So, H. J. et al. (Eds.) (2020). Proceedings of the 28th International Conference on Computers in Education. Asia-Pacific Society for Computers in Education

Mobile Technology Facilitated Physics Learning Course: A Systematic Review from 2010 to 2019

Prapawan THONGSRI[a], Banjong PRASONGSAP[b], Patcharin PANJABUREE[c], & Niwat SRISAWASDI[d*]

[a]*Faculty of Education, Sakon Nakhon Rajabhat University, Thailand*
[b]*Lahan Sai Ratchadaphisek School, Buri Ram, Thailand*
[c]*Institute for Innovative Learning, Mahidol University, Thailand*
[d]*Division of Science, Mathematics, and Technology Education, Faculty of Education Khon Kaen University, Thailand*
*niwsri@kku.ac.th

Abstract: This paper summarizes the research on the use of mobile technology over the last ten years, where mobile learning issue in physics education have been discussed. However, there is less study revealing the trend of applying mobile technologies for teaching/learning physics regarding systematic analysis. In this study, a meta review of the studies published in academic journals indexed by SCOPUS ranging from 2010 to 2019 was conducted to analyze years of published paper, and learning strategies. The results revealed that the use of mobile technologies in physics education have been increased in the past decade. It was also found that mostly mobile technologies have been applied in scientific experiment for physics learning as a learning tool. In addition, mobile learning strategies have seldom been adopted in inquiry learning, research and development, blended learning, collaborative and STEM. In contrast, it was found that the number of studies using a system development has been increasing in recent years.

Keywords: Mobile technology, mobile learning, mobile device, physics learning, physics application

1. Introduction

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). Currently, mobile gadgets have been getting a famous era in our life. In educational system, these devices supplied educators with the opportunity to convert teaching and gaining knowledge for addressing twenty-first century learning settings. This transformed instruction creates a greater flexible learning versions that give blessings to college students who could get admission to to multiple records assets and shifted from an authority-based totally mastering shape to a structure primarily based upon the idea of a network of learners (Hamm et al., 1955). It also gives educators the capability to connect with learners in many ways with devices that they use on a regular basis (Ward et al., 2013). Recently, with the advancement of technologies, more and more mobile devices have been served as technological tools for supporting learners to learn in science classrooms. These devices, including laptops, tablet PC, and smartphones, have been developed rapidly to provide better computing efficiency and mobility, and have grown in popularity as learning devices since 2002 (Lim, 2011). That is to say, the challenge is the introduction of a learning-based solution for achieving goals and choosing the right mobile technologies, as well as developing a complex technology-based environment to support and enhance the learning process. There is general agreement that mobile learning facilitates the access to education, besides, some characteristics of mobile learning can contribute to change the way in which we teach or learn. An important feature of mobile learning is that one of its goals, different from those of a traditional transfer of knowledge from teacher to student, is to empower students to actively participate in the construction of their own learning (Pena-Bandalaria, 2007). Also, mobile learning can facilitate designs of authentic learning by targeting problems of interest to the learner

(Traxler, 2007), as well as ease lifelong learning by supporting learning that occurs during the many activities of everyday life (Sharples, Taylor, & Vavoula, 2005). In teaching context, teacher involvement occupies a fundamental position of mobile learning in formal education settings (Prieto et al., 2014). For physics learning, physics mobile learning (PML) is a learning medium, and it is used as a new learning strategy and provides an interesting transformation experience (Shaheen, 2010). PML process can support higher-order learning performance through students' participation in the use of technology, especially using mobile learning in critical thinking processes, and facilitates the students' information with reference to the difficulty of physics material in the school room (Mcfarlane, 2013). Moreover, it enables students to learning with their lifestyle and allows them in obtaining better knowledge in terms of language and subculture, in particular in improving their potential of diagram-based representation and critical questioning (Chiang, & Lee, 2016).

2. Review Literature

2.1. Physics Learning and Previous Studies

Physics is one branch of science that is classified as the most fundamental physical knowledge and it is related to the basic principles of the universe (Serway & Jewett, 2004). Experience or direct observation with the five senses makes it easy for students to learn. These experiences will develop the ability of students gradually to understand abstract concepts of Physics, think logically, and even make generalizations (Mundilarto, 2002). Getting to know Physics must facilitate students to construct their expertise and thinking talents (Gedgrave, 2009). However, the physics learning process is still centered by the teacher's role (Rusnayati & Prima, 2011). Teachers were not creative enough and had few experience in developing learning media basing on specific instructional goals in terms of various kinds of and attractive materials for students (Mardiana & Kuswanto, 2017), and most teachers only inform how to solve physics problems by using existing equations (Suryani, Harahap, & Sinulingga, 2017). Therefore, the physics teaching in today class is needed to be transform into more motivated and supportive way to learn by active involvement with the support of today's technology.

The concept of physics is physical know-how, that is students' gaining knowledge may be supported with the help of the media. Teachers, laboratory equipment, textbooks, scholar worksheets might not enough to attain the skills and learning preferences of each student. Computer and electronic generation could contain college students in various styles of science gaining knowledge, assist them to process facts, and develop cognitive skills in an extra individual manner than conventional teaching and learning models. Technology media can also help college students visualize summary standards and standards of physics. Other studies suggests that using smartphones could enhance learners' patience in learning, and enable them to have interaction in content advent and communication (Collete & Chiappetta, 1994). By using social media (Goksu & Atici, 2013). Applications on smartphones enable students to more actively discussing content with classmates and teachers, as well as allowing them to collaborate learning (Hamdani, 2013). Media in the form of smartphone applications could also improve students' scientific characters, such as curious, creative, and conscientious characteristics (Fatima & Mufti, 2014). Science learning is one of the characteristics of higher-order thinking skills. The results of previous research showed that smartphones are proven to provide students the opportunity to be active learner in learning activities.

2.2. Mobile Learning in Science and Previous Study

To date, pedagogy of mobile and ubiquitous learning has become more important in context of science education (Srisawasdi, Pondee, & Bunterm, 2018). Mobile learning provides possibilities for students to learn wherever and whenever, supports the learning process of Physics. It has been recognized as an efficient learning medium and facilitates conveyance of the materials or tools. Previous studies have found that mobile technology is able to support the involvement of students in creative, collaborative, critical, and communicative learning activities (Alhadi & Saputra, 2016). Mobile technology offers great affordances to support science learning (Crompton et al., 2017). With the capability to store a significant quantity of getting to know content (e.g., eBooks, videos, and audios) on a single device, mobile technology makes it less difficult for college kids to access statistics and manage academic resources. A growing wide variety of science education apps permit college students to conduct technology experiments, record data, and manipulate science simulations (Zydney & Warner, 2014). Internet-connected mobile devices also enable anytime and anywhere teacher-student and student-student interaction and communication. Teachers can use mobile devices to provide timely feedback to students, and students can use their mobile devices for self-directed remedial learning (Zhai, Zhang, & Li, 2018). Nonetheless, mobile technology research in science education has found inconsistent effect sizes on student achievement. A recent meta-analysis by that examined 27 mobile technology studies in science learning reported effect sizes ranging from .392 to .738 (Sung, Chang, & Liu, 2016). However, it was found a negative effect. Researchers call for innovative technology-integrated learning to make it possible to adopt new and arguably better approaches to instruction and/or change the content or context of learning. (Lawless & Pellegrino, 2007). Currently, 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). Studies on mobile learning in science education indicated that different tools/applications could be used to support science learning and that mobile devices with internet access could facilitate students' online investigations, such as simulations, video, and virtual labs (Nikolopouloul & Kousloglou, 2019).

3. Research Methodology

This resource of research study examined papers from SCOPUS database ranging from 2010 to 2019 by searching for the publications whose titles, abstracts, or keywords met the logical conditions. Such that, key words as "mobile" AND "physics" AND "learning" were used to select the items that are article on 12th November 2019. A total of 265 publications were found for this study. By removing 47 nonrelated-article papers, 36 papers were comprised in the present study related to mobile technology in physics learning course research. 47 non-related mobile technology in physics learning were excluded. Those are related to Computational thinking 25 papers, Biology 3 papers, Machine 4 papers, Environments 3 papers, Robots 3 papers, Chemistry 1 paper, Vehicle 1 paper, Mathematics 1 paper, Medical 1 paper, Neuropsychiatric 1 paper, Estimate human 1 paper, Schizophrenia 1 paper, Microwave circuits 1 paper, Physiological Measurement 1 paper, as display in Figure 1.

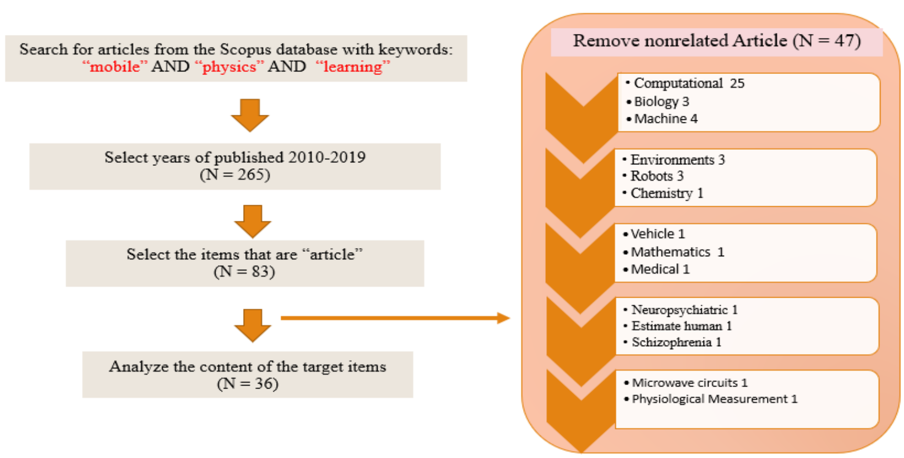

Figure 1. Scopus database searching steps.

4. Research Result

4.1. Years of Publication

There were 36 papers in this study. The papers were classified and reviewed by two researchers based on the coding scheme. If there were inconsistent coding results, we would discuss until agreement was reached. Those do not use abbreviations in the title or heads unless they are unavoidable. Figure 2 displays the papers on the application of mobile-based physics learning from 2010 to 2019. There were no literature reviews mobile-based physics learning in 2010, after 2010, one paper started published in 2013, then increased in 2014 with two papers and four papers in 2015, then decreased in 2016 to 2017. Academics attention to this field had increased in 2018 to 2019.

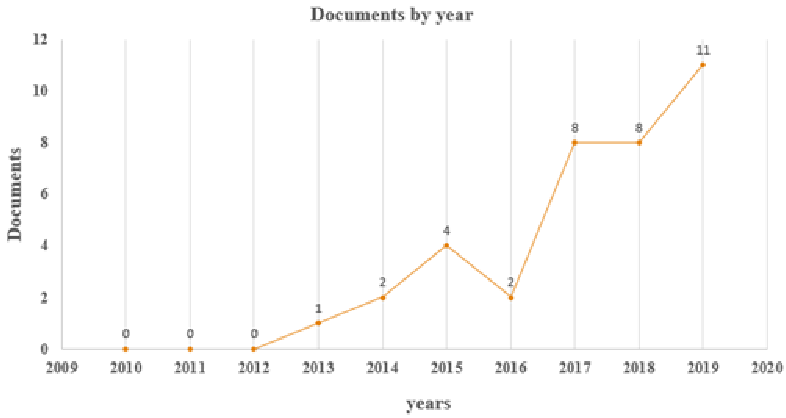

Figure 2. Years of published paper using mobile technology in Physics Learning Course from 2010 to 2019

4.2. Learning Strategies

The distribution of learning strategies applied in mobile-based physics learning from 2010 to 2019 is indicated in Figure 3. The greatest proportion is inquiry-based learning approach, with a total of 18 papers, while the second are research and development, blended learning and collaborative learning with each four papers. The third greatest is project-based learning, with a total of three papers. The forth learning strategy is problem-based learning with a total of two papers. Also, the fifth is STEM with a total of one paper.

Figure 3. Learning strategies

5. Conclusion and Discussion

A meta-review and analysis of using mobile technology in physics learning from 2010 to 2019 were performed in this study. The results in this study indicated that the quantity of studies increased over many years. Moreover, it was found that the number of publications which integrated the mobile technology in physics learning are greatly increased over the decades. It was also found that many studies used newly system development in the learning activities. This implied that numerous researchers have considered to develop the application of mobile devices in science by focusing on mobile technology in physics learning. In addition, mobile learning strategies have been less adopted in inquiry-based learning, research- and development-based learning, blended learning, collaborative learning, and STEM. In contrast, it was found that the number of studies using a newly system development has increased in recent years.

Acknowledgements

This research was financially supported by Graduated School , Science Education program Faculty of Education Khon Kaen University, Thailand. I would like to thank all members of Frontiers of Educational Science and Technology (FEST) Research Network, Thailand for their academic supports and inspiration about technology-enhanced learning in science.

References

Alhadi, S., & Saputra, W. N. E. (2017). The relationship between learning motivation and learning outcome of junior high school students in Yogyakarta,.In C. S. A. Jabar, L. Purnastuti, M. F. A. Ghani, M. Khairudin, S. Indartono, R. Utari, … F. Fatimah (Eds.), Proceedings of the 1st Yogyakarta International Conference on Educational Management/Administration and Pedagogy (YICEMAP 2017): *Advances in Social Science, Education and Humanities Research,* 66, 138-141.

Chang, C.-Y., & Hwang, G.-J. (2019). Trends in digital game-based learning in the mobile era: A systematic review of journal publications from 2007 to 2016. *International Journal of Mobile Learning and Organisation*, 13, 68-90.

Chiang, C. L., & Lee, H. (2016). The effect of project-based learning on learning motivation and problem-solving ability of vocational high school students, *International Journal of Information and Education Technology*, 6(9), 709-712.

Collete, A.T., & Chiappetta, E. (1994). *Science instruction in the middle and secondary schools*. New York, Macmillan Publshing Company.

Crompton, H., Burke, D., Gregory, K. H., & Gräbe, C. (2016). The use of mobile learning in science: A systematic review. *Journal of Science Education and Technology*, 25(2), 1-12.

de la Pena-Bandalaria, M. (2007). Impact of ICTs on open and distance learning in a developing country setting, The Philippine experience. *International Review of Research in Open and Distance Learning, 8*(1), 1-15.

Fatima, S., & Mufti, Y. (2014) Pengembangan media pembelajaran IPA -Fisika berbasis android sebagai penguat karakter sains siswa, *Journal Kaunia*, X (1), pp.59-64.

Gedgrave, I.. (2009). *Modern teaching of physics*, Delhi: Global Media.

Goksu, I., & Atici, B. (2013). Need for mobile learning: Technologies and 0pportunities, *Procedia Social and Behavioral Science,* 103, 685-694.

Hamdani, D. S. A. (2013). Mobile learning: A good practice, *Procedia Social and Behavioral Sciences*, 103, 665-674.

Hamm, S., Satsman, G., Jones, B., Baldridge, S., & Perkins, S. (1955). A mobile pedagogy approach for transforming learners and faculty, In Berge, Z., & Muilenburg. L. (Eds.) *Handbook of Mobile Learning*. NY: Routledge. New York.

Lawless, K. A., & Pellegrino, J. W. (2007). Professional development in integrating technology into teaching and learning: Knowns, unknowns, and ways to pursue better questions and answers. *Review of Educational Research*, *77*(4), 575-614.

Lim, K. Y. (2011). What does the Tablet PC mean to you?: A phenomenological research. *Innovations in Education and Teaching International, 48*(3), 323-333.

Mardiana,N., & Kuswanto, H. (2017) . Android-assisted physics mobile learning to improve senior high schools students' divergent thinking skills and physics HOTS, *AIP Conference Proceedings*. pp.1868.
Mcfarlane, D. A. (2013). Understanding the challenges of science education in the 21st century, New opportunities for scientific literacy. *International Letters of Social and Humanistic Sciences*, 4, 35-44.
Mundilarto. (2002) Kapita selekta pendidikan Fisika. *Yogyakarta*: Universitas Negeri Yogyakarta.
Nikolopouloul, K., & Kousloglou, M. (2019). Mobile learning in science: A study in secondary education in Greece. *Creative Education*, 10, 1271-1284.
Panjaburee, P., & Srisawasdi, N. (2018). The opportunities and challenges of mobile and ubiquitous learning for future schools: A context of Thailand. *Knowledge Management & E-Learning, 10*(4), 485-506.
Prieto, J. C. S., Migueláñez, S. O., & García-Peñalvo, F. J. (2014). ICTs integration in education, mobile learning and the technology acceptance model (TAM). In *Proceedings of the Second International Conference on Technological Ecosystems for Enhancing Multiculturality* (ed. García-PeñalvoF. J.), pp. 683-687. ACM.
Rusnayati, H., & Prima, E.C. (2011) Penerapan model pembelajaran problem based learning dengan pendekatan inkuiri untuk meningkatkan keterampilan proses sains dan penguasaan konsep elastisitas pada siswa SMA, *Proceedings of Seminar Nasional Penelitian, Pendidikan dan Penerapan MIPA*, Universitas Negeri Yogyakarta, pp.331-338.
Shaheen, R. (2010). Creativity and education, *Creative Education*, 1(3), 166-169.
Sharples, M., Taylor, J., & Vavoula, G. (2005). Towards a theory of mobile learning. In *Proceedings of mLearn*, 1(1), 1-9.
Serway, R. A., & Jewett, J. W.(2004). Physics for scientist and engineers, *6th Edition. United States*: Thomson Brooks/Cole.
Srisawasdi, N., Pondee, P., & Bunterm, T. (2018). Preparing pre-service teachers to integrate mobile technology into science laboratory learning: an evaluation of technology-integrated pedagogy module. *International Journal of Mobile Learning and Organisation, 12*(1), 1-17.
Sung, Y. T., Chang, K. E., & Liu, T. C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. *Computers & Education*, 94, 252-275.
Suryani, W., Harahap, M.B., & Sinulingga, K. (2017). The effect of scientific inquiry learning model using mind mapping and critical thinking ability toward student's science process skills in senior high school, *Jurnal Pendidikan Fisika,* 6(2), 86-90.
Traxler, J. (2007). Defining, discussing, and evaluating mobile learning: The moving finger writes and having writ. *International Review of Research in Open and Distance Learning, 8*(2), 1-12.
Ward, D. N., Finley, J. R., Keli, G. R., Clay, & G. Tansy (2013). Benefits and limitations of iPads in the high school science classroom and a trophic cascade lesson plan, *Journal of Geoscience Education, 1*(61), 378-384.
Zhai, X., Zhang, M., & Li, M. (2018). One-to-one mobile technology in high school physics classrooms: Understanding its use and outcome. *British Journal of Educational Technology*, *49*(3), 516-532.
Zhai, X., Sun, W., Guo, Y., & Zhang, M. (2016). Smart classroom: An evaluation of its implementations and impacts — based on the longitude data of physics learning in a high school. *China Educational Technology*, 356(9), 121-127.
Zydney, J. M., & Warner, Z. (2014). Mobile apps for science learning: Review of research. *Computers & Education*, 94, 1-17.