Supporting to Learn Calculus Through E-test with Feedback and Self-regulation

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Abstract. This study is designed to support students in learning calculus. Many freshmen are often struggling in calculus. The reasons are many and complex; largely because the students' backgrounds are insufficient and partly because students are not involved in class, passively listening to the lectures by the traditional teaching methods. Thus, student's learning motivation is often low, and lacking of self-regulation to monitor self-learning goals. Here we intend to arouse the interest of students by technological aids, to inspire their willingness and attitude in active learning, and to train students on effective learning methods. We not only provide video materials on the campus E-teaching platform for reviews, and set up discussion forums for communication, but also offer E-test for each unit volume with feedback (see appendix) to examine students' understanding quickly. In general, several types of data including selected interviews are carefully collected and analyzed. Results in this study indicate that most students express their positive responses about these contexts to support their learning in calculus.

Keywords: E-test; Learning motivation; Scaffolding; Self-regulation

Introduction

In this era of educational reforms, all teachers are searching for ways to improve learning environments and instructional approaches. For example, in recent years, flipped classroom has widely challenged attention in the world, students are usually expected to watch video at home then do the exercises in the classroom and discuss the unsolved problem with classmates and teachers. Basically teacher facilitates the learning environment and provides scaffolding in cases of discussion and interaction. Under this situation, students may feel that such learning process is more funny than boring, and they certainly should have interest and motivation to achieve in these processes (Cleary & Chen, 2009).

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In the technological world, the National Council of Teachers of Mathematics (NCTM) in the United States pointed out "The curriculum should make appropriate and ongoing use of calculators and computers" (NCTM, 1989) and "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (NCTM, 2000). This means integrating technology in teaching and learning processes is current trend (Chen & Lai, 2015; Karadeniz, 2015; Girard, 2002; Porzio, 1995). Likewise, there is no question to extend that technology can support learning and teaching in calculus (Ben-Zvi, 2000). This study is designed for freshmen to learn calculus effectively.

Calculus is an extensive course of general mathematics. Many professional courses in high educational level need calculus as prerequisite or tool to develop further, particularly those courses provided in the college of science or engineering. Since calculus has rigorous and consistent content structures, hence learners should learn it step by step by understanding, otherwise, learners may be off the track and get lost soon. Therefore, when students learn calculus, they need to know some better ways or strategies to make progress on their goals, and teachers can advise students in these cases.

Teaching calculus engaging is really a tough endeavor, and there are no easy ways. In order to make this paper to be brief and focused, more attention is placed upon the achievement involving E-test with feedback. Note that, instead of complexity, E-test items mostly focus on big ideas in each topic and limited computation. In the whole semester, we provide eight E-tests. Besides, formal midterm and final tests generally include high level paper-and-pencil problems such as sketching graph or basic proof.

We provide appropriate learning environments with video materials and guidance, we inspire students to observe and think independently. Additionally, discussion forums and teaching assistant are lent to the learning processes of exploration, problem solving and team cooperation. Certainly, self-regulatory processes also play an important role of achievement among students (Bandura, 1986). Hopefully students can understand and apply the basic knowledge, skills, and various methods in calculus to solve problems.

Literature and Methods

Self-regulation refers to the ability to develop, implement, and flexibly maintain planned behavior in order to achieve one's goals. It is essential to the learning process (Jarvela & Jarvenoja, 2011; Zimmerman, 2008).

Based on teaching experience in calculus, we fully understand that students' prior knowledge and motivation may facilitate the development of self-regulation in classroom contexts. Also, research has shown that students who are able to regulate their learning in the face of the difficulties perform better than students who lack of self-regulation (Pintrich, 2000). Hence, teachers need to know influential factors and strategies to promote self-regulated learning and motivation. For instance, we tell students to see the importance in learning calculus step by step, encourage students to set attainable goals such as studying calculus together for a couple of classmates, and ask students to keep a record of the amount of time they spent on calculus every week.

For each unit about calculus, we provide video materials on the campus Moodle E-teaching platform for students' reviews at any time, and set up discussion forums for communication. Moreover, we offer E-test for each unit volume with feedback (see appendix) to examine students' understanding quickly. Basically, E-test is usually open on Friday and Saturday, and students can take test at any place and any time. However, students are only given one hour to take each test, and each item is randomly presented during the test.

For convenient consideration, samples are selected from the computer science department. There are more than fifty freshmen to participate this study for one semester in calculus (II), and they are divided into two groups; Exp group and Control group; depending on the even or odd of their student identification numbers. At the beginning, please note that students in Control group have a bit higher (2 points in average) than students in Exp group regarding their background in calculus (I).

All problems in each E-test are multiple choices, please see samples in appendix. When students in Exp group provide incorrect answer in the first try, then "Hint" feedback will present immediately. At this moment, students can think about again, and they can provide next answer in the second try, and the like. When students in Control group provide incorrect answer in the first try, then there is no "Hint" feedback, but they can provide next answer in the second try based on their knowledge. On the other hand, no matter when students can employ the discussion forums to seek help or clarify their concepts. Actually, many critical data can be collected from the Moodle E-teaching platform, including their spent time in each test. Besides quantitative data, researchers also collect and analyze the interviews data from several samples.

Procedures for E-test on line :
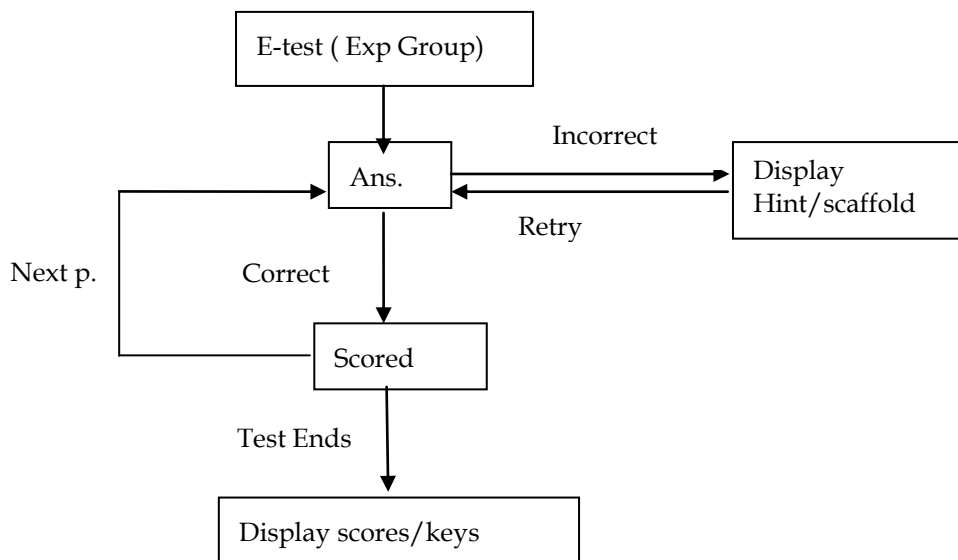
(a)   Flow chart for experiment group
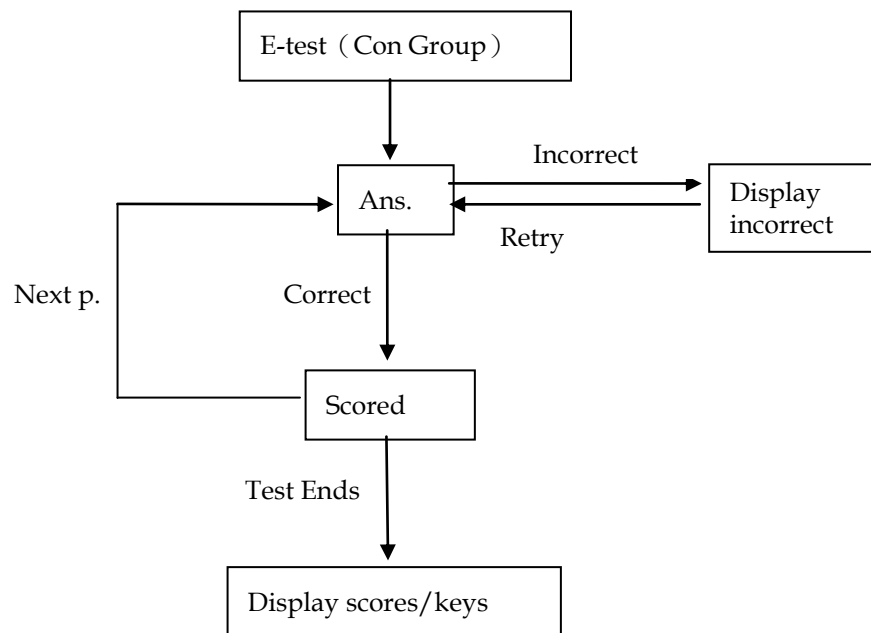
(b)   Flow chart for control group

Findings and Discussions

In the whole semester, students are provided eight E-tests, each test contains 10 problems. Note that the correct ratio in the following table is calculated from the (total/10) divided by the number of students who take this E-test. For example: {(197/10) / (29-4) }=78.80%. In addition, the corresponding pie chart indicates the spent time students take this test.

The first E-test：

Exp group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	25	23	21	20	23	23	23	18	3	18	197	78.80%
Absent	4	Correct at second time	0	2	4	5	2	1	1	1	11	5	32	12.80%
		Third and above	0	0	0	0	0	1	1	6	11	2	21	8.40%
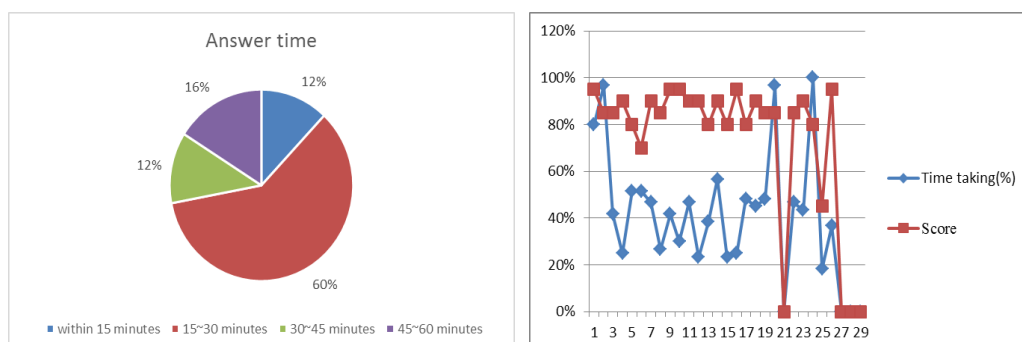
Figure 1：Outcomes of the 1st in Exp group

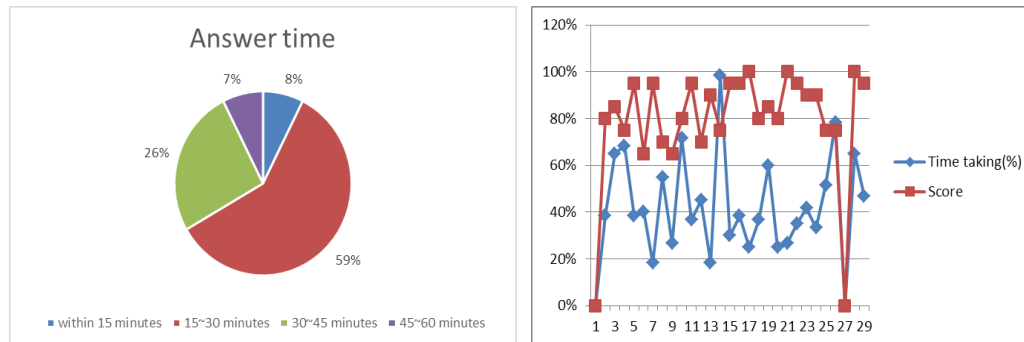| Control group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	26	24	24	22	26	25	25	19	4	22	217	80.37%
Absent	2	Correct at second time	1	1	3	3	1	2	1	4	8	1	25	9.26%
		Third and above	0	2	0	2	0	0	1	4	15	4	28	10.37%

Figure 2：Outcomes of the 1st in Control group

*Comments***:**
(1) This is the first E-test on line, students try to understand some operating environments.
(2) At the first try, students in Control group perform a bit better.
(3) At the second try, students in Exp group perform slightly better.
(4) Research indicates that feedback(or hint) can assist students in improving their achievement (Nitko & Brookhart, 2010). Also, it can promote students' motivation (Wigfield, Kauda, & Cambria, 2011) and self-regulation.

The second E-test：

Exp group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	12	12	10	23	17	19	20	14	16	9	152	54.29%
Absent	1	Correct at second time	6	4	7	4	6	5	4	4	3	11	54	19.29%
		Third and above	10	12	11	1	5	4	4	10	9	8	74	26.43%
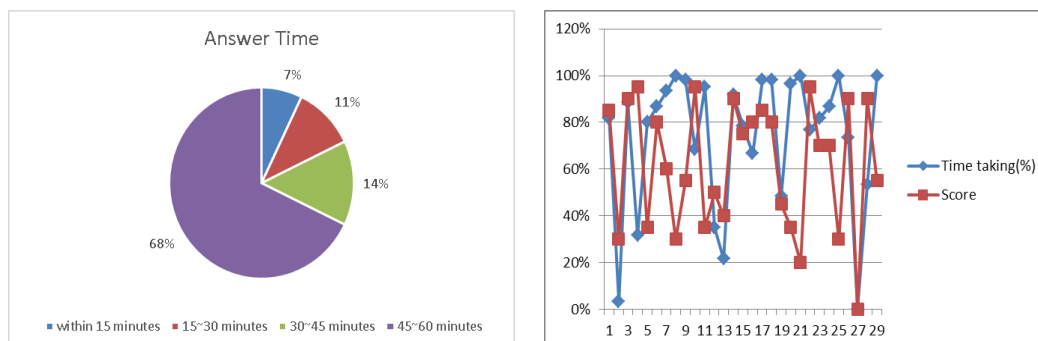
Figure 3：Outcomes of the 2nd in Exp group

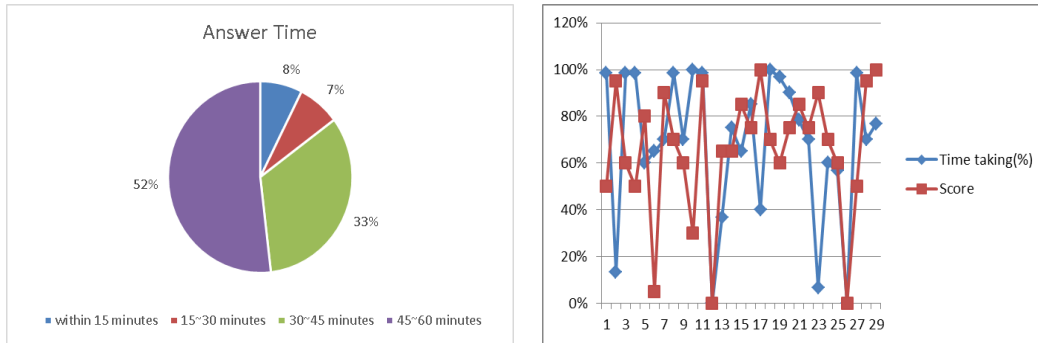| Control group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	17	13	13	21	20	22	17	12	16	15	166	61.48%
Absent	2	Correct at second time	7	8	4	1	2	2	8	5	6	6	49	18.15%
		Third and above	3	6	10	5	5	3	2	10	5	6	55	20.37%

Figure 4：Outcomes of the 2nd in Control group

Comments:
  (1) Students in Control group obviously perform better than students in Exp group do at the first try.
  (2) However, at the second try, the outcomes between two groups look very close.
  (3) It looks evident that students in Exp group generally spend longer time to take this test.

The third E-test：

Exp group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	24	10	21	19	22	20	20	24	21	20	201	71.79%
Absent	1	Correct at second time	3	10	3	7	2	4	6	2	6	5	48	17.14%
		Third and above	1	8	4	2	4	4	2	2	1	3	31	11.07%
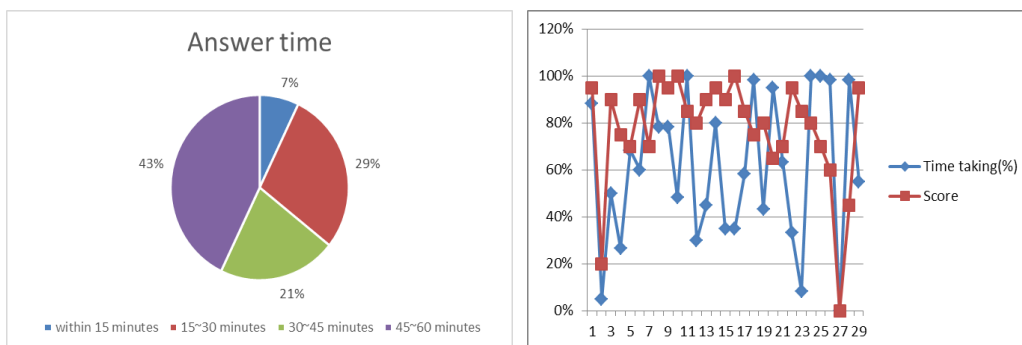
Figure 5：Outcomes of the 3rd in Exp group

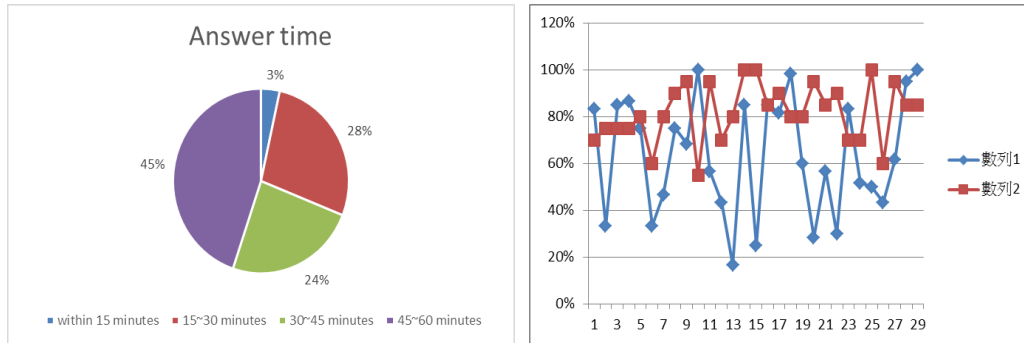| Control group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	29	10	23	20	25	22	22	22	23	20	216	74.48%
Absent	0	Correct at second time	0	12	3	6	2	5	4	4	3	3	42	14.48%
		Third and above	0	7	3	3	2	2	3	3	3	6	32	11.03%

Figure 6：Outcomes of the 3rd in Control group

Comments:
(1) At the second try, students in Exp group perform slightly better than students in Control group do.
(2) In case we consider the outcomes of the first try and the second try together, two groups almost make no differences.

The fourth E-test :

Exp group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	19	19	16	18	21	24	20	20	21	14	192	76.80%
Absent	4	Correct at second time	1	3	7	1	1	1	4	3	2	5	28	11.20%
		Third and above	5	3	2	6	3	0	1	2	2	6	30	12.00%
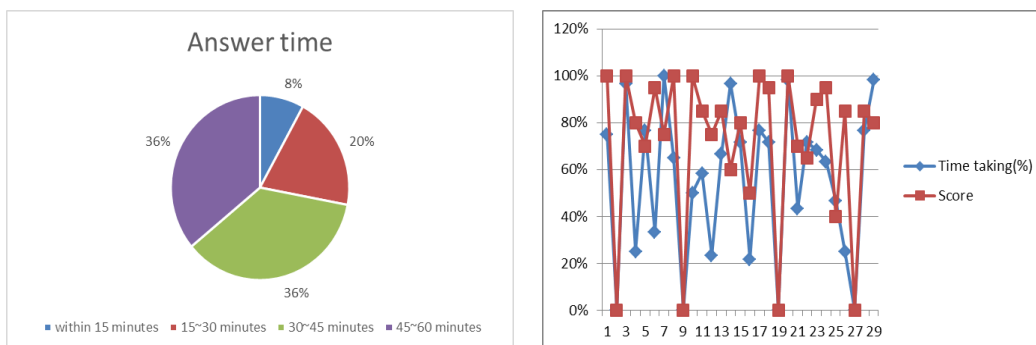
Figure 7：Outcomes of the 4th in Exp group

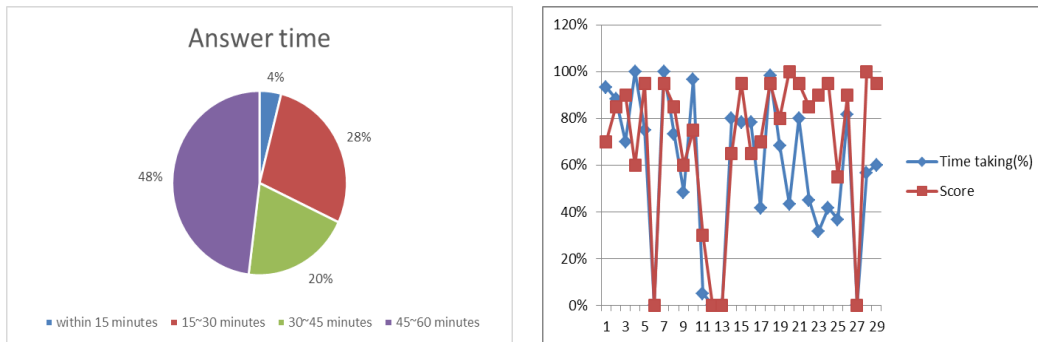| Control group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	15	22	16	17	21	21	20	19	21	14	186	74.40%
Absent	4	Correct at second time	7	1	6	3	2	2	1	3	3	4	32	12.80%
		Third and above	3	2	3	5	2	2	4	3	1	7	32	12.80%

Figure 8：Outcomes of the 4th in Control group

Comments:
  (1) At the first try, students in Exp group perform a bit better than the students in Control group do.
  (2) No big differences between two groups exist at the second try.

The fifth E-test :

Exp group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	20	18	16	16	17	13	14	6	11	13	144	60.00%
Absent	5	Correct at second time	3	3	3	2	2	6	0	11	6	7	43	17.92%
		Third and above	1	3	5	6	5	5	10	7	7	4	53	22.08%
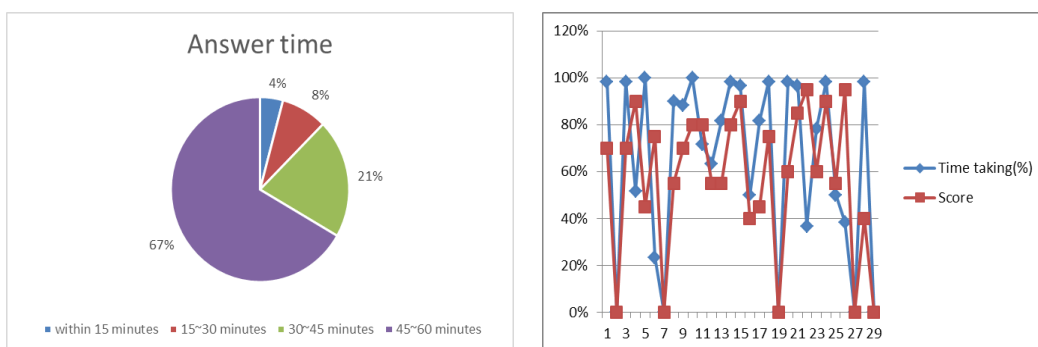
Figure 9：Outcomes of the 5th in Exp group

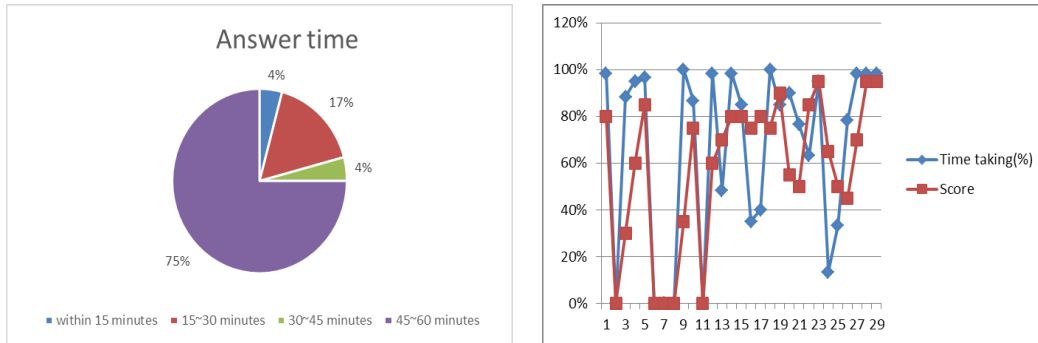| Control group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	18	20	17	13	13	15	10	14	11	15	146	60.83%
Absent	5	Correct at second time	4	2	4	7	4	4	4	5	7	3	44	18.33%
		Third and above	2	2	3	4	7	5	10	5	6	6	50	20.83%

Figure 10：Outcomes of the 5th in Control group

Comments:
  (1) There is no big difference between two groups.
  (2) It seems evident that students in both groups generally spend longer time to take this test.

The sixth E-test :

Exp group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	20	18	10	18	21	16	11	8	21	20	163	65.20%
Absent	4	Correct at second time	3	1	9	3	3	2	8	7	1	3	40	16.00%
		Third and above	2	6	6	4	1	7	6	10	3	2	47	18.80%
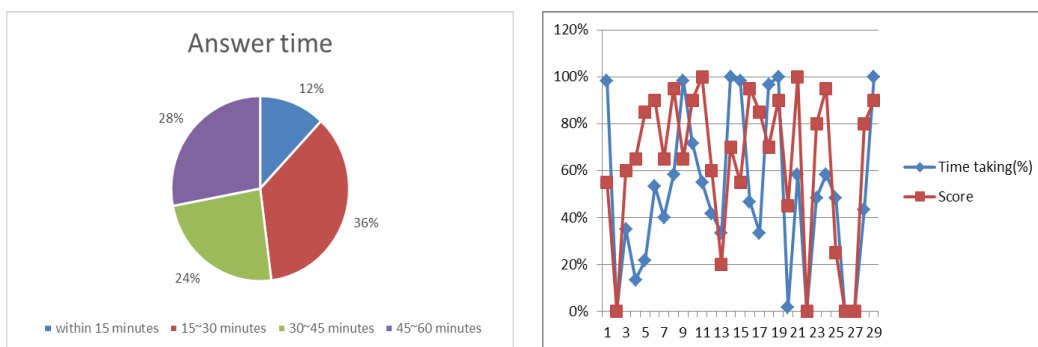
Figure 11：Outcomes of the 6th in Exp group

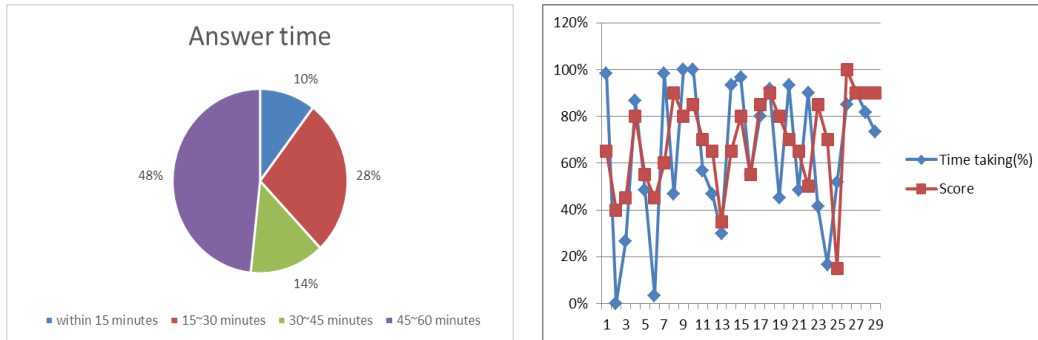| Control group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	16	22	16	22	16	22	8	13	20	16	171	58.97%
Absent	0	Correct at second time	8	2	8	4	9	2	6	6	3	9	57	19.66%
		Third and above	5	5	5	3	4	5	15	10	6	4	62	21.38%

Figure 12：Outcomes of the 6th in Control group

Comments:
(1) At the first try, students in the Exp group perform a bit better than the students in the Control group do.
(2) At the second try, students in the Control group perform a bit better than the students in the Exp group do.
(3) Obviously, students in Control group generally spend longer time to take this test.

The seventh E-test :

Exp group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	24	16	22	18	17	18	15	18	21	26	195	72.49%
Absent	2	Correct at second time	2	3	2	5	5	4	4	4	4	1	34	12.64%
		Third and above	1	8	3	4	5	5	7	5	2	0	40	14.87%
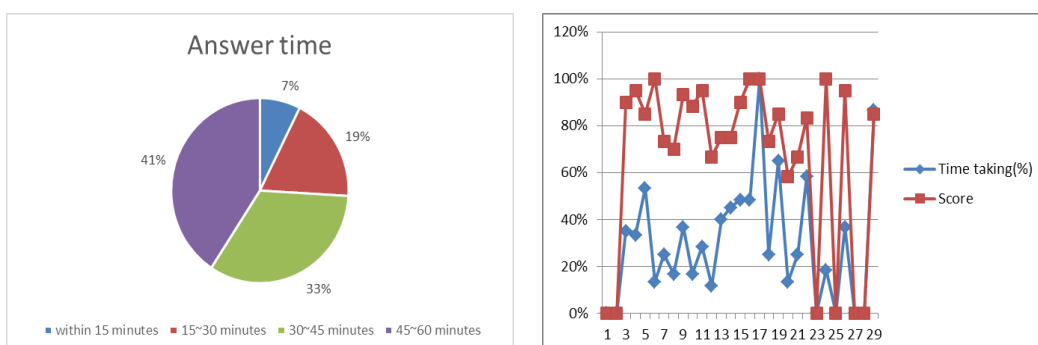
Figure 13：Outcomes of the 7th in Exp group

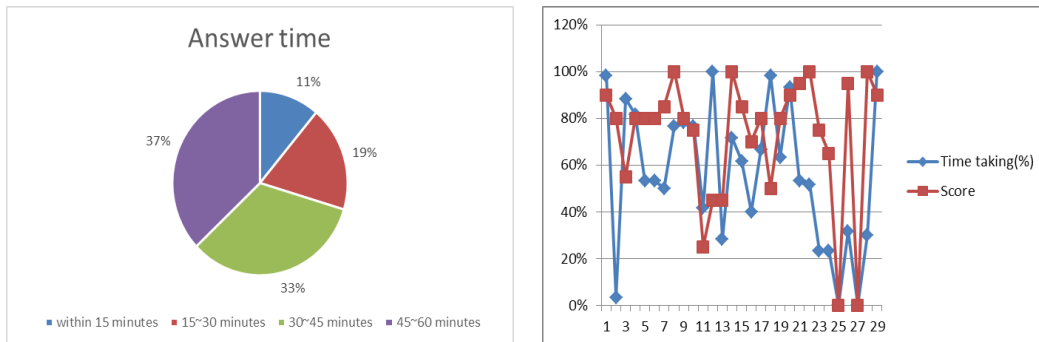| Control group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	24	17	16	16	16	21	18	18	21	22	189	70.00%
Absent	2	Correct at second time	2	5	3	7	8	3	2	6	2	3	41	15.19%
		Third and above	1	5	8	4	3	3	7	3	4	2	40	14.81%

Figure 14：Outcomes of the 7th in Control group

Comments:

(1) At the first try, students in Exp group perform a bit better than students in Control group do. Conversely at the second try.

(2) Generally, outcomes between two groups look very close.

The eighth E-test :

Exp group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	22	21	22	13	19	19	5	3	-	-	124	84.35%
Absent	6	Correct at second time	1	2	1	5	4	1	0	0	-	-	14	9.52%
		Third and above	0	0	0	5	0	3	0	1	-	-	9	6.12%
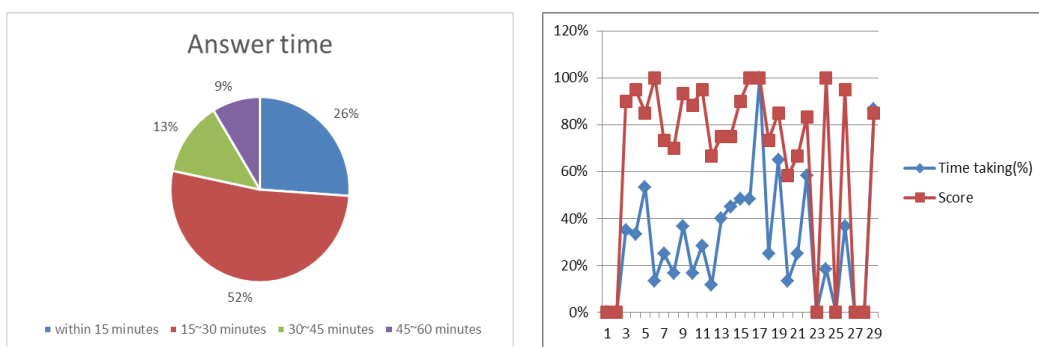
Figure 15：Outcomes of the 8th in Exp group

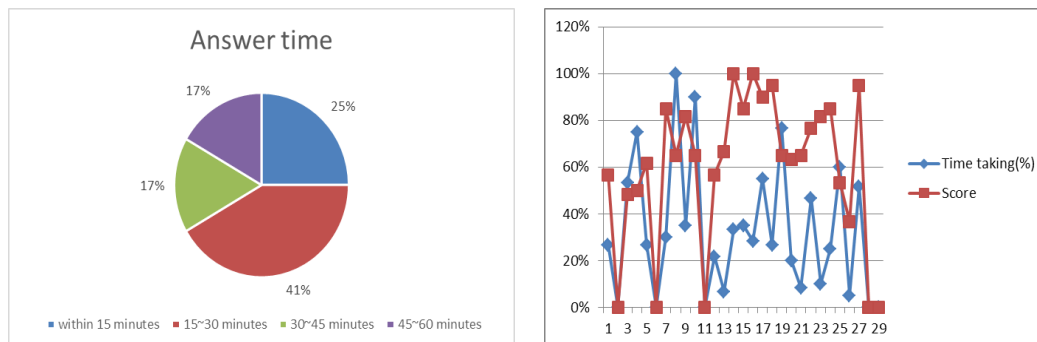| Control group		Question No.	1	2	3	4	5	6	7	8	9	10	total	Correct ratio
Total	29	Correct at first time	24	22	18	13	17	15	1	3	-	-	113	71.97%
Absent	5	Correct at second time	0	1	4	5	3	4	0	0	-	-	17	10.83%
		Third and above	0	1	2	6	4	5	9	0	-	-	27	17.20%

Figure 16：Outcomes of the 8th in Control group

*Comments***:**
 (1) This E-test only contains eight items because each has more computation involved.
 (2) Students in experimental group perform clearly better than students in control group do.
 (3) Close examination on the performances of Exp group indicates that they really make progress in E-test.

Conclusion

Note that this study basically covers the content of calculus (II). We know that the road to learn calculus is not always straight and smooth, and successful learning usually requires appropriate pressure and self-regulation, as well as stamina and patience. We believe that "It is sometimes tough, but learners stick with it necessarily." Based on analyses of collected data, we did find that most students agreed these approaches to help their learning. Comparing with calculus (I) last semester, the results from interviews indicated that students were less anxious about calculus (II) in midterm or final comprehensive tests. In general, more students in experiment group have a higher self-learning motivation, a high percentage of students rated this course as more than interesting and dynamic organization, and more students use video materials for reviews after class. Indeed, almost all students perform calculus (II) better than calculus (I).

Although students in control group perform E-test a bit better than the students in experimental group do in several times. However, students in experimental group increase 11.5% from midterm to final comprehensive test, and students in control group only increase 7.9%. Much more, among 6 (in the experimental group) of 7 students (in the whole class) overwhelmingly increase their scores (more than 20 points) from midterm to final comprehensive test. Thus, our approaches obviously arouse the interest of students.

References:

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice-Hall.

Ben-Zvi, D. (2000). Toward understanding the role of technological tools in statistical learning. *Mathematical Thinking and Learning,* 2(2), 127-155.

Boekaerts, M. & Corno, L. (2005). Self-regulation in the classroom: A perspective on assessment and intervention. *Applied Psychology: An International Review*, 54(2), 199-231.

Chen, J.C., & Lai, Y.L. (2015). A Brief Review of Researches on the Use of Graphing Calculator in Mathematics Classroom. *International Journal of Learning, Teaching and Educational Research,* Vol. 14, No. 2, 163-172.

Clarebout, G., Horz, H., & Schnotz, W. (2010). The relations between self-regulation and the embedding of support in learning environments. *Educational Technology Research and Development,* 58(5), 573-587.

Cleary, T.J., & Zimmerman, B.J. (2004). Self-regulation empowerment program: A school-based program to enhance self-regulated and self-motivated cycles of student learning. *Psychology in the Schools,* 41, 537-550.

Cleary, T.J., & Chen, P.P. (2009). Self-regulation, motivation, and math achievement in middle school: variations across grade level and math context. *Journal of School Psychology,* 47 (5), 291-314.

De Corte, E., Mason, L., Depaepe, F., & Verschaffel, L. (2011). Self-regulation of mathematical knowledge and skills. In B. J. Zimmerman, & D. H. Schunk (Eds.), *Handbook of self-regulation of learning and performance* (pp. 155-172). New York: Routledge.

Elstad, E., & Turmo, A. (2010). Students' self-regulation and teacher's influence in science: Interplay between ethnicity and gender. *Research in Science & Technological Education,* 28 (3), 249-260.

Girard, N.R. (2002). Students' representational approaches to solving calculus problems: Examining the role of graphing calculators. (University of Pittsburgh, 2002). *Dissertation Abstracts international,* 61(10A), 3502.

Graham, A.T. &Thomas, M.O.J. (2003). Building a versatile understanding of algebraic variables with a graphic calculator. *Educational Studies n Mathematics* 41: 265-282. Kluwer Academic Publishers. Printed in the Netherlands.

Jarvela, S., & Javenoja, H. (2011). Socially constructed self-regulated learning and motivation regulation in collaborative learning groups. *Teachers College Record*, 113(2), 350-374.

Karadeniz, I. (2015). UCSMP Teachers' Perspectives when Using Graphing Calculators in Advanced Mathematics . *Graduate Theses and Dissertations.* http://scholarcommons.usf.edu/etd/5712

Kastberg, S., & Leatham, K. (2005). Research on graphing calculators at the secondary level: Implications for mathematics teacher education. *Contemporary Issues in Technology and Teacher Education* [Online serial], *5*(1). Available: http://www.citejournal.org/vol5/iss1/mathematics/article1.cfm

Labuhn, A.S., Zimmerman, B.J., & Hasselhorn, M. (2010). Enhancing students' self-regulation and mathematics performance: The influence of feedback and self-evaluative standards. *Metacognition and Learning*, 5 (2), 173-194.

Levine, L.E., Mazmanian, V., Miller, P., & Pinkham, R. (2000). Calculus, Technology and Coordination. *THE Journal*, 28(5), 18-24.

National Council of Teacher of Mathematics. (2000). *Principles and Standards for School Mathematics.* Reston, VA: Author.

National Council of Teacher of Mathematics. (1989). *Curriculum and Evaluation Standards for School Mathematics.* Reston, VA: Author.

Nitko, A. & Brookhart, S. (2010). *Educational Assessment of Students, 6th Edition*. Prentice Hall, USA.

Porzio, D.T. (1995). *Effects of differing technological approaches on students' use of numerical, graphical and symbolic representations and their understanding of calculus*. ERIC Document Reproduction Service No.ED391665.

Wigfield, A., Klauda, S.L., & Cambria, J. (2011). Influences on the development of academic self-regulatory process. In B. J. Zimmerman, & D. H. Schunk (Eds.), *Handbook of self-regulation of learning and performance.* New York: Routledge.

Zimmerman, B. (2008). Investigating self-regulation and motivation: Historcal background, methodological developments, and future prospects. *American Educational Research Journal,* 45(1), 166-183.

Zumbrunn, S., Tadlock, J., & Roberts, E. (2011). *Encouraging Self-Regulated Learning in the Classroom: A Review of the Literature.* MERC, Viginia Commonwealth University.

Appendix: (E-test 4)

1. Evaluate the definite integral. $\int_{\ln 2}^{\ln 4} e^{-x} dx$ = ?

    (A) 6

    (B) $\dfrac{1}{16}$

    (C) $\dfrac{3}{4}$

    (D) $\dfrac{1}{4}$

    (E) No answer

Hint: (A)(B)(C)(E): Note the derivative: $D(e^{-x}) = -e^{-x}$ and recall the identity: $e^{\ln X} = X$.

2. Differentiate the function $f(x) = \ln\left(\dfrac{e^{5x}+1}{e^{2x}+1}\right)$.

    (A) $\dfrac{2e^{2x}+1}{5e^{2x}+1}$

    (B) $\dfrac{5e^{5x}}{e^{5x}+1} - \dfrac{2e^{2x}}{e^{2x}+1}$

    (C) $\dfrac{5e^{5x}}{e^{5x}+1} + \dfrac{2e^{2x}}{e^{2x}+1}$

    (D) $\dfrac{e^{2x}+1}{e^{5x}+1}$

    (E) $\dfrac{e^{5x}}{e^{5x}+1} - \dfrac{e^{2x}}{e^{2x}+1}$

Hint: (A)(C)(D)(E): Use the property $\ln(\dfrac{A}{B}) = \ln A - \ln B$ first, then differentiate both sides..

3. Find the indefinite integral. $\int 6^{5x} dx$ = ?

    (A) $\dfrac{1}{\ln 6} 6^{5x} + C$

    (B) $\dfrac{1}{5} 6^{5x} + C$

    (C) $\dfrac{\ln 6}{5} 6^{5x} + C$

    (D) $\dfrac{1}{5\ln 6} 6^{5x} + C$

    (E) $5(\ln 6)6^{5x} + C$

Hint: (A)(B)(C)(E): Recall $D(6^{5x}) = ?$

4. Find an equation of the tangent line to the graph of $y = \log_2 x$ at the point $(32,5)$.

    (A) $y = 5 + \dfrac{1}{\ln 2}(x-32)$

(B) $y = 5 + \dfrac{1}{2\ln 32}(x - 32)$

(C) $y = 5 + \dfrac{1}{32\ln 2}(x - 32)$

(D) $y = 5 - \dfrac{1}{\ln 2}(x - 32)$

(E) $y = 5 + \dfrac{1}{32}(x - 32)$

Hint: (A)(B)(D)(E): Recall $D(\log_2 x) = ?$ Note that slope of tangent line is $y'(32)$.

5. Write the following expression in algebraic form. $\sin\big(\arccos(2x)\big) = ?$

   (A). $\sqrt{1 - 4x^2}$
   (B). $1 - 2x^2$
   (C). $1 + 2x^2$
   (D). $1 + 4x^2$
   (E). $\sqrt{1 - 2x^2}$

Hint: (B)(C)(D)(E) : Recall that if $\theta = \arccos(2x),\ then\ \cos\theta = 2x$

6. Find the integral $\displaystyle\int \dfrac{t}{t^4 + 81}\,dt = ?$

   (A) $\dfrac{1}{18}\arctan 9t^2\,dt + C$

   (B) $\dfrac{1}{18}\arctan\dfrac{t^2}{9}\,dt + C$

   (C) $\arctan\dfrac{t^2}{81}\,dt + C$

   (D) $\dfrac{1}{9}\arctan 81t^2\,dt + C$

   (E) $\arctan\dfrac{t^2}{9}\,dt + C$

Hint: (A)(C)(D)(E): Recall $\displaystyle\int \dfrac{du}{a^2 + u^2} = ?$

7. Find the area of the shaded region for the function $y = \dfrac{5}{\sqrt{4 - x^2}}$.
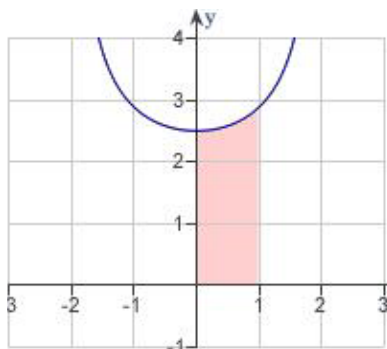
   (A) $\dfrac{\pi}{6}$

(B) $\dfrac{5\pi}{6}$

(C) $\dfrac{\pi}{2}$

(D) $\dfrac{2\pi}{3}$

(E) $\dfrac{\pi}{3}$

Hint: (A)(C)(D)(E) : Recall $\displaystyle\int \dfrac{du}{\sqrt{a^2-u^2}} = ?$

8. Find the indefinite integral. $\displaystyle\int \sinh(6-3x)dx = ?$

(A) $\dfrac{1}{6}\operatorname{sech}(6-3x)+C$

(B) $\dfrac{1}{3}\operatorname{sech}(6-3x)+C$

(C) $\dfrac{1}{6}\cosh(6-3x)+C$

(D) $\dfrac{-1}{3}\cosh(6-3x)+C$

(E) $\dfrac{1}{3}\cosh(6-3x)+C$

Hint: (A)(B)(C)(E) : Recall $D[\sinh U] = ?$ $D[\cosh U] = ?$

9. Find the derivative of the function $y = \cosh^{-1}(5x)$

(A) $y' = \dfrac{5}{1-25x^2}$

(B) $y' = -\dfrac{5}{25x^2+1}$

(C) $y' = \dfrac{5}{\sqrt{25x^2-1}}$

(D) $y' = \dfrac{5}{\sqrt{25x^2+1}}$

(E) $y' = \dfrac{5}{\sqrt{1-25x^2}}$

Hint: (A)(B)(D)(E): Note how to differentiate inverse hyperbolic functions, $D[\cosh^{-1} u] = ?$

10. Evaluate the definite integral. $\displaystyle\int_1^7 \dfrac{e^{7\sqrt{x}}}{\sqrt{x}}dx = ?$

(A) $e^{7\sqrt{7}} - e^7$

(B) $\dfrac{e^{7\sqrt{7}} - e^7}{7}$

(C) $\dfrac{2(e^{7\sqrt{7}} - e^7)}{3(7)^{3/2}}$

(D) $\dfrac{e^{7\sqrt{7}} - e^{7}}{14}$

(E) $\dfrac{2(e^{7\sqrt{7}} - e^{7})}{7}$

Hint: (A)(B)(C)(D): Evaluate the definite integral of an exponential function using substitution. Note that $D[e^{u}] = ?$