Mobile Technology in Teaching Physics

Suthichon Pokonwong[1,] and Pornrat Wattanakasiwich[1,2*]

1 Department of Physics and Material Science, Faculty of Science, Chiang Mai University, Chiang Mai, 50200, Thailand
2 Physics Education Research Laboratory, Faculty of Science, Chiang Mai University, Chiang Mai, 50200, Thailand
**Corresponding author. E-mail: pwattanakasiwish@gmail.com*

Physics Education Research Unit

Department of Physics and Materials Science,
Faculty of Science, Chiang Mai University, Thailand

ABSTRACT

This paper aimed to review literatures about how mobile phone is implemented in teaching physics from more than twenties papers in journals with a section on physics teaching such as Physics Education, European Journal of Physics, The Physics Teacher, American Journal of Physics, etc. In the past few years, technology of smart mobile phones has changed the way we lives and also are going to change the way we, as physics educators, teach. In this paper, a use of the smartphone for teaching physics was divided into five categories, according to applications (Apps). Firstly, the applications are used as a voting system. Secondly, the applications worked with built in sensors are for using as data collection instruments. Thirdly, the applications are for viewing teaching videos. Fourthly, the applications are used as a way for an instructor to communicate with students outside of the classroom. Fifthly, the applications with interactive simulation are used for students to learn from physics simulations or games. Examples of each category are given and discussed their possible implications for teaching physics.

LITERATURE REVIEW

The study began with a review of relevant literature on effective mobile technology in teaching and learning physics. A use of the smartphone for teaching physics was divided into five categories, according to applications (Apps). This is described in the next section.

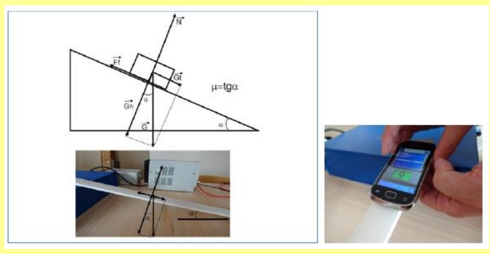

Figure 1. Determination of the friction coefficient on a slope using the smartphone

Mobile technology in physics teaching

1) **Use mobile app as a voting system.** Instant feedback is an important key to make an interactive classroom. With the wireless network and mobile technology, the classroom voting system is easy to setup and use. Stav et al. (2010) pointed out that a real-time feedback from using mobile voting system helped both students and teachers to adjust their teaching and learning to better match learning.

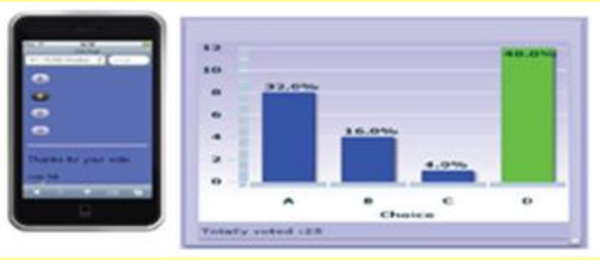

Figure 2. Using a mobile app as a voting system

2) **Use mobile sensor app for collecting data.** The applications working with built in sensors are for using as data collection instruments . For example, Martínez and Garaizar (2014) used mobile apps to measure a real motion and obtained an object's positions as a function of time. These data could be used to analyze other variables such as its velocity, acceleration and/or angular frequency. Vogt and Khun (2013) conducted a free fall experiment using mobile app. Acceleration along the x, y and z axes were displayed as graphs, as in Figure 3 (a). Moreover, there are also many mobile apps for generating, detecting sound, displaying sound wave and FFT analyzing peak frequency, as shown in Figure 3 (b).

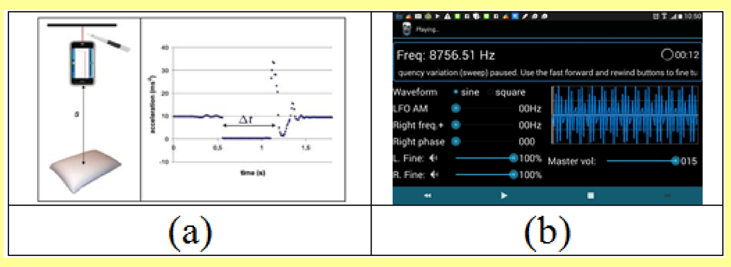

Figure 3. Mobile sensor apps for detecting (a) motion (b) sound wave

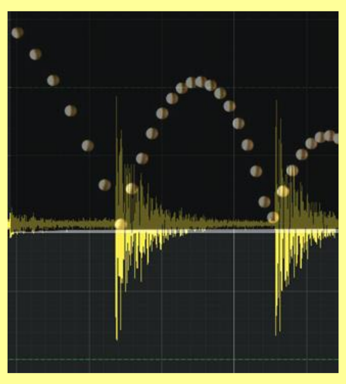

Figure 4. Determination of the critical sizes

Impact times	Calculated value of g (m/s^2)
$t_1 = 0.248$ s; $t_2 = 0.955$ s; $t_3 = 1.617$ s	9.82
$t_1 = 0.201$ s, $t_2 = 0.898$ s, $t_3 = 1.549$ s	10.06
$t_1 = 0.129$ s, $t_2 = 0.830$ s, $t_3 = 1.479$ s	9.77

Table 1. Determination of gravitational acceleration on the basis of three impact times, with an initial height of 0.7 m each time

3) **Use mobile app to learn or review lectures.** González et al. (2014) and Pargas and Speziale (2014) developed mobile app to include all teaching materials such as physics principles, equations and exercises. Their students found this app to be interesting and quite helpful because they could review materials anywhere at any time easily. Stojanovska et al. (2013) designed and created video presentations that could be viewed with a mobile app.

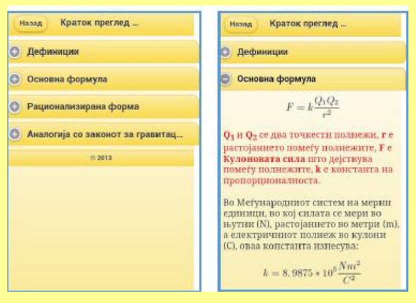

Figure 6. Overview of the lesson, with collapsible blocks of content

Figure 7. Video presentation of a physics lesson

4) **Use mobile app to communicate outside of a classroom.** Social media is part of today generation. A mobile app for social media makes communicate with students outside of the classroom easier. Students can also post their problems with homework or weekly assignment on the social media. Teachers can respond easily and other students can benefit from the teacher response as well.

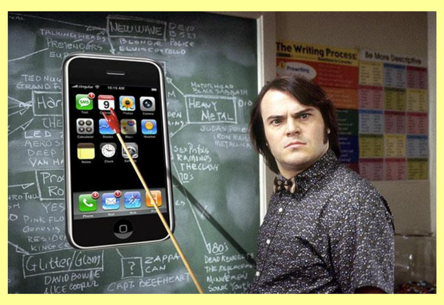

Figure 8. Teachers can respond easily with student

Figure 9. student can learning outside of classroom

5) **Use mobile app for adding visualization and simulation.** Physics contents require a nice visualization and display to convey correct understanding. Many mobile apps display and visualize both physics and related mathematics in various forms such as simulation, games, animations or videos. Figure 10 displays a snapshot from one mobile app to visualize a magnetic field direction. Anderson et al. (2014) used video games to support pre-service elementary teachers learning of basic physics principles. They found that a group of students learned using this game did significantly better on the post-test than a control group, as show in table 2.

Figure 10. Screenshot – Magnetic Field with a charge

Group	N	N_M	N_F	Pre-Test	Std. Dev	Post-Test	Std. Dev	Change
Experimental	71	30	41	6.2	1.70	9.4	1.20	3.2
Control	65	20	45	5.9	1.72	8.3	1.27	2.8

Table 2. Comparison of Means and Changes in Pre-Post Scores

CONCLUSION

From reviewing literatures in physics teaching, we found that mobile applications can be used to improve physics teaching in 5 different ways. Firstly, the applications are used as a voting system. Secondly, the applications worked with built in sensors are for using as data collection instruments. Thirdly, the applications are for viewing teaching videos. Fourthly, the applications are used as a way for an instructor to communicate with students outside of the classroom. Fifthly, the applications with interactive simulation are used for students to learn from physics simulations or games. All in all, mobile technology will become influential to how students learn physics in this 21st century.

ACKNOWLEDGMENTS

We would like to thank Thailand Center of Excellence in Physics (ThEP), Graduate school and Faculty of Science, Chiang Mai University, Thailand. We extend our appreciation to the Promotion of Science and Mathematics Talent Teacher (PSMT) for supporting the first author in conducting this research study.

REFERENCES

1. C. Wieman and K. Perkins, "Transforming physics education", Physics today 58.11 (2005) 36.
2. N. D. Finkelstein, W. K. Adams, C. J. Keller, P. B. Kohl, K. K. Perkins, N. S. Podolefsky, and S. Reid, "When learning about the real world is better done virtually: A study of substituting computer simulations for laboratory equipment", Physical Review Special Topics-Physics Education Research 1.1 (2005), 010103.
3. C. E. Wieman and K. K. Perkins, "A powerful tool for teaching science", Nature physics 2.5 (2006) 290.
4. N. Finkelstein, W. Adams, C. Keller, K. Perkins and C. Wieman, "High tech tools for teachingphysics: The physics education technology project", Journal of Online Learning and Teaching 2.3, 2006.
5. J. Kuhn and P. Vogt, "Applications and examples of experiments with mobile phones and smartphones in physics lessons", Frontiers in Sensors 1 (2013) 4.
6. M. Á. González, M. Á. González, C. Llamas, M.E. Martín, J. Vegas, Ó. Martínez, C. Hernández and M. Herguedas, "Mobile phones for teaching physics: using applications and sensors", Proceedings of the Second International Conference on Technological Ecosystems for Enhancing Multiculturality, ACM, 2014.
7. R. P. Pargas and B. J. Speziale, "Revamping the Classroom - Teaching Mobile App Software Development Using Creative Inquiry", in Proc. CSEDU 3 (2014) 71-79.
8. C. C. Chou, L. Block and R. Jesness, "A case study of mobile learning pilot project in K-12 schools", Journal of Educational Technology Development and Exchange 5.2 (2012) 11-26.
9. L. Martínez and P. Garaizar, "Learning Physics down a slide: A set of experiments to measure reality through smartphone sensors", International Journal of Interactive Mobile Technologies iJIM 8.3 (2014) 40.
10. J. Kuhn and P. Vogt, "Analyzing free fall with a smartphone acceleration sensor", The Physics Teacher 50.3 (2012) 182-183
11. M. Davidsson, "A Mobile Application With Embodied Multimodal Interactions for Understanding Representations of Motion in Physics", Proceedings of the IADIS International Conference on Mobile Learning, 2012.
12. P. Klein, M. Hirth, S. Grober, J. Khun and A. Muller, "Classical experiments revisited: smartphones and tablet PCs as experimental tools in acoustics and optics", Physics Education 49 (2014) 412.
13. M. Sievers, W. Reinhardt, D. Kundisch and P. Herrmann, "Developing Electronic Classroom Response Apps for a Wide Variety of Mobile Devices: Lessons Learned from the PINGO project", mLearn 955, 2012 .
14. CIORUŢA and M. COMAN, "The Idea of Implementing a Mathematics Platform form Android Devices with Help of App Inventor", Scientific Research & Education in the Air Force-AFASES 1, 2014.
15. F. Hao, D. Clarke and C. Shepherd, "Verifiable classroom voting: Where cryptography meets pedagogy", Springer Berlin Heidelberg, 2013
16. F. Hao, M. N. Kreeger, B. Randell, D. Clarke, S. F. Shahandashti and P. H. J. Lee, "Every Vote Counts: Ensuring Integrity in Large-Scale Electronic Voting", The USENIX Journal of Election Technology and Systems 1, 2014.
17. J. Stav, K. Nielsen, G. Hansen-Nygard and T. Thorseth, "Experiences Obtained with Integration of Student Response Systems for iPod Touch and iPhone into e-Learning Environments", Electronic Journal of e-Learning 8.2 (2010) 179-190.
18. M. Sievers, W. Reinhardt, D. Kundisch and P. Herrmann, "Developing Electronic Classroom Response Apps for a Wide Variety of Mobile Devices: Lessons Learned from the PINGO project", mLearn 955, 2012.
19. J. Anderson and M. Barnett, "Using video games to support pre-service elementary teachers learning of basic physics principles", Journal of Science Education and Technology 20.4 (2011) 347-362.
20. L. F. Stojanovska, "Design and Development of Interactive m-Learning Applications for Learning Physics", QUAESTI-Virtual Multidisciplinary Conference 1, 2013.