Mobile Learning in Informal Science Education: A Systematic Review from 2010 to 2019

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Abstract: Over the last ten years, mobile-assisted science learning in informal context has been discussed widely in educational research community. However, the trend of applying mobile technology in informal science learning still lacks systematic analysis. In this study, a meta review of the studies published in academic journals, indexed by Scopus, from 2010 to 2019 was conducted to analyze year of publication, kind of informal learning context, and learning strategies. The results revealed that the use of mobile technologies in informal science learning have been increased in the past decade. It was also found that mostly mobile technologies have been applied in informal science learning as a learning tool. In addition, mobile learning strategies have seldom been adopted in collaborative learning, inquiry learning, and non-specified. In contrast, it was found that the number of studies using a system development has increased in recent years. Moreover, most studies reported the process of using mobile devices in context of informal science education.

Keywords: Learning technology, mobile technology, science learning, smartphone, learning context

1. Introduction

Understanding children's interest both in the short and long-term in science is fundamentally important in educational research because interest can increase children's motivation for learning in science (Deci, 1992). Moreover, interest can also support their willingness to participate in science related activities and jobs in the future (Ainley & Ainley, 2011). As such, supporting short-term interest (i.e., situational interest) is critical because it is the first step toward further developed, long-term interest (i.e., individual interest) in science (HiDi & Renninger, 2006). Meanwhile, informal learning settings (e.g., museums, nature centers, and zoos) are powerful venues to trigger situational interest in science (Lemke, Lecusay, Cole, & Michalchik, 2015). Learning experiences in informal settings can provide unique opportunities for the development of situational interest because informal settings offer novel and diverse resources (e.g., exhibits, specimens, and games). Relatedly, interactive resources in informal settings can create opportunities to support learner-centered interactions where people can focus on activities related to their own agenda and goals (Barron, 2006). Moreover, informal learning setting have the flexibility to adopt new kind of technologies (e.g., mobile devices, virtual reality, and augmented reality) to further facilitate the learner-centered interactions. As mobile devices, i.e. smartphones and tablets, are becoming increasingly affordable and ubiquitous in everyday life, mobile devices are used to augment learners' interactions in informal learning spaces by enhancing novel experiences, customizing learning content, and expanding available perspectives (Charitonos, Blake, Scanlon, & Jones, 2012). The rapid development of mobile technologies offered more chances to design and develop innovative learning approach with mobile devices in preparing schools and students for a future (Panjaburee & Srisawasdi, 2018). Combining the benefit of informal settings and mobile devices, their team posits that mobile technologies offer supplemental resources that can be leveraged to generate and develop situational interest during informal learning activities.

To date, pedagogy of mobile and ubiquitous learning has become more important in context of science education (Srisawasdi, Pondee, & Bunterm, 2018). Although there have been numerous valuable syntheses of previous studies on mobile learning in informal science education, there are areas that need further examination. For example, the study findings demonstrate that in both formal and informal learning environments, mobile gadgets, particularly smartphones and tablets, along with open source applications are efficient alternatives to mono functional at devices. There is possible for using mobile learning in the area of informal science education due to the aspects that make it unique and well fitted to features and functions of mobile technology. Nonetheless, there have been no studies of the informal learning work in school science conducted to date. In this research, literature on mobile devices informal science learning from 2010 to 2019 was reviewed for understanding the use and patterns of informal science education and mobile learning in science.

2. Literature Review

2.1 Informal Learning and Mobile Technology

Informal learning is the name given to unstructured learning that takes place, like a classroom, away from the traditional, formal learning settings. It has no clear goals or goals set, as the learner is often unplanned and self-directed. Informal training features a few hallmarks that differentiate it from more formal learning styles. The biggest is that it's not a scheduled way to learn. This usually occurs naturally and inadvertently with the learner stumbling into a learning situation. In addition, situated mobile games allow teachers or informal educators to focus their students' or visitors' attention on specific aspects of the informal learning space and its exhibits or displays. Concurrently, settings on informal learning (e.g., museums, nature centers, and zoos) are important places to stimulate interest in science in circumstances (Bell, Lewenstein, Shouse, & Feder (2009). Learning in informal settings can offer unique opportunities to develop situational interest, as informal settings offer new and diverse tools (e.g., exhibits, specimens, and games). Respectively, interactive tools can create opportunities to promote learner-centered experiences in informal settings (Barron, 2006) where people can focus on their own goals and target related activities. Furthermore, informal environments often have the versatility of adopting new technologies (e.g., mobile devices, virtual reality, and augmented reality [AR]) to promote more learner-centric experiences. As mobile phones and tablets are become ever more accessible and ubiquitous in everyday life, mobile devices are used to increase interactions between learners in informal spaces by enhancing novel experiences, customizing learning content, and broadening the viewpoints available (Lyons, 2009). Informal environments and mobile devices combine advantages, their team argues that mobile technologies offer additional resources that can be leveraged during informal learning activities to create and grow situational interest. In the previous studied researcher reported that summer camp children engaged in learning on-the-move adds to the understanding of how to integrate context-sensitive technologies into informal science learning experiences. When the video data were coded to understand the types of sense-making conversations children had while using the mobile learning materials, we found the children engaged in describing, identifying, and interpreting/analysis talk related to science (Zimmerman, 2019). In addition, from the results of learning performance, stay-time, behavioral pattern analysis, and interviews, it was found that the mobile label assisted system can effectively guide visitors to interact with exhibits, conduct thoughtful learning, and prolong the visiting stay-time. Visitors are willing to visit the science museum with it (Chen, Xin, & Chen, 2017).

2.2 Mobile Learning in Science and Previous Studies

As the mobile learning area has grown and apps have developed, a range of ephemeral interpretations of mobile learning have arisen and mobile learning is a relatively new field of study, there is a lack of studies that systematically evaluate and analyze work on mobile learning. Mobile devices were mainly for communication purposes, they found few ties to communication or cooperation study, and most studies assisted inexperienced learners. Mobile learning has a great potential to promote learning success for students in specific subjects such as science , inquiry-based learning, collaboration, , communication, critical thinking, and motivation (Chang & Hwang, 2019). The ubiquity, flexibility, facility of access and diverse mobile technology capabilities make them valuable and necessary in the current times. Nevertheless, these are underused weapons in education in the science schools and, in parallel, students' interest and engagement in science domain follow a descendant trend (Bano, Zowghi, Kearney, Schuck, & Aubusson, 2018). Mobile technology and internet-access devices can help students investigate simulations online, video and virtual labs, exercises monitor and personal importance of learners (e.g., personal inquiry learning) and enhance engagement/participation in the learning process. For example, mobile devices have been successfully used in inquiry-based science learning to facilitate students into their inquiries, support formative or self-assessments and promote problem solving (Nikou, Economides, 2018). The smartphone can be a powerful device to collect data, especially with the various sensors that the modern smartphone carries; among the common built-in sensors are the accelerometer, gyroscope, magnetometer, GPS receiver, microphone and camera. In this studied found that intrinsic and career motivation significant correlated with flow and enjoyment of learning experience with the AR. As such, this implied that chemistry learning activity with the use of mobile AR should consider ways to promote students' motivation before implementing the activity (Nachairit & Srisawasdi, 2015). Furthermore, mobile technology-supported science learning is a topic under investigation. Studies on mobile learning in science education indicated that different tools/applications can be used to support science learning and that mobile devices with internet access can facilitate students' online investigations such as simulations, video and virtual labs (Nikolopouloul & Kousloglou, 2019). The ubiquitous Geography learning system, which uses smartphone equipped with cameras and wireless communication facilities to support ubiquitous learning for Geography, is proposed. They adopt ADDIE Model in entire study, from materials analyzing, learning contents design and development, system implementation to evaluation. The use of these low-cost and popular technologies makes ubiquitous Geography learning system more available than other previously developed u-learning systems (Yang & Chang, 2017). In addition, Prasongsap & Srisawasdi (2018) reported an impact of smartphone-based inquiry laboratory on middle school students' scientific understanding and their scientific explanation performance. The finding showed that the significant different in students' scientific understanding was detected between pretest and posttest after their participating with smartphone-based laboratory. They expressed positive scientific explanation performance to the technology-enhanced physical science learning with smartphone-based laboratory.

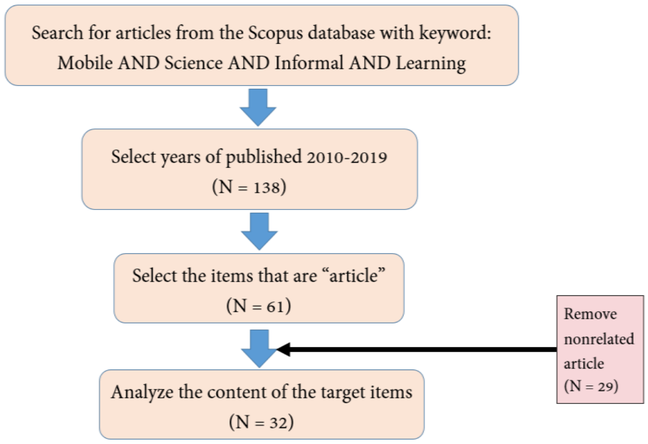

Figure 1. Scopus database searching steps

3. Research Methodology

This meta-review study examined papers from Scopus database, published from 2010 to 2019, by searching for the publications whose titles, abstracts, or keywords met the prescribe logical condition. The keywords used were Mobile AND Science AND Informal AND Learning, and the selective items was article only discovered on 14th November 2019. A total of 138 papers published were released from the database and it was an appropriate number for this study. By removing 77 non-article papers, 61 papers were comprised in the present study. By deleting 29 which were not related to mobile-based informal science learning, that is not related to student learning, papers focused on mobile-assisted informal science learning, mobile use for learning activities in science, only has been extracted in a final number of 32 articles, as show in Figure 1.

4. Research Result

4.1 Year of Publication

There were 32 papers as unit of analysis in this study. The papers were classified and reviewed by two researchers based on the coding scheme. If there were inconsistent coding results, both researchers would discuss until agreement was reached. Figure 2 demonstrates the papers on the application of mobile-assisted informal science learning from 2010 to 2019. There were no literature reviews focusing mobile-assisted informal science learning in 2010; after 2010, three papers started publishing in 2011, then decreased in 2012 with one paper which is equal to 2013. Since 2014 to 2017, academics have increased attention to this field and then continuously decreased in 2018 to 2019.

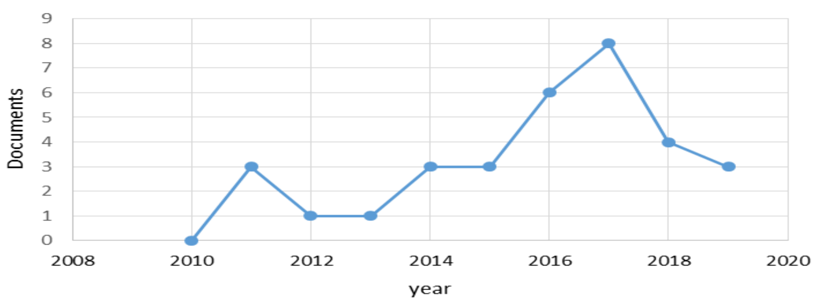

Figure 2. Published papers using mobile-assisted informal science learning from 2010 to 2019

4.2 Kind of Informal Science Learning

In this study, the researchers investigated kind of informal learning in science for each article. From the review analysis, there was a total of seven informal learning setting in science, including (i) museum, (ii) exhibition, (iii) nature center, (iv) after school, (v) community, (vi) botanical garden and (vii) non-specified. As illustrated in Figure 3, among all 32 papers, there were 20 non-specified, without specifying exact location of student's learning activity. For more details, those studies focused on development of learning system and mobile application to promote informal science learning with mobile devices. The second place is museum which is equal to exhibition is equal to four locations; one paper adopted nature center, after school, community, and botanical garden.

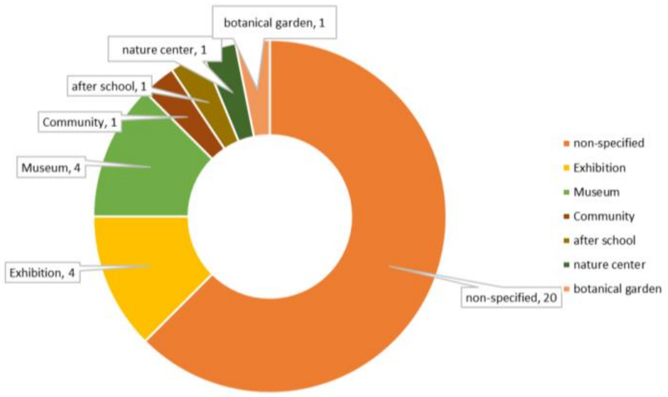

Figure 3. Kind of informal science learning setting

4.3 Learning Strategies

The distribution of learning strategies applied in mobile-assisted informal science learning from 2010 to 2019 is indicated in Figure 4. The greatest proportion is collaborative learning, with a total of 11 papers, while the second rank is inquiry learning, with a total of 8 papers. The third rank is non-specified, with a total of three papers and the forth learning strategy are STEM and 5E, and they are equal to two paper. In addition, there are seven of each one paper such as creative skill, open learning environment, experimental learning, socio-technical system, learning-on-the move strategies, and science project.

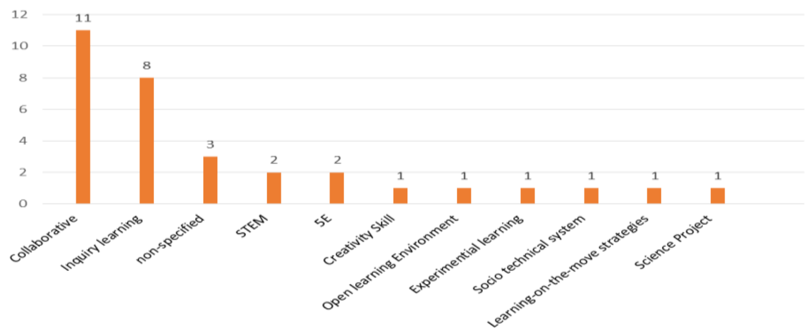

Figure 4. Learning strategies applied in mobile-assisted informal science education

5. Conclusion and Discussion

A meta-review analysis of using mobile-assisted informal science learning from 2010 to 2019 was performed in this study. This result indicated that the quantity of studies increased over many years and decreased in the last few years. Moreover, it was found that the number of publications which integrated mobile technology into informal science learning are greatly increased over the decades. It was also found that most of studies used learning system and mobile application development in the methodology. This implied that numerous researchers have considered to develop the application of mobile devices in science which focuses on informal learning setting. Although informal learning has become more popular due to the use of mobile technologies and devices, this reveals that more studies are required to develop learners' scientific learning process during informal science settings. This implies that investigating effects or impacts of mobile learning appraoches in context of informal science education remains an important and critical challenging question to educators and researchers.

On the other hand, it can be found that many learning strategies, for example, direct instruction, peer review, thematic debate, project-based learning, and contextual mobile learning, have hardly been implemented in mobilized science education. In the years ahead, the effectiveness of using these learning strategies with mobile technology in context of informal learning settings has been recorded in several studies; therefor, it is attempting to investigate the feasibility of applying them to science education. Exclusively, inquiry-based learning, contextual mobile learning, project-based learning, problem-based learning, peer assessment quality of critical thinking, and problem-solving could be helpful to the learners in terms of their higher-order thinking.

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