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Trigonica: An Interactive iOS Application for Learning Trigonometry

Pattapol KONGWATTANANON , Lavalin KANJANABOSE, Krittaya LEELAWONG* & Chinda TANGWONGSAN
Mahidol University International College, Thailand
*ickrittaya@mahidol.ac.th

Abstract: Fitting a whole lesson in a mobile phone is not easy, especially when we wish to enhance the user's experience to motivate his or her learning. The application has to provide contents and assessments in a way that is attractive to the user and digested enough to be used in a short time frame while waiting for friends or buses but also can be used for a full review of the materials. Trigonica introduces the concepts of trigonometry in three short lessons with hand-on activities. The learner can take a dynamic quiz after each lesson and also a comprehensive quiz. The user can also share their experience with his or her community via Facebook posts after finishing a quiz.

Keywords: trigonometry, m-learning, iOS learning app

1. Introduction

Many students in Thailand found that trigonometry was difficult to interpret. By studying trigonometry, it was likely that individuals had to deal with different kinds of technical elements described under strict contents (Yoshiwara & Yoshiwara, 2007). With various complicated functions provided, those who feel learning was not worth the effort vaguely approached main conception of trigonometry study.

Trigonometry was introduced as one of the fundamental functions in mathematics (Math Academy Online / Platonic Realms, 2011). Trigonometry did not only provide ways to calculate angles and sides of triangles, but its concept of measurement also could be applied in other fields of study and in real life. However, in our informal interview, students tended to believe that the hardest subject of mathematics was still trigonometry.

Therefore, we hypothesized that technology could change their attitude. Nowadays technologies were ubiquitous, and computers were integrated with our everyday's lives (Jones & Jo, 2004). Examples of ubiquitous technology were microprocessors, mobile phones, and many other devices. Such technology had been used in education in various learning activities, such as augmented reality that combined computer generated images with the human visual system to create the augmented display (Azuma, 1997), and e-learning as education that students could access online (Jones & Jo, 2004). The same concept of e-learning could be applied to m-learning (Jones & Jo, 2004). Instead of using cursor pointing on screen, many ubiquitous devices let the user interact with applications by touching directly on screen. In addition, a number of these devices allows multi-touching that could further enhance the user's experience in interacting with the devices.

2. Previous Work

There were not many iOS applications supporting trigonometry learning. Some of them offered only formula sheet while some others were traditional offering readings and quizzes. Some had interactions but offered no assessment.

Feature / Application	iFormulas	Khan Academy: Trigonometry	Triangle Solver	Trigonometry for iPhone	Trigonometry Help	Trigonometry Tutor
Lessons		✔		✔		✔
Formula Sheet	✔					✔
Images/Graphs/Diagrams		✔		✔		✔
Quizzes				✔		
Community Connection						
External Feedback						
Interaction with App			✔		✔	

Figure 1 Some Features of iPhone Applications for Trigonometry in the App Store in May 2011

3. Designs and Features

We would like our app to be a complete learning package. Therefore, we followed the How People Learn framework (Committee on Developments in the Science of Learning, 2000) that suggested four components of an effective learning environment--learner-centered, knowledge-centered, assessment-centered, and community-centered. The learner-centered aspect concentrates on learners being active and constructive in a learning environment. The knowledge-centered specifies that learning is effective when students can acquires knowledge and skills necessary to understanding and transferring of that knowledge. The assessment-centered focuses on giving learners opportunity to evaluate and reflect on their knowledge in both formative and summative forms. Finally, the community aspect enhances the social aspects of learning that involve learning from and working with people in the society. These four aspects are not exclusive, as shown in Figure 2; they have to be designed to interact and integrate with each other to make learning effective.

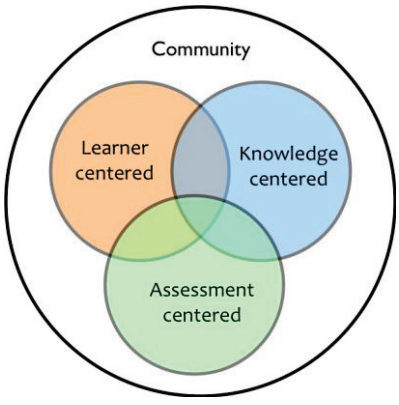

Figure 2 Framework for Effective Learning Environments

To support the HPL framework, Trigonica had three main components, incremental lessons, dynamic quizzes, and interactivities. The community aspect was supported lightly by enabling sharing of the quiz score via Facebook to generate competitiveness. The three incremental lessons were an introduction to trigonometry, functions, and identities, respectively, as shown in Figure 3. Sample contents of each of the three lessons were shown in Figure 4 to Figure 6. The learner could start reading from lesson 1 or skip between lessons in any order. The formulas and interactive illustrations were collected in two separate pages for quick reference, as illustrated in

Figure 7 and Figure 8. The user can switch from one section to another at any time.

Figure 9 to Figure 12 displayed fours of the interactive illustrations. Users interacted with these illustrations by pinch their fingers in and out to explore the graphs, or dragged the corners of right triangle or unit circle to explore the values that were automatically calculated according to the chosen functions.

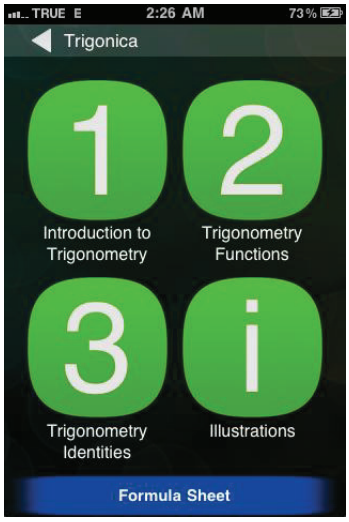

Figure 3 The Main Page of the Study Section

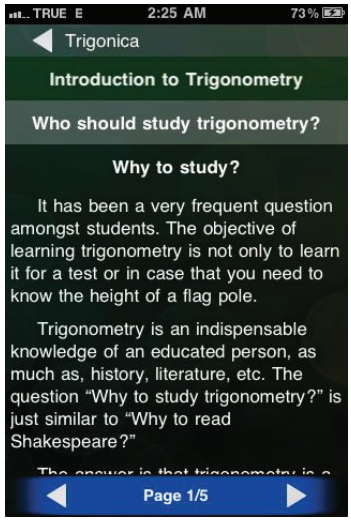

Figure 4 Lesson 1: Introduction to Trigonometry

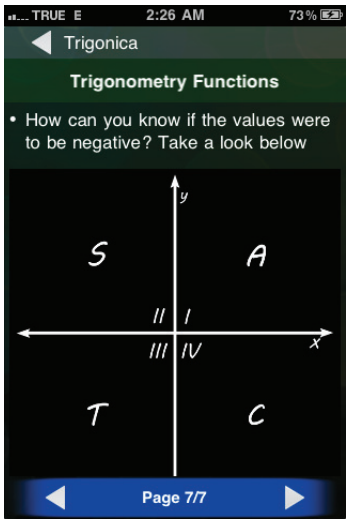

Figure 5 Lesson 2: Trigonometry Function

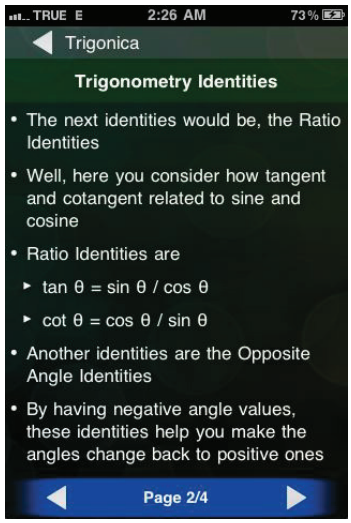

Figure 6 Trigonometry Identities

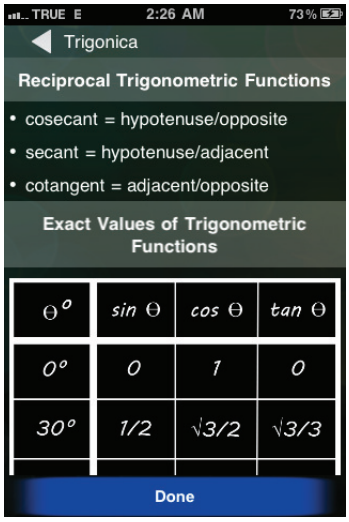

Figure 7 Formula Sheet

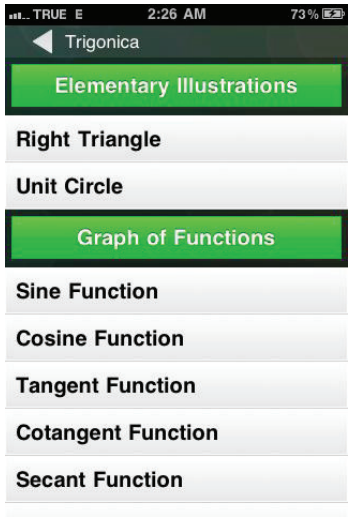

Figure 8 Interactive Illustrations Menu

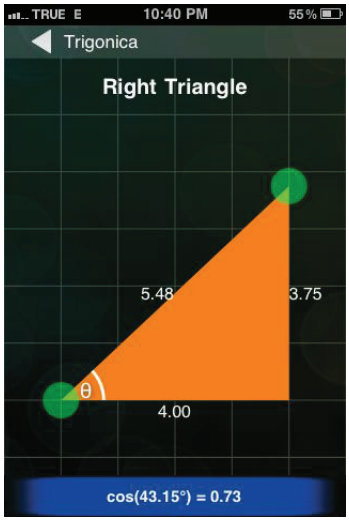

Figure 9 Interactive Right Triangle

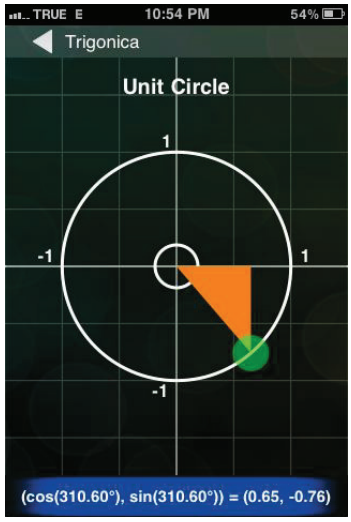

Figure 10 Interactive Unit Circle

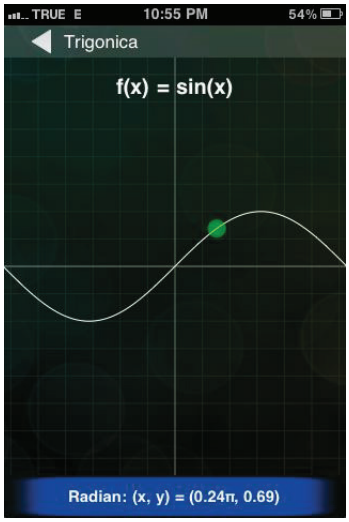

Figure 11 Interactive Sine Function Graph

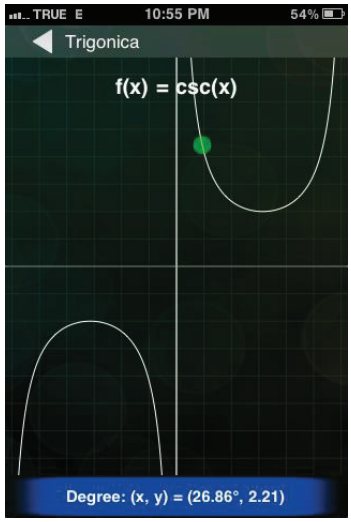

Figure 12 Interactive Secant Function Graph

The main page of the quiz section, shown in Figure 13, was designed to look the same as that of the knowledge section but with a different quiz for each button click. Each quiz started with an instruction as displayed in Figure 14. Instead of fixed multiple-choice questions, each of Trigonica's quiz was a combination of three types of questions, true/false (Figure 15), multiple-choice (Figure 16), and single-word-answer (Figure 17). Questions in each quiz is randomized and, if there is a number, it could also differ from that in the same question appeared in a previous quiz. The number of questions in the comprehensive quiz would be twice more of that in a lesson quiz.

Trigonica gave delayed feedback; it summarized the learner's performance only at the end of a quiz, as illustrated in 錯誤! 找不到參照來源。Figure 18. The score would be recorded if he or she had logged in via his or her Facebook account, and statistics could be recalled later. As mentioned previously, the learner could share this score with friends on their Facebook wall.

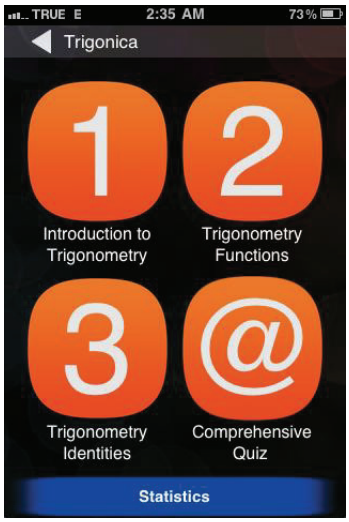

Figure 13 Main Quiz Menu

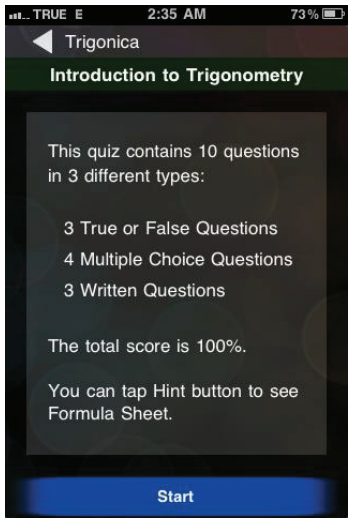

Figure 14 A Quiz's First Page

Figure 15 A True/False Question

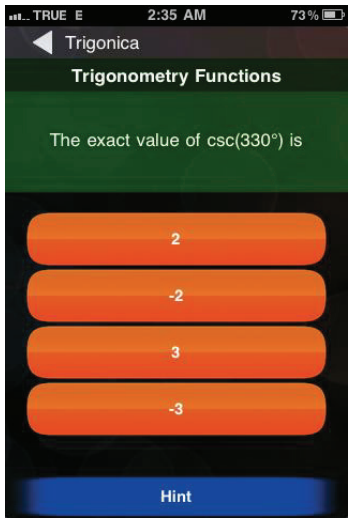

Figure 16 A Multiple-Choice Question

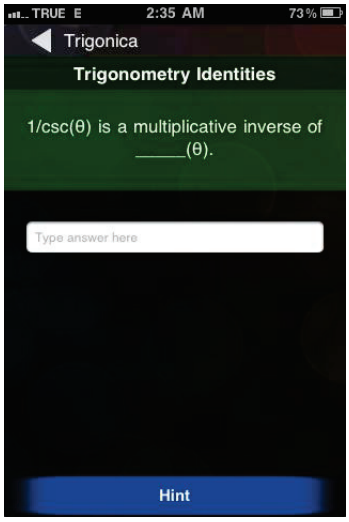

Figure 17 A Single-Word-Answer Question

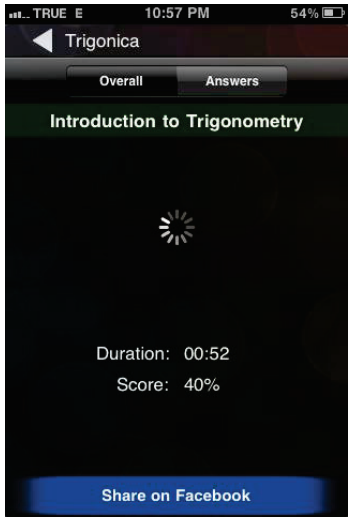

Figure 18 A Quiz's Performance Summary

There were three components to be concerned under the project; Web Server, iOS Device, and Facebook Graph API, as shown in Figure 19. All three components were connected by the availability of the Internet connection. By a user opening an application on the iOS device, the device would automatically send POST or GET method request to web server via Internet. Our Web server would check for matching information with Facebook Graph API in order to confirm the validity of the user's account.

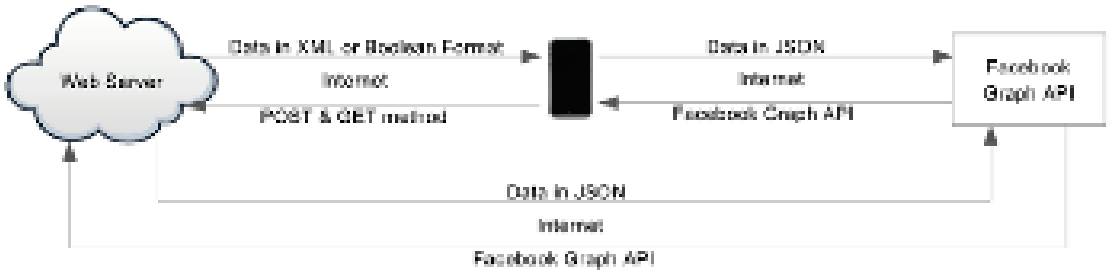

Figure 19 Three components of the project: Web Server, iOS Device, and Facebook Graph API

4. Conclusions

The application had been in the App Store since May 2011, and it was featured in the 2011 MUIC Open House for the Computer Science Program. Feedback from high school students visiting the fair was positive. Many students wished to have the application for their study in trigonometry and also in other subjects. Lately, a small study had been conducted, and the results were being analyzed.

Acknowledgements

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