M-Learning in Promoting Green Building Awareness in Palestine

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Abstract. Most Palestinians have yet to have the urge to participate in green building practices. To enhance green building education in Palestine, we built a mobile application named "Let's Go Green" to deliver awareness and incorporate green building technologies. In order to validate the mobile learning (m-learning) effect, we have conducted separate measurements by using ARCS motivation model and paper-based quiz among 80 engineering and architecture students in Hebron, Palestine. The students were split into two groups; group A (experimental; applied m-learning method) and group B (control; adopted conventional lecture note method). This study has three important findings (1) m-learning users found to have stronger learning motivation than those who used the conventional lecture note; (2) m-learning users generally exhibited better learning effectiveness than non-users; (3) the m-learning was found to be attractive to the students, implying that it can be an important content for educational and leisure for green building education. The findings demonstrated that the Let's Go Green Application is an effective instructional material to improve students’ knowledge on green building. This application can be downloaded for both smartphones; Android, and iPhone. These functions have not been implemented yet, therefore this is the first attempt of such an approach.

1. Introduction

Globally, policymakers aim at reducing greenhouse gas emissions and propagating resource-intensive steps to meet their sustainability goals [1]. Focus has risen steadily toward ‘sustainability’ or “go green” and energy efficiency rating schemes in the building construction sector. As the construction sector contributing to natural resources and energy depletion, generated significant waste with considerable amounts of toxic air emissions [2], it faces urgent pressure as regards environmental management and sustainability in many countries [3]. The industry aims at complying with a new trend of shifting from conventional practice into sustainable building practice also known as a green building. This practice requires a thorough move-in decision-making throughout the entire life cycle of a building which includes its design, construction, operation, and disposal [4]. Green building is designed to preserved natural resources while at the same time reducing the impact of buildings on human health and the environment [5].

In 1990, the UK Building Research Establishment established the very first green building assessment system, known as Building Research Establishment Environmental Assessment Method (BREEAM) [6]. BREEAM was originally used for assessing newly built office buildings but was subsequently extended to different building types to assist designers in their preliminary planning and
design phases [7]. After BREEAM’s development, an increasing number of other countries have developed their own green building assessment systems, such as the Leadership in Energy and Environmental Design (LEED) assessment method, which is developed by the U.S. Green Building Council and Canada’s GB Tool System [8]. At present, 26 green building assessment systems have been developed and implemented worldwide [9]. These assessment systems are focused on the building or construction’s life cycle covering the programming, design, construction, and operation stages. Furthermore, they contain the element of energy and water efficiency, materials and resources, and indoor environmental quality [1].

Despite the global trend towards sustainable buildings, it is undeniable that there is a dearth of green building awareness. Studies have shown that people are unwilling to accept the green building concept commonly due to a lack of understanding of the benefits [10]. This raised concern about green building, when there was a common perception that green building construction costs are rather high, as the environmentally friendly and energy-efficient equipment and facilities are pricier than conventional materials [11].

As it was relatively difficult to create awareness in other developing countries, it can be harder for Palestine, a state with acute political instability and regional tension with Israel. The occupied Palestinian territories of the West Bank and Gaza Strip are facing great obstacles in the provision of infrastructure services for their inhabitants [12]. This has profound repercussions across all sectors, which include energy as well as the local economy. The current political situation has made it extremely impossible to control resources, especially energy and water. Due to their dire situation, it is not a surprise that most Palestinians built their homes without recourse to an engineer, which intensifies random construction, as the people treat the building not as a living space, but, as a facility, without giving special attention to thermal comfort, good ventilation and natural lighting [13].

Owing to this bitter reality, the concept of sustainability or green buildings is a strategy where the people can achieve efficiency with scarcity [12] as a radical solution to the situation in Palestine in general. There are serious attempts by the government of Palestine in introducing the green building concept to the people. The Ministry of Education is working on improving the school buildings and complying with the high-efficiency green design standards by applying certain aspects, observing mandatory requirements that can be applied within the possibilities of their tight financial [13]. The researchers believe that targeting the entire Palestinian society in spreading green awareness is through a platform that is portable and individual-oriented, mobile phone.

1.1. Overview of mobile learning (m-learning)

Mobile phones, formerly a conventional device used only for wireless voice communication, have now begun to become mobile computing. This has been achieved through value-added services such as the Short Messaging System (SMS), the Multimedia Messaging System (MMS), the Wireless Application Protocol (WAP), the Global Positioning System (GPS), the General Packet Radio Service (GPRS), photo capture and transfer, voice mail, voice over Internet Protocol (VoIP), video conferencing, electronic mail, music download, and 3G. They have all become part of the concept of mobile telephony [14].

Today, mobile is a multilateral platform that supports two-thirds of the global population, delivers connectivity and infrastructure that drives new digital economies, and addresses socio-economic challenges. Globally, mobile phone subscriptions stood at 7.676 billion by 2019 at a penetration rate of 66.9%, with 414 million subscriptions in the Middle East and North Africa [15]. By 2022, 90% of all mobile subscriptions are projected for internet-enabled "smartphones,” which already constitute the majority of them. [15][16]. Recent research identifies a spectrum of avenues across mobile phones which smartphones in particular, may contribute to the fortunes of deprived communities. Mobile phones are seen as instruments that can be used to utilize digital resources [16][17] strengthen and grow personal networks [16][18][19], and improve coordination and mobility in daily life [20][21]. Researchers believe it is reasonable to utilize these devices and their users to acquire and provide data and services.
to help achieve sustainability objectives. This study presents the development and testing of a green building application which enables the users to understand the concept of green building practice by providing data on the Palestinian green building background, global case studies, green building materials, and material purpose.

The inevitable mobile phone technology facilitates the provision of micro-learning apps, enabling users to access worldwide information everywhere [22] conveniently, across borders of subject, discipline, and organization [23]. Due to its huge potential for scalability, the applications that have even a minor effect on resource utilization or greenhouse gas emissions will have a greater impact than any organizational sustainability campaign could deliver [24]. This technology has steadily drawn interest from educators, academics, and businesses designing learning programs and publishing educational materials. It offers the opportunities for collaborative interaction and learning opportunities for geographically dispersed individuals and groups [25]. Even though at present used in small-scale ventures, mobile learning can be useful in more educational settings.

Mobile learning technology enables learners to learn in any context, independent of the time and place. M-learning can be described as a service that provides the learner with general information or educational content electronically [26] which is derived from e-learning activities [27]. Some scholars identified m-learning as a natural product of the evolution of e-learning [28], however, more recent definitions position m-learning as a method that intersects mobile computing and e-learning [29][20], using mobile technology to achieve omnipresent learning anytime, anywhere [31] and that emphasizes learners’ mobility and personalized learning [32].

Mobile learning technologies have a promising future if they are properly integrated into the current system, or if the system is subject to critical technology change. Integrating m-learning requires a sensitive pedagogical design to benefit students. A learner with required skills and strategies can benefit from the applications voluminously and share content and resources in a self-determined manner [33][34].

1.2. ARCS motivation model and instructional materials motivation survey

Students in the conventional lecture-based teaching model often lack independent thinking ability and learning motivation compared to systems that encourage more independent thinking and interaction [35][36]. Motivation is often seen as the key to either learning success or learning failure in educational psychology [37]. Motivation to learn is inseparable from efficiency in learning: greater motivation improves learning outcomes and encourages the learner to strive and learn more [38]. The IMMS survey instrument is an integral part of the ARCS model designed by Keller [38][39][40][41][42]. The IMMS tool is used to measure the motivation of students. According to Keller [39], four components affect motivation in the learning process: attention, relevance, confidence, and satisfaction (ARCS). All components contribute to motivation throughout the learning process [33][39][42][43]. To motivate students, four instructional design principles should be met [43].

Principle 1. Attention. A variety of strategies or tactics should be involved to gain and sustain the attention of learners.

Principle 2. Relevance. Clear objectives should be established and the content of instruction should be relevant to the experiences of learners, academic requirements, or work.

Principle 3. Confidence. The learning environment should help learners develop a positive attitude and expectancy towards success.

Principle 4. Satisfaction. Help the learners to achieve a sense of satisfaction. Keller states students' overall satisfaction is reinforced if the first three principles are met [43][44]. Learning is satisfactory when learners can implement the knowledge they have learned for practical purposes (in this case, environmental protection through green building) which ultimately gives them a sense of satisfaction.

The motivational model of ARCS could provide deliberate instructional criteria to ensure that course design and training material reflect the attributes of learners and meet their needs [45]. Supporting the progress of Keller's ARCS motivation model, the IMMS survey was designed to assess whether the
training material complies with the above principles and examines student motivation levels. This study uses both the ARCS motivation model and the Keller-modified IMMS to develop mobile application based instructional materials and evaluate whether they effectively convey the knowledge, elevate motivation and inspire people to learn about green building.

2. Methodology
A survey was conducted among 80 students majoring in architecture/engineering at higher technical schools/colleges (average age of 18 years old) in Palestine, divided into two groups (A and B). In group A, (the experimental group), was asked to download the ‘Let’s Go Green’ App and spent 30 minutes learning about green buildings using the mobile application. While group B (the control group), students were given conventional lecture-note with the same content of the mobile application and spent 30 minutes with the material. These participants are students that yet exposed to the topic of green buildings practices. Following the completion of the learning activity, the students from both groups will be required to complete a quiz of 20 multiple choice questions on green building within 30 minutes then they were required to complete the survey on their learning experience as well. Since the size of the respondents was large, an Internet-based method was used. There were two categories i.e. (i) background and, (ii) attractiveness of learning material and learning effect using the system. The first category was designed to get the demographic of the participants. In the second category, to gain information on their experience with the m-learning/conventional method. The IMMS for this study used 19 questions answered on a five-point Likert-type scale to measure the motivational reactions of learners (1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly agree) on instruction materials.

2.1. Development and design of the mobile application
The ‘Let’s Go Green’ mobile application presented in this research shares information on green buildings. This application was developed through ‘dart’ programming language which workable for any platform. It was divided into three topics/categories: ‘About Green Building’, ‘Palestine and Green Building’ and ‘Case Studies’. ‘About GB’ explains the brief concept of green buildings, while “Palestine and GB” describe the geographical distribution of Palestine and strategies to promote green buildings in Palestine. “Case studies” and where the application shares the outstanding of green buildings projects from other developing and developed countries. Figure 1 presents the steps of the mobile application, which is as follows:

1. Starting action: The user clicks on the mobile application on the Springboard icon to launch the app. As the application launches, a splash screen of the green building logo appears.
2. Dealing with the menu: Users are given a list of green buildings topic through three options: About GB, Palestine and GB, and Case Studies.
3. Routine actions: Users will get access to information on each option provided. When the user clicked on About GB, a brief explanation on GB will be displayed and so for all other three options.
4. Ending action: As the user is done browsing through all the options given, it is considered as the user has completed the course.
Figure 1. Flow diagram on for ‘Let’s Go Green’.

Figure 2. Let’s Go Green Application Image

3. Result
Between September and October 2020, 80 of the 100 students (a response rate of 80%) completed the IMMS. Forty-seven of the 80 (58.75%) were women, and 54 (67.5%) have a computer and internet access at home, 74 (92.5%) own a mobile phone device with internet access, and 50 (62.5%) access the internet from their phone several times a day. This shown mobile phones and the internet have become an essential item for the local society and the scalability of this device can bring about a change in spreading knowledge and information on green building practices.
A reliability analysis of the perceived task values of 19 items was performed. The Cronbach’s alpha presented the questionnaire to reach acceptable reliability, where the experimental group has $\alpha = 0.805$ while the control group $\alpha = 0.708$. All items appeared to be worthy of retention, resulting in a decrease in the alpha if deleted. All of the students in group A (experimental) and B (control) returned instructional material motivation surveys; the survey items and students’ results are shown in Table 1. For the experimental group (which used the mobile application), relevance items scored the highest among the ARCS ($M = 4.2$), followed by attention ($M = 4.075$), indicating that the learners believed that the ‘Let’s Go Green’ application capable of stimulating learners’ attention and interest concerning green building issues. The results for the confidence items ($M = 4.025$) show the importance of clear explanation and users were confident that useful knowledge related to green construction was learned, and that the efficacy of learning could be improved with repeated use of the app. The results for the satisfaction items ($M = 4.02$) indicating that the learners were satisfied with the mobile application as a method of green building instruction. For all four categories and most items, the average scores in the experimental group are 4 or greater, significantly higher than the those in the control group who underwent conventional lecture notes/material. The result indicated that students were strongly motivated to use this app to learn about green building [46].

Table 1. IMMS result

| ARCS Category | Questionnaire items | Mean (Grou p A) | St. Dev. (Grou p A) | Mean (Grou p B) | St. Dev. (Grou p B) |
|---------------|---------------------|----------------|--------------------|----------------|--------------------|
| Attention     | The material can draw my attention and interest from the beginning. | 4.1750 | .63599 | 3.5750 | .64847 |
|               | The content is capable of drawing people’s attention. | 4.0000 | .66216 | 3.4750 | .52563 |
|               | The material content can successfully draw my attention. | 3.8500 | .74421 | 3.5000 | .63851 |
|               | From the material, I can discover interesting and unexpected results. | 3.9750 | .83166 | 3.8250 | .61966 |
|               | The different experiences and learning I gained from the material held my attention. | 4.1750 | .74722 | 3.7500 | .59861 |
|               | Many parts of the material found to be interesting to me. | 3.7500 | .91111 | 3.2750 | .61550 |
|               | Average Attention | 4.0750 | - | 3.6333 | - |
| Relevance     | I comprehend the material content. | 4.0500 | .71432 | 3.6250 | .61550 |
|               | I realised its educational importance after studying the material. | 4.1250 | .91111 | 3.9750 | .54302 |
|               | The material content is very practical for me. | 4.2750 | .75064 | 3.9750 | .46340 |
|               | The content and design of the material triggered my interest to understand it. | 4.3500 | .69982 | 3.8750 | .47972 |
|               | Average Relevance | 4.2000 | - | 3.8125 | - |
| Confidence    | I have confidence that I can find ways to acquire green building knowledge through the material. | 4.0000 | .59914 | 3.8750 | .53349 |
|               | I have confidence that I can learn a lot of useful knowledge from the material. | 4.1750 | .84391 | 3.9750 | .54302 |
|               | I consider many of the contents in the material to be straightforward for me. | 4.0500 | .78283 | 3.8750 | .78283 |
3.1. Validation of the Learning Effect

The 30-minute green building quiz was used as a learning effect validation tool (full score = 100). The scores ranged from 50 to 85 among the 80 quizzes distributed and returned, with a median score of 69.75 for group B and 80.75 for group A. One sample t-test was run on two groups, it was discovered that the p-value was smaller than 0.0001 and it is significantly smaller than 0.05, indicating that the learning effectiveness for students in the mobile-based learning group was significantly higher than for students in the conventional learning group. This result is consistent with the theory proposed by Keller [44] that the use of mobile applications in education can improve students’ motivation and learning. The findings demonstrated that the Let's Go Green Application is an effective instructional material to improve students’ knowledge on green building.

4. Conclusion

Rapid environmental change and urbanization have become an issue of great concern, hence, many national governments are focusing on designing customs-compliant green building assessment systems. Promoting green building, however, confronted many obstacles, for instance a lack of interest in greener building practices, owing to a widespread ignorance of its benefits. Since awareness-raising in other developing countries has been relatively difficult, it can be more difficult for Palestine, a state with acute political instability and regional tension with Israel where, managing resources like water and energy is awfully impossible, and therefore, green building practices shall be the answer to achieve efficiency with scarcity. Considering the identified advantages of m-learning in education, a mobile application, “Let’s Go Green” has been developed and tested so that users are inspired to learn on how to improve the ecological friendliness of buildings in any environment setting.

In this study, the effectiveness of green building education was assessed through an ARCS motivation test and a quiz on green building. The results showed that in the m-learning process, there were strong learning motivations for experimental subjects, implying that the app was practical and attractive as well as stimulating users' attention and interest, and also helping them gain useful knowledge about green building, resulting in a high degree of satisfaction. The quiz results indicated that the experimental group learned significantly more than the control group, implying mobile-based learning was more effective than conventional learning for the same material. These findings can encourage development in the future of innovative teaching models and educational material. Although the study here shows that m-learning is a valid and potentially successful teaching model, there are a number of constraints and issues that need to be address such as continual improvements in mobile learning to reach the optimal potential considering the content and graphics for leisure purposes are required. For example, some users have suggested, the app must offer more interactive mechanisms,
such as a 360° 3D panorama of green buildings. Notably, the aim of this paper is not to challenge nor undermine the effectiveness of traditional teaching methods or other techniques in the repertoire of teachers. Much rather this study suggests that m-learning should be seen as an effective teaching aid to enhance the teaching practice, curriculum development, and the educational field as a whole. With the increasing ubiquity of consumer electronics, m-learning delivered via smartphone is yet another promising means of delivering knowledge, including green building education. Thus, green building concepts could be popularized faster and more conveniently.

5. References
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Acknowledgments
We would like to express gratitude to the students in Hebron for their willingness to participate in this survey and their school’s administration and teachers for allowing the survey to be conducted out. This project is financially supported by UKM research University grant TAP-K015598.