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The Application of Merging Mobile Devices into Mathematics Course in Vocational High School –A Case Study of Calculus

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Abstract

This research is designed to explore if 2nd grade vocational high school students in Taiwan can get improved after merging mobile devices into the mathematics course. Vocational high school students, when they faced with abstract conceptual courses in mathematics classes - such as Calculus, if only explained by texts and graphs on textbooks and teachers' blackboards, are still quite difficult for many vocational students. In this study, the topic is about Calculus. The APP-GeoGebra of the mobile device can be easily manipulated to draw many graphs of the functions and is easy to observe these features. Because of its convenience and portability, the researcher chose mobile phone as the tool because it could be widely used in supporting learning and teaching. According to the questionnaire of the students, observation in class and the interview of the teacher, we found that mobile devices could be a good tool to help students studying and thinking. However, there seemed some restrictions mentioned and the development of using mobile devices in other math or science field might be worth in exploring in the future.

Key words: Mobile Device, mathematics education, calculus, Vocational High School

Introduction

Like the other countries in the world, students can choose academic or vocational high school after receiving the compulsory education. However, the students who study in the vocational schools are usually not as good as those in the academic schools at some basic subjects like language, math, or science (Lin, 1999). Because these subjects are mostly required courses in high school, the teachers should spend more energy on course design to improve the effectiveness of teaching and learning. Mathematics is very tough for students to study. Moreover, Calculus is too abstract for them to understand in their second year. The authors tried to merge the mobile phones which are usually not allowed to use in class in most campuses in Taiwan into the math classes to change the atmosphere of learning. It might be a good way to use the things the students are most interested in to help them study the things they are least interested in.

Literature review

A. Qualitative Change in Education Triggered by Mobile Devices

Teachers most commonly use the type of oral teaching in traditional classroom, which is the class model of teachers speaking and students listening. Although this is the most economical way, the main body is the teacher; teachers and students lack adequate interaction and are not easy to share instantly. With the advent of tablet PCs, students hold personal mobile devices in hand and can learn according to individual circumstances and needs; they will be able to instantly interact, recording and collecting relevant learning information after connecting the networks (Halpern, 2010; Henderson & Yeow, 2012). This helps teachers better understand students' learning conditions, reflect on their own teaching results, carry out formative assessment and provide appropriate feedback. The UNESCO once pointed out that information technology could create new and open learning environment for schools and also change traditional learning mode; information-based teaching is already a global trend (UNESCO, 2002).

B. Theoretical Basis of Teaching Media

The use of teaching media is quite common, and the reasons for teachers are not only to stimulate learning motivation (Liu et al, 2011) , increase attention (Sun, 2014) , easy to maintain and update teaching materials, and develop students' skills in the information age. The theoretical basis of teaching in the media is as follows:

Vygotsky's theory – ZPD: Vygotsky believed that there are two levels of human development, including the level of actual development and the level of potential development. The actual level of development is what Piaget calls the stage of child development, children in different kind of stage have different kind of ability; the potential level of development is the ability to solve problems under the cooperation of adults or partners. The gap between the two is called Zone of proximal development (ZPD). While students are learning, teachers provide a temporary support to help students reach the potential level of development from the actual level of development. This temporary support, also known as the scaffolding, can be a teaching strategy or teaching tool, along with students. As the ability is improved, the learning dominance is gradually returned to the students themselves. At this time, the students no longer need the aid of the scaffolding and successfully learn new knowledge and skills.

In addition, Gardner also proposed the theory of multiple intelligence, which emphasizes that everyone has all the intelligence, and each person's intelligence has its own uniqueness, so Gardner once mentioned that educators should do their best to understand students. Learning strengths and tendencies, and using this information to create the best

education for each student. And multimedia integrates film, animation, sound, text, pictures and other materials, and can be operated, listened, and watched, all providing different learning tools for students.

C. Usage of IRS

IRS, Interactive Response System, is a teaching application system that allows students in the class to immediately feed back information to teachers through mobile devices or electronic vehicles. It is one of the most important information application devices to improve the quality of classroom teaching in recent years. In fact, the so-called interactive room is to install IRS acceptors in the classroom, and each teacher and student has a remote control in hand in order to continue the interactive teaching activities which could not only maintain the former teaching habits, but also reduce the burden of teachers (Huang et al, 2001). This technology has been widely used in classroom teaching activities in Europe and the United States. The benefits of IRS for students and teachers are as follows (Liu et al, 2006) :

For students, the main results are as follows:

(1) Motivation to promote students' active participation: provide immediate and immediate feedback, enable students to respond to problems, and further strengthen students' motivation to participate in discussions.

(2) Encourage students to focus on and invest in learning content: Students must choose an answer to the question and encourage students to think about the problem.

(3) Assist students in deeper conceptual understanding: Students must further explain the reasons behind the answers, thus prompting students to explore their inner thinking.

For teachers, the main help is as follows:

(1) Assist teachers in diagnosing learning status and provide decision-making reference: The system can collect students' answers, help teachers to find out the students' learning problems immediately from the answers, fully assist teachers in assessing the situation, effectively clarify the myth concept, and inspire subsequent discussions.

(2) Improve the interaction between teachers and students: help teachers to effectively grasp the fairness of teacher-student interaction, so that all students have equal learning opportunities.

(3) Improve the fluency of teaching: encourage students to concentrate on the focus of learning, save teaching time, make the classroom situation rich and interesting without losing control.

IRS has many benefits, but there are also some areas that need attention, such as IRS is not the main body in the classroom, cannot replace the teacher. In the classroom, teachers are properly guided and given in-depth feedback to lead students to further study (Wang et al., 2002). Because of the real-time interactive nature of IRS, it can lead to students' interest, but it may also lead to too much excitement. Teachers still need professional guidance and management to maintain an appropriate class atmosphere.

Methodology

The subjects are 38 2nd grade students in the Dept. of Business Affairs in one vocational high school in New Taipei city in Taiwan. The topic is “Calculus & Its Applications” with key concepts, such as the limits (sequence and function), the derivative of polynomial function, the formulas and the applications of differentiation, the concept of integral, and the integral of polynomial function.

The APP- GeoGebra of the mobile device were used in this research, so we had to create an internet accessible environment and guide the student or the teams to download and install the APP- GeoGebra before the class. The teacher properly explain and demonstrate the ideas through GeoGebra. For example, the teacher used GeoGebra to find the tangent function on the point (2, 4) at the graphic of $f(x) = x^2$ as follows.

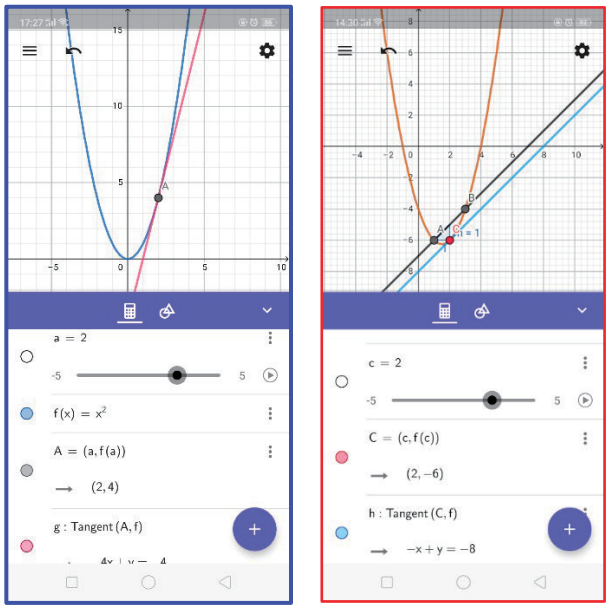

Fig. 1 the tangent function at the graphic of $f(x) = x^2$

The teacher also can use GeoGebra to introduce Lagrange's Mean Value Theorem and observe the concept directly as the figure above. After showing the results, the teacher could guide the students to draw the graphs of the functions through GeoGebra to help them discuss and answer the questions. For example, to ask the students to observe the concave and inflection points of the curve of $f(x) = x^4 - 4x^3 + 12$ with GeoGebra.

We used “sli.do” in this research as our Interactive Response System. It is one of the IRS systems and has applied into many conferences and courses. The teacher or the speaker is able to collect the results and feedback immediately and allow the anonymous questions and comments to encourage the introverted students to get involved. At last, we recorded and analyze the data after collecting them.

Results and Conclusion

According to the results and feedbacks from the students, we have got some conclusions as follows. For most of the students, math is still a very abstract and frustrating subject during the process of studying. It is a very good way for those students who are not good at abstract thinking to study mathematics through appropriate Apps like GeoGebra.

It has indeed reduce the students’ anxiety and increase their learning interest, because students are able to watch the graphs

of a bunch of equations directly through GeoGebra. It is really exciting and practical for their learning.

TABLE I
The Likert scale results from students' feedback

	strongly agree	agree	neutral	disagree	strongly disagree
1. I like the way to use Apps in the class more.	**80**	**12**	**8**	**0**	**0**
2. I am more concentrated when using Apps in the class.	**54**	**34**	**12**	**0**	**0**
3. Using Apps to draw the graphs of functions will help me learn Mathematics.	**72**	**20**	**8**	**0**	**0**
4. I will consider to use GeoGebra to help me solve the questions I don't really understand.	**32**	**20**	**24**	**16**	**8**
5. It is easy for me to use Sli.do with my mobile phone.	**28**	**20**	**32**	**12**	**8**
6. I feel easy to use Sli.do in the class.	**80**	**16**	**4**	**0**	**0**

Based on Table 1, we have found that although more than half students will choose to use GeoGebra to help themselves solve the questions, but there are still almost half students who won't use it to figure out the answer. It might mean that some of them still get into some trouble with using GeoGebra when studying Math. Therefore, the teacher had better carefully show how to use the App according to the students' need before the class. It is a good way through the easy functions for them, such as $y = x^2$, $y = \sin x$, and so on. After the students get used to the App, the teacher begins their class.

Through using Sli.do, the teacher is able to collect the students' response and the questionnaire so that the teacher can adjust the way of teaching immediately if necessary. Moreover, more introverted students get encouraged to ask questions and involved in the class, because it is allowed them to be anonymous to do that.

Compare to the situation that paper and pencil tests are widely used in high schools, IRS systems is another convenient and objective choice for teachers to conduct formative assessments. However, we still cannot view in Chinese although we are able to input Chinese words already. There are some students who feel difficult to use GeoGebra. Otherwise, there are some IRS systems we can view in Chinese like CCR (ccr.tw), or Socrative (only in Simplified Chinese). Both of them are still audience interaction tools offering interactive Q&A, live polls and insights about your audience.

Finally, although the students are able to see the graphs of the functions immediately through the App, some of them still think it is easier to observe the graphs on textbooks or on the blackboard, especially for Inflection points.

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