STIMULATING STUDENTS’ CREATIVITY IN AN INTEGRATED LEARNING ENVIRONMENT WITH TECHNOLOGY

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Abstract: In this article a couple examples in a case study how to stimulate students’ creativities in their mathematical activities by using a technology are shown. There are many kinds of technology to help students exploring relations between elements on a figure or behaviours of a function. By using these technologies mathematical situations are visualized and their dynamical movements are observed. Multiple representations of mathematical concepts (Goldenberg, 1997) on these technologies provide an integrated learning environment in which numeric data, a graph/a geometrical figure, an algebraic expression and problems are linked on one screen. Then this integrated learning environment makes it possible for students to create rules, to find new problems by themselves and to jump out to new world if a good task is given. Through these activities shown in this study students’ creativity is stimulating.

Key words: Creative activities, Integrated learning Environment, Spreadsheet, DGS, Technology
INTRODUCTION

When creativity is discussed in education, many articles are written about activities for gifted students. But these days the pace of change is so fast and it is often the case that material learnt at the secondary education provided by the course of study often becomes outdated in a very short time. Moreover, all kinds of quantitative information are surround us in our daily life and we have to make judgments with these data depending on the situation and create good new ideas from these data. Therefore, for all students living in such a changeable world, to promote creativity not only for gifted students but also ordinary students in mathematics education from an overall perspective is vital importance. Sometimes it is very hard to promote creativity of ordinary students but technologies must help it. The propose of this study is to provide new type of activities in a class and to show how effective on promoting creativity of ordinary students by using technology.

1. An Integrated Learning Environment by Technology

A Technology provides an integrated learning environment. For example, a Dynamic Geometry Software (DGS) provides an environment linked geometrical figures and algebraic expressions by dynamical movements. And a spreadsheet and a graphical calculator link numeric data, graph and expression in one screen.
In these environments, students are able to explore characteristics of figures or behaviors of functions by operating parameters flexibly and observing these movements, then they find many new ideas by themselves. Students are able to examine their own ideas by trial and error with technology. These activities must stimulate creativity even for ordinary students.

Following examples show how students’ ideas are stimulated and expanded.

1-1 Exploring Circles by using DGS

(1) Exploring the characteristics of a circle (Fig.1)

This is a trial in a middle school class. Drawing a circle through two points is one of the geometrical problems in a middle school. By paper and pencil, students have to know the centre of a circle is on the perpendicular bisector of these two points. But by using DGS, they don’t need to know such knowledge. Students drew many circles on a screen and move them through fixed two points and they understood that these points make a line with characteristics of perpendicular bisector of these two points by themselves. Then they found only one circle through three points. At the following class, they explored a circle through four points and found many theorems of inscribed angle or an inscribed quadrangle by themselves.

They categorized quadrilaterals to be able to have a circumscribed circle.

(2) Exploring more (Fig. 2)

After the activity of drawing a circumscribed circle of four points, they tried to draw an inscribed circle of a quadrilateral. Moreover, you can explore whether
there are rules in the relation between length of sides of the circumscribed quadrilateral and the given circle.

![Figure 2. Trial drawing a circumscribed circle of the circumscribed quadrilateral of a given circle](image)

### 1-2 Examples by using a spreadsheet

A spreadsheet is installed in computers of almost all schools and numeric data, a graph and an expression are integrated on one sheet and students are able to explore behaviors of a function and find any rules for each situation by inputting numeric data on a table.

1) Exploring functions by integrating numeric data, expressions and graph.

This is a trail in a middle school. Quantitative relationships in concrete situations were recognized by inputting numeric data into a table and rules were found by themselves (Kakihana K., Fukuda C. and Shimizu K., (2003)). On the tasks of exploring between variable width, perimeter or area and the height of a rectangle, the first grade students before learning function were able to find the relation between variables and write the expression for it beyond the text book.

When you use a spreadsheet students try to change the situation by input numeric data by themselves and to find the rules between each data and then they observe the shape of the function and think the behaviour of it. For example (Fig. 3.1),
the area of a rectangle was fixed, and the variable was height, and the other variable with co-variance was width. Through this activity, students change the part of fixed data and get another function which students never learn in a middle school.

This task is also visualized on DGS (Fig. 3.2). When you move the point P on the Fig.3.2, you can see the change of the height of the rectangle keeping 10 square cm. Then you can observe the shape of the function. This is drawn by Cabri II plus and it show the algebraic expression also.

(2) Understanding the concepts of a differential and an integral formula by exploring on a spreadsheet.

This is the trial in the third grade of a high school and the first grade in university who have not studied before. This activity started from a liner function and a quadratic function. We’ll show the case of a tertiary function (Fig. 4). Students were asked to draw the function y=5(x-1) (x-2) (x-3). During drawing, a couple students asked teacher the mean of expression 1E-15, 2.2E-15 and 1.33E-15 on the y column. Then the teacher explained it means very small number. They
understood that these points mean y=0 and their value of x on the x coordinate axis. Then they were asked to calculate the gradient for each two x points and to explain the relation between two graphs. Through these activities, students were able to find the behaviors of this function by observing these numeric data and two graphs. They accepted the meaning of the solution of the function on the graph and understood the meaning of the point of relative maximum and minimum point and an inflection point from numeric data and graph. They predicted the behavior of the differential function from the graph shown in the Fig.4. After that they get a differential expression of many kinds of polynomial expression by using a graphing calculator. They tried to find formulas of differential of a polynomial expression. Through these activities, students understand the meaning of a differential. These activities help students to understand the meaning of a differential and the behaviour of differentiated function for a polynomial.

2. A Calculator helps students’ creative activity

In Japan, it is very rare to use a calculator in elementary schools. And in elementary school students learn integer or they learn until hundredth digits of numeric data. But when students use calculator, their activities are expanded.

2-1 Students’ ideas are helped by a calculator

This trail is in the 6th grade classes of Ushiku Kamiya elementary school in IBARAKI. This activity is “Let’s find the cube with 2008cubic centimeter in volume. Students started calculating 12*12*12 then 13*13*13, then continued to try to find the length of side of that cube by calculating about 12.5, 12.6 12.7. Most students thought there is only approximate number for this volume. One
boy found the length must be less than 12.7 and bigger because 12.6*12.6*12.6 = 2000.376 and 12.7*12.7*12.7 = 2048.383. Then his trial started from 12.615, 12.616, 12.6159… at last his calculator shows 12.615987* 12.615987* 12.615987 = 2008. He found the method how to approximate the right number by himself. Calculator helps his works. Friends around him also tried to do it. When they found the length of side of cubic with 2008 cubic centimeter, they are so excited. They found the limitation of the calculator, also. They understood what error was. Teachers have never expected such activities in this task.

Then they were asked to construct any solid with 2008 cubic centimeter in the total volume after drawing a sketch and a projected diagram. A lot of ideas were come out and they calculated the sum of volumes by using calculator then fixed the length of each side to be 2008 cubic centimeter of the total volume. And then they constructed it by their projected diagram.
3. CONCLUSIONS AND FUTURE WORK

Through these activates, students found characteristics of figures, the meaning of behaviour of functions and so on by themselves. Students excited and wondered what has happened. Wada said in creative activities, there should be amusement or wander (Wada, 1997). Watanabe (2007) called these activities “Do Math course”. In Japanese mathematics classes, it is usually said the mathematical activity means only to solve a problem by manipulating formulas of calculations. Students learn skills of getting a solution and then exercise same kinds of the problem. It is a dull activity to train and solve a given problem (Watanabe, 2007). In creative activity, they should think about answers to be solved. In the first case, software which provides dynamical operations for an object on a screen helps students find the geometrical relations by themselves. And the second example, the use of graphs, numerical tables, or computer algebra system gives students viable access to a solution and behaviour of functions. Third one, students are actually interested in constructing solid and even in calculation of total volume. Through these activities the mathematical thinking are stimulated, because there are many chance for students to have the various mathematical perspective. To think a new mathematical theorem is fun. When you make a new theorem, you must have the flexibilities and the inquisitiveness for the mathematics. These contents are not far from the contents of Education Ministry guidelines in Japan but their activities are very different. We will continue to provide these examples for giving students mathematical fun and stimulating creativity.

REFERENCES

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