REVIEWING THE EFFECTIVENESS OF GEOMETER’S SKETCHPAD REPRESENTATIVE FOR CURVE LINES SKETCHING

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Abstract

This qualitative experimental research is to study the effectiveness of Geometer's Sketch Pad (GSP) software to draw the curve line for the subject Basic Calculus. The study involved 30 student teachers from IPG Kampus Ipoh, majoring in Mathematics, 4th semester who are currently enrolled in a Bachelor of Education programme (PISMP). The focus of study is Graph Function which is one of the topics in Basic Calculus subject. Student teachers are exposed to an alternative method in graphing the function and later determine the extreme point (maxima or minima) by using computer software applications (GSP). The effectiveness of this method will be analysed through the findings from the survey questionnaires, interviews and the researcher’s own observations in the actual classroom situation. Discussion of the findings of the research questions is based on the perception of student teachers through interviews, the results from the questionnaire survey and also through researcher’s observation in the real classroom. The results of this study will hopefully provide some information to educators in choosing the method that can improve students’ understanding of the lesson content being taught especially in graph function.
Abstrak


Keywords: Graph functions, Geometer’s Sketchpad, student teachers, curve line, teachers achievement, attitude

INTRODUCTION

Research Background

According to Skemp (1987), Calculus is one of the subjects that most students learn without understanding. The reason might be that with Calculus, there has traditionally been an overwhelming emphasis on the manipulation of symbols, notion of derivative and the fundamental theorem of Calculus that has been too abstract for many students. In Calculus, teachers expect their students to spend large amounts of time attempting to paper-and-pencil algorithms for the derivative and
integration processes. Students are required to memorize symbolic computational techniques and formulas, but they do not really understand and quickly forget them.

To better understand student learning ability to grasp certain concepts, teachers need to assess student solution procedures in detail, especially the representation for their solutions, including formulas, graphs and language such that teachers can determine if students misunderstand a certain concept or are stuck at a specific point (Aimsworth, 2002). Teachers can then provide more effective guidance to students. Sometimes in the pressure to move through the curriculum and to finish the syllabus, teachers forget about the best way of delivering the contents and students are not given ample time to understand the concept being delivered. Therefore, it is important to occasionally step back and think about the subject as a whole and what are the important concepts the teachers want students to develop by using suitable method which the students can understand better. According to these ideas, this research is done to study students’ achievement in sketching the graph of function and later, getting the extreme values through the efforts of suitable method as compared to the traditional representation.

**Reflection on Teaching and Learning**

Nowadays, teaching Mathematics is very challenging as many students are not able to understand the tedious concepts and algorithm, which later lead to demotivation especially when it is taught badly. Mathematics seems to inspire fear and intimidation in students and even when they are in the higher level like IPGM. Therefore, it is paramount that student teacher are inspired with the beautiful of mathematics and its importance in daily life. Mathematics must also be provided with logical reasoning skills to build on subsequently more rigorous experiences of formal geometry (Noraini Idris, 2007). Logical reasoning skills give the student teachers the ability to grasp certain concepts, facts and procedures better. Training in logical reasoning skills encourages the student teachers to think for themselves, to develop their own hypotheses and ideas and to understand better the methods used.

To instill the logical reasoning skills in mathematics, this subject cannot be taught one way. Student teachers must not stick to the method being taught without seeking the alternative way of the working as these kinds of attitude make mathematics become “strict to the rule method”.
Therefore, I need to teach other method to my student teachers which is more suitable in delivering certain concepts of mathematics and that can cater for students logical reasoning skills. This is important as IPGM produces future effective teachers who must be responsible, qualified, enthusiastic, intelligent and innovative to lead their pupils’ need through the comprehensive teacher education programme. The method that I choose must also be more interesting and can help to understand difficult concepts better. For example, the graph of function is taught in Form Four, Additional Mathematics syllabus. This is continued in the Form Five Modern Mathematics syllabus where students are exposed to the shape and properties of graphs of linear, quadratic and cubic functions (Ministry of Education, 1998, 2003). In the latest Modern Mathematics curriculum specifications, the suggested learning activities is to explore the graphs of functions using the Geometer’s Sketchpad (Ministry of Education, 2006). This is then expanded in the Mathematics T syllabus for Form Six (Grade 12) students whereby the students need to understand the more complex concept of functions, the type of functions, and the basic properties of the graphs of algebraic functions, trigonometric functions and absolute value functions (Malaysia Examination Council, 2003). In the schools, traditional method is applied as usual from year to year to teach this topic. Students have to undergo tedious process especially when they want to get the extreme values of a curve. As this topic is repeated during Pra-PISMP and PISMP in the subjects Mathematics 2 and Basic Calculus, I, as a researcher try to apply multiple representations, traditional method first and followed by applying GSP to compare the student teachers’ success. The respondents are 30 student teachers from Mathematics school, IPGKI. According to the observation made by the researcher, when this topic is taught using the chalk and talk method (traditional method) in the classroom, the student teachers are not able to sketch the graph of functions in a given short time and lead to the failure of determining the behavior of the extreme values of the function. The graph which is drawn by sketching, is not smooth, not according to scale and distorted. Student teachers also cannot visualize the shape of the graphs and have a poor understanding of it. Students teachers also showed their frustration, boredom and unhappiness while performing the given tasks. They also fail to see the importance or applicability of content in the subject matter which lead to a poor attitude and lack of motivation.

FOCUS OF THE RESEARCH

Review Issues/ Statement of Problem and Analyse of Statement Problem

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From the researcher’s observations during the lecture and tutorial time, the student teachers lack in sketching the graph of functions in a given short time. This lead to the failure to determine the extreme values of the functions which is also due to the inability to grasp the skills of differentiation process. The student teachers’ interest are also very low to complete the given task.

**Review of Related Research and Literature about the issue**

Students knowledge and skills are very fragile and apparently learned without much depth in conceptual understanding (Hiebert, 1992). Therefore, it is necessary to change the way mathematics is taught. In 1989, the Curriculum and Evaluation Standards for School Mathematics was published by the National Council of Teachers of Mathematics (NCTM) which recommended the change in the way the teachers teach mathematics. Mathematic educators also have long promoted the use of technology in the teaching and learning of mathematics (National Council of Teachers of Mathematics 1989, 2000). Electronic technologies like computers and educational software are believed essential tools for the teaching and learning of mathematics.

Although it is often pointed out that introducing computer programs too early in the curriculum can cloud the mathematical theory with computations syntax, Cretchley (2000) from his research noted that students was found to become more mathematically confident when computational tools were used as part of the learning program. According to Leong Kwan Eu (2013), from his research which involved 43 Form Six students from an urban secondary school in Kuala Lumpur, Geometers’ Sketchpad really encouraged and facilitated the students’ understanding and interest in graphing function. With Geometers’ Sketchpad, students’ not only solve problems or compute solutions, they can construct models to solve problems and generate solutions and thus have experiences closer to that of doing algebra than simply studying it. In his research, Almeqdadi (2000) found a significant difference between the means of the students’ scores on the post test of those using GSP and those using only the book in the learning of some geometrical concepts. Students using the GSP performed significantly better than those using books only. McClintock et al., (2002) did a qualitative study on students’ development of 3D visualisation in the Geometer’s Sketchpad environment. The students were taught geometric solids among other concepts for 10 to 20
weeks using GSP. They found that the GSP and the associated activities were effective in helping the students develop 3D visualisation and achieve conceptual understanding of geometry content. The immediate feedback provided by the dynamic environment allowed the students to verify or change their conjectures. They found that the students have progressed significantly in terms of their geometric thought.

RESEARCH OBJECTIVE

This study is carried out to determine whether GSP can be an alternative method to sketch the graph of function and to get the extreme values of the function when there exists constraints like a short time given. The researcher also want to investigate whether there is a change from negative to positive attitude of learning among the student teachers. Lastly, it is hoped that this study will further encourage the usage of this software in the teaching and learning of graph functions among the students and teachers.

RESEARCH QUESTIONS

The research questions that the researcher’s seek to answer are:

i. Do student teachers’ attitudes about ‘Sketching the Graph of Function’ improve when they are taught concepts through the use of GSP?

ii. What are the student teachers’ perceptions about using the GSP in learning graph functions ?

iii. Are student teachers better able to apply concepts of extreme values of the function and their behavior after using GSP?

TARGET GROUPS
The target groups are 30 student teachers majoring in Mathematics from IPGKI.

DATA COLLECTION PROCEDURES

In my action research, I use Kurt Lewin model (1946) which involve a few steps. According to Lewin (1946), action research shows a cycle of steps (a spiral of steps). An action research cycle has four stages, namely planning (planning), monitor (observing) and reflecting. This cycle will continue into the next cycle involving re-plan, act, observe and reflect to generate a new cycle if the actions undertaken fail to achieve the desired progress.

I intend to introduce GSP to my student teachers after the traditional method is applied in teaching Graph Function. I want to see the achievement and attitude of learning among the student teachers in the visualizing and graphing of functions by using the new method. Here are the procedures being carried out while conducting this research.

<table>
<thead>
<tr>
<th>Period</th>
<th>Small Topic</th>
<th>How the GSP technology is applied?</th>
<th>Class Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>Graphing the equation</td>
<td>GSP is not yet used. Students teachers are asked to read books or find articles from internet about GSP.</td>
<td>Student teachers learn to sketch the function by using traditional method (pencil and paper) through the text book.</td>
</tr>
</tbody>
</table>
### Second

**Determine the extreme values and behavior of the values.**

Students teachers have done their reading and will discuss with the lecturer on the usage of GSP. The GSP software is installed in their laptop and I will teach them how to apply GSP in the given exercise to be tried at home.

### Third

**Graphing the equation Using GSP**

I will show the student teachers how to graph the function by using GSP software. They will be required to create their equations and draw the graph of functions on the coordinate plane, followed by plotting points on the curve line and join the points to produce a line. They will trade laptops with their partner in order to peer check their work.

Student teachers are taught to determine the extreme values of the function by using traditional method that is differentiation process (first derivative), followed by determining the behavior of the extreme values (maximum or minimum) by using second derivative and examining the gradient each side of each extreme point.

The lecturer will review points made by the student teachers on the coordinate plane. The student teachers will be given certain functions and they need to draw the curve line by using GSP. Later they will be shown to plot 4 points and join the points with a line.
Fourth

Determine the behavior of the extreme values of the functions

I will explain to the student teachers how to measure the slope of two points by using GSP software. Then I will teach them how to drag one point to a fix point (lowest and top points on the curve line) until the points join together to get the value of the slope, as zero. This will give the extreme values of the function. Then I will teach the trainee teacher how to get the behavior of the extreme values by using GSP software.

The student teachers will measure the gradient of the two points by following instructions from the lecturer. The lecturer will lead the trainee teachers to get the extreme values followed by determining the behavior of them. Answers will be verified by their partners.

INSTRUMENTATION

The instruments developed by the researcher are survey questionnaires, interviews and observation. Once the data has been compiled, the researcher will triangulate the data from the three different sources (surveys questionnaires, interviews, and observation).

REFLECTIONS ON THE ACTION

Data Analysis And Interpretations From Research Findings

Research Question 1
Do trainee teachers attitudes about ‘Sketching the Graph of Function’ improve when they are taught concepts through the use of GSP?

Measurement 1: Student Surveys –Questionnaires Likert Scale
Surveys on student teachers attitudes towards GSP using a Likert scale questionnaire.

The researcher will collect and compile the datas from the surveys questionnaires. The researcher will calculate the mean value of each
question. The researcher will then look for trends on what type of learning methods that the student teachers prefer. The researcher will look at the student teachers outlying scores, those who score very well or very poorly, and will try to determine the reasons of the scores. The student teachers will be asked to choose from the given options with the given score marks below. Then, the researcher will compile the survey data as below to show the mean scores of the whole.

Strong Disagree (1), Disagree (2), Neutral (3), Agree (4) and Strongly Agree (5)

**Analysis of data:**
**Table 1: Learning Attitudes about Graph Function**

<table>
<thead>
<tr>
<th>No</th>
<th>The analysed statement</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>It is easy for me to work with the GSP.</td>
<td>4.4242</td>
</tr>
<tr>
<td>2.</td>
<td>I prefer learning Calculus concept using GSP as it gives accurate answers.</td>
<td>4.4621</td>
</tr>
<tr>
<td>3.</td>
<td>GSP can illustrate shape of graphs clearly to make me understand better.</td>
<td>4.4015</td>
</tr>
<tr>
<td>4.</td>
<td>When I am learning to sketch graph function, I can read and interpret graph easily with GSP.</td>
<td>4.4091</td>
</tr>
<tr>
<td>5.</td>
<td>I become more confident in problem solving when using GSP.</td>
<td>4.3485</td>
</tr>
<tr>
<td>6.</td>
<td>I prefer learning Calculus by using GSP when working with a small group of classmates.</td>
<td>4.2727</td>
</tr>
<tr>
<td>7.</td>
<td>I like to work on my own to complete Calculus assignments with explanations from the lecturer and with aid from GSP.</td>
<td>4.4773</td>
</tr>
<tr>
<td>8.</td>
<td>I enjoy completing today’s assignment by using GSP</td>
<td>4.3788</td>
</tr>
<tr>
<td>9.</td>
<td>I would be able to explain today’s assignment by using GSP to a classmate who is absent.</td>
<td>4.3561</td>
</tr>
<tr>
<td>10.</td>
<td>I prefer learning Calculus concepts through GSP than through text book.</td>
<td>4.4242</td>
</tr>
<tr>
<td></td>
<td>Whole Mean</td>
<td>4.3955</td>
</tr>
</tbody>
</table>
Based from the mean value scored by each question in the questionnaires, all the mean values are between agree and strongly agree, that shows the good feedback from the student teachers about GSP application in graphing function. Therefore, the research question answers student teachers’ attitudes about sketching the graph of function have improved when taught concepts through the use of GSP.

**Research Question 2**

What are the students perceptions about using the GSP in learning graph functions ?

**Measurement 2 : Interview**

Interview will be done between the researcher and the student teachers.

**Analysis of Data:**

The interview between the researcher and the student teachers was carried out as below.

Findings from the interview:

St 1 : I find that GSP is a good way to understand the concept of graph function and its extreme values.

St 2: It is easy for me to work with the GSP program and it is very enjoyable learning something new in Calculus with GSP.

St 3 : I like to see the dynamic diagrams and graphs created by using GSP which help me to understand better.

St 4: Now, the Calculus class is fun and interesting. GSP can make our learning in Calculus much more easier and interesting.

St 5: I think using GSP save a lot of time, is faster and convenient.

St 6 : I think GSP has to be used after the teacher teaches the basic concepts of differentiation.

St 7: Calculus becomes easier and more interesting, now I understand why we have to set \( \frac{dy}{dx} = 0 \) in order to find the maximum
value.

St 8: GSP is fun. By using GSP it gives me a deeper and better understanding of the lessons.

St 9: GSP gives me a clearer picture of how the graphs of the derivative $f'(x)$ looks like.

St 10: I never used GSP before, it was quite difficult at the beginning. But now I like to draw model before I solved the mathematics problem, I can animate the point and it helps me a lot.

St 12: With GSP, we are able to visualize the characteristics of the graphs such as when the graph is increasing or decreasing.

St 13: Using GSP is very enjoyable, I learn better and faster. Calculus has become more fun and easy to learn.

St 14: The activities made us do a lot of discovery and exploration, which were impossible without GSP, especially the complicated ones.

St 15: The activities that go with GSP enable us to work with pairs and group. Learning mathematics now become easier and enjoyable.

St 16: The answer from GSP is accurate. It is easier when we see the graph on the screen. It is just like answering the problem without using much energy.

St 17: Complicated problems can be solved in an interesting way and can be understood better with GSP.

St 18: GSP helps me save time understanding the mathematical reasoning of what we are doing instead of spending time trying to work out long mathematical computation.

St 19: By using GSP, the illustration of graph were not only clear but also made the concept much more basic and easier to understand.

St 20: Traditional method (pencil and paper) is important, but GSP is needed for tedious operations which take a much longer time to solve. Furthermore traditional method produces static finishing
product which is not really understood by us.

St 21: We are not able to plot the graph of function if we are not given ample time as the process of graphing the equation is very slow. Therefore, GSP helps a lot especially during short time given to us.

St 22: By changing the position of the points, we can see what happens to the gradient as those values increase, become negative, or even zero immediately. It is now very enjoyable to learn Calculus.

St 23: By animating the parameters, we can see the continuous change that results. So, instead of seeing a discrete, unconnected set of function plots, we can see a continuous whole function which make us understand better.

St 24: The importance of the dependence relationship between the dependent and independent variables in an equation is now very clear by using Sketchpad in which the $x$- and $y$-axes are positioned in parallel, so that moving $x$ along the $x$-axis produces a dynamic change in $f(x)$ along the $y$-axis.

St 25: By using GSP, we can save time and also can get experience to work collaboratively.

St 26: I still have problems especially when it comes to sketch complex equation because this need more skills, for example sketching curve with modulus function and how to fix suitable range for this curve. Thanks a lot, as GSP can help me to get the the answer.

St 27: GSP make me feel comfortable learning this topic. Effective learning occurs as we actively engage in discussions and experience the movement of curve as we change the equations.

St 28: GSP produces fun learning experience. I think the usage of GSP need to be spread to other geometric topics as well.

St 29: GSP gives a complete explanation to my doubt and increase my skills in solving geometry problems.

St 30: GSP software boosts my confidence to learn graph function.
From the interviews done between the researcher and the student teachers, the researcher has noticed that majority of the student teachers agree that they enjoy working with GSP application as they can save time and also can get experience to work collaboratively. GSP has increase the student teachers’ confidence and motivate them to work harder. Most student teachers who used the Geometer’s Sketchpad found that graph functions had become more interesting as their understanding of the graph functions topic has improved. In addition, the student teachers adopted a positive attitude in the learning of graph functions. Many students teachers also agree that using the Geometer’s Sketchpad had enabled them to better communicate with their friends and lecturer and has improved their self-confidence.

Therefore, research question 2 can be answered as the students perceptions about using the Geometers’ Sketchpad in learning graph functions is very good.

**Research Question 3**

Are students better able to apply concepts of extreme values of the function and their behavior after using GSP?

**Measurement 3 : Observation**

**Analysis of Data:**
The researcher will be monitoring student teachers motivation and understanding, based from discussions that they have in class and what the student teachers say as they leave the classroom. The researcher will look for the student teachers’ engagement and their ability to explain the concepts to their classmates.

From the observation, the researcher found that with the use of GSP, the student teachers pay more attention in the topic being discussed. The researcher noticed that, if the student teachers are late to class, they will look for the lecturer and ask her to teach the topic they missed. This kind of situation has not happened before. Student teachers are very active most of the time and give the lecturer their cooperation. There were more discussions in the class than before. Student teachers’ feedback confirmed that GSP had facilitated their visualization and exploration of geometrical concepts. This finding is similar to Khairiree’s (2004) observation, where students worked and learned cooperatively to explore the geometric
properties in the presence of GSP. The researcher also noticed that the student teachers struggle to complete the given task if the time given is not enough, especially when they are asked to solve the given tasks by using traditional method. Although the student teachers are able to sketch the graph of function by sketching, the result is not good as compared to the sketch of graph by using GSP. Student teachers can plot the graph of functions much faster by GSP than by doing the graph manually so they found GSP very helpful as they have enough time to check the graph drawn just in case they make a mistake. Furthermore, the researcher can see that the class environment becomes more enjoyable, with discussions being held among the student teachers.

Therefore, research question 3 is answered as student teachers are able to apply concepts of extreme values of the function and their behaviour after using GSP better as compared to the previous method.

**Research Implication**

According to Aimsworth (1999), multiple representations is a need for all the Mathematics educators to cultivate students’ critical thinking and reasoning ability through mathematical problem solving. Students multiple representation skills must be stimulated and applied for explanation and criticism in the problem solving process. Due to the time and tool limitations in the physical classroom, ICT tools like Geometer’s Sketchpad should be adopted for better understanding of Mathematics concept. This research also has proved that GSP has helped to instill positive attitude toward mathematics. The results of the study shows the good impact of how the usage of Geometer’s Sketchpad is useful in the teaching and learning Graph function in subject Basic calculus. This will further increase the student teachers and lecturers enthusiasm and willingness on the potential of using Geometer’s Sketchpad as an effective tool in learning mathematics. The result of this research also supports the findings of Lester (1996) which mentioned that Geometer’s Sketchpad provides intelligent capabilities for improving teaching and learning. These findings also supports the results of Groman (1996) that students reaction is overwhelmingly positive on using Geometer’s Sketchpad in mathematics class. The result of this research also supports the findings made by Leong Kwan Eu (2013) that the use of Geometers’ Sketchpad in the mathematics classroom is useful in helping students perform better in
graphing of functions. As ICT materials can run by themselves, students will undoubtedly benefit from it. With the use of GSP, students will be more investigative in trying out their ideas and they will not have to worry about time as the use of GSP negates time as the deterrent. Consequently, the use of GSP may produce a generation which is not only ICT literate but also Mathematics literate. Therefore, the findings from this research can be an evidence to encourage classroom teachers and even curriculum developers on the potential of the Geometer’s Sketchpad as an effective tool in learning geometry.

PROPOSED FOLLOW UP ACTION

The power of current and future technology can no longer be ignored in classroom situation. The technology is changing fast at an exponential pace. The availability of new technology lead to the changing of curriculum. To walk shoulder-to-shoulder with other countries, the government must take notice on the nation’s human capital development towards achieving the standard of a developing country as well as early preparation to compete the era of globalization, where GSP knowledge is one of the branch to it. The researcher wants to suggest that the Geometers’ Sketchpad usage should be further applied by the teachers and lecturers in all areas of mathematics. Further studies need to be done, using GSP especially on the time duration needed for students to learn and explore difficult concepts like plan and elevation, solid geometry etc. More research also need to be conducted in normal classroom settings in Malaysian schools, in order to explore further the utilization of the GSP in mathematics learning. Therefore, the researcher intend to continue the second circle of this action research by using GSP in other field of Mathematics especially in trigonometric, geometry and algebra.

REFERENCES


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