

# **A Study of Constructivist in Mathematics in Virtual Class with Moodle and the Geometer's Sketchpad**

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## **Abstract**

The purpose of this research study is to explore how can Moodle enhances students construct their mathematics knowledge. The samples of this research were first year students of International College, Suan Sunandha Rajabhat University. Moodle website of mathematics course was designed. The components of the Moodle website were course description, course outline, mathematics contents and topics, worksheets, assignment, and chat room. Mathematics activities using the Geometer's Sketchpad were designed and embedded in this Moodle website.

Research finding showed that students were able to construct their mathematics knowledge through Moodle in virtual classes or on-line learning environment by communicating and receiving helping from peers. The students explored their mathematics activities with the Geometer's Sketchpad, they interacted by dragging and animating as much as they wanted. Through Moodle, the shy students who never asked questions in normal class were able to ask and received feedback from lecturer and their friends. The students reflect their thinking by chats, write answers, informal talk and discuss with their friends. The students had positive attitude toward mathematics.

## **Introduction**

As part of the regular quality assurance process used at International College, Suan Sunandha Rajabhat University (SSRUIC), the teaching and learning process at SSRUIC has to be improved in order to raise the quality of the Graduate. Throughout Year 2010, monthly meetings were held with all staff. At these meeting details of course content were mapped out, paying attention to offer the possibility of reinforcement of concepts. With the intention of encouraging the students' involvement in their learning during classes and after classes, these discussions were predicated by the requirement that all courses offer at SSRUIC have to be student centered learning, constructivist approach, problem-based learning and using Information and communication Technology (ICT). This provided a challenge to mathematics courses, because a traditional mathematics lesson would be conducted in the following sequence: a lecturer would begin the lesson by briefly presenting the mathematics concepts or procedures following by working out one or two examples as illustration for students in the class. The lecturer would then assign some time in class for students to work out similar problems and additional exercises would be given as homework to reinforce the learning achieved. If the mathematics course was to be student centered learning, constructivist approach, problem-based learning and using ICT, the tradition teaching and learning had to be changed. The lecturers have to find the meaningful problem-based learning to enhance student to do to learn inside classroom and in virtual classroom. This research will

explores only how can Moodle and the dynamic software program the Geometer's Sketchpad enhances students construct their mathematics knowledge in virtual classroom.

## **Use of ICT in Mathematics Education in Thailand**

From year 1996 until present, student-centered learning is compulsory method of teaching in Thailand (Ministry of Education, 1996). The appropriate use of ICT can increase the level of students' understanding by supporting the development of mathematical concepts, procedures and processes through connecting new knowledge to students' prior knowledge. According to Sierpiska (1994), understanding is the mental experience of a person by which he/she relates an object to another object. Personal understanding of a concept is grasping or acquiring the meaning of the object. Understanding is a matter of being able to do a variety of thought-provoking things with a topic, such as explaining, finding evidence and examples general listing, applying and representing the topic in new ways. (Blythe,1998). Therefore, in order to help students learn mathematics with understanding the teacher should facilitate the construction of ideas concepts and processes through a careful selection of resource materials and relevant with the real world problems. The students should be actively involved in the learning process and work as a team.

## **Moodle and the Geometer's Sketchpad (GSP) in Thailand**

Nowadays Information and communication Technology (ICT) has an effect to teaching and learning in mathematics in Thailand. There are various ICT which can be used effectively in mathematics subject inside class and after class through e-learning environment or virtual class. One of them is a dynamic mathematics software named *the Geometer's Sketchpad (GSP)*. GSP was employed in mathematics classes and also in virtual class on line learning through Moodle website. Moodle website were embedded in at least 80% of universities website in Thailand. GSP and Moodle were translated into Thai language.

## **Moodle**

Moodle is a course management system for online learning. The acronym **MOODLE** stands for *Modular Object-Oriented Dynamic Learning Environment*. It was developed by Martin Dougiamas of Curtin University of Technology, Perth Australia. Moodle has been developed as an OpenSource software project. The design of Moodle is based on socio-constructivist pedagogy. Dougiamas (2011) described that:

“Our motivation was to investigate links between the participants' experiences and the website. Our intention is not only to improve the quality of this postgraduate course, but also to improve the ability of Moodle as a tool to create online courses that embody and further develop our social constructionist pedagogical framework.”

Dougiamas created his own learning environment in the open source format. Moodle was designed to support and promote users interested in developing constructivist, student-centered learning environments (Dougiamas, 2011). This means its goal is to provide a set of tools that support an inquiry and discovery-based approach to online learning.

Moodle purports to create an environment that allows for collaborative interaction among students as standalone or in additional classroom instruction (<http://dougiamas.com>).

According to Taylor & Maor (2000) the constructivist on-line learning environment consists of six major components: relevance, reflection, interactivity, tutor support, peer support and interpretation. Dougiamas (2011) explained that his Moodle were in line with Taylor & Maor ideas, Dougiamas developed Moodle with emphasized on elements of the students' environment that were focus on the web site as a tool for navigating the course, web site content, activities and resources, the online tutor's participant and support, and the students' participation and support. Moodle consist of different learning activities such as lesson, journal, wiki, forum, chat, and quiz. Moodle's design is grounded in a socio-constructivist theory of learning. Learning task can be designed to allow for cooperation between the lecturer and students or among students by using different formats of social interaction. Students interact with each other synchronously in chat rooms, engage in asynchronous discussion in Wikis and forums. The Wiki module in Moodle enables students to compose or work together on a text while online (Dougiamas, 2011).

In addition, Dougiamas developed Moodle as new tools for lecturers and learners to enable richer forms of dialogue combining content and communication through which teaching and learning can occur. The tools allow both lecturer and learner to construct environments in their computer within which they can construct representations of their understandings of the subject and share them with others in a variety of ways. Tools are based on web-enabled databases, and keeping things simple to maximise the potential use.

## **The Geometer's Sketchpad (GSP) in Thailand**

GSP was introduced in Thailand since year 2000, and in year 2004 GSP was translated into Thai language and has been used widely in Thailand. After that more than 3,000 mathematics teachers have been trained to use GSP as a tool in their mathematics classes. There were more than 500 workshops conducted on the use of GSP by various agencies in Thailand. The Lab Schools Project (or Dream School Project) of the Ministry of Education, Thailand has set up 175 GSP Training Centers throughout Thailand. These 175 GSP Training Centers have trained mathematics teachers at primary and secondary mathematics levels. Where as The Institute for the Promotion of Teaching Science and Technology (IPST), and universities such as Suan Sunandha Rajabhat University have trained lecturers on the use of GSP within mathematics contents at university level.

GSP empower students to use their ability to access, drag, visualize, and create graphical representation, which will enable them to develop their mathematical thinking skills, concepts and understanding. GSP provides opportunities for students to investigate and discover mathematics concepts in particular geometric and algebra concepts. By using GSP students learn through exploring, investigating and discovering. GSP can be used inside class, after class and also in virtual class through e-learning environment such as Moodle.

## **Method and Procedure**

The purpose of the study was to explore how can Moodle and the dynamic software program the Geometer's Sketchpad enhances students construct their mathematics knowledge in virtual classroom. The sample was students who study in Course *IGM 1101: Business Mathematics* of International College, Suan Sunandha

Rajabhat University. The duration of this study was from December 2010 to September 2011. The research study consists of designing and developing a Moodle module, developing learning objects for Course *IGM 1101: Business Mathematics* using GSP and developing Moodle website embedded with *IGM 1101: Business Mathematics* lessons and GSP. This Moodle website was implemented for 15 weeks.

## Research Questions

1. What are the components of Moodle in virtual class in Business mathematics?
2. How Moodle and GSP enhances students construct their mathematics knowledge in virtual classroom?

**Research Question 1:** What are the components of Moodle in virtual class in Business mathematics?

Based on this research, the components of Moodle website of *IGM1101: Business Mathematics* in virtual class consist of the following topics:

- 1) Users name
- 2) Weekly structure:  
15-week of *IGM1101: Business Mathematics*  
Course outline, lesson plan and learning objects
- 3) GSP online activities were embedded through out the 15-week
- 4) Handouts/lecture notes
- 5) Assignments and homework
- 6) Problem-Based learning questions
- 7) Journal
- 8) Wiki
- 9) Web board
- 10) Chat room
- 11) Students photographs and information
- 12) Quiz/Assessment/Evaluation

Figure 1: Moodle website of *IGM1101 Business Mathematic*

**Research Question 2:** How Moodle and GSP enhances students construct their mathematics knowledge in virtual classroom?

The following examples show lessons and activities in Business mathematics incorporate with GSP and Moodle which were used in this research.

**Example of Lesson 1: Linear Equation and Break-Even Analysis**

In commercial situations it is important to determine how many items must be manufactured and sold to cover expenses. When the point is found it is know as the break-even point. The process for determining this point is break-even analysis. A profit is made if income is greater than expenses.

If we let:

- a) the total income generated can be expressed by the linear equation:  $I = sx$ ; where  $I$  = total income;  $s$  = income per item;  $x$  = number of items sold; and
- b) the total expense incurred can be expressed by the equation:  $C = vx + f$ ; where  $C$  = total expense;  $v$  = cost of manufacturing each item;  $x$  = the number of items manufactured;  $f$  = fixed cost

The break-even point is the point of intersection of the straight lines representing the total income and total expenses/cost functions.

In a new sketch of GSP; using the Line Tool draw

- a line  $I = sx$ , this line has a slope equal to  $s$  and passes through the origin and
- a line  $C = vx + f$ , this line has a slope equal to  $v$  and a y-intercept equal to  $f$
- The point of intersection of the two straight lines  $I = sx$  and  $C = vx + f$  is called a break-even point

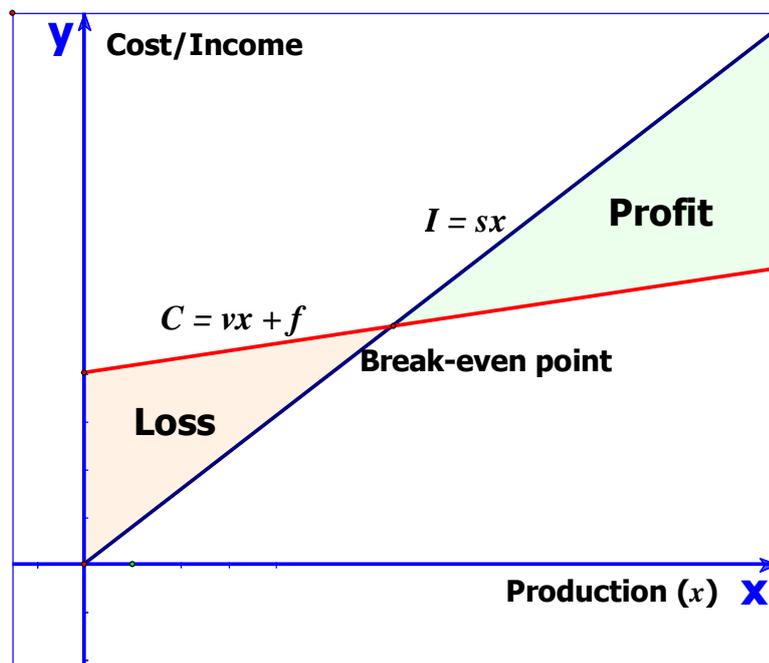


Figure 2: A break-even graph

**Example:** KK shop manufactures its products at a cost of \$40 per unit and sells them for \$100 per unit. If the shop's fixed cost is \$1,200 per month, determine the KK shop's break-even point.

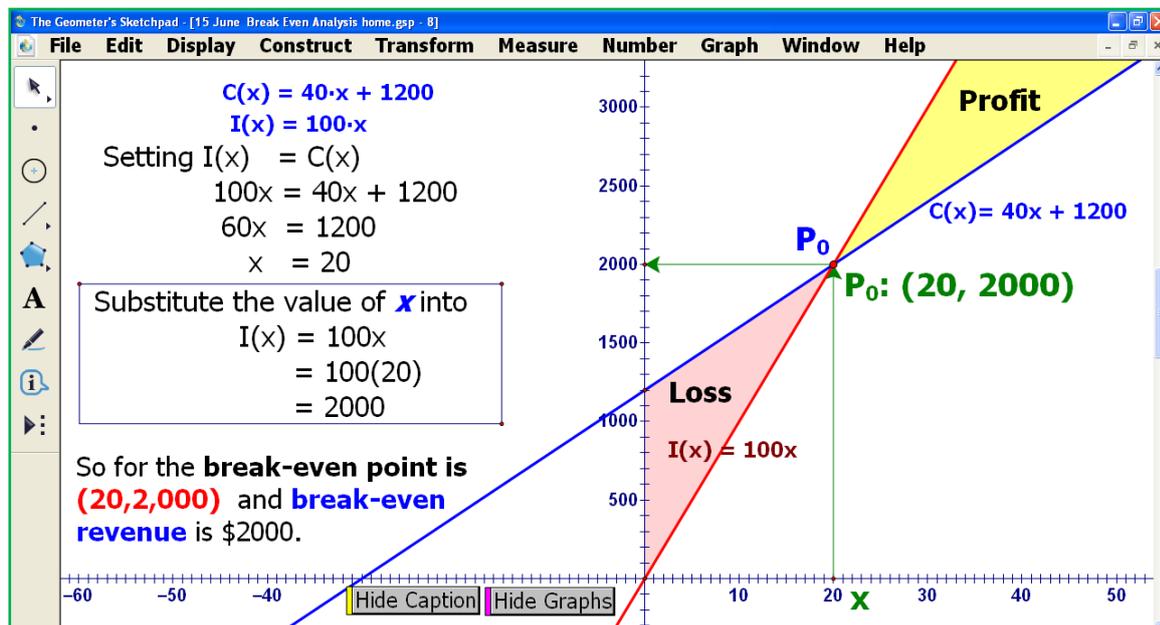


Figure 3: A break-even graph of KK shop manufactures

Base on the research finding the students dragged point  $x$  to the left and the right to observe the value of points that lie in the *loss region* and *profit region*. Students were able to develop their knowledge and understanding of break-even analysis. That is to determine the number of items that are required to be made and sold in the break-even period.

## Example of Lesson 2: Linear programming and Application in Business

In business it is difficult to figure out how to maximize profit or how to minimize cost because there are many factors to consider. Many practical problems involving maximizing or minimizing a function subject to certain constraints. Maximization or minimization problems that can be formulated in terms of a linear objective function and constrains in the form of linear inequalities are called linear programming problems (Tan, 1995). The GSP was introduced and described how to construct graphs of each constraint, to shade the region of feasible solution, to explore the coordinates of each vertex of the feasible region and to investigate and also to calculate the value of optimization function at each one of them. The following example was employed in this research study.

**Example:** A nutritionist advises a person who is suffering from an iron and vitamin B deficiency to take at least 2400 mg of iron, 2100mg of vitamin B1 and 1500 mg of vitamin B2 over a period of time. Two vitamin pills are suitable, Brand A and Brand B. Each Brand A pill contains 40 mg of iron, 10 mg of vitamin B1 and 5 mg of vitamin B2, and cost 18 Baht. Each Brand B pill contains 10 mg of iron, 15 mg of vitamin B1 and 5 mg of vitamin B2, and cost 24 Baht.

What combination of pills should be purchased in order to meet the minimum iron and vitamin B requirements at the lowest cost?

Students learned how to analyze the problem, to construct a table of variable, to determine the constraints and state the objective function.

**A table of the variable:**

	Brand A	Brand B	Minimum Requirement
Iron	40 mg	10 mg	2400 mg
Vitamin B1	10 mg	15 mg	2100mg
Vitamin B 2	5 mg	15 mg	1500
Cost per pill	18 C	24C	

We have to decide how many pills of Brand A and Brand B should be purchased to meet the minimum vitamin requirement at the lowest cost.

**Let  $x$  be the number of Brand A pills**  
 **$y$  be the number of Brand B pills**

**Constraints:**  Hide Constraints

Constraint 1 Iron Requirement:  $40x + 10y \geq 2400$   
 Constraint 2 Vitamin B1 Requirement:  $10x + 15y \geq 2100$   
 Constraint 3 Vitamin B2 Requirement:  $5x + 15y \geq 1500$   
 Constraint 4  $x \geq 0$   
 Constraint 5  $y \geq 0$

Hide Objective function

**Objective Function:**  
 The function in term of  $x$  and  $y$  that is to be minimized cost per pill  
 $C = 18x + 24y$

Figure 3: Constraints and objective function

GSP was introduced and described how to construct graphs of each constraint, and to shade the region.

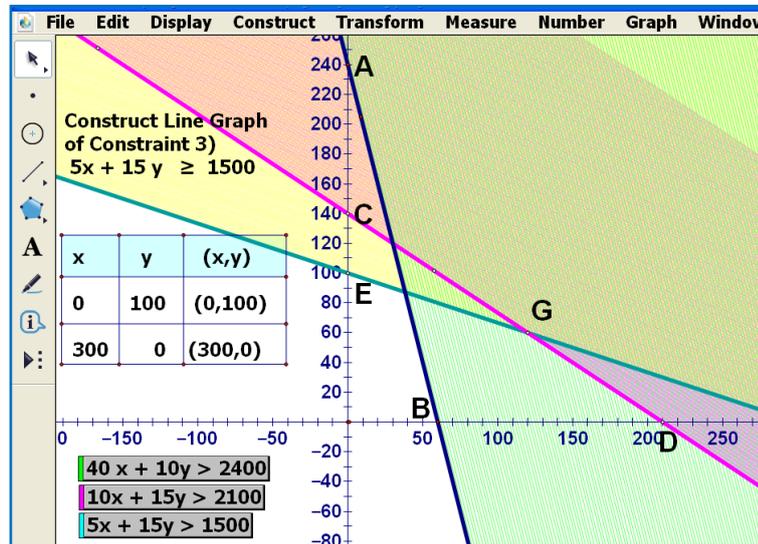


Figure 4: Graph of Constraints and shaded region

GSP was employed to construct graphical solution of Linear programming Problems: The Method of Corners. Students explore Graph of the Feasible Set and find the coordinates of all corner points (vertices) of the feasible set.

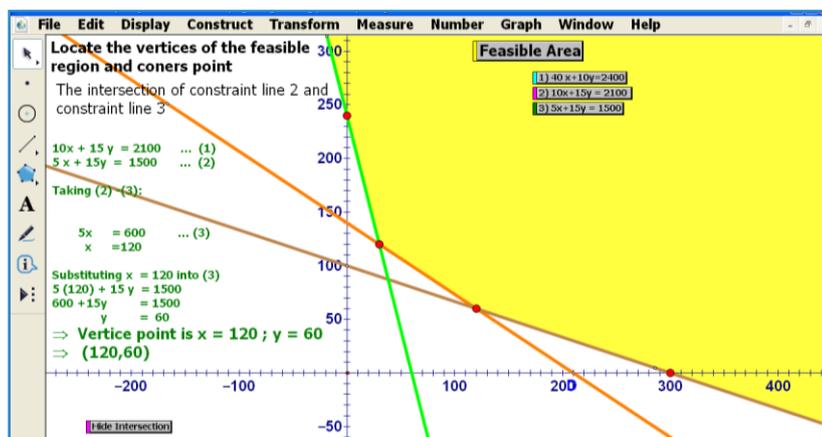


Figure 5: Graph of the Feasible Set

The Objective Function is

$$C = 18x + 24y$$

Students found that the minimum for the objective function

$C = 18x + 24y$  occurs at the vertex G (30,120) and has the value 3420.

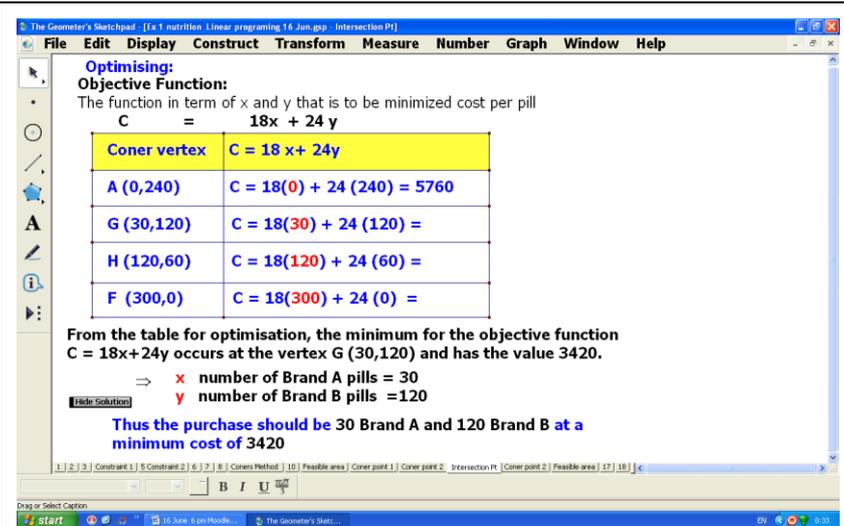


Figure 6: Cornor points and Objective function  $C = 18x + 24y$

These activity had showed how GSP empower students to use their ability to access, drag, visualize, and create graphical representation, which will enable them to develop their mathematical thinking skills, concepts and understanding. Students were able to explore the activity inside class and after classroom.

## Student learning business mathematics with the Geometer's Sketchpad through Moodle in virtual classroom

The research findings show how Moodle and GSP enhances students construct their mathematics knowledge in virtual classroom. The students reflect their thinking by chats, write answers, informal talk and discuss with their friends. The following are excerpted from students' semi-structured interview.

- The activities made us do a lot of discovery and exploration, which were impossible without GSP and Moodle. This is because during class we have no time to explore and investigate the graphs of different functions, especially the complicated ones;
- I do not want to ask questions in normal class because I feel shy to ask. Through Moodle I can asked and received feedback from lecturer and my friends.
- It gave me a deeper and better understanding of the linear programming lessons because of GSP and Moodle.
- The activities that go with it enabled us to work by pairs & group. Learning became easier;
- With the Moodle and GSP, we were able to visualize the value of point at break- even point and the value of the loss region and profit region;
- I learned how the inequality graphs look like;
- There are a lot of new discoveries while we use GSP;

- It made business mathematics activities more enjoyable. It is a big help in plotting the graphs of functions that are quite tedious and difficult to do manually;
- The activities that go with the Moodle and work with my friends after class are challenging;
- I cannot access the GSP file and upload my assignments because I can use Moodle only in the College. I do not have internet access in my house;
- GSP is a useful tool in learning business mathematics;
- Learning business mathematics has become more enjoyable;
- I learned a lot from my friends through Moodle, I like to chat with my friends through Moodle.
- Business mathematics has become more fun and easy to learn;
- With the GSP, solving linear programming became easier and so it was faster and easier to understand. We were able to investigate more challenging problems.

## Conclusion

The research findings show that GSP empowers students to visualize and encouraged them to make conjectures before attempting to proof. The feedback from students' semi-structured interview revealed that when they used GSP to construct graphs it was not only clear but also make the concepts in business mathematics much more basic and easier to understand. GSP is an instrument in enabling them to obtain a deeper insight into the concepts. In addition, the research findings had showed that for the effective online instruction the Moodle webpage should do as follows:

- Give students clues and explanation about what they are learning;
- The GSP Program file have to explain clearly.
- Highlight the most effective information;
- Eliminate all visual and sound;
- Ask students to explain why.

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