Review of research on mobile language learning in authentic environments

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ABSTRACT

We reviewed literature from 2007 to 2016 (March) on mobile language learning in authentic environments. We aimed to understand publications' trend, research focus, technology used, methodology, and current issues. Our results showed that there was increasing trend in the publications. Students' perceptions towards mobile learning technologies and language proficiency were the most common research topics. The most frequently used technologies were smartphones, mobile phones, and personal digital assistants, whereas the most common target language was English as a foreign language. In addition, university and elementary school students were the most common participants. We found that learning activities in most studies were carried out in classroom and specified locations outside of campus. Authentic learning environments in most studies were familiar to students and learning activities were designed using instructor-centered approach. Most studies collected and analyzed qualitative and quantitative data. We also discovered some issues associated with earlier studies, e.g. many studies did not focus on applying newly learned knowledge by students to solve their real-life problems or recently developed intelligent technologies for language learning were overlooked. Based on our results, we discuss some implications and make suggestions over mobile language learning in authentic environments for the educators and researchers.

1. Introduction

The rapid advancement of information and communication technologies in the last years has created new opportunities for education (Reynolds & Anderson, 2015). Given that most people own mobile devices nowadays, learning can be extended beyond a traditional classroom (Wu, 2016). Related literature suggests that mobile technologies are reshaping learning and instruction by supporting, expanding, and

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enhancing course content, learning activities, and student interactions with the instructor, peers, and learning content (Abdous, Camarena, & Facer, 2009; Wu, 2014). Technologies help overcome many limitations and obstacles in a traditional classroom, i.e. a lack of language-use opportunities, individualized learning, feedback and interactions (Ahn & Lee, 2015) and can offer a seamless learning experience, i.e. to learn anytime and anywhere (Liu & Chen, 2015).

An authentic environment is one important prerequisite for effective learning (Hwang, Ma, Shadiev, Shih, & Chen, 2016; Ibáñez et al., 2011). Authenticity emphasizes meaningful learning in contexts that involve real-world problems (Reynolds, 2013; Shadiev & Huang, 2016). An authentic environment provides several critical characteristics. First, it provides authentic contexts that reflect the way the knowledge will be used in real life. Second, it provides authentic activities that have real-world relevance, ideally ones which present complex tasks to be completed over a sustained period of time. Third, it creates an opportunity for sharing learning experiences and accessing the experiences of learners regardless of their level of expertise. Finally, it promotes reflection and enables authentic learning assessment within the tasks (Herrington & Oliver, 2000; Newmann & Wehlage, 1993; Wong, 2013). Instructional design frameworks were proposed in the literature for educators and researchers to follow in designing authentic learning environments (Herrington & Oliver, 2000; Newmann & Wehlage, 1993). Here are some examples from the literature focused on different language skills. Ahn and Lee (2015) designed learning activities supported by mobile technology. Through mobile devices, students were able to continuously and spontaneously access authentic learning resources, to practice speaking skills, to receive instant feedback on accuracy in pronunciation, and to modify utterances. Students in Chen and Chang (2011) received learning material in physical learning environment outside of school to improve listening comprehension. With the support of mobile devices, students were able to connect learning content with authentic context and integrate the world outside with the world of material on the device. Li and Hegelheimer (2013) focused on facilitating students' grammar learning and writing. Using mobile devices, students could access learning material, situated assignments which contained target specific errors, and corrective feedback to improve writing quality. Lan, Sung, and Chang (2007) designed a learning system for collaborative EFL reading. With support of mobile devices, students received authentic reading materials, read them, and received instant peer-feedback when they experienced some reading difficulties.

According to Shadiev, Hwang, Huang, and Liu (2015), familiar authentic environment is familiar and relevant with predictable situations from students' background and previous experiences. It can be found at places which students visit almost every day, e.g. near school or home. A familiar, authentic environment creates advantages in comprehension and application of new knowledge. Students enter authentic environments many times; information and

experiences related to these environments are stored in their brains as background knowledge so that environments become familiar. When students enter these environments again to learn, background knowledge guides their behavior and helps predict what is to be expected and looked for in a familiar environment. In such environment, students are more inclined to learn as they apply new knowledge to solve daily real-life problems which they are likely to encounter frequently as they occur in a familiar, natural context (Golonka, Bowles, Frank, Richardson, & Freynik, 2014). Huang, Shadiev, Sun, Hwang, and Liu (2016) suggest that authentic learning environments in real-world contexts which are rich in resources for learning can be created through the design of learning activities supported by mobile technologies. Mobile multimedia tools enable students to create learning materials, such as pictures, audio, and video, in authentic environments. Utilization of multimedia tools for learning tasks stimulates student imagination, helps elicit meaningful output, makes learning more interactive and richer in information; multimedia aids also tend to make participation more engaging (Golonka et al., 2014; Wong, Chen, & Jan, 2012). In addition, students are able to practice the target language repeatedly and regularly and to acquire diverse learning goals which increase the richness of their language experience by using multimedia aids. Following these discoveries, more and more language teachers have become interested in mobile language learning which has been successfully implemented in a number of studies (Burston, 2014; Golonka et al., 2014; Duman, Orhon, & Gedik, 2015).

It is suggested that language learning requires that students take ownership of learning activities (Agbatogun, 2014). Comas-Quinn, Mardomingo, and Valentine (2009) argued that ownership makes mobile language learning engaging, motivating, and it increases control over goals, communication, and instant sharing. Putting a student at the center of learning enables shifting from linguistic inputs and mental information processing to the things that learners do and say while engaged in meaningful activity (Comas-Quinn et al., 2009). That is, students will be engaged in real learning activities which are meaningful, contextual, and situated.

Scalability and sustainability are important for any language-learning programs. Scalability is an ability of language-learning programs to be adapted in a wide variety of contexts whereas sustainability is an ability of language-learning programs to remain in use (Clarke, Dede, Ketelhut, & Nelson, 2006). Wingkvist (2009) suggested that scalability shows ability of an initiative to grow and sustainability demonstrates how well the result fits the intended setting. For example, mobile language-learning programs designed by one group of scholars for some specific authentic contexts can be easily and effectively applied by another group of scholars for different authentic environments; this will show that mobile language-learning programs are scalable. In terms of sustainability, studies on mobile language learning in authentic contexts shouldn't be carried out in short term (a few days, weeks, or month) but longer (one or more years) to

ensure that students benefit from language-learning programs in long term. Several strategies to make learning programs scalable and sustainable are discussed in Oliver and McLoughlin (2003) and Wingkvist (2009). Wingkvist (2009) argued that while most mobile-assisted learning studies focus on the technology and its effect on learning, we still need to ensure that mobile-assisted learning is scalable and sustainable.

Several review studies on mobile language learning were already published. Burston (2014a) provided a comprehensive overview of existing mobile language-learning studies, a comparative analysis of mobile language-learning applications, and a discussion of issues related to mobile language-learning curricular integration. In the other review study, Burston (2014b) systematically reviewed mobile language-learning projects with a particular focus on the pedagogical challenges facing its exploitation. Duman et al. (2015) analyzed mobile language-learning studies to examine their characteristics and research trends. Golonka et al. (2014) summarized evidence for the effectiveness of technology use in language learning focusing on empirical studies that compare the use of newer technologies with more traditional methods or materials.

This study goes beyond existing review studies because we focus on mobile language learning in authentic environments. We present an extensive coverage of mobile language-learning research carried out in authentic environments with respect to their research topics, employed technologies, and methodologies. We address the following research questions:

(1) What were the trends regarding authentic mobile language learning in related literature from 2007 up to 2016?
(2) What were research topics in the literature on authentic mobile language learning from 2007 up to 2016?
(3) What mobile technologies were used in authentic mobile language-learning studies from 2007 up to 2016?
(4) What methodologies were employed in authentic mobile language-learning studies from 2007 up to 2016?
(5) In addition, we make a critical analysis of authenticity of and student familiarity with learning environments. We also focus on instructor-centered vs. student-centered design and scalability and sustainability of mobile language-learning projects.

2. Methodology

Research articles were searched using search terms such as mobile, language, learning, authentic, environment, and multimedia from ACM Digital Library, EBSCO Discovery Service, ERIC, PsychINFO, and Social Sciences Citation Index databases. First, we compiled a list with all articles which matched the search terms. Then, we narrowed down the selection of research articles for

inclusion in this present review. To this end, the first list of articles was screened through the following criteria to guide the selection: (1) studies that were written in English; (2) studies that were published between 2007 and 2016 (March); (3) studies with a focus on mobile language learning in authentic environments; and (4) studies that were published as full text in the following top 10 journals which are related to educational technology and indexed in Social Science Citation Index (SSCI): *Computers & Education, Educational Technology Research and Development, ReCALL, Journal of Computer Assisted Learning, Interactive Learning Environments, British Journal of Educational Technology, IEEE Transactions on Learning Technologies, Language Learning & Technology, Educational Technology & Society,* and *Computer Assisted Language Learning.* Articles published in SSCI journals are usually reviewed using rigorous and stringent criteria and have higher impacts in the field (Duman et al., 2015). Other type of publications, e.g. book reviews, commentaries, or editorial materials, were excluded from this review. After filtering the first list of articles based on above-mentioned criteria, a total of 37 articles were selected and reviewed. The reviewed publications were organized into four dimensions that address (a) the number of articles published by journals and year, (b) research focus, (c) technology used, and (d) methodology. These categories provided an organizational framework to understand publications trend, research topics that articles were focused on, types of technology employed in studies and their methodology.

3. Results and discussion

3.1. The number of articles published by journals and year

Table 1 shows the number of published articles by certain journal in specific year. The highest number of articles were published in Educational Technology & Society ($n = 10$) and the lowest in IEEE Transactions on Learning Technologies ($n = 0$). According to the results, the highest number of articles was published in 2013 ($n = 8$) whereas the lowest number was published in 2008 ($n = 1$). Our results showed that the number of articles published in different years was

Table 1. Studies on mobile ESL/EFL learning in authentic environment from 2007 until 2016 (March).

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016 (March)	Total
ET&S	0	0	0	3	1	1	2	1	1	1	10
CALL	1	0	0	0	1	0	2	1	1	0	6
CAE	0	0	0	1	1	1	1	1	0	0	5
ReCALL	0	1	2	1	0	0	0	0	0	0	4
LLT	1	0	0	0	0	0	2	0	0	0	3
JCAL	1	0	1	0	0	1	0	0	0	0	3
ILE	0	0	0	1	0	0	0	0	1	1	3
BJET	0	0	0	0	0	0	1	0	1	0	2
ETRD	0	0	0	0	0	0	0	0	1	0	1
IEEE TLT	0	0	0	0	0	0	0	0	0	0	0
Total	3	1	3	6	3	3	8	3	5	2	37
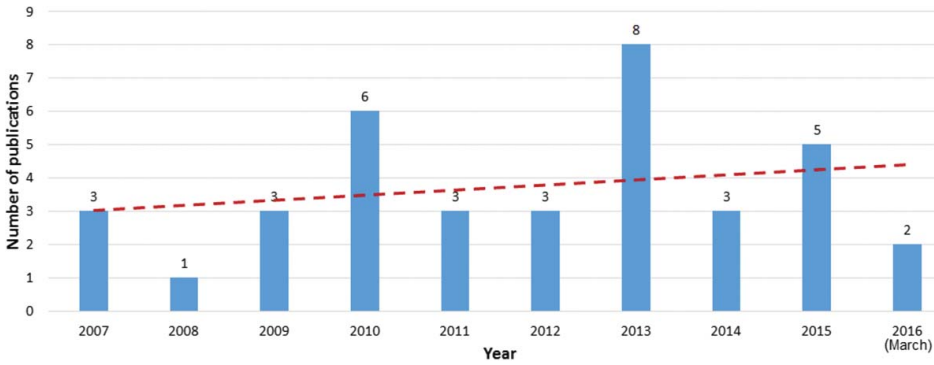
Figure 1. Publication trend (shown as a dashed red line).

not consistent. However, Figure 1 shows that the trend in publishing articles in selected journals for the past ten years was increasing.

3.2. Research focus

Table 2 presents research focus of the reviewed publications. According to the results, the most common research focus was on perceptions ($n = 33$) and learners' proficiency ($n = 32$), followed by learning behavior ($n = 16$) and then, by learning differences ($n = 6$).

Most reviewed studies focused on exploring student perceptions towards language learning in mobile authentic environments, i.e. perceptions in general, learning attitude, Technology Acceptance Model, learning motivation/satisfaction, cognitive load, and cultural constructs. The reason why perceptions received so much attention in these studies was because researchers aimed to

Table 2. Research focus.

Research focus	Subcategory	Publications number
Perceptions ($n = 33$)	Perceptions in general	17
	Learning attitude	7
	TAM	6
	Learning motivation/satisfaction	5
	Cognitive load	4
	Cultural constructs	2
Proficiency ($n = 32$)	Proficiency in general	8
	Listening	8
	Speaking	5
	Writing	3
	Reading	2
	Vocabulary	9
	Idioms/phrases	4
	Grammar	2
Learning behavior ($n = 16$)	Learning records on the system	9
	Observation	5
	Assignment	2
Learning differences ($n = 6$)	Learning proficiency	3
	Learning preferences	2
	Gender	1

show that mobile learning technologies were positively perceived and accepted by students. Besides, researchers used these results to support their findings on the effectiveness of mobile learning on language proficiency. This enabled researchers to triangulate the data from different sources. Our review showed that students had positive perceptions in most studies.

Most studies aimed at proficiency, in general; it included all language skills or some specific skills only, such as listening, speaking, writing, reading, vocabulary, idioms/phrases, and grammar. One reason that explains this finding is because researchers aimed to test the feasibility of their approach (i.e. mobile language learning) on the target language skills. Our review showed that the approach had positive effect on student language proficiency in most studies.

Most reviewed studies focused on learning behavior as well. Researchers aimed to explore what learning behaviors students had in mobile authentic environments and their relationships with language proficiency. In these studies, learning behavior data was recorded by mobile systems or collected through close observation of student learning processes and learning assignments.

Reviewed publications focused on learning differences as well, e.g. on students with different aptitude (i.e. high vs. low proficiency), learning preferences (i.e. visual vs. verbal or active vs. passive), and gender.

Based on our results, we suggest that some other issues need to be investigated in future studies as well. For example, the following issues: application of newly learned knowledge to solve daily real-life problems in authentic language-learning environments with technology, how to ensure that students are engaged in learning activities, and long-term continuation of such activities.

3.3. Technology used

Table 3 shows type of technology used in reviewed articles. The most used technologies were smartphones ($n = 11$), followed by mobile phones ($n = 9$), and then by personal digital assistant (PDA) ($n = 8$). Next most used technologies were tablet PC ($n = 4$) followed by not specified ($n = 3$). The least used technologies were humanoid robots ($n = 1$) and interactive television ($n = 1$).

Students used smartphones for learning vocabulary, grammar and target expressions, and practicing speaking, writing skills, or all skills. In reviewed studies, students learned material (e.g. vocabulary/idioms) in class first, and

Table 3. Technology used.

Technology	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016 (March)	Total
Smartphone	0	0	1	2	1	1	3	1	1	1	11
Mobile phones	2	1	1	0	0	1	2	0	1	1	9
PDA	0	0	1	2	2	1	1	1	0	0	8
Tablet PC	1	0	0	0	0	0	0	0	3	0	4
Not specified	0	0	0	0	0	0	2	1	0	0	3
Humanoid robots	0	0	0	1	0	0	0	0	0	0	1
Interactive television	1	0	0	0	0	0	0	0	0	0	1

then they practiced their language skills outside of school by taking photos of objects (e.g. campus cafeteria or bookstore) and describing objects in sentences/paragraphs/stories with idioms. Finally, students shared created content for peer reviews. Learning supported by smartphones positively affected language proficiency. Students who used smartphones had higher learning motivation and they performed better compared to those who used other methods. Students thought of learning with smartphones as fun while familiar contexts inspired them to write more and make writings more thorough. Students expressed great interest in Automatic Speech Recognition which improved their speech input.

Regarding mobile phones, in most reviewed studies, students received learning content on their devices via SMS or MMS, and they were engaged in learning activities. Results in the reviewed studies demonstrated that mobile phones were useful for informal language learning, gaining new contextual and cultural knowledge, recalling vocabulary, reducing cognitive load, facilitating listening skills, student-centered and collaborative learning, and vocabulary learning. When language proficiency of students in the experimental group (with mobile phones) was compared to those in the control group (other methods) after experiments, former outperformed.

In PDA related studies, students received and studied learning material (e.g. new vocabulary, reading passage, or instructional video) on their devices. In other studies, the learning system on PDAs led students to target objects (e.g. an animal in zoo or campus library) and displayed related learning material for students to study. Our review showed that PDA learning systems had positive effect on learning motivation, vocabulary learning, listening comprehension, speaking skills, reading achievement, and language proficiency.

Our findings are consistent with the technological development in the last years (Hsu, 2013). For example, mobile phones were the first in the market, and therefore, they were employed earlier into language-learning programs. The table shows that studies with mobile phones were carried out since 2007. Most studies indicated limitations of mobile phones such as small screens with low-resolution display, inadequate memory, slow speed (Hayati, Jalilifar, & Mashhadi, 2013; Li & Hegelheimer, 2013), the sound quality was inadequate for careful listening to audios (Lin & Yu, 2016; Nah, White, & Sussex, 2008), and it was difficult to type using mobile phone keypads (Chang, Lee, Chao, Wang, & Chen, 2010; Li & Hegelheimer, 2013). Later, more convenient, powerful, and capable technologies were developed so that researchers started using them (Tai, 2012). For example, PDAs were employed in various studies from 2009. However, due to some limitations of PDAs, they were replaced with more recent powerful technologies (e.g. smartphones). Our table shows that PDAs were no longer employed after 2014.

How language-learning activities were designed using various technologies is in line with technological development as well. Students received small-sized learning content on their mobile devices via SMS or MMS whereas students were exposed

to larger content on PDAs (Viberg & Grönlund, 2013). PDA-based learning systems guided students to specific areas where students received context-related material to learn. Smartphones, due to their advanced capabilities, enabled students to do much more than PDAs. For example, students were able to receive learning content much bigger in size, take photos and record audio with better quality, use both wireless and mobile connection, and take advantage of many other functions which were absent in PDAs, e.g. automatic speech recognition to improve speech input (Ahn & Lee, 2015; Oberg & Daniels, 2013). In addition, screen size of smartphones was bigger which made studying learning material easier. Smartphones enabled students to have more variety of learning activities. That is, students were no longer restrained to activities guided by the learning system; instead, students were able to find objects on their own, in places which were more meaningful and interesting to them, create their own content, and share it with peers (Cheng, Hwang, Wu, Shadiev, & Xie, 2010; Wong et al., 2012).

For the future studies, we suggest considering other technologies as well. There are more advanced intelligent technologies exist nowadays and can be employed for supporting language learning in authentic environments. For example, wearable devices, such as clothing and accessories, incorporating computer and advanced electronic technologies. Some recent popular examples are optical head-mounted displays, smartwatches or smart bracelets. According to Bower and Sturman (2015) and Sawaya (2015), such devices provide a wide range of educational affordances: pedagogical avails (in situ contextual information, recording, simulation, communication, first-person view, in-situ guidance, feedback, distribution, and gamification), benefits to educational quality (engagement, efficiency, and presence), and subtend logistical advantages (hands-free access and free up space). However, to the best of our knowledge, not many studies, particularly recent ones, applied them for mobile language learning in authentic environments. We believe that this is very promising research direction for future studies.

3.4. Methodology

Table 4 illustrates methodology of reviewed studies. According to the results, the most common target language in reviewed publication is English as a foreign language (EFL) ($n = 30$), followed by English as a second language (ESL) ($n = 5$). We found that Chinese as a second language (CSL) was a target language in two studies and Hindi as a foreign language (HFL) was in one study. This finding demonstrated that mobile technologies can be applied to learning different languages in authentic environments. One reason that explains why EFL received so much attention is because English is the most popular language nowadays and EFL learners lack an authentic learning environment in which they were able to learn target language (Lin, 2015). Mobile technologies had great potential to overcome this limitation. It was possible to create authentic learning

Table 4. Methodology.

Reference	Language/ participants/ level	Location/familiarity	SC[g] / IC[h]	Data collection
Fallahkhair et al. (2007)	ESL/14/NS[a]	NS	IC	QL[i]: observations, interview, questionnaire
Lan et al. (2007)	EFL/52/ES[b]	Classroom/F[e]	IC	QT[j]: learning behavior
Stockwell (2007)	EFL/11/U[c]	Classroom, lab, outside (NS)/F	IC	QL: questionnaire QT: learning behavior
Nah et al. (2008)	EFL/30/U	NS	IC	QL: questionnaire, interviews
Abdous et al. (2009)	EFL/113/U	Classroom, outside (NS)/F	IC	QL: questionnaire
Comas-Quinn et al. (2009)	EFL/8/U	The cathedral square and the town of Coruna/NF[f]	SC	QL: questionnaire
Liu (2009)	EFL/64/HS[d]	Classroom, campus/F	IC	QL: questionnaire, interviews QT: pre-test/post-test
Chang et al. (2010)	EFL/100/ES	Classroom/F	IC	QL: questionnaire, interviews, learning behavior
Chen & Li (2010)	EFL/36/HS	Campus (specified areas)/F	IC	QL: questionnaire QT: pre-test/post-test
Cheng et al. (2010)	EFL/10/U	Campus (any areas)/F	SC	QL: questionnaire, interviews QT: learning behavior
de Jong et al. (2010)	HFL/35/NS	NS	IC	QL: interviews QT: pre-test/post-test
i Solé et al. (2010)	ESL/12/U	A place in London/NF	SC	QL: questionnaire, interviews
Liu & Chu (2010)	EFL/64/HS	Classroom, campus (specified areas)/F	IC	QL: questionnaire, interviews QT: pre-test/post-test
Chang et al. (2011)	EFL/162/U	Taipei zoo/NF	IC	QL: questionnaire QT: pre-test/post-test
Chen & Chang (2011)	EFL/162/U	Taipei zoo/NF	IC	QL: questionnaire QT: pre-test/post-test
Ibáñez et al. (2011)	EFL/12/NS	Cultural sights of Madrid/NF	IC	QL: interviews, observations
Huang et al. (2012)	EFL/40/U	Classroom, campus (specified areas)/F	IC	QL: questionnaire
Tai (2012)	EFL/35/ES	The Lin Family Mansion and Garden/NF	IC	QL: questionnaire, interviews QT: pre-test/post-test
Wong et al. (2012)	CSL/34/ES	Classroom, campus (assigned areas)/F	SC	QL: artefacts
Hayati et al. (2013)	EFL/60/U	Classroom and outside (NS)/F	IC	QL: questionnaire QT: pre-test/post-test
Hsu (2013)	EFL/45/U	Local night market/NF	IC	QL: questionnaire
Hsu et al. (2013)	EFL/81/ES	NS	IC	QL: questionnaire, interviews QT: pre-test/post-test
Li & Hegelheimer (2013)	ESL/19/U	NS	IC	QL: questionnaire QT: pre-test/post-test, self-editing
Oberg & Daniels (2013)	EFL/122/U	Classroom, lab, outside (NS)/F	IC	QL: questionnaire QT: pre-test/post-test
Viberg & Grönlund (2013)	ESL & EFL/345/U	Classroom and outside (NS)/F	NS	QL: questionnaire
Wang & Smith (2013)	EFL/10/U	Classroom and outside (NS)/F	IC	QL: questionnaire, interviews QT: learning behavior, quiz
Wong (2013)	CSL/34/ES	Classroom, campus, home, other (NS)/F	SC	QL: artifacts, questionnaire, interviews QT: pre-test/post-test
Agbatogun (2014)	ESL/99/ES	Classroom/F	IC	QT: pre-test/post-test
Hwang et al. (2014)	EFL/59/ES	Campus (specified areas)/F	SC	QL: questionnaire QT: pre-test/post-test
Lin (2014)	EFL/84/HS	Classroom and lab/F	IC	QL: questionnaire QT: tests, learning behaviors
Ahn and Lee (2015)	EFL/302/HS	Classroom and outside (NS)/F	IC	QL: questionnaire
Huang and Huang (2015)	EFL/65/U	NS	IC	QL: questionnaire QT: pre-test/post-test/delayed-test
Hwang et al. (2015)	EFL/40/HS	Classroom and outside of campus (situational context)/F	SC	QL: questionnaire QT: pre-test/post-test, learning behavior
Liu and Chen (2015)	EFL/116/U	Classroom and outside of school (situational context)/F	SC	QL: questionnaire QT: pre-test/post-test/delayed-test
Shadiev et al. (2015)	EFL/59/HS	Local community/F	SC	QL: questionnaire, interviews QT: pre-test/post-test, learning behavior
Huang, Yang, et al. (2016)	EFL/80/ES	Classroom and campus (specified areas)/F	IC	QL: questionnaire, interviews QT: pre-test/post-test
Lin and Yu (2016)	EFL/32/HS	NS	IC	QL: questionnaire QT: pre-test/post-test/delayed-test

[a] NS – not specified; [b]ES – elementary school; [c]U – university; [d]HS – high school; [e]F – familiar; [f]NF – not familiar; [g]SC – student-centered; [h]IC – instructor-centered; [i]QL – qualitative; [j]QT – quantitative.

environments using mobile technologies, e.g. students were able to visit places with real objects and daily-life situations and mobile technologies provided related authentic content and tools for seamless learning experience, i.e. to learn anytime and anywhere. Interaction with real objects stimulated students' imagination, helped bring out meaningful output, and enabled repeated and regular practice in target language.

The most common research subject group was university students (n = 17), followed by elementary school students (n = 9), and then by high school students (n = 8). One reason to explain this finding was that university students, in contrast to younger group, had their own mobile devices. Besides, university students had necessary experience, skills, and competency to use mobile technologies for learning. Therefore, it was not required to purchase mobile devices and to instruct university students how to use technology. On the other hand, not many elementary or high school students had their own mobile devices and were able to use them efficiently. Therefore, mobile devices needed to be purchased and students instructed. In addition, studies with younger subjects were usually tightly controlled – students were closely monitored and they carried out learning tasks in the class, in campus, or some specified locations.

All reviewed studies created authentic learning environments; however, they were created at various locations. According to our results, learning activities in most studies were carried out in specified locations outside of campus (n = 8), followed by in classroom and outside (n = 7), and in locations which were not specified (n = 7). In other reviewed studies, learning took place in classroom and campus (n = 6), in classroom and lab (n = 3), in campus only (n = 3) or in classroom only (n = 3). This finding suggested that since mobile technologies afforded learning to take place at any locations, researchers designed learning activities not only in classroom but also outside. Students acquired new knowledge in the class and then applied it to solve learning problems outside of classroom, i.e. in places like campus, zoo, or local community.

Learning environments in most studies (n = 23) were familiar to students. That is, students learned in classroom, classroom and campus, and classroom and outside of campus. Students were familiar with their classroom and campus as well as the environment outside of campus (e.g. local community or their homes) since students visited these places almost every day. Therefore, the context there was related to students' background and previous experiences. Learning environments were not familiar to students in seven studies (n = 7). Students learned targeted language in Taipei zoo, the cathedral square and the town of Coruna, local night market, some places in London, cultural sights of Madrid, and the Lin family mansion and garden. Usually, students visit such places only a few times a year or even once in a lifetime, and therefore the learning context there was familiar to students at a certain level or unfamiliar at all. Learning environments were not specified in seven studies (n = 7); therefore, it is not clear whether students were familiar with learning environments or not.

Most reviewed studies created an authentic learning environment in classroom, lab, and campus. Some studies were carried out outside of campus. Educators and researchers need to consider authenticity of such environments, for example, how to ensure that learning environments are authentic and to what degree. Classroom environment is much different than that outside; classroom has much less real objects and students are less likely to experience a wide variety of real-life problems that they are able to experience outside. On the other hand, what we learn in zoo or in a foreign city may not be so useful for our everyday life because we visit such places less frequently and objects and problems there are quite different from that in our daily life. This is why in some countries (e.g. South Korea, Japan, and Taiwan) students study the target language very hard and for long time but not many of them are able to apply newly learned knowledge to solve their real-life problems (Ahn & Lee, 2015; Hwang et al., 2016). Perhaps, researchers need to consider some existing instructional design frameworks for authentic learning environments (see Herrington & Oliver, 2000; Newmann & Wehlage, 1993) when designing learning activities. Another issue to consider is familiarity with authentic learning environments. There are so many objects that surround us in our familiar environments, e.g. a bus stop or local cafeteria near our homes, which we see and experience every day and are relevant and meaningful to us. We can use these objects to practice the target language and they will be used in our future communication as well. This is the reason why some studies designed learning activities in familiar environments such as campus, local community or home. In contrast, some studies designed learning activities in local zoo or historical sites in a foreign city. We seldom visit such places and this is why they are not so familiar or meaningful, and we less likely will practice the target language using such context in our daily life. Students are not fluent with the target language and if their learning environments are not familiar then students need to make some efforts to familiarize themselves with environments instead of focusing on language acquisition. Therefore, familiarity with authentic learning environments is important for learning and needs to be considered by educators and researchers in the future.

Learning activities were designed using instructor-centered approach in most studies ($n = 27$). That is, the instructor developed instructional content, designed learning scenarios with specified locations in campus or outside. For example, students visited zoo where the learning system led students to target animals and displayed learning material to study. On the other hand, learning activities were designed using student-centered approach in other studies ($n = 9$). That is, although students were assigned learning tasks, they had more flexibilities to select locations and objects that are interesting to them, and to create their own learning content. For example, students visited places in their local community, e.g. a convenience store or a bus stop, to take photos of places and objects there and describe them using newly learned vocabulary, phrases, and grammar in the target language. We believe that instructor-centered approach is more

appropriate for elementary school students due to their language ability and skills. However, students of higher level, e.g. high school or university, should be given more flexibility to choose places and objects they are interested in for language learning. The role of the instructor then will be to instruct, to assign learning topics/tasks, and to guide and scaffold students when it is necessary. Student-centered approach will enable to build real authentic learning environments – students will visit places of their interests, actively learn content which is meaningful to them, and solve daily real-life problems. Students will be able to learn language through creating their own content, i.e. taking pictures of objects and describing them using newly learned vocabulary, phrases, and grammar. In such environments, students may learn from each other, acquire knowledge related to other subjects (e.g. science), and their learning will not be limited to tasks assigned by the instructor.

Most studies adopted qualitative and quantitative ($n = 23$) methodology and either qualitative ($n = 12$) or quantitative ($n = 2$) methodology. This finding suggested that most studies used different data sources (i.e. qualitative and quantitative) to triangulate their findings in order to make them sound and strong. Our review results showed that not many studies tested their approaches through designing experiments and analyzing quantitative data but through exploratory design and using subjective evidence only (e.g. student responses to questionnaires). We suggest addressing this issue in future studies by collecting the data through assessing EFL proficiency of students who learn with mobile technologies and comparing it with that of students who learn without technology or other tools. We also suggest that in the future researchers may collect the data based on psycho-physiological measures. For example, brain waves or eye tracking may objectively show student learning states (i.e. concentration, cognitive processes, and so on) whereas heartbeat, pulse or facial expression may help measure student affective states (i.e. motivational, satisfaction, and so on) during learning. Finally, future studies may use big data and employ learning analytics to understand and optimize student learning and the environment in which it occurs better. Such approaches will ensure that findings are based on solid evidence and results are applicable to broader population.

We also suggest that two important dimensions, such as scalability and sustainability of applying learning activities supported by mobile technologies in authentic environments for the target language learning, need to be considered in the future. In terms of scalability, most reviewed studies carried out short term learning activities (i.e. few days, weeks or months), with small sample size using the instructor-centered approach. When the instructor-centered approach was employed, one or a few teachers were involved in setting up learning activities, preparing learning content, tasks, and contextual environment which was difficult for teachers and researchers who helped them (Chang et al., 2010). Students were not very interested in learning activities controlled by the instructor and therefore, not much content was created by students. On the other hand,

with students-centered approach, students have greater flexibility to explore locations of their interests and create their own content. Students learning in authentic environment with mobile technologies may create interesting and diverse content which can be shared with other students. Other students, in turn, may create their own content as a part of their learning tasks which can be related to content of other students. If learning activities are long-term, students may create more content. Our trendline showed increase in research on mobile technology applications for authentic language learning which means more students will be involved in learning activities supported by mobile technologies in the nearest future, so more content is expected to be created. Therefore, the increasing number of contributions and participants can make this approach scalable. For this to happen, we need long-term studies with more participants who have more flexibility to learn in authentic environments.

Students-centered approach can also be useful in terms of sustainability of learning activities supported by mobile technologies. One reason is because all contributions are from students, i.e. students contribute by taking photos in authentic learning environments and making written or oral descriptions of objects. Students consider these contributions as their own. Students create content in locations which are interesting and meaningful to them. This makes students become engaged in creating their own content and they do it for longer time. Therefore, students-centered approach to language-learning programs makes them sustainable.

It is suggested that a unified online learning platform for authentic learning needs to be created. A platform will enable any students or instructor to enter it, and then to create and share content with others from the same or different school or to access content created by others. For example, Google® Maps service: using it, local businesses promote their services, and then people find these businesses and use their services. After that, people leave comments, reviews, and photos as well as their grades for these services. Others may consider such feedback to use these services. User contributions on Google® Maps increase every day. All these contributions are useful for other users as well as local businesses. As a result, Google® Maps becomes scalable and sustainable since most contributions are from users. Google® Maps or other similar services can be used as a learning platform for language learning. Our review showed that authentic learning environments were created at various locations, so students may create their content in different places, upload it on a platform and anchor to locations where it was created. Our review also showed that earlier studies focused on different levels of education, i.e. university students, high school or elementary school students. A unified online learning platform will be able to accumulate artifacts created by students through different educational levels into student learning portfolio. Later, students may monitor their own learning progress whereas an instructor may give some useful suggestions based on it. This may happen in the long term. Learning portfolio on a unified online

learning platform can be useful for other scholars as well; for example, it can be used as a control variable to make comparison with different related data. Other students or teachers may also refer to learning portfolio. For example, students who learn similar topics may explore content created by other students to learn from it, e.g. get inspirational ideas when creating their own content. While studying content created by others, students may also find mistakes in their own content and improve it. When they visit location where content was created, context may provide numerous cues and facilitate language learning. In addition, created content can be useful for students who are going to study it the next year or even for students from different schools. Instructors may design learning activities based on content which was already created by other students.

We also suggest that learning in authentic environments should not be limited to one particular subject. When students visit authentic learning environments outside of campus to learn target language, they may also learn other subjects, like science, and practice related skills (Huang & Huang, 2015; Shadiev, Huang, Hwang, & Liu, 2017). For example, in neighboring cafeteria, students may practice how to order food and drinks in the target language and at the same time, learn fractions and practice their calculation skills for mathematics class using the technology. This will help creating more content in authentic environments not only for their language class but for math class as well and enable scalability and sustainability with respect to other subjects. A few recent studies consider scalability and sustainability (Huang, Shadiev et al., 2016; Shadiev et al., 2015). These studies tried to reach scalability and sustainability. Although this is a promising research venue for the future, not many studies focused on this issue yet.

4. Limitations

Two limitations of this review study need to be acknowledged and addressed in the future. There are many articles on mobile language learning in authentic environments that were published in some other well-known journals (e.g. the System and CALICO Journal) or conference proceedings which we did not include in our review. One reason for this is because we focused on top ten SSCI journals on educational technology which usually are reviewed using rigorous and stringent criteria and have higher impacts in the field. This approach allowed us to provide only a partial view of the larger literature on the topic. Therefore, future research may explore studies on mobile language learning in authentic environments published in other journals, conference proceedings, and academic dissertations in order to provide extensive and detailed information. Another limitation is that our review study was limited by the search terms, research questions, and the time range of the articles published. We used various search terms, had diverse research questions, and covered the articles published in the last ten year, in order to present more details on reviewed studies and to cover various areas of research focus within a larger time range. However, future

studies may consider including more search terms and research questions as well as increasing the time range of the articles published.

5. Conclusions

Our results showed that publications trend was increasing and most publications focused on exploring perceptions and improving language proficiency. Most reviewed studies suggested that in general, students had positive perceptions towards mobile language learning and it had positive effects on language proficiency. We found that the most used technologies were smartphones, mobile phones, and PDAs. The most common target language was EFL, and the most common participants were university and elementary school students. Learning activities in most studies were carried out in classroom and outside (in specified locations). Most studies followed instructor-centered approach and learning environments were familiar to students. In most studies, qualitative and quantitative data was collected.

Compared with earlier review studies, we learned that the highest number of articles was published in different journals and most findings related to trends, research focus, technology used and methodologies are similar. We also discovered the following issues associated with earlier studies: (1) Research focus – application of newly learned knowledge to solve daily real-life problems in authentic language-learning environments with technology were not considered in many studies; (2) Technology used – not many studies considered applications of recently developed intelligent technologies for supporting language learning in authentic environments, e.g. wearable devices; (3) methodology – (a) some studies carried out language-learning activities in authentic environments in which learning contexts were familiar to students at a certain level or unfamiliar at all; (b) whether environments are authentic and to what degree were not considered in many studies; (c) in most studies, learning activities were designed using instructor-centered approach instead of student-centered approach; (d) not many studies tested the effectiveness of learning activities supported by mobile technologies on the target language proficiency using quantitative data or trough experimental designs; (e) other quantitative data collection was not considered, e.g. based on psycho-physiological measures, such as brain waves or eye tracking, which may objectively show student learning and affective state; (f) not much attention was paid on scalability and sustainability of language-learning programs in reviewed studies.

Based on our results we suggest that not only language proficiency should be a focus of mobile language-learning research but also (1) application of newly learned knowledge to solve daily real-life problems in authentic learning environments, (2) student engagement in such activities, and (3) long-term continuation and scalability of learning activities. We suggest incorporating current advanced intelligent technologies into mobile language-learning programs, such

as wearable devices. Such technologies provide many educational affordances while they were not considered in earlier studies. We also need to consider authenticity of learning environments, i.e. to ensure that learning environments are really authentic and to high degree. Besidehuangs, authentic learning environments should be related to students' background and experiences and students need to be familiar with them as it influences the quality of their learning. Last but not least, we suggest that apart from perceptions and language proficiency, we also need to consider scalability and sustainability of mobile language learning in authentic environments. For that, we need to design learning activities based on students-centered approach which is more interesting, meaningful, and engaging to students. A unified online learning platform for authentic learning can be useful for authentic students-centered language learning. It will enable any students or instructor to enter it, to create and share content with other students and instructors from the same or different schools. Learning in authentic environments should not be limited to one particular subject so that students may learn other subjects in authentic environments at the same time.

Disclosure statement

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