Efficacy of Teaching Calculus by Using Derive

Bunpot Suwannaprasert
bunpots@nu.ac.th
Department of Mathematics, Faculty of Science
Naresuan University,
Thailand

Abstract

Computers are integral part of the classroom and home environment of students at present. Their effects are on student's cognition. Particularly salient is largely substantiated claims concerning the cognitive benefits of computer programming. This study assessed the efficacy of teaching Calculus on the topics of integration, area between two curves and volume under the surface by using computer programming, Derive, to the first year students at Naresuan and Mea Fah Luang Universities. The results had shown that students understood the concepts of the contents better. And they enjoyed using Derive to check the correct answers of the problems.

The increasing acceptance of the critical necessity for students to become literate in leading to increased prominence of computers in the home and university environment. There are clearly answered the questions regarding the effects of computer used on students' learning. Papert (1980) has proposed that computer programming environments can create conditions under which intellectual models take root, conditions in which students can master notions formerly though too abstract for their developmental level. Computers can make the abstract concrete as they help students learn more effectively. And the computer programming environment holds the promise of being an effective device for cognitive process instruction.

Mathematics is a subject which is developed and changed. It is developed by mathematicians and mathematics educators for supporting the social needs. Now, the world of technology and mathematics has changed dramatically more than in the past twenty years. The growth of technology has made mathematics teaching using only the chalkboard out of date. So, it is appropriate to change the methods of teaching mathematics to take advantage of current technology.

In the real world situation at the twenty-first century, educators (Allesi & Trollip, 1991; Bailey, 1990; Sherwood, 1986) commented that the computer programming technology is becoming an increasingly popular adjunction to instruction. It has been developed to cover such diverse areas as in mathematics and many areas application. They recommended that to use computer programs for teaching are appropriated. Students can have their own interaction to understand the concepts of the lesson.

Derive is a computer programming technology which can be illustrated the capabilities to execute numerical, graphical, and symbolic tasks. Numerous Derive screen displays are performing standard mathematical tasks in PC computer with Windows version (Kutzer, 1996). The Derive provided the necessary tools to solve real-world applications of mathematics. Either of these tools free from the long and tedious calculations. Its result lie at the heart of the calculus.

The widespread acceptance of new technology provides the opportunities to computer programming for teaching as educational media at present in Thailand. However, no study to investigate the effectiveness of such computer programs in the real classroom situation has yet to be conducted.

Hence, the purpose of this study is to investigate the effectiveness of experiences in computer programming, Derive, to the first year students for learning Calculus on the topics of integration, area between two curves and volume under the surface. They are the bachelor program in mathematics and computer science at Naresuan University and the bachelor program in information technology and food at Mea Fah Luang University.

Method

The method used in this study was the testing group of the evaluation of the teaching program.

Instrument: The Derive program (Soft Warehouse, Inc., Honolulu, Hawaii, USA) was installed from its Setup.exe file into the computers for the students used. The Derive program runs on Windows in PC compatible with a 25-MHz, 486 SX processor up, 16 MB of RAM, a 256 color VGA card and monitor, and a mouse. The contents for using the Derive program to check the correct answers are the followings:

1. Integration: Process of accumulation.
2. Area between two curves.
3. Volume under the surface.

See examples for using the Derive program to calculate the problems in the appendix.

Subjects: The testing-group was 120 students: 60 students from Naresuan Univesity and 60 from Mea Fah Luang University.

Procedure: The numbers of the evaluation program were use to test the teaching program in the academic year 1999 at Naresuan and Mea Fah Luang Universities. The participants evaluated the teaching program immediately after finished exercises by using Derive.

Results

The evaluations of the teaching program were administered immediately after participants finished exercises. The following results include some of most common positive and negative comments.

1. Eighty-six percent of participants that responded to question number one like (23%) or felt OK (63%) about working the problems with the Derive program. Fourteen percent dislike it.

2. Seventy-nine percents like the Derive program for helping the learners to do the exercises easier; 21% did not.

   Positive comments --- Lessons were fun and one can catch the concepts faster. Better way of learning: one learns a lot. It was hard but good. Lessons were short and good to the point.

   Negative comments --- Hard lesson boring. It could be done better with paper and pencil. I do not like working with computer.

3. Eighty percent of participants felt that they had learned new ways of working on the exercises by the Derive program, 20% did not.

   Positive comments --- Learned easier and different ways to mathematics learning. I was never good at math but now I feel that I have learned a whole lot. I did not think that one could learn math concepts by computer programming.

   Negative comments --- I did not understand some things.

4. Eighty-four percent of participants felt that the Derive program had helped students understand better mathematics, 16% did not.

   Positive comments --- Learn a lot and had more experience with it. Like being timed on each question. I did not learn all the ways to use computer in this matter before. Now I can use it when having program like this.

   Negative comments --- Not too good at it. It is the same to me.

5. Eighty-eight percent of the participants that replied to question number 5 felt that the Derive program for teaching the concepts of mathematics was important; 12% did not.

   Positive comments --- Professors should do like this for helping students to understand mathematics more than the traditional way. We use computer a lot but it is not like this purpose.

   Negative comments --- I prefer learning by human professor.

6. Seventy-two percent of the participants felt that the lesson for practicing on the Derive program needed no improvements; 28% did.

   Suggestions for improvement --- Make contents and lessons from easier to harder questions. Make contents more entertaining.

These results imply that the participants considered the Derive program can increase some aspects of problem-solving ability. Evidence is provided that computer programming may effect cognitive domain in mathematics. It is shown that the Derive program can affect students' learning. The advent of the computer programming poses new educational challenges.

Conclusion

The research described here focused on the perceptions for the participants who are using the Derive program for learning Calculus on the topic of integration, area between two curves and volume under the surface at Naresuan and Mea Fah Luang Universities. The results of this study imply that the Derive program for teaching mathematics is considered to be important by individual or by small group studying. Students can learn the concepts in the contents by their own, they can take time depending on their understanding.

Base on the finding of this study, there are interesting points to note. The participants considered the computer programming for teaching mathematics should become a part of mathematics curriculum for every level. The computer's versatility is both educational and recreational context presages and even greater future impact in the classroom. This study has shown the realistic way of teaching mathematics by using computer programming, it extends the work in demonstrating that computer programming can increase students' learning in mathematics.

The existing methods of teaching mathematics is dominated by chalkboard for a long time. However, the research indicates that the participants feel that teaching mathematics by using computer programming is important and appropriate the present classroom situation. Therefore, there is clearly the need of mathematics professors for any institute to make it realistic as long term plans and keep option open.

REFERENCES

Allessi, S.M., & Trollip, S.R. (1991). Computer-based instruction: Method and development. Englewood Cliffs, NJ: A Division of Simon & Schuster.

Baley, Z. T. (1990). CAI and interactive video enhance students scores on the college level academic skills test. T. H. E. Journal, 1(1), 82-85.

Kutzer, B. (1996). Introduction to derive for windows. Linz, Austria: Gutenberg-Werbering Ges. m.b. H.

Papert, S. (1980). Mindstorms: Children, computers, and powerful ideas. New York: Basic Books.

Sherwood, R. D. (1986). The development of videodisc based environments to facillitate science instruction. (ERIC Document Reproduction Service No. ED 275503)

Weimer, R. C. (1998). Applied calculus with technology. New York: Brooks/Cole Publishing Company.

APPENDIX

Suppose the Derive was installed in the PC computer, the opening screen of Derive appears as in the Figure 1.

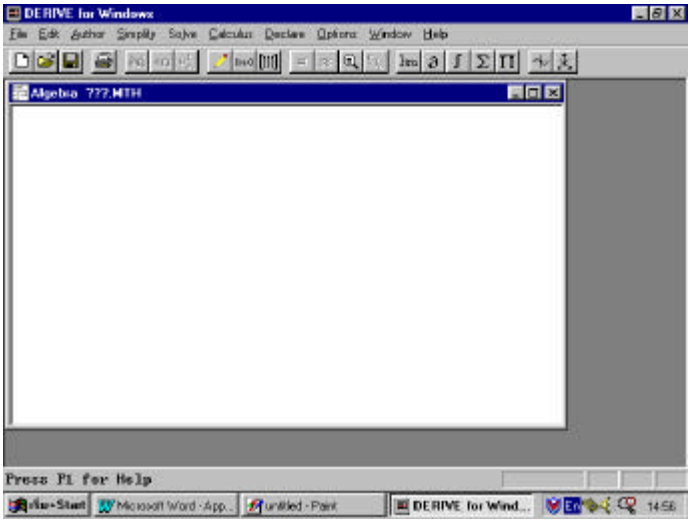

Figure 1.

The commands can be assessed by cycling from one to another via the tab key or by pressing the key on the keyboard is identified.

For using the Derive to check the correct answers about to determine an approximation to the area of the region bounded by the curve defined by

$$f(x) = x^2 + 2,$$

the x-axis, the line $x = 2$, and the line $x = 4$.

we can show answers from the calculations as follows:

(1) To show that the area of upper sum of 5 subintervals in $[2, 4]$ is:

$$\text{Area} = \sum_{k=1}^{5} f(x_k)\Delta x = 25.12,$$

where $f(x) = x^2 + 2$, $x_k = 2 + (k)(\Delta x)$, and $\Delta x = \frac{4-2}{5} = \frac{2}{5}$.

The commands and output of Derive are as follows:

User Keystrokes	Derive Output
1. Click  button. Type ((2 + 2k/5)^2 + 2)(2/5). Choose Variable k, Definite sum, 1 as Lower limit, and 5 as Upper limit. <OK>	Calculate sum: #1: $\sum_{k=1}^{5} ((2 + \frac{2k}{5})^2 + 2)\frac{2}{5}$
2. Click  button.	Simplify: #2: $\frac{628}{25}$
3. Click  button.	Approximate: #3: 25.12

(2) To show that the approximation of definite integral in [2, 4] is

$$\int_2^4 f(x)\,dx = \lim_{n->\infty} \sum_{k=1}^{n} f(x_k)\Delta x \approx 22.6666,$$

where $f(x) = x^2 + 2$, $x_k = 2 + (k)(\Delta x)$, and $\Delta x = \frac{4-2}{n} = \frac{2}{n}$.

The commands and output of Derive are as follows:

User Keystrokes	Derive Output
1. Click  button. Type ((2 + 2k/n)^2 + 2)(2/n) Choose Variable k, Definite sum, 1 as Lower limit, and n as Upper limit. <OK>	Calculate sum: #1: $\sum_{k=1}^{n} ((2 + \frac{2k}{n})^2 + 2)\frac{2}{n}$
2. Click  button.	Simplify: #2: $\frac{4(17n^2+9n+1)}{3n^2}$
3. Click  button. Choose Variable n, ∞ as Limit point, and Left for approach from. <OK>	Calculate limit: #3: $\lim_{n->\infty} \frac{4(17n^2+9n+1)}{3n^2}$
4. Click  button.	Simplify: #4: $\frac{68}{3}$
5. Click  button.	Approximate: #5: 22.6666

(3) To show that the exact definite integral in [2, 4] is:

$$\int_2^4 f(x)\,dx = 22.6666,$$

where $f(x) = x^2 + 2$.

The commands and output of Derive are as follows:

User Keystrokes	Derive Output
1. Click  button. Type x^2 + 2. Choose Variable x, Definite integral, 2 as Lower limit, and 4 as Upper limit. <OK>	Calculate integral: #1: $\int_2^4 (x^2 + 2)\,dx$
4. Click  button.	Simplify: #2: $\frac{68}{3}$
5. Click  button.	Approximate: #3: 22.6666