From Constructivist Educational Technology to Mobile Constructivism: How mobile learning serves constructivism?

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Abstract

Constructivist theory of learning suggests that individuals construct meaning through authentic experiences and social interactions. Thanks to the ample learning experiences and opportunities for unlimited interaction anywhere, anytime, mobile technologies have given birth to a concept called mobile learning. However, there seems a need to ground mobile learning on constructivist learning principles, i.e. define a new scope for constructivism: "mobile constructivism." This paper aimed to explore the relationship between constructivism and mobile learning and how they serve each other. To this end articles, which have based mobile learning activities on constructivist learning principles, were reviewed systematically. Results were synthesized and discussed under four major themes: the expansive potential of constructivist educational technology, integrating different kinds of constructivism in mobile learning, social consequences of mobile learning; and elemental principles of "mobile constructivism".

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INTRODUCTION

Constructivism is a theoretical foundation, which has promises for forming the discussion of technology and its application in social studies (Doolittle & Hicks, 2003). Gilakjani, Lai-Mei, & Ismail (2013) suggest that teachers who use a constructivist approach in instructional procedures are in favour of using mobile learning (mLearning) to achieve their goals. Mobile technologies can have a great impact on learning as they are becoming more ubiquitous, embedded, and networked. They provide users with enhanced capabilities for rich social interactions, context awareness and internet connectivity. From the learning perspective, since learners have the biggest responsibility in knowledge construction in mobile learning, it is thought to be closely related to constructivist approach. Phumeechanya and Wannapiroon (2013) also argue that the right learning theory for ubiquitous learning environment is constructivism, thanks to the use of mobile devices in accessing knowledge sources anytime and anywhere.

With the help of mobile technologies, learners receive feedback from teachers and peers almost instantly, anytime and anywhere. In virtual or online environments created with technologies and guided or controlled by teachers, learners can share their works, successes and doubts, which results in motivation, creating and expanding knowledge (Chai & Fan, 2016; Cobcroft et al., 2006; Cochrane & Bateman, 2010; Fahlman, 2013; Thinley et al., 2014). Learners' engagement in these interactive and collaborative tasks, does not only support social construction of knowledge, it also leads students to be more creative, critical and active in learning (Cobcroft et al., 2006). Scaffolding as one of the important elements of constructivist educational theory, can be performed more frequently and easily with constructivist educational technologies (Cochrane & Bateman, 2010; Fahlman, 2013). Although mobile learning has its roots in constructivism and stands for a favourable approach to perform constructive learning, there seems a need in the literature to ground mobile learning on constructivist learning principles, i.e. define a new scope for constructivism: "mobile constructivism." Thus in the present study we aimed to review the literature to explore the relationship between constructivism and mobile learning and how they serve each other.

Theoretical framework

Constructivism

Constructivist theory has its origins in both psychology and philosophy that go back through many years and many philosophers, such as Kant, Dewey, Hegel, and Vico (Doolittle & Camp, 1999). According to Fosnot (1996, as cited in Doolittle & Camp, 1999), constructivism requires active construction of knowledge and meaning from experiences. It refers to how the material is understood by the learners and how the teachers can teach effectively (Mvududu and Thiel-Burgess, 2012).

Before giving a certain definition for constructivism, it is vital to describe what constructivism is not. Constructivism is not a description of teaching or a process of the knowledge being accumulated and stored in human brain (Fosnot & Perry, 1996; Ertmer & Newby, 2013). It is, on the other hand, a non-positivist (Fosnot & Perry, 1996) theory of learning that suggests individuals' learning process happens through creation of meaning from their experience, perceptions, interactions and interpretations within their social and developmental context (Fosnot & Perry, 1996; Greer et al., 1999; Ertmer & Newby, 2013). Another definition by Fosnot & Perry, (1996) claims that constructivism is a post-structuralist psychological theory that constructs learning as an interpretive, recursive, non-linear building process by active learners interacting with their physical and social world. It is a psychological theory of learning that

describes how structures, language, activity, and meaning-making occur. The term constructivism has often been used as an umbrella term for a wide diversity of views (Duffy & Cunningham, 1996, p.2).

Although the main responsibility of learning in constructivist educational theory is on the student this should not be considered as there is no role for the teacher. In fact, the teacher has a central role that is thought to be more central than in most instructional design frameworks (Duffy & Cunningham, 1996, p.4). The role of the teacher can be resembled to a manager or coach, and many other apprentice frameworks (Duffy & Cunningham, 1996, p.5-6). Rather than the teacher, it is the learner who is responsible for defending, proving, justifying, and communicating their opinions to the classroom environment (Fosnot & Perry, 1996). In constructivist theory teachers should employ modelling, think-alouds and guided practice in the classroom to meet the needs of student achievement (Garner, 2008). Constructivist strategies are especially effective in situations that learners have trouble understanding through reflection-in-action. Tasks that require a high level of processing such as problem solving, personal selection and monitoring of cognitive strategies are frequently best learned with constructivist strategies like situated learning, cognitive apprenticeships, social negotiation (Ertmer & Newby, 2013).

Constructivist theory emphasizes that an external reality may not be understood in the same way by different learners. As individual and social experiences play a crucial role in the process of learning, the focus of social studies is perspective rather than the external truth. This variability in learning is described as having three principal divisions, cognitive constructivism, social constructivism and radical constructivism (Steffe & Gale, 1995 & Moshman, 1982, as cited in Doolittle & Hicks, 2003).

Cognitive Constructivism

Cognitive constructivism is a personal perspective based on the work of Swiss developmental psychologist Jean Piaget. Cognitivist theory has two essentials, "ages and stages" component, which foresees what a child can and cannot perceive at different ages, and a "theory of development" which depicts how cognitive abilities are developed in children (Amineh & Asl, 2015). In cognitive approach the focus is on each individual's cognitive actions. Cognitive approach emphasizes the constructive activity of individuals as they try to make sense of the world, attempt to resolve the conflict or alternatively construct themselves and their world by accommodating to experiences (Duffy & Cunningham, 1996, p.6). Garner (2008) defines cognitive structures as "basic, interconnected psychological systems". These structures allow people to process information by "associating it with former knowledge and experience, finding patterns and relationships, identifying rules, and generating abstract principles" (Garner, 2008). Unlike Vygotsky, Piaget ignored social and cultural groups in his research and his tasks underestimated the effect of culture (Blake & Pope, 2008, p.61). Psychologists and educators draw their attention from behavioural methods to complex cognitive processes such as thinking, problem solving, language, concept formation and information processing (Snelbecker, 1983, as cited in Ertmer & Newby, 2013).

From the cognitive constructivist perspective, knowledge is the result of correct internalization and (re)construction of external reality. The results of this internalization process are cognitive processes and structures that correspond exactly to the real world processes and structures (Doolittle & Hicks, 2003). The claim that reality can be known by the individual differentiates cognitive constructivism from both social and radical constructivism (Doolittle & Camp, 1999).

Social Constructivism

An increasing number of constructivist views emphasizes on the cultural integration of learning, employing the methods and framework of cultural anthropology to examine how learning and cognition gain meaning in the environment rather than stored in the head of an individual (Duffy & Cunningham,

1996). Unlike von Glasersfeld and Piaget, sociocultural approach has its focus on the socially and culturally situated context of cognition (Duffy & Cunningham, 1996). This social constructivist approach examines the social origins of cognition, for instance, the effect of an individual's appropriation of language as a mediating tool to construct meaning (Duffy & Cunningham, 1996). In the last decade, terms like "cognitive constructivism" and "social constructivism" have become common in the literature and thus plenty of definitions are available in the literature (Fosnot & Perry, 1996, p.17). We cannot understand an individual's cognitive structure without observing it interacting in a context, within a culture. But, neither can we understand culture as an isolated entity affecting the structure, since all knowledge within the culture is only, to use Cobb's terminology, "taken-as-shared" (as cited in Fosnot & Perry, 1996, p.17). Vygotsky's theory of social constructivism suggests that learner construct knowledge through interaction with other people, especially more knowledgeable others. To Vygotsky the socio-cultural environment is critical for cognitive development (Blake & Pope, 2008). Social interaction plays an important role in student learning. It is through social interaction that students learn from each other, as well as adults (Blake & Pope, 2008, p.61). Garner (2008) posits that students generally come to school without these cognitive instruments as they experience limited interaction with the adults in their families, but more passive exposure to media (Garner, 2008).

Social constructivism can be placed somewhere between the predictable and objective reality of the cognitivists and the construction of individual and consistent reality of the radical constructivists. The truth is socially constructed and it results from "co-participation in cultural practices" (Cobb & Yackel, 1996, p. 37). For social constructivism, "truth is not to be found inside the head of an individual person, it is born between people collectively searching for truth, in the process of their dialogic interaction" (Bakhtin, 1984, as cited in Doolittle & Hicks, 2003, p.80).

Radical Constructivism

Radical constructivism is a way of thinking about knowledge and the act of knowing. The term "radical" was first used for the work of Piaget on genetic epistemology. Radical constructivism is a progressive research programme and it has many strengths. It is an approach to the problems of knowledge and knowing. The main assumption of this approach is that knowledge is in the heads of people, and thinking subject has no alternative but to construct what they know on the basis of their own experience (von Glasersfeld, 1995). The great number of criticism to radical constructivism, when first mentioned in a conference, served it to be more popular and allowed it to be internationally accepted. While he was teaching genetic epistemology, Glasersfeld (1995) wanted to distinguish his studies on constructivism from other versions of it and therefore, he called it 'radical' and laid out two basic principles; "knowledge is not passively received but built up by the cognizing subject and the function of cognition is adaptive and serves the organization of the experiential world, not the discovery of ontological reality" (p.18). Because radical constructivism follows a radical rebuilding of the concepts of knowledge, truth, communication, and understanding, it cannot be seen similar to any traditional epistemology. Based on these, radical constructivism has two principles formulated with the help of Piaget's theory of cognitive development: "1) Knowledge is not passively received either through the senses or by way of communication, knowledge is actively built up by the cognizing subject. 2) The function of cognition is adaptive, in the biological sense of the term, tending towards fit or viability, cognition serves the subject's organization of the experiential world, not the discovery of an objective ontological reality" (von Glasersfeld, 1995, p.51).

Mobile Learning (MLearning)

With an increase in the use of mobile devices, a mobile society has emerged (Boticki & So, 2010; Bozkurt, 2015; Chung et. al., 2015; El-Hussein & Cronje, 2010). In 2011, Franklin (2011) states that 85 billion text messages were sent each month and the use of mobile devices for communication purposes had increased %450 percent in two months. As another evidence for massive use of mobile devices, Gheytasi

et al., (2015) noted individuals use their mobile devices more than two hours a day. With this speed of proliferation, it was inevitable for these mobile devices to be used in the field of education and soon they had taken their places in the classrooms. Being used by almost all of the students and teachers, mobile devices had the potential to become effective learning tools.

Mobile devices can be defined as portable, light electronic devices that enable users to communicate, access and share data through internet connection. Laptops, smartphones, tablet computers, e-readers, portable gaming devices, mp3/4 players, PDAs and cameras are examples of frequently used mobile devices (Simonova, 2016). Being used anywhere, anytime, mobile devices are informal, contextual, portable, continuous, effective, interactive and personal (Aburezaq ve Isthaiwa, 2013; Chen et. al., 2012; Franklin, 2011; Geddes, 2004; Hwang & Chang, 2011; Kukulska-Hulme, 2009). These feasibilities of mobile devices not only provide support to the classroom teaching, they also let individuals learn anything outside the classroom (Alzahrani, 2015; Andujar-vaca & Martinez, 2017; Baran, 2014). As these useful devices become popular (Hashemi et. al., 2011; Muhammed, 2014; Şad & Göktaş, 2014), especially among young people now called "digital natives" (Prensky, 2011), the mobility made its way into education and the term mobile learning emerged.

MLearning is the learning experience that takes place anywhere, anytime through mobile technologies (Bozkurt, 2015; Cavus & Ibrahim, 2009; Gheytasi et. al., 2015; Harris 2001; Traxler, 2005; Trifonova, 2003; as cited in: Bozkurt, 2015). As well as supporting classroom learning, mLearning allows students to access information continuously, create knowledge through online interaction with peers and evaluate their own performances thanks to the online community that provides instant feedback (Alzahrani, 2015; Amry, 2014; Andujar-vaca & Martinez, 2017; Baran, 2015; Looi et. al., 2015). mLearning provides (Chen et. al. 2012; Hashemi et. al., 2011):

- access to documents and sources,
- access to questions and self-evaluation test,
- watching classes and tutorials,
- access to live and archived classes,
- access to audio and video sources,
- access to asynchronous content,
- exhibiting students' work,
- access to virtual learning communities.

These capabilities of mLearning create an individual learning setting for students (Geddes, 2004), lead them to learn by exploring, organizing and saving data (Looi et. al., 2010), provide flexibility in time and space (Andujar-vaca & Martinez, 2017) and allow teachers to give feedback rapidly (Baleghizadeh & Oladrostam, 2010). Consequently, the mobility of learning is not only based on mobile devices, it is also based on the mobility of students, the content and the online audience (Hashemi et. al., 2011).

Mobile Seamless Learning

In seamless learning, learners have the "opportunity to collaborate and interact in new ways with their peers and the physical world, as well as the physical world can be augmented with the use of digital technologies" (Otero, Milrad, & Rogers, 2011, p.18). Seamless learning refers to "a new phase in the evolution of technology-enhanced learning, marked by a continuity of the learning experience across

different environments" thanks to "ubiquitous access to mobile, connected, personal, handhelds." (Chan et al., 2006, p. 6).

While the definition of seamless learning by Chan et al. (2006) represented a rather technology-supported approach to the concept, the term seamless learning was first used by Kuh (1996) about a decade earlier. Kuh (1996) was the first person to coin the term seamless learning, who emphasized "what was once believed to be separate, distinct parts (e.g., in-class and out-of-class, academic and non-academic, curricular and co-curricular, or on-campus and off-campus experiences) are now of one piece, bound together so as to appear whole or continuous" (p.136). Kuh (1996) emphasized the integration of the learning experiences in different contexts, but did not mention about the role of technology. He designed six principles for creating seamless learning environments at universities: 1- Generate enthusiasm for institutional renewal 2- Create a common vision of learning 3- Develop a common language 4- Foster collaboration and cross-functional dialogue 4- Examine the influence of student culture on student learning 5- Focus on systemic change (Kuh, 1996). Today it is apparent that all six principles defined by Kuh (1996) to create seamless learning environments are dominated by mobile technologies. For example Wong and Looi (2011) defined Mobile-assisted seamless learning as a combination of WMUTE (Wireless, Mobile, and Ubiquitous Technologies in Education) and seamless learning. As a result of their review of 54 selected papers on seamless learning they defined the following ten features that characterize the seamlessness of a WMUTE design:

"(1) Encompassing formal and informal learning; (2) Encompassing personalized and social learning; (3) Across time; (4) Across locations; (5) Ubiquitous knowledge access (integrating context-aware learning, augmented reality learning, and ubiquitous Internet access); (6) Encompassing physical and digital worlds; (7) Combined use of multiple device types (including "stable" technologies such as desktop computers, interactive whiteboards with mobile devices); (8) Seamless switching between multiple learning tasks (such as data collection, analysis, presentation and communication). (9) Knowledge synthesis (integrating prior and new knowledge, abstract and concrete knowledge, and multi-disciplinary learning); (10) Encompassing multiple pedagogical or learning activity models." (p.9)

Thus, it is important to take these formal and informal or individual or social learning experiences as a whole. These social networking platforms might provide a potential seamless learning space, which Chan et al. (2006) suggest, have the capacity to extend classroom-based formal learning time into informal learning time so as to embrace opportunities for out-of-school learning. In seamless learning, learners have the "opportunity to collaborate and interact in new ways with their peers and the physical world, as well as the physical world can be augmented with the use of digital technologies" (Otero, Milrad, & Rogers, 2011, p.18)

Seamless learning has the key aspects of continuity and fluidity across physical, virtual or blended the settings or spaces (Keppell, 2014). Seamless learning refers to "a new phase in the evolution of technology-enhanced learning, marked by a continuity of the learning experience across different environments" thanks to "ubiquitous access to mobile, connected, personal, handhelds." (Chan et al., 2006, p. 6). In seamless learning, learning happens continuously bridging the formal and informal learning contexts through different technologies (Milrad et al., 2006). Continuity refers to uninterrupted nature of learning regardless of time and space, while fluidity implies transition from formal to inform, from individual to social learning (Keppell, 2014).

Purpose of the study

Recent increase in the use of mobile technologies in different areas including learning and teaching, created a need to base these new tools on existing learning theories such as constructivism. A wide range of researches (Alzahrani, 2015; Amry, 2014; Andujar-vaca & Martinez, 2017; Baran, 2015; Looi et. al., 2015) evidently show how mobile technologies could serve the the basic elements of constructivism such

as meaning creation and social interactions. Furthermore, constructivism finds its place in mobile learning. Therefore, it is seen significant to gather and synthesize the studies that are aiming at both of these important research areas. The purpose of this paper is to explore the relationship between constructivism and mobile learning and how they serve each other. With this elemental purpose we tried to answer the following research questions:

1.   What is the expansive potential of Constructivist Educational Technology?

2.   Which different types of constructivism can be integrated in mobile learning?

3.   What are the social consequences of mobile learning?

4.   How can mobile learning expand our notions of teaching and learning from now on? Is the next term mobile constructivism?

METHOD

Reviews of research are also pieces of research, which aim to review the literature to make it "available in a more digestible form" (Gough, Oliver, & Thomas, 2017, p. 2) and to direct researchers to new research areas (Petticrew & Roberts, 2008). In this qualitative study we aimed to review the literature to explore the relationship between constructivism and mobile learning and how they serve each other. As stated above, this paper tries to gather researches and presents them in a synthesis using systematic review method.

It is recommended that a review study should follow certain steps to be systematic. These steps include "identifying and describing the relevant research, critically appraising research reports in a systematic manner, and bringing together the findings into a coherent statement, known as synthesis" (Gough, et al. 2017, p. 5). To this end, we made more than one searches in databases including Teacher Reference Center, ULAKBİM National Databases, ULAKBIM Turkish National Databases, Social Sciences Citation Index, ScienceDirect, Scopus, SAGE Knowledge, Academic Search Complete, Arts & Humanities Citation Index, DergiPark, Directory of Open Access Journals, ERIC, and Scholar using the keywords or descriptors "mobile learning/mLearning", "ubiquitous learning", "constructivism", "social constructivism", "cognitive constructivism", "radical constructivism". The main aim was to have access to scientific research, which base mobile learning activities used in the research on constructivist learning principles as their theoretical background. Researchers scanned through a large amount of results by reading the titles and abstracts and have reached 20 articles, which have studied mobile learning or ubiquitous learning on the basis of constructivism or constructivist learning principles. In systematic reviews, well defined inclusion and exclusion criteria helps researchers address the research questions more to the point (Petticrew & Roberts, 2006). For this study we defined our inclusion criteria as a connection between mobile learning and constructivism, in a way that they serve each other. Mobile learning studies that did not mention constructivism, and yet still had evidence of constructivism such as "collaborating with peers to learn" were also included.

The studies obtained from this searching process were then carefully studied and coded into excel sheets by researchers. Researchers looked for and coded pieces of information on the title, the year, the purpose, which type of constructivism it was based on, how it created the relationship between constructivism and mobile learning, which technological tools it employed, the method, the samples, the variables it focused on, the evidence of constructivism, results, and implications for each of the studies. Researchers then tried to develop connections between these findings and synthesised them into

research reports. As similar points and ideas related to constructivism and mobile learning accumulated, it formulated a basis for each one of our research findings.

Next, researchers have critically appraised the research reports in a systematic manner seeking answers to such questions as "How does the study theoretically associate mobile learning with constructivism?", "How does the study use mobile technologies in terms of constructivist learning principles?", and "What are the implications of the research findings in terms of mobile constructivism?" etc. Finally, we have brought together, i.e. synthesized the findings under four major themes: the expansive potential of Constructivist Educational Technology, integrating different kinds of constructivism in mobile learning, social consequences of mobile learning; and mobile constructivism.

FINDINGS

What is the expansive potential of Constructivist Educational Technology?

Jonassen, Peck & Wilson (1999, p.12) describe technology as "the designs and environments that engage learners". Hannafin and Hill (2002) explain these learning environments as the contexts in which learners work collaboratively to use various tools and learning materials to pursue the learning goals and problem-solving activities. Although the need for the application of technology in the field of social studies is definite, its integration into that field has not been at a desired level so far. Constructivism is a theoretical foundation, which has promises for forming the discussion of technology and its application in social studies (Doolittle & Hicks, 2003). Constructivist educational technologies are able to turn virtual environments into successful learning settings where learners create knowledge, involve in meaning-making interactions, work collaborative and creatively, reflect on their own or peers' performance. To achieve these goals, Cochrane & Bateman (2010) suggest that it is vital to integrate and employ technologies in learning pedagogically, make use of feedback as formative assessment, chose devices and software appropriately and provide pedagogical and technological support. An effective integration of technology into learning environments creates a stage to perform constructivist theories and instructions (Chai & Fan, 2016; Cobcroft et al., 2006; Gilakjani et. al, 2013;Thinley et al., 2014). Constructivist theory suggests creation of knowledge through experiences, which could easily happen in virtual environments with the help of technology. However not every technology or application serves constructivism (Thinley et al., 2014). Therefore, provided that the ideal technologies, websites or applications are pedagogically engaged, constructivist goals will be achieved (Chai & Fan, 2016; Cochrane & Bateman, 2010).

Gilakjani et al. (2013) emphasize how frequently constructivist teachers use technologies to realize their goals. Educators with constructivist instruction aims eventually end up using mobile technologies since they are quite compatible with constructivist goals. The social interaction, continuous guidance that mobile technologies provide are the important elements constructivism need yet cannot obtain enough in classrooms. For this reason, in social studies, technology is resembled to a "sleeping giant" as most teachers do not benefit from the whole potential of it (Doolittle & Hicks, 2003, p. 3). Song and Kong Siu (2017) made a study on the affordances and constraints of a mobile technology called BYOD (Bring Your Own Device) for teaching and learning. They came to the conclusion that more teachers can benefit from the mobile technology by designing learning activities to achieve intended learning outcomes across different settings; it can also empower teachers to make use of the online learning trails on BYOD to assess students learning process, and identify their learning problems to make pedagogical refinement where it is necessary.

The interaction and collaboration that constructivist educational technologies provide have a huge impact on learning. In virtual or online environments created with technologies and guided or controlled by teachers, learners can share their works, successes and doubts, which results in motivation, creating and

expanding knowledge (Chai & Fan, 2016; Cobcroft et al., 2006; Cochrane & Bateman, 2010;Fahlman, 2013; Thinley et al., 2014). Learners' engagement in these interactive and collaborative tasks, does not only support social construction of knowledge, it also leads students to be more creative, critical and active in learning (Cobcroft et al., 2006).

Scaffolding is an important element of constructivist theory. Thus, receiving feedback from teachers and peers almost instantly, anytime and anywhere shows that scaffolding can be performed more frequently and easily (Cochrane & Bateman, 2010; Fahlman, 2013). Phumeechanya and Wannapiroon (2013) state that the right learning theory for ubiquitous learning environment is constructivism, thanks to the use of mobile devices in accessing knowledge sources anytime and anywhere. Authors suggest that an instructional model based on problem-based learning and scaffolding corresponds to different contexts of ubiquitous learning environment. This constructivist model enables learners to learn anything anywhere and anytime through their mobile devices, and enables instructors to control the class, check out the learning results, and evaluate the learners.

How different kinds of constructivism can be integrated in mobile learning?

Constructivist learning approach encourages students to be active constructors of knowledge and requires teachers to give the students opportunities to participate in the learning process. In this sense, mobile technologies provide a unique opportunity for learners as they provide them with both a supporting tool and a realistic context in which learners can construct meaning personally.

It is the diversity of experiences that leads us to divide constructivism into three different types: social, cognitive and radical. This review study revealed that especially the first two of different kinds of constructivisms can be observed in mobile learning settings. For example, some studies (Barry, Murphy & Drew, 2015; Cochrane & Bateman, 2010; Cobcroft, Towers, Smith, & Bruns, 2006; Fahlman, 2013; Gilakjani, Lai-Mei, & Ismail, 2013; Thinley, Geva & Reye, 2014) have revealed clear connections between social constructivism and mobile learning. Thinley, Geva & Reye (2014) have applied social constructivist pedagogical approaches in their teaching by using mobile technologies as primary means of communication in their researches. According to them, it creates a collaborative learning setting where learners construct knowledge by interaction and sharing. Another research (Barry, Murphy & Drew, 2015) suggests that environment has an effect on learning as learners create different meanings in different learning settings, which is in line with social constructivist approach. Thus, to integrate social constructivist approach in learning, they studied the effects of using mobile information and communication technologies (ICTs) in learning. Cobcroft, Towers, Smith, & Bruns (2006), suggest that social constructivism can be applied through mobile technologies as learners construct and share knowledge not only with their classmates, but with peers from all around the world. Another way how social constructivism was integrated in mobile learning is pointed out by Cochrane & Bateman (2010) who benefitted from key aspects of mobile learning such as connectivity, mobility, personal podcasting and vodcasting while teaching. In a research by Fahlman (2013) that examined nurses' use of mobile devices during the informal learning to gain professional development, it was reported that collaborative functions of mobile learning such as e-mailing, interacting with others through online communities were more frequently used than individual learning functions, which shows the role of social constructivism in mobile learning. Nurses also used their mobile devices individually for meaning making and creation of knowledge purposes to gain professional development and competence, which points out cognitive constructivism as well.

Chai & Fan (2016) employed a constructivism-based model (MIC-Mobile Inverted Constructivism) to let students become the leading actor in their learning experience by using mobile interaction technologies.

Learners involved in cognitive operations to create meaning and learn through social media while their teachers observed and provided feedback. Social media stands as an environment where learners live a virtual life through which they create new knowledge. Similarly, Gilakjani, Lai-Mei, & Ismail (2013) suggest that teachers, with the help of mobile technologies, create constructivist learning environments on which learners involve in dynamic knowledge construction processes. Researchers also state that implementation of constructivism and technologies into learning serve each other as technology-supported environments make great knowledge-building tools.

Lan and Tsai (2011) made a study on mobile memo system and found out that mobile technologies encourage and facilitate student interaction and collaboration through discovering, sharing one's thinking, gathering and discussing. Similarly, authentic and meaningful contexts in which students work collaboratively are emphasized in social constructivist approach.

Habel and Stubbs (2014) explored the effect of student response system (SRS) usage on peer-learning, student preparation and engagement through the use of VotApedia, a form of mobile phone voting, in large first-year law lectures, a discipline that has not previously been used for such implementations. The study is based on social constructivist approach as SRSs support the social construction of learning and understanding. They are used to provide the tools for creating authentic learning environments and enhancing the communication. Moreover, in this study, SRSs were used in a discursive context of divergent questioning, which supports the constructivist pedagogies that are essential to the implementation of SRSs. It was found that as the use of SRSs for group discussion promoted peer learning, it led to a measurable improvement in student performance. Mobile phone voting led to increased student engagement. A clear link between attendance and engagement when SRSs are used to supplement an already interactive lecture style was also found. The students who particularly reported the benefits of the SRS were those who had difficulty learning in the traditional lecture format: those who struggled to remain engaged or devote attention to the material being delivered.

Though limited in number, some mLearning research also referred to the principles of cognitive constructivism, usually together with social constructivism. For example, Song and Kong Siu (2017) examined a mobile teaching and learning process called BYOD (Bring Your Own Device) in higher education. They relate this mobile process to cognitive constructivism as BYOD reveals affordances by creating, editing or drafting documents and also to social constructivism as it helps students share their needs and information, communicate collaboratively in anywhere at anytime and work in a collaborative way. Ogunduyile (2013) made a study on the use of mobile technologies in teaching and learning of the English language and came to the conclusion that mLearning can afford the learners the chance of using authentic English. In this sense, cognitive constructivism is integrated into the mobile learning as mLearning makes it possible for learners to construct their own knowledge. Ogunduyile (2013) implied that mLearning is related to social constructivism as well since teaching through mobile learning helped in increasing interaction and engaged learners and it also facilitated a more friendly teacher and students relationship. Phumeechanya and Wannapiroon (2013) benefited from cognitive constructivist view of learning and used mobile devices with internet access and Context-aware Module to enhance problem-solving skills and context awareness. Another study by Hu (2013) intended to show how mobile devices are being used in vocabulary learning activities. The study suggested that with mobile devices, learners have a unique opportunity to construct knowledge and share it with peers by interacting in a naturalistic context and getting access to supporting tools for their learning. With mobile affordance of the immediate data collection, learners can have opportunities to visualize the idiom-and-context association. Knowledge construction is related to cognitive constructivism while sharing and interacting is related to social constructivism.

What are the social consequences of mobile learning?

In the information age we live in, people are faced with a variety of new information and realities to

learn, which require them to develop lifelong learning skills. Learners use the mobile devices very frequently in and out of schools. They come across plenty of information in social media and other websites. They learn new things through instant messages and sharings by people they met on social networks. Thus formal learning activities conducted within schools according to a certain curriculum cannot be enough for learners to develop lifelong learning skills (Şad & Ebner, 2017). With the use of mobile technologies in education, learning can easily move outside of the classroom, and transform into a seamless part of daily life (Naismith et al., 2004).

The use of mobile technologies uncovers a massive potential as it allows students immediate collaborative tasks, interactions and to learn in contextual situations (Barry, et.al., 2015). It also creates opportunities for teachers to observe, assist and guide learning without being limited to the classroom (Geddes, 2004). In a mobile learning setting where learners engage with knowledge with their social identity, learning experience will be more individual, contextual and effective (Güneş, 2016). Another social consequence of mobile learning is its ability to extend the time and space teachers (who were previously limited by the school and the time spent there) used for scaffolding (Aburezaq & Isthaiwa, 2013; Cochrane & Bateman, 2010).

According to a study carried out by Wong et. al. (2010) creating artefacts and making discussions on their products through mobile devices and online sharing platform make students pay more attention to their surroundings and thus they make better associations with their real-life contexts and the target idioms. Another finding is that students perform better in small-group face-to-face discussions compared to asynchronous online discussions and shared artefacts via Web 2.0 (wiki) technology deepened students' understanding of the idioms. For further studies, the researchers suggest that personalized-to-social learning activities could be used in other school subjects.

Lan and Tsai (2011) made a study on mobile-memo system and found out that there is a significant difference in multimedia choices of female and male students. Males prefer taking photos while females prefer voice recording. Students regard mobile memo system as helpful and convenient for mobile learning. The researchers came to the conclusion that handheld devices contribute to the pedagogic theory, encourage students' learning, satisfaction and enthusiasm. Students welcomed critiques of peers, which was not usually observed in a classroom setting (Richards, 2012).

Wang (2014) carried out a study, which aims to improve learning quality by fostering collaboration among students and between students and instructors through interactive mobile assisted social e-learning (iMASE) module in a speech and debate course. The results indicated that the quality of students' learning experiences could be predicted by the quality of feedback students gave and received. This finding is consistent with social constructivism, which suggests that feedback should be given frequently. Learning is a social activity the Web 3.0 has afforded individuals the opportunity to connect and communicate at almost no cost at anywhere and anytime. Results suggest that e-cooperative learning with mobile networking apps promoted a social constructivist learning environment. The participants improved their learning achievement through a high frequency of communication with peers and instructor in an iMASE module. Students' sense of community and connectedness in the learning environments enhanced their learning. The technology-based learning environment played an important role in supporting social skills. In a web social setting, students' abilities can be recognized and their beliefs about their self-worth can be promoted. The Web 3.0 gave individuals the opportunity to connect and communicate at almost no cost at anywhere and anytime and lastly, e-cooperative learning with mobile networking apps promoted a social constructivist learning environment.

How can mobile learning expand our notions of teaching and learning from now on? Is the next term mobile

constructivism?

Constructivism and mLearning are closely related to each other as they both aim to provide students with student centered, context-rich, authentic and constructive learning environments (Jonassen, 1991; Naismith et al., 2004). mLearning requires learners to take the most responsibility for constructing knowledge. With the opportunities for discussion and feedback, and scaffolding knowledge, mLearning facilitates attaining a 'certain knowledge' by the learners and the community (Stefani, Mason & Pegler, 2007). In this sense, Walker and Logan (2008) and Jones and Issroff (2007) mention 'learner engagement' which they explain as the positive effects of mLearning on learning ownership and self-esteem. Mobile learning also allows learners to be active, critical and creative (Cobcroft et al., 2006; Cochrane & Bateman, 2010; Liu & Chen, 2015). In their research Chai & Fan (2016), have found that students are more creative while using mobile technologies in learning as active participants.

In several constructivist frameworks, emphasis is given on formative assessment and authentic tasks. In Richards' study (2012), in which he aims to explore the impact of formative assessment through oral responses captured by mobile phones on 8th grade students' understanding of algebraic inequalities, mobile learning serves as a part of formative assessment and provides authentic tasks. The study is grounded on cognitive and social constructivism. In Richard's study (2012), most students agreed that receiving feedback on computers from teacher and peers in the form of voicemail on mobile phones was helpful in understanding the subject and that the creation of multimedia artefact was a good way of showing their understanding of a topic. Instead of receiving information passively, students became active content producers as they created representations of their understanding using devices. Such an application with several disciplines may inform educators about the ways a mediated dialogue may strengthen meaningful learning and formative assessment for students.

Learning activities powered with mobile technology can be labelled as constructivist since they are student-centred, problem-based, and collaborative. Students are active in acquiring knowledge, solving problems, conducting experiments and in producing common artefacts (Palmárová & Lovászová, 2012). In their study, Palmárová and Lovászová (2012) designed and examined an engaging outdoor activity (inspired by a treasure hunt game i.e. Geocaching) based on student collaboration and active use of mobile technology for an informatics education course. Pupils collaborated constructively and the adventurous and competitive nature of the learning activity resulted in high intrinsic motivation to learn. The study is an example of a well-designed constructivist/ constructionist learning activity and can be easily adapted for using in any other school subject or some after-school context as well.

In Song and Kong Siu's study (2017), 17 higher education teachers from different departments used mobile devices, apps and other BYOD (Bring Your Own Device) websites and apps like moodle, edmodo etc. during teaching and learning process for enabling students to share information, work collaboratively and communicate. The study developed the framework of seven affordances, which are resource access, communication, resource collection, resource submission, construction, resource sharing, and representation, and three main constraints, which are technical, social and personal constraints in BYOD-supported learning environment. These findings could be used for pedagogical practices.

In an experimental study carried out by Ogunduyile (2013), the researcher examined the integration of mobile technologies in English language learning process. A mobile chat app to enable the learners to use the target language outside the classroom, a blog for posting assignments and a group on Facebook for accessing questions and instructions are used in language teaching in this study. The students did the assignments via these mobile and digital media tools. The study concludes that as mLearning is cooperative, collaborative and learner centred, It enhances active involvement of the students in the acquisition of linguistic knowledge. The integration of mLearning in the teaching of English in secondary schools would afford learners the opportunity of having a method that is 21st century compliant and availing the learners the digital age benefits. However, to fully enjoy the benefits offered by this

innovation, the schools must be given some infrastructural face lifts in terms of good network connection and stable electricity.

Phumeechanya and Wannapiroon (2013) used mobile devices with internet access and Context-aware Module to develop a ubiquitous scaffold learning environment using problem-based learning model to enhance problem-solving skills and context awareness. During the learning process, the system notified the learners via their mobile devices about the upcoming activity. The learners received assistance automatically from Learner' Context-aware Module and they could communicate with their friends and instructors all the time. Both learners and teachers benefited from the mobile learning process as learners were able to study anything anywhere and anytime through their mobile devices, and instructors managed the learning in an efficient manner anywhere and anytime. However, preparing the infrastructure, learners and instructors is a prerequisite for any education institute that aims to apply this instructional model. All the users must have mobile devices with internet and it is the limitation of using this model.

Hu (2013) states that the blended use of Web 2.0 technologies and mobile phones give the learners the chance to share learner-created content in authentic environments. In Hu's study, learners aimed to learn idioms by creating their own artifacts or collecting them via mobile phones and they made online discussions to achieve a profound understanding of the idiom. Mobile phones and Web 2.0 technologies provided learners with an authentic and social learning environment.

Mobile Learning, which is considered to promote deep learning and reflection, is regarded as a social constructivist model of learning by various commentators (eg. Charitonos, Blake, Scanlon, & Jones, 2012b; Sharples et al., 2009, as cited in Scanlon, 2014). However, in addition to the social side of learning, mobile learning enhances complex cognitive skills such as problem-solving, context awareness and information processing regardless of time and space. Strong relationship between constructivism and mobile learning is shown clearly in this study. Detailed descriptions of how they serve each other and how they benefit each others' feasibilities are given as well. Since constructivism and mobile learning are quite compatible with each other and they are often being used together, could "mobile constructivism" be a new method in learning and have certain principles as mobile learning and constructivism has? If so, what would be the framework for mobile constructivism? Deep research and analysis on both constructivism and mobile learning have shown that the essential aspects of each could represent the principles of "mobile constructivism". These principles are;

a)   Ubiquitous Interaction

b)   Dynamic learning network

c)   Informal learning settings

a. Ubiquitous Interaction

Learning through authentic interaction is a key aspect of social constructivism (Blake & Pope, 2008) and it can be achieved through mobile learning easily (Andujar-vaca & Martinez, 2017). Thanks to the internet and mobile devices, people and groups can interact beyond time and space (Doolittle & Hicks, 2003). Just like in social constructivism, mobile constructivism also focuses on collaboration and creates learning settings, which encourage collaboration through interaction and sharing. Learners interact not only with the physical and social world around them, they also interact with the social world virtually. Learners can interact with the technology, the teacher and each other anytime, anywhere in all circumstances. Mobile technologies encourage interaction and collaboration through discovering, sharing, gathering and

discussing (Lan & Tsai, 2011; Ogunduyile, 2013). Research related to mobile learning and constructivism has clearly shown that interaction has many functions. When used correctly interactions between students and teachers provide (Barry, Murphy & Drew, 2015; Cochrane & Bateman, 2010; Fahlman, 2013; Gilakjani, Lai-Mei, & Ismail, 2013; Thinley, Geva & Reye, 2014):

- flexibility in both formative and summative assessment through feedback

- motivation as a result of sharing successful learning outcomes

- critical thinking by reflecting on their own and peers' work

- scaffolding opportunities for teachers

b. Dynamic learning network

An emphasis on a social, online/virtual environment is visible in almost all studies concerning social constructivism and mobile learning. This environment is a dynamic network of information, where individuals can learn something new, expand existing knowledge and achieve deep learning by means of asking questions in online communities, texting with peers or teachers, searching, listening or watching different sources (Looi et. al., 2015). This learning network is dynamic since the devices used to access it, the information and the residents are constantly changing (Chen et al., 2019). This environment is also a setting for students to exhibit their learning outcomes (Chai & Fan, 2016).

In constructivism, learners construct knowledge either by themselves (Duffy & Cunningham, 1996) or by interacting with other individuals (Blake & Pope, 2008). Mobile constructivism encompasses personal and social learning and creates a virtual learning environment in which learners can carry out learning activities themselves or by interacting with peers and teachers. Mobile learning makes use of e-cooperative learning settings in which participants connect and communicate whenever and wherever they want. It helps them to have a sense of community and connectedness in the learning environment and thus make them more motivated and engaged in learning (Wang, 2014). This e-cooperative learning community is dynamic in that the participants can connect to each other anytime and anywhere to ask, answer, give and receive feedback, discuss, or share etc. Being a part of a community, which is active all the time, motivates the learners and makes the learning process more enjoyable.

Mobile learning naturally provides dynamic formative assessment opportunities as it forms a virtual learning atmosphere where an intensive feedback exchange take place between students and teachers (Andujar-vaca & Martinez, 2017; Cochrane & Bateman, 2010). Instant social media comments, continuous text message exchanges, lots of likes and reviews all become effective assessment tools with mobile learning (Baleghizadeh and Oladrostam, 2010; Fahlman, 2013; Ozdamli, 2013). In a learning experience without mobile learning, the evaluation and assessment is limited by teachers. Mobile learning with its social interaction capability eliminates this limit and lets the society learners live in, become the judge. These feedbacks are not always result in evaluation of learning outcomes. Chai & Fan (2016) state that when students share their success, they feel more motivated.

c. Informal learning settings

Using mobile devices to design learning activities, which learners can access in different settings results in learning in informal settings. Learning takes place continuously with the help of different mobile technologies (Milrad et al., 2013). Considering that learners spend much of their time outside the formal learning settings and mobile devices are commonly used among learners, we can say that learning is taking place more in informal settings. According to the constructivist view of learning and teaching, feedback should be given frequently. As mobile devices enable learners to communicate with peers and teachers outside the classroom, learners can give or receive feedback more frequently than in traditional settings. Giving or receiving feedback in informal settings is found to be better as learners welcome

online critiques more than the critiques in classroom (Richards, 2012).

Learning in informal settings deepens learning as it uncovers the learner's real potential. In a classroom setting, many possible problems such as anxiety, limited time, distracting students, overly dependent students and unpreparedness may prevent the learners from using their whole potential. However, informal learning settings eliminate all these problems and reveal the learner's real potential.

DISCUSSION & CONCLUSION

Constructivist theory of learning suggests individuals learn through creation of meaning from their experience, perceptions, interactions and interpretations within authentic experiences and social interactions (Ertmer & Newby, 2013; Fosnot & Perry, 1996). While cognitive constructivism emphasizes knowledge construction of learners through their experiences and attempts to solve a problem, social constructivism focuses on how individuals create meanings across different social environments depending on their cultural background or role in society (Duffy & Cunningham, 1996). Educators who have adopted constructivist instruction approach could benefit greatly from mobile seamless learning since it provides ample learning experiences and unlimited interactions anywhere, anytime because of its capabilities such as being informal, continuous, interactive and personal (Chen et. al., 2019; Geddes, 2004; Hwang & Tsai, 2011; Kukulska-Hulme, 2009).

Regarding the expansive potential of Constructivist Educational Technology, it can be concluded that it is still in its infancy stages and promises a lot as far as pedagogically integrated and used effectively. Effective use of these technologies depends largely on unlimited access to mobile sources. The importance of unlimited access to mobile sources comes from the fact that mobile technologies provide students with immediate collaborative tasks, interactions and learning in different contextual settings. Interactive and collaborative tasks contribute to the quality of learning by adding up to students' creativity and collaboration ability. Another benefit of constructive mobile technologies is about the natural feedback mechanism they provide. Through communicating, interacting and sharing on mobile devices, students produce meaningful output which can serve as an assessment tool for teachers later on. What makes that assessment tool precious is that teachers can evaluate the learners without being limited by time and place. Constructivist educational technology has contributed a lot to the teaching and learning processes with its unlimited virtual sources and learning environments and social platforms, which connect people beyond time and space. This technology empowers teachers, as it is easier to follow learner progress and identify their learning problems and assign tasks according to the level of understanding. However, constructivist educational technology has not been used in its full potential yet and thus it is described by some scholars as 'sleeping giant' (Doolittle & Hicks, 2003). One of the biggest constraints, which prevent the users from fully enjoying this innovation is that not all learners have mobile devices with the internet and both teachers and learners need some training on using educational technologies.

When it comes to the different types of constructivism which can be integrated in mobile learning, it can be concluded that cognitive and social constructivism can form the basis for mobile learning. Constructivism requires active construction of knowledge through experiences and interactions. Cognitive constructivism emphasizes individual construction of knowledge and social constructivism focuses on how individuals create meanings across different social environments (Duffy & Cunningham, 1996). In that sense, mobile technologies provide different and authentic learning experiences and a virtual environment where learners can take the lead and create new knowledge or different meanings in

different online settings, which serves cognitive and social constructivism. Cochrane & Bateman (2010) suggest that the key aspects of mobile learning such as connectivity, mobility and personal podcasting corresponds with social constructivism. The use of mobile technologies for communication purposes serves social constructivist pedagogical approaches as it makes it possible for students to share and teachers to guide (Thinley, Geva & Reye, 2014). Sharing ideas and learning outcomes with peers from all around the world in different learning settings is a goal of social constructivist theory and it can be easily performed through mobile learning (Barry, Murphy & Drew, 2015; Cobcroft et. al., 2006). Mobile learning happens via personal mobile devices, and every individual becomes the leading actor in their learning experience, which points out the cognitive constructivist side of mobile learning. It can be concluded that constructivism and mobile learning are interconnected as the former's aim is successfully achieved by the latter's functions.

The research explains how mobile technologies are integrated in learning and how they help learners and educators with the key aspects of constructivism such as interaction, collaboration and authentic experience. These create an informal atmosphere where social and cognitive constructivism can easily be implemented and contribute to formal lessons. When the potential of mobile learning is effectively employed, students engage with knowledge with their social identity and are involved in individual, contextual and effective learning experiences. Having described a strong relationship between constructivism and mobile learning, it can be concluded that the key aspects of constructivism are associated with mobile learning from a "mobile constructivism" perspective. Since constructivism and mobile learning target a student-centered, context-rich, authentic and constructive learning environment, "mobile constructivism" can be a new method that has principles covering the key aspects of both constructivism and mobile learning. In such a case, the first principle of mobile constructivism would be "Ubiquitous Interaction" which moves the key aspect of social constructivism- interaction with social environment- to a seamless context, the main proponent of which is mobile devices. The second principle would be "Dynamic Learning Network" which describes how learners are involved in knowledge construction, evaluation and deep learning through a constantly changing online and virtual brain like environment (Looi et. al., 2013). The last principle would be "Informal Learning Settings" which emphasizes what learners can learn by accessing mobile devices in informal settings rather than formal settings such as schools. Using these devices for learning purposes does not necessarily mean bringing these devices into formal learning environments, but it does mean learning and feedback are moved towards informal settings.

Learning which is moving towards a more mobile and informal context is expected to have some prerequisites and consequences. Before adapting a mobile constructivist educational view, all users must have mobile devices with seamless internet connection, which could be regarded as a limitation of using this model. Another prerequisite is that all users must be given training on how to use their mobile devices for learning, teaching, and assessing. As for the consequences, it can be concluded that users are able to access information anytime, anywhere; communication, interaction, learning and assessing in formal classroom setting continues outside the classroom, in informal settings as well, which promotes learning; informal learning settings lower the affective filter level of students and thus promotes learning; informal assessment gives a better chance for formative assessment and provides teachers with a process-based type of an assessment rather than product-based. Rapidly-changing word around us seems to be making way for a more mobile world and it seems inevitable in near future for all people to be a part of this seamless communication world.

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