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Assessing the Use of Smartphone in the University General Physics Laboratory

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In this study, smartphone was used to alter the traditional procedure by involving students in active learning experiences prior to the laboratory meeting. The researcher surveyed students' view on the effect of using smartphone to enhance learning in the general physics laboratory. The use of smartphone was evaluated by having 120 students who enrolled in the Fall Semester 2013 at a Chinese university general physics laboratory fill out subjective opinion survey forms. Results showed smartphone was a very useful tool to provide background on the lab safety information, administrative requirements, general knowledge of physics lab equipment, but not very useful to show how to write a laboratory report. This was because the laboratory report evaluation was according to the individual instructor's specific preferences. Interestingly, it was also found male students prefer smartphone learning strategy more than female students, although no significance was presented.

Keywords: educational technology, physics education, smartphone

INTRODUCTION

Today's students live in a digital world. These students are called digital natives (Prensky, 2005; McLaren, 2008).Within the rapidly expanding technology marketplace, digital world is ubiquitous to their very being. Mobile devices provide a constant connection to the digital world. Education is no exception to this technical revolution. In higher education, these students are asking the question, "Why must I sit in class when I could have the professor's lecture on the Web? Is being in the classroom necessary?" Mobile devices now provide access to information and services that were previously available only on networked personal computers. The mobile devices currently supported by this mobile application are smartphones (e.g. iPhone, HTC and so on). Many colleges and universities deliver course content to their students via an internet browser. Mobile learning is a newly released mobile application that offers course content on mobile devices, giving students "anytime, anyplace" access to their blackboard courses (Lee & Chan, 2007). Mobile learning allows students not only to browse course content but also to interact with courses. For example, a student may read course discussion using his or her smartphone and then add comments to it.

Smartphone in education and technology enhanced learning has become popular

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in recent years. Smartphone put powerful, user-owned computing devices into the pockets of students and academic staff. It incorporate computing power and memory capable of running complex software and storing huge amounts of data. whilst ways of making use of smartphones in higher education have been explored since they first became available, building upon interest and innovation in the use of mobile technologies for learning. It is important, therefore, for educators to understand the potential of these devices to teaching and learning (Woodcock, Middleton, & Nortcliffe, 2012). Cochrane & Bateman (2010), reflecting on three years of action research into the pedagogical affordances of smartphones, correlate the user-centred and social value of Web 2.0 technologies to education with the smartphone's capacity to facilitate student-centred social constructivist pedagogies. In a study by Chen et al. (2013), A mechanism was proposed for integrating printed materials and digital content using smartphones. The pedagogical strategy of constructive feedback was designed to increase self-awareness,offer personalized suggestions, and encourage cognitive development..

State of the literature

- Mobile technology is beginning to change the way we learn. Mobile Learning offers course content on mobile devices, giving students "anytime, anyplace" access to their blackboard courses.
- Mobile learning allows students to use mobile devices to access educational resources, connect with others, or create content, both inside and outside classrooms.
- Making use of smartphone in education have been explored since they first became available. However, adoption of smartphone in physics education remain limited.

Contribution of this paper to the literature

- We used smartphone to alter the traditional physics laboratory experiments procedure by involving students in active learning experiences prior to the laboratory meeting.
- So the laboratory time can be devoted entirely to student scientific experimentation and to maximize the laboratory sessions' collaborative educational experience.
- The study showed that smartphone is a useful tool in the general physics laboratory learning, and male students prefer this learning strategy more than female students.

However, adoption of smartphone in physics education remain limited. The current governing pedagogical paradigm in most physics courses is still the lecture, in which the instructor presents material, usually based on the textbook or laboratory manual, to students in a classroom or laboratory environment. In the traditional general physics laboratory, the instructor often devotes an initial 40 minutes of a three-hour lab session to introducing the experiment, demonstrating the equipment set up, and responding to student questions about the experiment's theoretical or practical concepts. Students may spend little or no individual or group effort in preparing for the lab prior to the actual laboratory meeting. So the student does the experiment by following, step-by-step, the procedures in his/her laboratory manual and does not think about what is being done, or why. This traditional model stifles creativity and active learning in the classroom, denying students the opportunity to develop essential higher-order thinking skills. Inquiry-based, student-centered learning during the laboratory experiment requires that the student have prior basic knowledge of the theory, background, and procedures of the experiment (Bransford et al., 1999). New physics education strategies must be developed, incorporating the use of technology to streamline the curriculum and reform the pedagogical approach of education in the classroom or laboratory (Menkhoff et al., 2011). Smartphone assisted, student centered learning can not only provide this background information on the experiment in advance, and promotes the development and use of Bloom & Krathwohl (1984)'s higher level thought processes of data analysis, synthesis, and evaluation during the conduct of the laboratory experiment. It provides the beginning physics student with individualized instruction designed to maximize the laboratory sessions' collaborative educational experience by improving the student's advanced understanding of the basic concepts, techniques, and procedures covered by the laboratory experiment (Zielinski & Swift, 1997). So the laboratory time can be devoted entirely to student scientific experimentation and to maximize individual student-student and student-instructor contact.

Research focus

In this study, smartphone was used to alter the traditional procedure by involving students in active learning experiences prior to the laboratory meeting. Several different makers of smartphone are currently available. Popular manufacturers include Apple, HTC, Samsung, Nokia and so on. The cheapest smartphone made in China is below 100 Euro. Smartphone has become multi-functional, multimedia products that allow users to watch videos, and view digital photographs, Word, PowerPoint, Excel and other documents. The purpose of the study was to explore the influence of smartphone in physics laboratory experiments. The following question was used to support the survey:

1. Do students view the smartphone as a useful tool in the general physics laboratory learning?
2. Are male and female students different on view of effectiveness of smartphone assisted instruction?

METHOD

In this study, smartphone was used to link alter the procedure by involving students in active learning experiences prior to the laboratory meeting. The hypothesis is the smartphone can provide the general physics student with individualized, self-directed instruction designed to maximize the education experience of the laboratory meetings by improving student understanding of the basic concepts, techniques, and procedures covered in each laboratory experiment.

Sample of research

The projected sample was 124 students majored in electronics engineering who were taking the general physics laboratory course (PHYSLAB 1302) offered by the physics experimental teaching center at the University of Science and Technology Liaoning (USTL) during the Autumn semester of 2013. PHYSLAB 1302 is 3-credit physics laboratory experiments course for students majoring in engineering. Altogether 120 students completed the survey for analysis. 80 participants (67%) were male and 40 participants (33%) were female.

Instrument and procedures

The instrument used to evaluate the effectiveness of the smartphone was a survey. Smartphone users (students) and instructors completed the survey forms that were previously approved by the USTL institutional research board. The survey forms contained two-part questions designed to evaluate the smartphone's effectiveness as an instructional tool to introduce the beginning general physics laboratory.

The part 1 of survey form contains 4 items that ask students to rate their agreement using a five option Likert scale, that ranges from strongly disagree (1) to strongly agree (5) to probe students' view about the availability of smartphone in the general physics laboratory learning as follows:

Q1: The smartphone provides information and administrative requirements for working safely in the general physics laboratory.

Q2: The smartphone provides background on the basic concepts used in the physics laboratory.

Q3: The smartphone improves general knowledge of physics lab equipment.

Q4: The smartphone shows how to write a good laboratory report.

Additionally, part 2 of survey forms solicits the recommendations on improving the smartphone instructional tool's effectiveness.

The programs required students download physics experiments instructional content from USTL physics experimental teaching center web site to their smartphones. These documents styles included Word, PowerPoint, Excel, video, graphic figures and so on.This permits the student to review the background, special safety precautions, and equipment set up for each experiment at home or class before performing the actual experiment in the laboratory. The student may view the content as many times as necessary. The downloaded content contained two parts: 1. Introduction to the general physics laboratory: course syllabus, course administrative requirements/grading policies, safety orientation, laboratory equipment, and procedures of laboratory report. 2. Laboratory experiments: measurements and data handling, 9 general physics experiments. It provided theoretical construct, statement of the problem and the hypothesis, setup, lab procedures and methods of recording experimental data. Fig. 1 is a screenshot of a smartphone on spectrometer experiment.

Data analysis

The data of the smartphone evaluations were obtained at the end of the fall semester 2013. The survey forms were then analyzed and evaluated. In addition to descriptive analysis, nonparametric statistic (Mann-Whitney U test) was used in this study. All statistical procedures were performed with the Statistical Package for the Social Science (SPSS version 19.0). The statistical significance in this study was set at a .05 level with two-tail tests.

Figure 1. A screenshot of a smartphone

RESULTS

The purpose of this study was to investigate effect of the smartphone as a tool in the general physics experiment courses from the students' view. Students' overall responses of smartphone assisted learning is summarized in Table 1, the number of students is presented in the brackets.

Do students view the smartphone as a useful tool in the General Physics Laboratory learning? The comments below summarized the overall responses on the survey forms.

Q1: The smartphone providing information and administrative requirements for working safely in the general physics laboratory was rated as "agree" or better by 96% (115 out of 120).

Q2: The smartphone providing background on the basic concepts used in the physics laboratory was rated as "agree" or better by 98% (118 out of 120).

Q3: The smartphone improving general knowledge of physics lab equipment was rated as "agree" or better by 99% (119 out of 120).

Q4: The smartphone showing how to write a good laboratory report was rated as "agree" or better by 23% (27 out of 120).

Are male and female students different on view of effectiveness of smartphone assisted instruction? Variability of results at the likert scale is very small, nonparametric statistic (Mann-Whitney U test) was used. When comparing the survey results to determine whether there were differences between male and female participants, it was found that although the mean scores from male participants on all the four questions were higher than the mean scores for female participants, however, no significant differences by gender were found. The means, standard deviation, and the Mann-Whitney U test of the responses compared by gender are presented in the Table 2.

Although the smartphone assisted learning in this study was viewed as a useful tool to provide information on working safely in the general physics laboratory, background on the basic concepts used in the experiments, and general knowledge of physics laboratory equipment (survey questions 1-3). However, the rate which students (Both the male and female students) expressed agreed the smartphone was

Table 1. Students' overall responses of smartphone assisted learning

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Q1	25%(30)	71%(85)	4%(5)	0%(0)	0%(0)
Q2	23%(28)	75%(90)	2%(2)	0%(0)	0%(0)
Q3	24%(29)	75%(90)	1%(1)	0%(0)	0%(0)
Q4	2%(2)	21%(25)	71%(85)	7%(8)	0%(0)

Table 2. Gender comparison on view of effectiveness of smartphone assisted instruction (M=Male, F=Female)

	Gender	Mean	SD	U	z	p
Q1	**M**	4.23	0.503	1528	0.40	0.69
	F	4.18	0.501			
Q2	**M**	4.25	0.436	1528	0.78	0.44
	F	4.15	0.483			
Q3	**M**	4.26	0.443	1471	0.72	0.47
	F	4.17	0.446			
Q4	**M**	3.20	0.488	1555	0.25	0.80
	F	3.12	0.686			

useful to correctly write a physics laboratory report was much lower than the rate of Q1, Q2 and Q3 respectively.

Additionally, part 2 of survey forms solicits the recommendations on improving the smartphone instructional tool's effectiveness. Most students indicated that the content needs more videos or detailed information on using software to analyze experimental data, and telling them what was important. A student said, "I think that using mobile phones enables us to learn many skills and a lot of knowledge within a short time, and I feel comfortable when I use the mobile phone for educational purposes because it saves time and effort. However, it is better to offer more information on using the EXCEL or other software to plot and then run a regression on the data." Another student stated, "I learned about safety information, administrative requirement, and how to do the experiments, but sometimes it was hard to analyzing experimental data and write a better laboratory report, so it needed more information on these problems, it should combine the instructor's personally demonstration how the laboratory reports should be completed." A teacher said, "I hope that the faculty members communicate with their students by using the mobile phone for the educational purpose, smartphone should provide interactive user forums that help build a community for the students, professors, and teaching assistants."

DISCUSSION AND CONCLUSION

Smartphone is a newly released mobile application that offers course content on mobile devices, giving students "anytime, anyplace" access to their blackboard courses. Mobile learning is becoming an increasingly promising way of delivering instruction in higher education (El-Hussein & Cronje, 2010).Students are regarded as pioneers in forcing the faculty to change and adapt m-learning (Franklin, 2011).Mobile learning has the potential to transform learning from being highly intentional, structured, and directed, to an experience that is able to value informal and open learner-centered activity more continues to warrant consideration, for example in the design of tasks and learner engagement with the curriculum in general. In a study by Heath et al., (2005), mobile devices and mobile applications increased students' perception of their confidence with course content. By quickly accessing course documents and uploading and posting course content anywhere, students highlighted the advantages of using mobile devices in learning and spoke of the value of mobile learning as defined by Traxler (2010) and Sharples et al., (2007). AL-Fahad (2009) conducted a study to identify the female students at King Saud University in Saudi Arabia towards the use of the mobile phone in education. The results indicated the students' preference for using the mobile phone in their learning regardless of time and place. The mobile phone enabled them to communicate easily with each other, and to exchange information and data related to their instructional materials. Students described how they were able to communicate more with each other because of the mobile tools. Smartphones are becoming increasingly popular and their capacity is continuously improving, which should lead to a great potential for integrating printed materials and digital content in the future. Learning with mobile devices can help us to achieve educational goals if used through appropriate learning strategies (Jeng et al., 2010).

This study showed that the use of smartphone to assist learning in the general physics laboratory was viable and can supplement the traditional methods such as lectures or class presentations. Smartphone was a very useful tool to provide background on the lab safety information, administrative requirements, general knowledge of physics lab equipment and background on the basic concepts; however it was not a better tool to show how to write a lab report. This was significant because the laboratory report evaluation was according to the individual instructor's specific preferences; the instructors prefer to personally demonstrate how the laboratory reports should be completed. It indicated that maintaining the laboratory report was not a topic should be presented to the students in standardized manner. Interestingly, it was found that male students prefer the smartphone learning more than female students, although no significance was found. Maybe female students like face to face instruction more than technological instruction.

Recommendations for further research

Recommendations for further research are generated as follows:

1. It is recommended that a study must be conducted to have an objective evaluation such as pre-test and post-test to the students. This study was just a subjective evaluation.
2. It is recommended that this study must be extended to solicit evaluation from the instructors as an important supplement.

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REFERENCES

Al-Fahad, F.N. (2009). Students' attitudes and perceptions towards the effectiveness of mobile learning in king Saud University, Saudi Arabia. *The Turkish Online Journal of Educational Technology, 8*(2), 111-119.

Bloom, B. S., & Krathwohl, D. R. (1984). *Taxonomy of educational objectives book 1: Cognitive domain*. Addison Wesley Publishing Company.

Chen, N. S., Wei, C. W., & Huang, Y. C. (2013). The integration of print and digital content for providing learners with constructive feedback using smartphones. *British Journal of Educational Technology*, *44*(5), 837-845.

Cochrane, T., & Bateman, R. (2010). Smartphones give you wings: Pedagogical affordances of mobile Web 2.0. *Australasian Journal of Educational Technology, 26*(1), 1-14.

El-Hussein, M. O. M., & Cronje, J. C. (2010). Defining mobile learning in the higher education landscape. *Educational Technology & Society, 13*(3), 12-21.

Franklin, T. (2011). Mobile Learning: At the Tipping Point. *Turkish Online Journal Of Educational Technology-TOJET, 10*(4), 261-275.

Heath, B. P., Herman, R. L., Lugo, G. G., Reeves, J. H., Vetter, R. J., & Ward, C. R. (2005). Project Numina: Enhancing student learning with handheld computers. *IEEE Computer Society, 38*(6), 46–53.

Jeng, Y.-L., Wu, T.-T., Huang, Y.-M., Tan, Q. & Yang, S. J. H. (2010). The Add-on Impact of Mobile Applications in Learning Strategies: A Review Study. *Educational Technology & Society, 13*(3), 3-11.

Lee, M.J., & Chan, A. (2007). Pervasive, lifestyle-integrated mobile learning for distance learners: An analysis and unexpected results from a podcasting study. *Open Learning, 22*(3), 201-218.

McLaren, S. V. (2008). Exploring perceptions and attitudes towards teaching and learningmanual technical drawing in a digital age. *International Journal of Technology and Design Education, 18(2)*, 167-188.

Menkhoff, T., Thang, T. Y., Chay, Y. W., & Wong, Y. K. (2011). Using web-based ICT in learning: A case study of a knowledge management programme. *The Journal of Information and Knowledge Management Systems, 41*(2), 132–151.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (1999). *How people learn: Brain, mind, experience, and school*. National Academy Press.

Prensky, M. (2005). Listen to the natives. *Educational leadership, 63*(4), 8–13.

Sharples, M., Taylor, J., & Vavoula, G. (2007). A theory of learning for the mobile age. In R. Andrews & C. Haythornthwaite (Eds.), *The Sage handbook of E learning research* (pp. 221–247). London: Sage.
Traxler, J. (2010). Distance education and mobile learning: Catching up, taking stock. *Distance Education, 31*(2), 129–138.
Woodcock, B., Middleton, A., and Nortcliffe, A. (2012). Considering the smartphone Learner: an investigation into student interest in the use of personal technology to enhance their learning. *Student Engagement and Experience Journal, 1*(1),1-15.
Zielinski,T. J., & Swift, M.(1997). *Using computers in chemistry and chemical education.* American Chemical Society.

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