Exploring the Affordances of iPad in Learning Physics

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Abstract

The emergence of iPad and tablet PCs has generated much interest in how mobile computing may transform learning and teaching. The convergence of learning and technology has led to studies on mobile learning or m-learning, and its impact on formal and informal education (Sharples, Taylor, & Vavoula, 2007; McFarlane, Roche, & Triggs, 2007; Laurillard, 2007).

This paper aims to share the preliminary experience of leveraging iPad as a key mobile learning tool for secondary school students in learning physics. The content and instructional objectives for the physics lessons are aligned with a school-based learning framework. The affordances of iPad with regards to software applications, content and features that support learning would be explored. The variety of learning activities within and beyond the classroom, as well as shifts in pedagogy would also be discussed. Challenges faced by the teacher and students would be shared.

Keywords: mobile learning, affordances, iPad, physics

Introduction

With the convergence of learning and technology, Sharples, Taylor, & Vavoula (2007) noted that "education in the mobile age does not replace formal education, …; rather it offers a way to extend the support of learning outside the classroom, to the conversations and interactions of everyday life".

This in a way sums up the idea of mobile learning or m-learning which this paper is exploring with the use of iPad. Sharples et al. (2007) compared features of the "new learning" with the "new technology" to illustrate the convergence. The new technology is personal and supports personalized learning. It is user-centred just like learner-centred learning. It is ubiquitous, mobile and networked and allows for ubiquitous collaboration of the learners.

How mobile devices are used in schools for teaching and learning was studied by McFarlane, Roche, & Triggs (2007). They observed shifts in the way teachers teach and their students learn. Teachers would like to create more democratic learning environments, and to provide for more autonomous and personalized student learning. The learners using mobile learning devices appeared to have higher level of motivation and engaged in more out-of-school learner-directed activities related to the school curriculum.

In the context of mobile learning, Laurillard (2007) proposed and described how a Conversational Framework provides a means to analyze how a teaching method and a technological tool contribute to a learning process. Using the framework, Laurillard postulated that compared to a traditional learning activity, a "m-learning activity could build in more opportunities for digitally-facilitated site-specific activities, and for ownership and control over what the learners do".

In supporting the use of mobile learning, Low (2007) believed that "mobile devices support and encourage pedagogically sound teaching and learning practices, such as sharing, collaboration, and "building" of knowledge" and that "this mobile interaction, sharing, and collaboration can facilitate learning aligned with the principles of socially constructivist pedagogies". Low also highlighted the increasing importance of mobile literacy, as he observed that digital mobile devices have become the "industry standard equipment" for many industries and professions.

Currently in our context, physics education faces two challenges. Firstly, there is a declining enrolment of physics students beyond secondary education, a trend that would result in a shortage of engineers and related scientists in future. Secondly, female students' preference for subjects which have more "social relevance" also contribute to the decline in physics enrolment. Strategies to improve students' engagement in learning physics, such as mobile learning, could help to increase their interest in physics-related careers in future.

Methods

Our school decided to explore the use of a mobile device as part of our P21C^2 (Prototype 21st Century Classroom) pilot project this year. Two secondary 1 classes and two secondary 3 classes of students were selected for this pilot phase. The school loaned iPads to all students and teachers involved. All subject teachers of these classes undergone some basic training to use the device and design lessons to integrate its use in the classroom and beyond.

The iPad was chosen over other devices based on the following features: quick start-up and shut down, long battery life, light weight (Wifi + 3G model: 0.73 kg for iPad and 0.607 g for iPad 2) and suitable display for multimedia and inputs (P21C2, 2011a).

The iPad has the following user-friendly features:
1. The gadget has a user-interface so easy to use that anyone can grab it and use it right away without any training.
2. The user does not need to grapple with conventional desktop features such as multiple folders/files, software configurations, keyboard/ mouse operations.
3. The gadget is a "morphing information appliance" that has a touch interface that adapts to any specialized task with any required buttons/icons at the right place.

The iPad has many apps (applications) in many categories available at the online Apple Store. These apps cover various functions and subjects, most are affordable, many are free, and all are easy to install.

A school-based learning framework for P21C^2 which Engage, Excite and Empower the learners (Figure 1) was used to design the lessons (P21C2, 2011b). The framework seeks to enhance the quality of learning with several instructional strategies which promote:

- Student construction of knowledge
- Explorations into interdisciplinary connections
- Critical and metacognitive reflection
- Real life connection and application
- Differentiation for different student readiness and learning styles

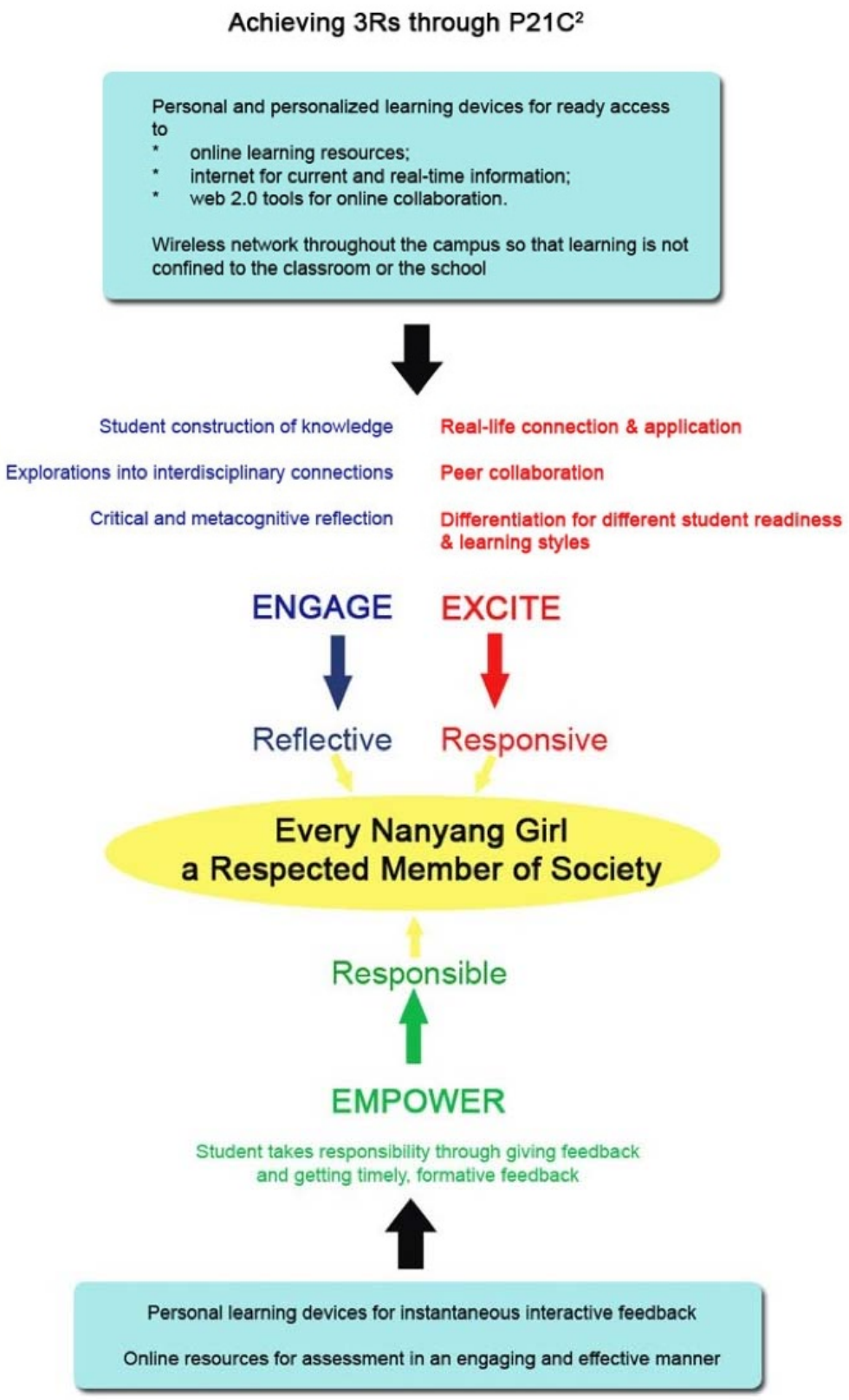

Figure 1. School-based Learning Framework

Teaching and Learning Resources and Platforms

Subject teachers design lessons to tap on the affordances of iPad to enhance teaching and learning. For each physics topic, interesting and authentic resources were used in conjunction with suitable and interesting apps (software applications from the Apple Store) and web tools to design lessons as illustrated in Figure 2.

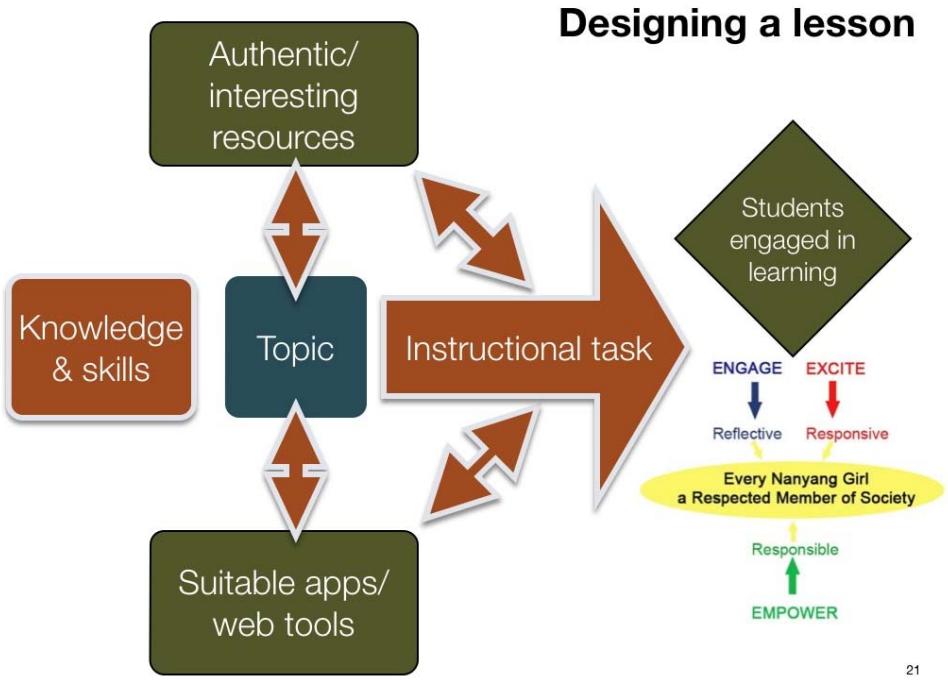

Figure 2. Designing a physics lesson.

Examples of how lesson resources and activities are used are shown in Table 1 based on the affordances of the iPad, using the categories of topic, resource type, role of resource and learning framework. The examples are mostly based on Secondary 1 physics lessons conducted by this author for the two secondary 1 pilot classes.

Topics	Resource Type	Role of Resource	Learning framework
All topics	wiki: pbworks.com	Upload lesson materials and resources for student access; Provide forum discussion by students on teacher-directed topics Provide sharing platform for student-directed queries	Online resources & collaboration
All topics	App: eClicker	Use wiki to deliver instant quiz and feedback	Formative assessment and feedback
Use of Bunsen burner	App: YouTube	Stream video clips from YouTube	Real life connection and application
Units	App: Convert Units	Conversion of units for most physical quantities	
Time	wiki: pbworks.com	Sharing by students on specific teacher-assigned questions based on internet research done.	Real life connection and application

Topics	Resource Type	Role of Resource	Learning framework
Time: simple pendulum	App: Spring 'n Things	Simulation of a simple pendulum with control of variables like gravity, air resistance	
Time	App: Metronome	Example of application of period and frequency	
Time	App: SPARKvue	Acceleration vs time graph - detection of vibrations by accelerometer in iPad	
All topics	App: Total Recall	Create mind maps	Student construction of knowledge
Temperature	wiki: pbworks.com	Post mind maps created by students for sharing and feedback	Online collaboration
Transfer of Thermal Energy	App: Photo Booth - using camera on iPad2	Using "thermal camera" mode to highlight "thermal radiation"	
Thermal properties	App: BounceBounce	Simulation of behaviour of molecules in a liquid	
Kinematics (Sec 3)	Using camera on iPad2	Capture video clip of laboratory practicals, e.g. a physics demonstration, motion of a ball	
Kinematics (Sec 3)	App: Video Physics	Analyze video clip of motion with quick plotting of graphs	Student construction of knowledge
Beyond syllabus enrichment: Tsunami	App: Keynote App: YouTube	Create slides to inform students of science and impact of tsunami Show animation of tsunami	Real life connection and application
Beyond syllabus enrichment: Nuclear Crisis	App: Keynote App: Mobile REMM	Create slides to inform students of science and impact of tsunami Provide information of types of radioactive elements, effect of radiation on human beings, type of treatment	Real life connection and application
Beyond syllabus enrichment: Exoplanets	Apps: NASA, Planets, Exoplanets, TED Internet resource Physics Ethics	NASA: Provides updated information, images and videos of space exploration; Planets: Provides information on planets Exoplanets: provides database of exoplanets and correlation diagrams; TED: streams video clips (also allow video downloads) of inspiring speakers. Group discussion on physics ethics of "space exploration"	Real life connection and application Collaboration

Table 1. Lessons resources based on the affordances of iPad.

Results & Discussion

At the end of one term of teaching the iPad classes, a survey was conducted to evaluate students' response to the use of the iPad in their learning. A total of 29 responses (out of 58 students) were obtained through the online survey (using SurveyMonkey). Questions 1 and 2 elicit information on name (optional) and class.

Question 3: Select the option that best describes how you feel about the given statement on iPad use.

The survey results (Table 2) suggest that most of the students (respond true some or most of the time)

- are comfortable with the use of the iPad (86.2%);
- can easily download and use new free Apps from the online Apple Store (96.5%);
- can easily follow the teacher's instructions in using the new Apps (96.6%); and
- can easily organize subject materials on their iPad (93.1%).

	True almost all of the time	True some of the time	Not true some of the time	Not true almost all of the time
I am comfortable with using the iPad.	**51.7% (15)**	34.5% (10)	10.3% (3)	3.4% (1)
I can easily download and use new free Apps.	**86.2% (25)**	10.3% (3)	0.0% (0)	3.4% (1)
I can easily follow the teacher's instructions in using new Apps.	**69.0% (20)**	27.6% (8)	0.0% (0)	3.4% (1)
I can easily annotate reading materials on my iPad.	37.9% (11)	**41.4% (12)**	17.2% (5)	3.4% (1)
I can easily organize my subject materials on my iPad.	**58.6% (17)**	34.5% (10)	6.9% (2)	0.0% (0)

Table 2. Results of Question 3.

It also indicates that there is significant difficulty associated with the annotation of reading materials using the iPad. On the ease of annotating reading materials on their iPad, only 37.9% indicate true most of the time while a larger group 41.4% indicate true some of the time. This difficulty is also reflected in the open-ended responses to question 5 below.

Question 5: List some ways in which the use of iPad in learning caused difficulties for yourself.

Key difficulties mentioned by the students include:

1. Difficulty in note-taking or making annotations: These includes some complexity in the use of the annotation apps for pdf files, the handling of equations in Maths or Physics, the discomfort in use of fingers for screen interaction or drawing, which makes the annotation process time consuming and tedious.
2. Difficulty with organizing materials for learning: File management processes of saving, uploading, downloading and printing of files are different from those in PC systems; some complexity and unfamiliarity makes it tedious.
3. Technical limitations: The students' iPad is a wifi model (not 3G), so internet access is not available all the time. This is taxing to students when much learning resources are posted online for student access.
4. Self-discipline: The presence of the iPad provides a strong temptation for the students to surf the net, play online games or explore new apps. This can be a major distraction from meaningful learning.

Although the survey was conducted by the author, the physics teacher of the respondents, the survey questions 3 and 5 did not focus on the use of iPad in physics class, so the responses here could be an overall response to their learning experience with iPad in all their subjects. For example, responses mentioned the subjects Mathematics and Chinese.

Question 4: Select the option that best describes how you feel about the given statement on iPad use.

The survey results (Table 3) suggest that most of the students (respond Strongly Agree or Agree)

- like to use the iPad for learning (82.8%);
- find iPad apps in physics interesting for learning (86.2%);
- feel the iPad allows them to share ideas and asks questions easily online (86.2%);
- feel the iPad has helped made learning more interesting (96.5%); and
- use the iPad not just for learning school subjects (93.1%).

	Strongly Agree	Agree	Disagree	Strongly Disagree
I like to use the iPad for learning.	34.5% (10)	**48.3% (14)**	17.2% (5)	0.0% (0)
iPad apps in physics are interesting for learning.	27.6% (8)	**58.6% (17)**	13.8% (4)	0.0% (0)
The iPad allows me to share ideas and ask questions easily via the internet.	**48.3% (14)**	37.9% (11)	13.8% (4)	0.0% (0)
Using the iPad has helped to widen my knowledge in physics.	20.7% (6)	**51.7% (15)**	27.6% (8)	0.0% (0)
Using the iPad has helped made learning more interesting for me.	44.8% (13)	**51.7% (15)**	3.4% (1)	0.0% (0)
I would recommend that other classes also use the iPad.	31.0% (9)	**48.3% (14)**	20.7% (6)	0.0% (0)
I use the iPad not just for learning school subjects.	41.4% (12)	**51.7% (15)**	6.9% (2)	0.0% (0)

Table 3. Results of Question 4.

To a lesser extent, many of the students (respond Strongly Agree or Agree)

- feel the use of the iPad has helped to widen their knowledge in physics (72.4%); and
- would recommend other classes to use the iPad (79.3%).

Question 6: Suggest how the use of iPad for lessons may be improved.

Key suggestions proposed by the students include:

1. More educational apps could be used, with teacher demonstration of use and students given sufficient time to explore an app before a lesson.
2. More online discussions could be included in lessons.
3. Extend the use of iPad to research, projects, lab experiments and class quizzes.

Interestingly, one student suggests that "more authority should be given to the students about how the lessons are carried out. The students can be tasked to plan their own lesson and present it to the teacher." This demonstrates a clear desire for greater autonomy in learning. This student is ready to take on greater ownership for personalized learning. Another important feedback is many students' preference for hardcopies of notes and worksheets to allow for easy writing and annotation. This is consistent with the students' perception of difficulty in note-taking or annotation, as reflected in their response to Questions 3 and 5 earlier. The students' suggestions also indicate a mixture of preference on the frequency of iPad use in class, with some wishing for more frequent usage and others less.

As a physics teacher, the author faced the following challenges:

1. exploring and employing a suitable file management system, that is easy for teacher and students to use;
2. exploring and selecting suitable apps and internet resources for class and independent learning;
3. providing timely and sufficient instructions for students to utilize apps effectively;
4. designing lessons with sufficient scope for discussion in class and out of class;
5. organizing and updating the physics wiki to encouraging online discussions and to keep up with lessons and students' needs.

To put things in perspective, not every lesson may need the use of the iPad or some form of internet-based resource or app. Most ways of using the lesson resources described earlier are applicable to any equivalent PC tablets, other than the iPad. Due to some commercial interest policy, the iPad currently does not support flash and java applets and animations.

Conclusion

The students' response in the survey indicates a generally positive attitude towards the use of iPad to enhance the quality of learning through a variety of apps- and internet-infused lesson activities. Their concerns about some learning difficulties such as making annotations and overcoming distractions from meaningful learning need to be addressed. Scaffolding on the use of suitable annotation apps with a stylus pen and sufficient standardized practice may be helpful to students. The school has also spoken to parents and supported the students in drawing up a code of conduct on appropriate use of the device and time management.

Future research may focus on the motivational levels and cognitive development of the students as well as the nature of student learning activities beyond the classroom.

The ubiquitous availability of iPad as a mobile learning device allows immediate searching of resource or information on internet, or sharing of ideas on an online platform, which also acts as a repository of process knowledge. The iPad has the potential to enhance the teaching and learning in an increasingly wirelessly connected world, where mobile learning would become the norm. In conclusion, using mobile learning is about changing the way we teach with the way students best learn.

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