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The role of memory stores in mobile-based English learning environment: A case study of Iranian learners

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Abstract

Multimedia learning such as mobile-based English learning occurs when learners employ their minds to represent words and images for instance texts and illustrations or animations and short stories. Thus, the appropriate use of materials and tools in teaching and learning is definitely helpful in building the process more meaningful. This study concentrates on how sensory memory, working memory, and long-term memory help Iranian EFL junior learners learn English in multimedia mobile-based learning environment and what are their attitudes and perceptions towards mobile-learning considering memory stores. A mixed-methodology single-case study research design (quantitative and qualitative) including a questionnaire and semi-structured interview is used. A group of 96 junior university learners from a population of 110 were randomly selected from a university in Esfahan, Iran. They are native speakers of Persian aged between 19 and 26. Based on the scores obtained from the Oxford Placement Test, they are placed in intermediate level. The findings of the descriptive analysis of the learners' psychological m-learning readiness indicated that Iranian learners are highly familiar with computing skills and they believe that English learning is an active process of selecting relevant information from what is shown and presented, organizing selected information into a coherent representation, and integrating learned information with their prior knowledge. Moreover, analysis from the qualitative data also supported the role of three memory stores. Thus, cognitive theory of multimedia mobile-based English learning environment suggests the idea that learners' brain presents words and pictures that are selected and organized dynamically to produce logical mental constructs. Therefore, all learners should be aware of their information processing stages.

Keywords: mobile-based learning; environment; sensory memory; cognitive model; working memory; long-term memory

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1. Introduction

Nowadays, new technologies change the way of learning in the classroom particularly in Iranian EFL learners' classrooms. Learners have enough opportunities to discover and explore the world and achieve a large amount of information along the way. New technologies can produce new approach of teaching and open new ways of learning (Thang Siew Ming, Najihah Mahmud, & Norizan Abd Razak, 2012). The rapid growth of naïve generation of mobile devices such as mobile phones, tablets as well as progression in wireless technology has made learning more interesting and motivating in multimedia mobile-based learning environment (Supyan Hussin, Mohd Radzi Manap, Zaini Amir & Pramela Krish, 2012; Gabarre, Gabarre, Rosseni Din, Mohd Shah, & Abdul Karim, 2013). According to Wagner (2005: p.45), ‘‘the value of deploying mobile technologies in the service of learning and teaching seems to be both self-evident and unavoidable’’.

In Iran, mobile learning is being explored by many individual educators and researchers. However, the concept of mobile education is still coming into view and still unclear (Traxler, 2007; Supyan Hussin, Mohd Radzi Manap, Zaini Amir & Pramela Krish, 2012). Also, Kukulska-Hulmefv & Traxler, (2007) believes that mobile learning is a fertile ground for innovation, but it is essential to understand that the success of mobile learning will depend on human factors in how to use the new mobile and wireless technologies.

In addition, Cognitive Theory of Multimedia Learning (Mayer, 2001) and Cognitive Load Theory (Sweller, 1999) provide a useful framework to explain the cognitive processing during learning via mobile which is considered as one of the multimedia learning tools. The core issue in this theoretical framework is how to contribute learners to learn a second/foreign language. According to Cognitive Theory of Multimedia Learning (CTML), instruction works well by applying appropriate and suitable cognitive processing in the learners during learning. For instance, they can be guided to choose relevant materials, organize the materials into a coherent cognitive representation, and integrate the representation with other relevant knowledge (Mayer, 2003; Mayer, 2005; Rouhi & Mohebbi, 2013).

Based on this approach, it is essential to persuade and encourage learners to involve in appropriate cognitive processing during second/foreign language learning. Thus, multimedia designers should follow three important elements in the second/foreign language learning materials: First, help learners decrease extraneous processing (cognitive processing that does not support the instructional goal and is attributable to confusing instructional design); second, contribute learners to manage essential processing (cognitive processing needed to mentally show the incoming material and that is attributable to the complexity of the material); and third, help learners to promote generative processing (cognitive processing aimed at making sense of the incoming material including organizing it and integrating it with prior knowledge) (Sweller, 1999; Mayer, 2005). To this end, cognitive model of multimedia learning shows the human information-processing system. That is, learners acquire information via memory stores which include sensory memory, working memory, and long-term memory. Pictures and words come in from the outside world as a multimedia presentation and enter sensory memory through the eyes and ears.

Sensory memory permits for pictures and printed text to be held as exact visual images for a very brief time period in a visual sensory memory and for spoken words and other sounds to be held as exact auditory images for a very brief time period in an auditory sensory memory. In other words, revealing unique information in both visual/pictorial and auditory/verbal formats lets learners use both information processing channels simultaneously and enables them to build integrated mental models that make the retrieval of the information more likely (Paivio, 1986; Plass, Chun, Mayer, & Leutner, 1998). Then, the central work of multimedia learning

occurs in working memory as Figure 1 indicates.

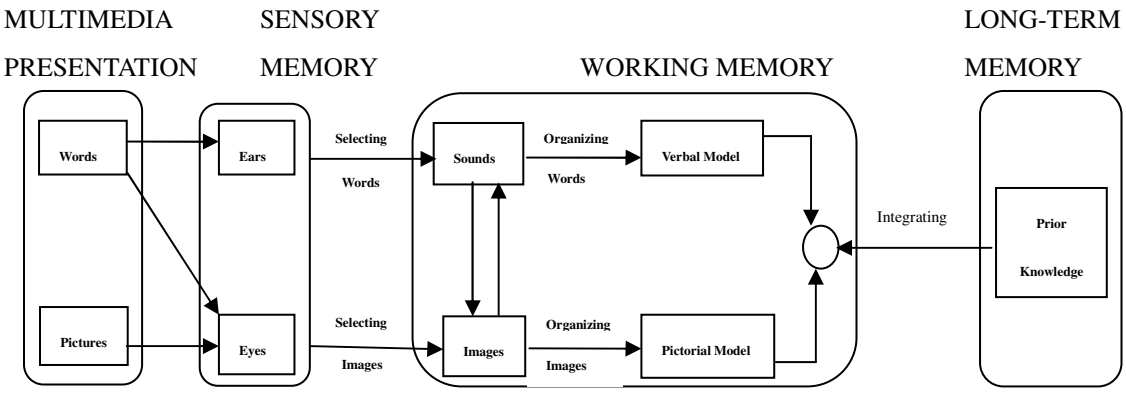

Figure 1. Cognitive Theory of Multimedia Learning Adapted from Mayer (2005)

According to Mayer (2005), working memory is utilized for keeping and manipulating knowledge in active consciousness. Therefore, the major cognitive processing needed for multimedia learning in general and mobile learning in particular which is observed in the Figure 1 and shown by the arrows labeled *selecting images, selecting words, organizing images, organizing words,* and *integrating*. Moreover, the long-term memory (LTM) which is considered as the third component of the human beings' cognitive system is described as a complex and fixed storehouse for learners' knowledge about the world and their experiences in it (Baddeley, 1986; Moore, Burton, & Myers, 1996; Schank, & Abelson, 1995).

Long-term memory holds a great amount of knowledge over long periods of time and stores information that is processed by working memory in the form of schemas. Hence, learners are usually engaged in learning by using their sensory channels (visual and auditory) within their working memories to make new schemas in their long term memories. Based on this framework, learners can concentrate only on a small amount of auditory/verbal and visual/pictorial presentation at once, and only a small portion of that information can be processed in working memory (Baddeley, 1992). Therefore, in presenting the second/foreign language learning content in auditory and pictorial formats via mobile, cognitive researchers argue that multi-media materials need high levels of cognitive processing to synthesize the visual and auditory streams of information and to extract the semantics of the message (Homer, Plass, & Blake, 2008).

According to Mayer (2011), learning depends on the efficiency of the learners' cognitive system. The cognitive demand enhances when learners are beginners in the knowledge domain and lack appropriate prior knowledge to guide their attention (Moreno, 2004; Sweller, 1999). The simultaneous processing of auditory and visual information place higher demand on learner's cognitive system, which may exhaust the limited cognitive resources available for processing the pertinent materials of the lesson (Chandler & Sweller, 1991). As a result, in order to have a meaningful learning in a multimedia mobile-based learning environment, the learner needs to be involved in all five cognitive processes including selecting words, selecting images, organizing words, organizing images and integrating (Mayer, 2001; 2005).

Many research studies showed that the use of technology leads to deep, better and more practical learning particularly in the light of second/foreign language learning. To this end, since many research studies were conducted in multimedia computer and mobile based learning environment without considering the role of memory stores in mobile-based English learning environment, the present study aims to find out the role of memory stores in mobile-based English learning environment. In other words, the purpose of the present study is to explore how sensory memory (Iconic Memory and Echoic Memory), working memory, and long-term memory can help Iranian EFL learners learn English through mobile phones. In other words, how mobile phones can contribute Iranian EFL learners to learn English? And what are Iranian EFL learners' attitudes and perceptions towards mobile-learning considering memory stores?

2. The study

2.1 Participants

This study is based on a mixed-methodology single-case study research design (quantitative and qualitative) using questionnaire and semi-structured interviews. The use of two instruments was taken into mind to conduct a methodological triangulation of the data. A single-case study research design permits and lets information about particular individuals in a group at the micro level as well as the whole population at a macro level be gathered (Berg, 2001). The participants were 96 Iranian EFL male (48%) and female (52%) junior university learners studying Teaching English as a Foreign Language (TEFL) at a university in the west of Esfahan, Iran. A group of ten male (5%) and female (5%) junior university learners (L1, L2, L3, L4, L5, L6, L7, L8, L9, and L10) out of these 96 learners were purposively chosen for the semi-structured interview. All participants were native speakers of Farsi/Persian aged between 19 and 26 and majoring in English Language Teaching. Based on their scores obtained from Oxford Placement Test (OPT) developed by Oxford University Press (Allan, 1992), they were all in intermediate level. By utilizing the criteria adapted from the OPT, their scores were between seventy and ninety-two (L1=74, L2=78, L3=82, L4=85, L5=88, and L6=89, L7=83, L8= 77, L9=79 and L10=92). These junior learners were selected because they were more competent in English language mobile-learning to make sure that they would be able to overcome the difficulties they face in mobile learning. The data were collected via a questionnaire and semi-structured interviews.

2.2 Instruments

The first instrument employed in this study was the Oxford Placement Test (Allan, 1992) to identify the learners' English proficiency levels. The second was the questionnaire uploaded at https://spreadsheets1.google.com/embeddedform?formkey=dEtjWFgyQUVwa240Q0ZmVnNRaG1EWmc6MQ which had already been employed by Supyan Hussin, Mohd Radzi Manap, Zaini Amir and Pramela Krish (2012) in their research study. The questionnaire included four sections (Section A: background information; Section B: hand phone facilities; Section C: internet access; and Section D: mobile learning). However, for this study only section D (mobile learning (21 items) was employed. A five-point Likert-Scale that ranges from one (Strongly Disagree) to five (Strongly Agree) was used to indicate the learners' attitudes and perceptions towards mobile-learning considering memory stores. Also, a semi-structured interview was employed to obtain an in-depth understanding that is best communicated through detailed examples and rich narratives used by learners (Rubin & Rubin, 2005).

The semi-structured interview protocol contained questions constructed based on the memory stores in multimedia learning. For instance, the interview questions were structured around prepared questions such as: *How do you attempt to use your mobile phone? How can your memory sensory (visual and auditory) help you learn English through your mobile phones? Can picture and photos help you learn English better? If yes, how?* In other words, the semi-structured interview was conducted to obtain insights into how Iranian EFL junior university learners learn English via mobile phones by using their memory stores (sensory memory, working memory and long-term memory)?

As Creswell (2002) believes, for the qualitative data, the small number of participants (n) is chosen because the aim is to learn or comprehend the central phenomenon. The number of people selected for a qualitative data varies from one study to another because the overall ability of the researcher is to provide an in-depth picture that decreases with the addition of each new person and that a total of twenty samples for interview in maximum can be representative of an idea.

The semi-structured interviews lasted about thirty to fifty minutes on average for each interviewee. The learners were also allowed to use their first language (Farsi) to enable them to clearly explain their attitudes and perceptions towards mobile-learning considering memory stores. The learners were also asked for their opinions,

attitudes and perceptions towards mobile-learning considering memory stores. All the interviews were tape-recorded in order for the researcher not to lose the learners' words. After collecting the data from the semi-structured interviews, the data was transcribed by the researcher. Then, the semi-structured interview data was analyzed by using an open-coding process to identify the themes. The relevant themes were sensory memory (iconic memory and echoic memory), working memory, and long-term memory.

After that the axial-coding in which the subthemes were refined and developed was employed (Strauss & Corbin, 1998) in order to organize and categorize them as themes and make them look more abstract. This was done by looking again at the interviewees' transcripts' replies personally based on the interview questions and answers. The subthemes connected and linked to one another based on the similarity in implications, they were put together under one category and coded. For instance, when learners talking about paying attention to the selected words that are shown in the mobile phone as they pass through their ears which had already been identified in the open-coding as subthemes coded as auditory channel. This was termed or coded as "Sensory Memory (Echoic Memory)".

All the verbatim transcriptions were read and re-read line by line separately in order that the researchers can identify the attitudes and perceptions of the learners towards mobile-learning considering memory stores. The three memory stores (sensory memory (iconic memory and echoic memory), working memory, and long-term memory) were employed to gauge the use of each of the three broad stages of multimedia mobile-based learning environment. Through the findings, the aim of this study was to identify the role and effectiveness of the memory stores in multimedia mobile-based learning environment. To maintain rigor in the methodology, the researcher used the inter-rater degree of agreement to examine the reliability of the data. Three experts in English Language Teaching field independently compared the coding schemes developed by the researchers (sensory memory (iconic memory and echoic memory), working memory, and long-term memory). The experts were given the definition of the themes used in this study. Regarding the units of analysis from the data, the Cohen's Kappa formula (Cohen, 1960) was used to calculate the reliability (K) value by averaging the three values determined by three experts. The process produced a high K-value (0.89).

3. Findings and Discussions

3.1 Descriptive Analysis of the Learners' Perceptions of Mobile-Learning Readiness

In order to discover the perception of the basic understanding of mobile-learning considering memory stores, descriptive statistics (means, standard deviations, and frequencies) of the psychological mobile-learning readiness questionnaire was computed (see Table 1). Table 1 shows that among the 96 intermediate junior university learners, 90% of them agreed with the item *"*I am afraid I will spend more money on my hand-phone bill because of mobile learning" with the highest average mean value of 4.29 and a standard deviation of 0.84. The item *"*I will upgrade my hand-phone if mobile learning is going to be implemented in my course*"* scored the next highest mean value of 4.20 and a standard deviation of 1.00 by 88% of the learners, followed by the item *"*I would like my lecturer to integrate mobile learning in my class in addition to face-to-face meetings in the class*"* (Mean=4.14; SD=1.05; F=85%). Then, the highest mean value of 4.04 and a standard deviation of 1.15 were noted for the item *"*Mobile learning is an alternative to conventional learning*"* by 79% of the learners. This was followed by the item *"*I don't mind paying extra money for mobile learning*"* scored by 67% of the learners with the mean value of 4.01 and a standard deviation of 1.38. This implies that these EFL learners are ready for mobile learning because their responses reveal positive perception. In other words, learning through mobile phones can save their time, be an alternative to web and internet based learning, spend more money on mobile phones, learn how to utilize their mobile phones for learning, and be an alternative to conventional learning.

Meanwhile, the item *"*Some of my lecturers are already integrating mobile learning in their teaching*"* scored the lowest average mean with the values of only 2.11 and a standard deviation of 1.12 by 67% of these learners. This indicates that these learners might not have had any experience in mobile learning. This may imply

that the learners expect their instructors and lecturers to use mobiles more frequently in teaching environments. To sum up, it is concluded that majority of the learners as revealed in Table 1 show positive perception for mobile-learning. Majority of the Iranian EFL learners are satisfied with the integration of mobile-learning in education. Since mobile-learning is at the very early stage in Iran, learners are doubtful as how best to engage in mobile-learning.

Table 1

Learners' Perceptions of M-Learning Readiness

	Psychological M-Learning Readiness	Mean	*SD*	%
1	I know what mobile learning is all about.	3.44	1.33	40%
2	I want to know more about mobile learning.	3.27	1.10	58%
3	I don't think I want to be involved in mobile learning.	2.79	1.05	59%
4	I prefer conventional learning than mobile learning.	3.34	0.93	47%
5	I think mobile learning is good for working adults who are pursuing their higher education.	3.67	1.27	70%
6	I don't mind paying extra money for mobile learning.	4.01	1.38	67%
7	Mobile learning will make my life difficult.	2.90	1.15	20%
8	I am not ready for mobile learning if the university implements it now.	2.50	1.46	38%
9	I would like my lecturer to integrate mobile learning in my class in addition to face-to-face meetings in the class.	4.14	1.05	85%
10	I am afraid I will spend more money on my hand-phone bill because of mobile learning.	4.29	0.84	90%
11	I will be ready for mobile learning after 2 years.	2.57	0.91	57%
12	I don't know how to use 3G facility in my hand-phone.	2.81	1.34	70%
13	I would like my lecturer to integrate mobile learning in my class besides online forum in my course	3.67	1.41	57%
14	Mobile learning will save my learning time.	3.57	0.81	72%
15	Mobile learning is an alternative to web based learning.	2.56	1.39	58%
16	I need to learn how to use my hand-phone for mobile learning.	2.64	1.21	60%
17	I am looking forward to engage in mobile learning.	3.51	1.37	58%
18	I will upgrade my hand-phone if mobile learning is going to be implemented in my course.	4.20	1.00	88%
19	Mobile learning is an alternative to conventional learning.	4.04	1.15	79%
20	I think my university is not ready for mobile learning using hand-phone facility.	3.91	1.14	70%
21	Some of my lecturers are already integrating mobile learning in their teaching.	2.11	1.12	67%

3.2 Semi-Structured Interview Analysis

The findings of the semi-structured interview protocol revealed several similarities and differences that emerged in the ways participants reported how sensory memory (Iconic Memory and Echoic Memory), working memory, and long-term memory can help them learn English through mobile phones and what are their attitudes towards mobile-learning considering memory stores. The analysis of the participants' data generated three themes sensory memory (Iconic Memory and Echoic Memory), working memory, and long-term memory). Each one is likely to occur several times throughout learning. These are discussed in the following:

Sensory Memory (Iconic Memory and Echoic Memory) - It was found that many learners asserted that when they work with their mobile phones, they can use their senses *to touch with their hands, see through their eyes and hear via their ears*. This implies that pictures and words enter the learners' sensory memory and is kept for a short period of time in visual and auditory sensory memories because the learners who are learning through mobiles store and keep what they receive before any cognitive processing takes place. For example, all learners

said that *when they see something on the screen of a mobile phone, when it is gone, it is still retained in their memory for a very short period of time*. This shows that when the learners see something on the screen of the mobile phones, their brains have very little time to process it and their iconic memory is kept for less than half a second. This implies that sensory memories are processed at the learners' pre-conscious level of awareness. It is possible to recall sounds after hearing them. For example, six interviewees (L1, L2, L4, L5, L6 and L7) out of ten interviewees said that *when they hear something playing on mobile phones, they can remember what they listen to just after hearing (a short time after hearing)*. However, L3, L8, L9 and L10 reported that *they only recall and remember a few words after hearing when there is no picture of it.* This reveals that learners take in the information they hear, they process that information, they keep it in their mind and then they remember what they hear. This may be forgotten due to not repetition and practice. Therefore, it is implied that the learners pay attention, listen, process, store, and remember the information they hear and forget because it has not moved to the long-term memory or if it has because the information is not repeated or practiced is faded gradually.

Working Memory - At this stage and process, learners choose some of the words and images for further processing in working memory and then they form the representation of sounds and images in their working memory. According to Atkinson and Shiffrin (1968), and Sorden (2005), working memory is a concept that grows out of the older model of short-term memory that is observed as a structure for temporarily storing and keeping information before it passed to long-term memory. For example, L2, L8, L9, and L10 reported that when *they work with their mobiles and try to learn something such as new words or getting some information on the internet, they try to process the information, but after a short time the more they try to remember the more they forget.* This implies that working memory is considered as a system with subcomponents that hold temporary information as well as process it in order that several pieces of verbal or visual information could be kept and stored and integrated (Sorden, 2005). In addition, L4, L3, L6, L8, and L10 reported that when *they look the words up in dictionaries, their visual memory is supposed to maintain and manipulate visual pictures of the words in their minds* or when *they look a new word up through mobiles*, they hear a sound (such as the spoken word *book*). This shows the mental conversion of a sound into a visual image (such as an image of a *book*). It is implied that when learners hear the word *'book'*, they also form a mental image of a *book*. According to Sorden (2005, p. 38), the main cognitive processing needed for multimedia learning in general and mobile learning in particular is shown by *"selecting images, selecting words, organizing images, organizing words,* and *integrating"*.

Long-Term Memory - At this stage, unlike working memory, long-term memory, which is parallel to the learner's storehouse of knowledge and information, can keep large amounts of knowledge over long periods of time. However, in order to actively think about materials in long-term memory it must be brought into working memory (Mayer, 2011; Sorden, 2005). L1, L3, L5, L6, and L9 asserted that when *they hear and read words in texts, they cannot remember them after all although they attempt to pass them into their long-term memory (LTM).* This indicates that the words were learned only for a short time and they were kept in their short-term memories and did not move into their long-term memories. Therefore, it is implied that recalling and forgetting are not controlled consciously but automatically. Madrid (2000) believes that the only way to make sure that something is remembered is through repetition and practice. Also, L2, L3, L4, and L9 stated that *sometimes they remember the English words and sometimes whatever they try to remember something they forget more*. This shows that their brains record what they see, hear, feel, taste, and smell with perfect precision that they can remember them later after a long time. Thus, vision and auditory are the most important memories because in many cases what learners see and hear makes up most of the memory. Many of the exercises in the brains are explicitly designed and planned to improve auditory and visual processing in order that their brains can take in what they see and hear with the speed and accuracy they need to form strong memories.

4. Implications

The implication of the study is that the limited working memory capacity should be elaborated by cognitive load theory for the instructional design and concentrates on ways in which instruction and training imposes cognitive load on learners. The multimedia mobile-based English learning environment messages should be

planned to facilitate English mobile-learning processes and all learners should be aware of their information processing stages. For instance, learners should be informed that their short-term sensory memory is a useful instrument because it allows the learners to notice and pay attention to words in the texts either reading texts or listening texts.

Also, the learners have the visual images of the words in the texts kept for a short period of time in their minds. It can be considered as an important experience because it contributes them to integrate their visual experiences. Thus, meaningful learning needs a wide range of essential cognitive processing for instance presenting words and pictures in mobile can be intended to foster second/foreign language learning. Mobile-based learning and teaching instructions should be designed to be involved in second/foreign language teaching. Also, with the enhanced pedagogical mobile-learning strategies, learners achieve sufficient skills and knowledge in mobile-based English learning environment. Many mobile learning applications facilitate learning process by using particular strategies such as being aware of working memory, sensory memory (Iconic Memory and Echoic Memory), and long-term memory. Therefore, mobile-based English learning environment facilitate learners' second/foreign language learning.

It is also implied that the use of mobile devices in the classrooms can be considered to be as pervasive in academic situations because the fast growth of learning and teaching mobile applications has developed opportunities for second/foreign language learning. These applications can promote second/foreign language learning in particular environment that make the learners be involved in learning. Thus, by utilizing mobile devices the learners can communicate, learn and practice their second/foreign language efficiently. It is essential for teachers and instructors to become more proficient in mobile-teaching second/foreign language as well. Furthermore, teachers and instructors had better teach words and pictures used and learned by mobile-devices in the ways that promote meaningful learning. The learners need to pay attention, listen, process, store, and recall the information, words and pictures they see and listen in order to be kept in their long-term memories. Hence, the role of instructional technology devices such as mobiles is to serve as a device that increases the power of learners' cognition.

5. Conclusions

This study focused on how sensory memory (iconic memory and echoic memory), working memory, and long-term memory contributed Iranian EFL junior learners learn English in multimedia mobile-based learning environments and what were their attitudes and perceptions towards English mobile-learning considering memory stores. In other words, the purpose of the present study was to explore how sensory memory (Iconic Memory and Echoic Memory), working memory, and long-term memory help Iranian EFL learners learn English through mobile phones and what are Iranian EFL learners' attitudes and perceptions towards English mobile-learning considering memory stores? Through the findings, it is concluded that Iranian EFL learners are satisfied with using mobile phones in their English learning because it can save their time and energy, be an alternative to web and internet based learning, learn how to use their mobile phones for learning, and be an alternative and optional to conventional learning.

It is also concluded that the lecturers and instructors should integrate mobile learning in their teaching environments. Although mobile-learning is considered to be used at the very early stage in Iran, learners are doubtful as how well to involve in English mobile-learning environment. In addition, when learners observe something on the screen of their mobile phones, their brains have very little time to process it and their iconic memories are kept for less than half a second, hence, sensory memories are processed at the learners' pre-conscious level of awareness. The learners notice, listen, process, store, and recall the information in their minds. Furthermore, Mayer (2001) asserted elements in the presented material correspond to words and images in the multimedia such as computers presentation, elements in working memory correspond to verbal and pictorial models in working memory, and schemas in long-term memory correspond to knowledge and information in long-term memory.

Moreover, the findings from the qualitative data also supported the role of three memory stores (sensory memory, working memory, and long-term memory). Thus, cognitive theory of multimedia mobile-based English learning environment recommends the idea that learners' brain presents words and images/pictures which are selected and organized dynamically to create logical mental constructs. To this end, it is important to assert that more research studies need to be conducted on the EFL learners' perceptions towards the role of memory stores in mobile-based English learning environment. It is hoped that by enhancing the learners' awareness of their information processing, the learners can overcome the problems they face while learning English in mobile-based environments.

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