educational assessment tools [4] [5] [6] in form of mobile app. We have adapted few changes regarding scoring calculation. The modifications are due to maintain uniformity among the tools, to measure the progress of a child and to quantify the qualitative data. The educator has to observe the child's behaviour and activities and record their performance level. The performance data are to be analyzed to generate the learning pattern at regular interval. All activities irrespective of tools are rated on a 6-point rating scale (0-5). Table 1 describes the levels of responses and score assigned in each level in detail

Table 1. Levels of responses and score assigned in each level in our proposed application

Levels	Meaning	Score Assigned
Total Dependent	One must do the task for the child	0
Physical prompt	Child needs physical help to do the task	1
Verbal prompt	Child requires verbal commands to perform the task	2
Gestural prompt	Child requires gestural help to accomplish the task	3
Occasional cuing	Child needs clues for thinking to perform the given task	4
Independent	Child can do the task on his own	5

Domain wise percentage indicates the levels of the performance, their strength and weakness too. The report incorporates graphical representation mentioning the comparison with previous assessment done (if any). Figure 1 and Figure 2 illustrates the input screen and report graph screen of the application implementing BASIC-MR assessment tool respectively.

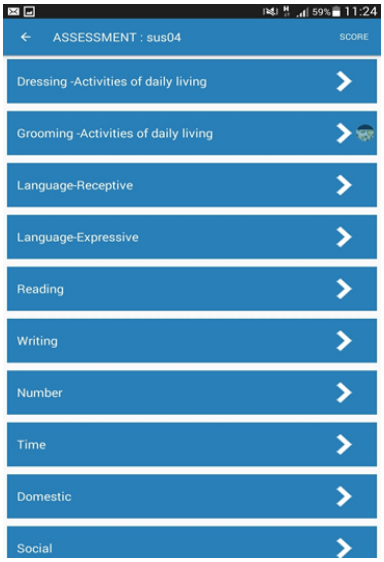

Fig. 1. Input Screen -BASIC-MR

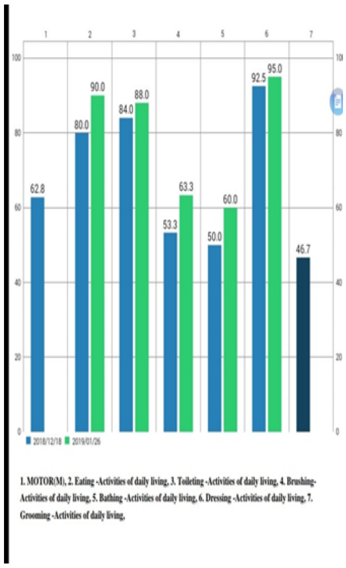

Fig. 2. Output Graph BASIC-MR

4 Experiments

We have undertaken 2 trials during the development of Autism Management tool app.

Trial 1: - About 20 children have been diagnosed by ISAA tool using the app. Also 10 students were assessed by Portage Guide, Basic MR (Part A), FACP (Pre-Primary) through the app. The qualitative feedback received lead to the design iterations.

Trial 2: - Trial was conducted at home of children. Trained parents of 16 children were involved in using ISAA app. Report generated by app (Figure 3 and Figure 4) is appreciated by parents as they were able to find out strength and weakness of their child in a systematic method.

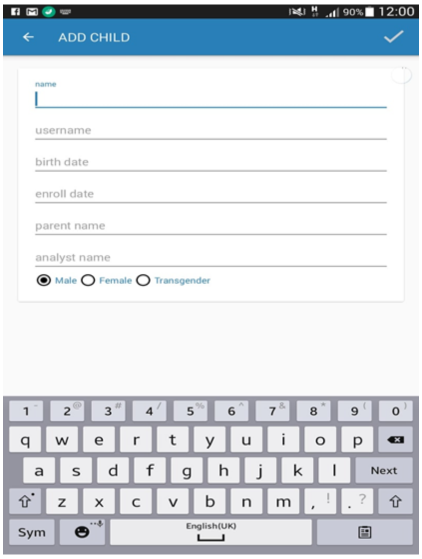

Fig. 3. Input Screen -ISAA app

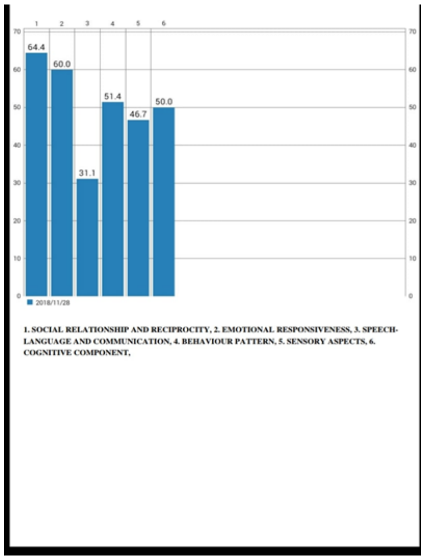

Fig. 4. Output Graph -ISAA app

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Digital Assessment Resources in Primary and Secondary School Classrooms

Teachers' Use and Perceptions

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Abstract—This short article reports on teachers' use and perception of digital assessment recourses in primary school classroom. A total of eighteen primary school teachers participated in the study where they were asked to experience of using Kahoot and ZipGrade as digital assessment resources. Self-reflection survey was distributed to the teacher participants to capture their attitude and perception about the two applications. Findings revealed that teachers were positive towards the application of two assessment technology in classroom practice. The findings highlighted some factors that encouraged teachers to use Kahoot! and ZipGrade as digital assessment tools including the creation of fun learning environment, practicality, automated scoring and direct feedback. Despite these benefits, two critical challenges were addressed by teachers when incorporating the digital application at school such as the school context as well as teachers.

Keywords—Digital assessment, assessment resources, teacher attitude and perception.

1 Introduction

The advancement of information and communication technology for teaching and learning has influenced the way teachers evaluate students' learning performance. Digital technology for educational assessment enhances assessment capabilities, offering teachers an opportunity "for improvement and diversification in the evaluation of learners, including addressing written communication skills, cooperation, teamwork, and reflective thinking" [1, p. 40]. Alderson [2] also argues that technology enables teachers to address the diversity of learners when undergoing classroom assessment. Moreover, assessment technological tools provide teachers with technical support to create tests, deliver students' responses to test items, allow automatic scoring and reporting [3].

This study aimed to explore teachers' perception of incorporating two digital applications for classroom assessment, Kahoot! and ZipGrade. Kahoot! is a free web and android based learning platform, a game-based student response system (GSRS) that combines the game-based learning approach and student response system or SRS [4], [5]. In the context of educational assessment, the combination of a game-based learning approach and SRS has enabled both teachers and students to engage with "game-like pre-made or impromptu quizzes, discussions and surveys" [6, p. 49]. Although many authors have perceived Kahoot! as an online learning platform such as Bicen and Kocakoyun [7], Dellos [6], Graham [8], Plump and LaRosa [4], Zarzycka-Piskorz [9], there is evidence of the incorporation of Kahoot! in classroom assessment practice in the literature, among others Ismail and Mohammad [10], Iwamoto, Hargis, Taitano and Vuong [11] and King [12].

Technically, Kahoot! is regarded as a simple and user-friendly application allowing instructors to use it at their ease [4]. In Kahoot!, teachers play their role as game show hosts and students act as players in a fun game show competing to earn points through answering various questions correctly [5]. Using the application, teachers are enabled to project the questions and alternative answers on a large screen, then students are asked to respond by clicking/pressing the colour and symbol of the correct answer on their own digital device, such as smartphone or tablet. Feedback of students' answers is displayed between questions. The students' score is evaluated not only through their correct answers but also by the amount of time they had spent to think of the possible answer and press the button in the applicaton.

The other application, ZipGrade, is a grading application that enables teachers to accelerate the grading process [13]. LeHew [14] suggests that as a digital application, ZipGrade helps teachers scan students' responses on ZipGrade generated answer sheets using their smartphone or tablet. As students' responses are appropriately scanned, ZipGrade automatically analyses the responses and imports the result into a digital grade book in the application [15]. Teachers then can obtain the scores with additional details, such as score distribution charts and statistical analysis for each test item.

Despite the benefits offered by the two digital applications as in the literature, our early observation prior to the study had revealed that only few Indonesian teachers in primary education have incorporated such applications to facilitate their classroom assessment. Lack of time, teachers' insufficient experience, or doubts regarding the scholarly advantages of such application use in the classroom may be contributing factors to teachers' reluctance to incorporate the applications in classroom practice [4].

2 Method

This current study aimed to explore teachers' perception of the incorporation of two digital applications for classroom assessment: Kahoot! and ZipGrade. To this end, a total of eighteen primary and secondary school teachers participated in the study and were asked about their experience of using Kahoot! and ZipGrade as digital assessment resources. Most participants were females (N=15), with few males (N=3) aged between 25 and 45 years old. Participants were designated by number to maintain anonymity (e.g. Teacher 12). Teacher participants were observed to have basic computer competence and internet browsing skills, allowing them to operate several Windows-based applications, such as Microsoft Word, Excel and Powerpoint. Teachers were also able to perform online activities such as email correspondence, uploading and downloading files to/from online databases and web browsing, activities which were believed to benefit teachers' online assessment using Kahoot! and ZipGrade.

2.1 Research procedure

Teacher participants were asked to take part in a one-day workshop on digital assessment methods for classroom practice held by the school. The workshop comprised two sessions, the first of which was a 90-minute seminar to provide teachers with knowledge regarding the nature of educational evaluation, classroom assessment and the role of technology to facilitate teachers' classroom assessment. The second session was a teacher workshop in which they were introduced to the two digital applications, Kahoot! and ZipGrade. Kahoot was introduced to facilitate online assessment in classroom practice, while the other application was aimed to help teachers with the scoring process in classroom settings. During the second session, teachers were given an opportunity to experience Kahoot! and ZipGrade with both teacher and student roles. After the workshop sessions, teachers were given three weeks to exercise digital assessment using Kahoot! and ZipGrade in classroom practice.

2.2 Data collecting method and analysis

Data were collected using observation and a self-evaluation survey. The researcher observed the workshop of eighteen participants where they practised using Kahoot! and ZipGrade to capture teachers' perceptions and attitudes towards the use of the applications for classroom assessment. In addition to observation, teacher participants were asked to complete a self-evaluation survey after three weeks of using the digital assessment tools in the classroom. Specifically, teachers were asked to respond to three questions:

- What do you think of Kahoot! and ZipGrade as digital assessment resources in the classroom?
- What benefits do you obtain when using Kahoot! and ZipGrade for classroom assessment?
- What challenges do you encounter when using the two digital assessment tools?

The collected data then were analysed qualitatively.

3 Findings and Discussion

Findings from both observation and self-evaluation survey revealed that teachers were positive towards the incorporation of technology for classroom assessment. Furthermore, teachers thought that Kahoot! and ZipGrade were of benefit to their classroom assessment practices as evidenced by Teacher 2 comment in the survey, "Kahoot! would be beneficial for the daily exams and it promoted the use of gadget for students' learning". Teachers considered that these digital assessment tools helped to create a fun learning environment, were practical, and they thought that the automated scoring and direct feedback were positive factors encouraging their application. Teacher 4 said that students were excited to perform tests with Kahoot! She suggested, "children were conditioned as they were playing a fun game instead of learning". Furthermore, Teacher 1 and 2 mentioned the practicality aspects of the applications. Kahoot! and ZipGrade were considered easy to use, with icon menus and functions helpful in guiding navigation of the application.

In addition, teachers affirmed that they allowed automatic scoring, providing students with direct feedback, which benefited teachers by speeding up their scoring, particularly for those teaching parallel classes at school (Teacher 1). Teacher 2 also commented that "ZipGrade application would help [her] in correcting students' exam". Such benefits have also been reported in Llamas-Nistal et al. [3].

Despite teachers' positive perception of assessment technology, the findings revealed several challenges that teachers encountered when using Kahoot! and ZipGrade, such as school infrastructure, school policy, assessment types, teachers' lack of knowledge and inappropriate scanning results. Some teachers felt that internet access was not reliable to support the use of Kahoot! and ZipGrade for classroom assessment. Teacher 3 affirmed that she was not using the two assessment tools frequently due to unreliable internet connection. She said that the poor internet connection had resulted errors in Kahoot!, thus had prevented her from using the application.

In addition, teachers mentioned that the incorporation of Kahoot! and ZipGrade in classroom assessment practice was restricted by school policy on smartphones. For many schools in Indonesia, the policy regarding whether smartphones are allowed to be used in the classroom varied and there has been dispute among teachers themselves. In the current study, teachers said that the school administration had restricted students bringing smartphones to school, so teachers did not use Kahoot! particularly in the primary school classroom setting. Teacher 1 wrote in her reflection:

"I felt that Kahoot! benefited me in 'ice breaking' session. Using Kahoot was fun and students enjoyed it. But, it was rather difficult to use Kahoot! so frequent. [it was because] students were restricted to bring smartphone to school. I had to obtain administrator's permission [if I want] to use Kahoot!"

Other challenges relevant to school policy concerned the answer sheet format. As discussed earlier, the ZipGrade application generated a formatted answer sheet to allow the application to scan students' responses [13]. Unfortunately, the school administration had assigned teachers to use pre-prepared school answer sheets. Teacher 2 emphasised that "we have not yet agreed on the model for school answer sheet and whether or now we can use Kahoot! model of answer sheet".

Teachers' reluctance to use Kahoot! was also driven by teachers' lack of knowledge related to the application. For instance, Teacher 14 mentioned her ignorance of using Arabic in Kahoot! had prevented her from not using the application for classroom assessment. However, according to the Kahoot! website, this application allows multiple languages (see Figure 1).

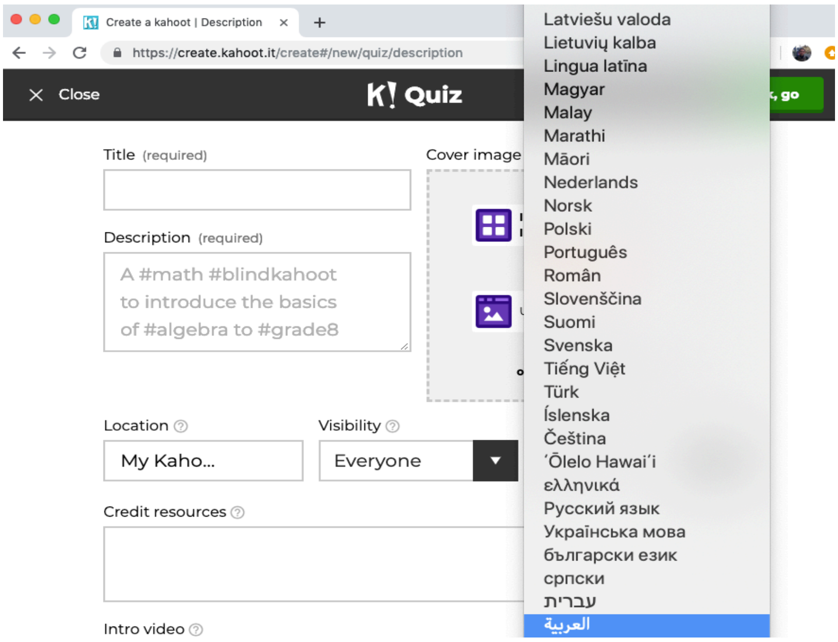

Fig. 1. Language support in Kahoot! (Image source: https://create.kahoot.it/create#/new/quiz/description)

In addition, teachers encountered inappropriate scanning results in ZipGrade! Four teachers reported that ZipGrade did not appropriately scan students' answers, resulting in some test items not being correctly scored. Teacher 6, for example, reported that she found some items were not scanned by ZipGrade: "when I did manual scoring, students' score was different from in ZipGrade's grade book". A similar situation was experienced by Teacher 16, assuming that "I was thinking if pauses in the scanning process may affect the ability of ZipGrade in producing correct scan". This is a critical issue for the ZipGrade developer to address in their further version development.

The challenges that teachers have experienced during the incorporation of assessment technology were interesting, though not surprising. Discussion on teachers' challenges in incorporating information and communication technology abound in the literature [16]–[19]. A literature review by Groff and Mauza [17] summarised several factors that affect the incorporation of technology in classroom contexts, two of which include school context and teacher factor. As the current study found, the school context, such as school culture, lack of support and resources, discouraged teachers from integrating technology in classroom instruction practice. Teachers also reflected that they had insufficient knowledge and competence to use technology, with school administrators not responding to such a situation, neglecting to provide teachers with technological support and responses. Moreover, teachers felt they were restricted to obtain equitable access to classroom technology or other school resources. Without full support from school administrators, teachers will achieve little success in incorporating classroom technology in their instructional practices [17], [19], [20].

4 Conclusion

The current study evaluated teachers' perceptions of the incorporation of two digital applications for classroom assessment: Kahoot! and ZipGrade, finding that teachers had a positive attitude and perception of the use of Kahoot! and ZipGrade in classroom practice. Teachers perceived that these applications benefited them in the creation of a fun and enjoyable learning environment, enabling automatic scoring and direct feedback. Nonetheless, the issue of the school culture related to the use of smartphones in the classroom as well as little technological support and resources needs to be addressed for successful implementation of such applications, as these issues may constrain teachers from achieving the success in the use of technology for assessment activity in the classroom context.

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