

# INTEGRATING DYNAMIC SOFTWARE AUTOGRAPH IN ENHANCING STUDENT'S CONCEPTUAL UNDERSTANDING AND MATHEMATICAL COMMUNICATION USING GUIDED INQUIRY APPROACH

**Ida Karnasih**

SEAMEO QITEP in Mathematics, Yogyakarta, Indonesia

[ikarnasih2001@yahoo.com](mailto:ikarnasih2001@yahoo.com)

**Vira Aviati**

**Teacher, SMA 13 Medan**

Universitas Negeri Medan, Indonesia

[viraaviati@yahoo.com](mailto:viraaviati@yahoo.com)

## Abstract

*The aim of the study was to investigate the effect of integrating Dynamic Software Autograph on students' conceptual understanding and mathematical communication using Guided Inquiry Approach. This experimental study was conducted at two vocational schools (tourism) of grade XI in Medan, Indonesia. The subjects were randomly selected. The main objectives of the research were to investigate: (1) whether the gain score of student's conceptual understanding through guided inquiry aided by Autograph software was better than those of students learned through conventional approach, (2) the mastery level of student learning, (3) the student's learning activity during study. Instruments used in this research were test of conceptual understanding and observation sheet of student's learning activity. Those instruments had been validated by the expert and the results of tryout of those instruments showed that all items in both tests were valid. The correlation coefficient for the conceptual understanding test was 0.8. The results of the research showed that: (1) the gain of student's conceptual understanding through guided inquiry aided by Autograph software (0.67) was higher than those of student's learned through conventional approach (0.53); (2) the mastery of students learning through guided inquiry approach aided by Autograph was better than those of students learning using conventional approach; and (3) students learned through guided inquiry approach aided by Autograph software was more actively engaged in learning (83%) than students who learned using conventional approach (68.78%)*

**Keywords:** *Dynamic Software Autograph, Conceptual Understanding, Guided Inquiry Approach*

## Introduction

The Progress of science and technology so fast these days and gives positive impact on mathematics teaching and learning, and also mathematics is realized as very important in the development of science and technology. However, the high demand for mastering mathematics is not directly proportional to the

results of students' mathematics learning. The fact demonstrates that students' learning outcomes in a mathematic is less encouraging. The government, particularly the Department of Education of Indonesia has sought to improve the quality of education one mathematics education, either through developing new curriculum, improving the quality of mathematics teachers through courses-upgrading, and increase student achievement through improving the minimum standards of the National Examination for graduation in mathematics. But apparently learning achievement of students is still far from expectations. Low mathematics learning outcomes are also found in some public schools in Medan. The average score of daily competence test in Grade X in 6 High Schools in Medan in learning simple algebraic functions and quadratic functions do not achieve the mastery level.

One of the problems encountered was due to the low level of students' understanding of mathematics concepts. Student learning more toward memorizing mathematics. In mathematics classrooms students are afraid to talk, to ask question even to share ideas to others. More student don't have self-confidence in doing mathematics. Often the students answer the questions by following the example of the teacher without understanding the concept. Hibert and Carpenter (2003) said, "understanding is a fundamental aspect of learning, so the learning model must include the subject matter understanding". Besides, understanding the cognitive taxonomy in Bloom are recognizable from the ability to read and understand the picture, reports, tables, diagrams, directives, regulations, and so on. Understanding is also included in one of the six principles for school mathematics (NCTM, 1989) in which "Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge". The understanding of mathematics concepts plays an important role and need to be improved in learning mathematics. However, most students generally do not have good understanding, in particular also do not understand the graph of quadratic functions.

Some teachers still use conventional method in teaching mathematics by explaining first the material, give one example problem, then students work the exercises. The medium used is usually only picture on the board then draw

graphs, makes tables, and gives sample of solved problem. Other teacher has begun to use ICT (e.g. Laptops and infokus), but just as the media used for display the contents of the module to students. Teacher taught in a conventional manner, which explains the subject matter displayed a computer. Although the teacher has not been able to use ICT but he facilitated student learning through ICT. evidence that in conventional learning students tend to quickly forget what has been taught by teachers. There are at least two consequences that must be faced if still learning with this pattern. First, students are less active and less embed this learning patterns of understanding the concept of making it less inviting critical attitude. Second, if the student is given a different matter with the exercises they are confused because they do not know where to begin their work (Mettes, 2009). Learning experiences must be shifted toward student active learning and building knowledge. The use of technology with inquiry approach will help students develop those matters and their conceptual understanding.

### ***Understanding Mathematics Concepts***

According to the Drivers and Leach (1993) understanding is the ability to describe a situation or an action. Understanding included in the cognitive domain of Bloom's taxonomy which is recognizable from the ability to read and understand the picture, reports, tables, diagrams, directions, and so on. The concept is an abstraction that represents a class of objects, events, or relationships that have the same attributes (Rosser in Dahar, 1998). So, the concept is an abstract idea that allows one to classify objects or events so as to determine whether the object or the incident is an example or not an example of the idea. While understanding the concept according to Hiebert (Ahmad, 2011) is related to the strength of the information contained in the concept conceived by schemata that have been previously owned. A concept, procedure, and fact can be understood by students thoroughly. When the mathematical object associated with the existing networks, the link between these objects is getting stronger. The seven indicators of conceptual understanding according to the NCTM (1989) are: (1) restate a concept, (2) classify objects according to certain properties, (3) give an example and not the example, (4) present in the various representations of mathematical concepts, (5) develop the necessary requirements and terms quite a

concept, (6) use, exploit, and choose the procedure or specific operations, (7) apply the concept to problem solving. In his study, the indicators of conceptual understanding were: (1) to restate a concept, (2) give example and not example, and (3) apply the concept to problem solving.

### **Guided Inquiry**

Piaget (2001) describes, “*mathematics is made (constructed) by children, not found like a rock nor received from others as a gift*”. Reys (2001) said the same things, “*knowledge is not passively received; rather, knowledge is actively created or invented (constructed) by students*”. And Brunner (Dahar, 1989) also explained the same idea:

*We teach a subject not to produce little living libraries on that subject but rather to get a student to think mathematically for himself, to consider matters as an historian does, to take part in the process of knowledge-getting. Knowing is a process not a product.*

Based on mathematics expert's opinion, Guided Inquiry approach can be used as an alternative that hopefully can enhance students' understanding of mathematical concepts, because in this approach students engage actively and work together to find, explore, experiment, and investigate from a variety of circumstances, to find and construct new ideas, new knowledge, based on various sources of information and prior knowledge or concepts that have previously mastered to infer and test conclusions. Bruner (in Dahar, 1989) considers learning in accordance with the invention of actively search knowledge by humans and by itself gives the best results. Knowledge gained through inquiry provides some benefits. First, the knowledge that last longer and are easier to remember than the knowledge learned in other ways. Second, the results of studying the effect of the invention have better transfer than other learning outcomes. Third, thoroughly study the invention and improve students' ability to think freely. In particular, inquiry learning to develop cognitive skills in training students to find and solve problems.

Several studies have been carried out by applying a guided inquiry approach, and the results are guided inquiry can improve students' understanding. Irawan (2009) in his research showed that it increased students' conceptual

understanding of trigonometric concept. Maryati (2007) showed that the gain of learning achievement of students who receive guided inquiry learning model is better than the gain of student experience with Model Treffinger. Latjompoh (2003) in his study said, the result of analysis of student learning showed that the learning activity of guided inquiry was completed effectively to achieve the purposes of learning both in the product and the process.

Based on the characteristics of guided inquiry with student centered have some advantages as well as the data supported the results of previous studies showed that guided inquiry can improve students' understanding. Guided inquiry approach was applied in and predicted to increase students' understanding in this study. Surely it would be easier if the search processes students are assisted with media that facilitate the investigation and experiments. The use of media computer including mathematical software such as Autograph will give a lot of convenience and enhance the quality of student understanding and learning of mathematics.

Guided inquiry learning is developed by cognitive view of learning and constructivist principles. According to this principle the students are trained and encouraged to learn independently. Explicitly Amin (Suriadi, 2006) suggests that an activity "inquiry or invention" means an activity which is designed so that students can discover the concepts and principles through his own mental processes. In this case the invention occurs when students in mental processes observing, classifying, making allegation, measuring, explaining, and drawing conclusions and so forth to find some concepts or principles.

Russeffendi (Suriadi, 2006) states that learning through inquiry is significant because: substantially sciences were obtained through inquiry.

- a. *Children learn by being actively engaged in and reflecting on an experience*
- b. *Children learn by building on what they already know*
- c. *Children develop higher order thinking through guidance at critical points in the learning process*
- d. *Children have different ways and modes of learning*
- e. *Children learn through social interaction with others*
- f. *Children learn through instruction and experience in accord with their cognitive development*

Through the six principles that students learn actively involved in the experience and reflect on these experiences, students learn to build knowledge on the terms of what they already know, students develop high level thinking skills through the guidance of the learning process, students have many ways of learning, students learn through social interaction with others, students learn through the guidance and experience according to their cognitive development.

### **Using ICT in Teaching and Learning Mathematics**

NCTM (1989) in one of the six principles for school mathematics explains that "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning." For the application in the classroom, the use of ICT can be integrated with multiple learning approaches. There are four different approaches can be implemented a integrating ICT in teaching and learning mathematics: (1) Expository learning; (2) Inquiry-based learning; (3) Cooperative learning; (4) Individual learning . The use of technology such as Autograph is perfect if it is integrated with guided inquiry. The use of technology has been recommended by the NCTM in its Curriculum and Evaluation Standards For School Mathematics (1989) and suggests that all student should have a calculator, possibly one that has graphing capabilities, and computer should be available at all times in every classroom for demonstration purposes and all students should have access to computers for individual and group work.

Autograph is one of dynamic software currently introduced for teaching and learning mathematics. With Autograph students can explore, investigate and search problems. Students can test more samples in a short time instead of just using their hands. So, with these experiments students can locate, construct and deduce the principles of mathematics, and finally understood how to draw and read graphs of quadratic functions properly. By using Autograph students can repeatedly try and produce many examples of graph of quadratic functions until the students can draw conclusions about how to draw graph quadratic function.

## Using Autoraph with Guided Inquiry Approach

In order for the implementation of guided inquiry approach is to work effectively, some steps need to be implemented by the mathematics teacher as follows:

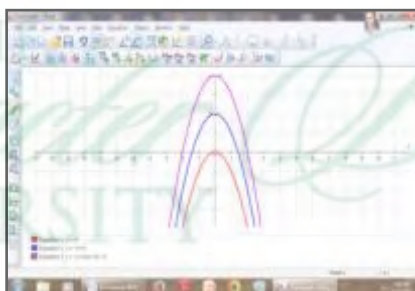
- a. Class can begin with authentic activity outside of classroom. Students are prepared before class start to do experiment concerning quadratic function (e.g. squirting water using hose, throwing ball, jumping robe etc.), or teacher give studens authentic problem on the worksheet (Figure 1)



Figure 1. Squirting Water by hose

Water Fountain

- b. In class, the teacher asks students to work in group to collect data from the picture and discover the predicted function (hypothesis) fit into the graphs. Different pairs do different pictures.
- c. Students (in group) observe the picture and collect data.
- d. From the data collected, students prepare, process, organize, and analyze data by making table. In this case, the guidance teachers can be given only to the extent necessary. This guidance should lead students to step into the direction through questions, or SAS.



- e. Students then prepare a conjecture (forecast) of the results of the analysis , e.g. students predict the first graph has equation of different forms. Different pairs do different pictures.

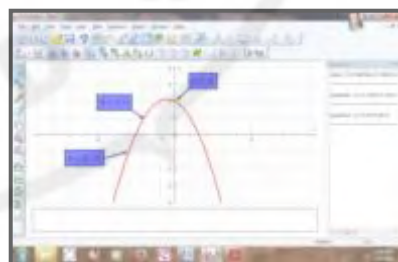
- f. The teacher checked the conjecture that has been created by the students. It is important to convince the truth forecasts by students, so it will be heading to be achieved. (Ask students to use Autograph to check their conjecture).
- g. The written conjecture (written *communication*) should be submitted also to the students to compile. Ask students to communicate their conjecture to other group and do presentation (*verbalization / oral communication*)
- h. Teachers should provide more exercises or additional questions and students examine whether the findings are true by Autograph.
- i. Teacher asks each group to summarize the results and write down the answer in their worksheet and do presentation.

Teacher can challenge students to create their own problems or teacher gives more problems can be given to students for practice for exploration.

Below are examples of problems to be solved by students in their group. Teacher observes students while working in their group, and give help when needed. And then ask students to create their own problems or select problems from textbooks'

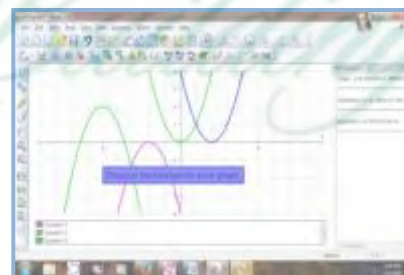
#### **Problem 1:**

- Teachers can vary the problems by giving students 3 points e.g. A(-2,-1), B(-2,1), C(0,2) on the graph. Other groups can choose different pairs of 3 points.
- Ask the groups to discover the function, and use Autograph to do exploration to get the function.
- Ask students to check their answer using Autograph.



#### **Problem 2:**

- Students are given equivalent graphs with different position and direction in the Autograph
- Ask students to work in groups to discover all of the functions related to the graph using Autograph .
- Discuss the solution with other groups and make conclusion.





In guided inquiry teachers can use intervention strategies that enable students to construct their own understanding. This strategy helps students look for the facts, explain and synthesis of facts (Kuhlthau, 2007). Bruner (Dahar, 1998) suggests that the knowledge gained by studying inquiry showed some strengths. First, the knowledge last long or longer to remember, or easier to remember. Secondly, inquiry learning outcomes transfer effects better than the other results. Third, a thorough study of students in the inquiry improves reasoning ability to think freely.

From the above description, the guided inquiry referred to in this research is the process by which students think, observe, digest, understand, make conjectures, explain, analyze so as to construct and find themselves desired general principles with guidance and instructions from teachers and work sheets, in the form of direct questions. Guided inquiry approach is certainly different from conventional or unconventional approaches that are often applied to the teacher in the classroom.

## **METHOD**

**Population.** The target population of the study was students of Grade XI with six Vocational Schools in Medan. Purposive random sampling was used to select the samples. Six schools which have computer lab from different districts were selected. From each school, two classes were randomly selected, one class as experimental and one class as control group. 196 students in the experimental group and 196 students in the control group were involved. Students in experimental group used Guided Inquiry Approach aided by Autograph and students in control group used Conventional Approach. This study was a quasi experimental study with Pretest-Posttest Control Group Design.

**Procedure.** The treatment group was first introduced to the Autograph software before the study. Students in Autograph group worked in group of three using computer installed with Autograph software. In this phase, the students were required to explore and be familiar with the software and its functions. In the second phase, students were introduced to the basic concept of the Quadratic

Functions topic using worksheets. This phase involves instruction using Guided Inquiry approach where students actively explore and discover concept of quadratic function.

**The instructional material.** The instructional material for this study consisted of 4 sets of 2-hour lesson plans for teaching and learning of Quadratic Functions. The lesson plan was based on the following phases: induction set phase, learning or acquisition phase, practice phase, closure phase and evaluation phase. Two modules were developed to enable the students to learn about quadratic functions. One was conventional Approach module and the other one was the Autograph Learning Module. The students involved were initially surveyed for their familiarity with the Autograph software. None of them in the group were found to have used Autograph. The modules were developed to enable the students to be familiar with the Autograph. The module introduced the various features in the tools necessary to explore effectively the Quadratic Functions.

**Instruments.** Two instruments were used in this study: comprehension test of quadratic functions which was based on indicators of understanding of the concept; observation sheets of student activity.

**Data Analysis.** Data was analyzed using t-test to test the different gain of understanding of concepts and communication both groups with previously tested for normality and homogeneity. Data tested were normalized on gain pretest-posttest scores understanding of the concept. In addition the data posttest scores were also calculated for testing the mastery level of understanding of the concept of whether achieving a minimum completeness criteria (KKM)  $\geq 65$ . Students' activity during learning processes was also assessed using student activity observation sheet.

## **Results and Discussion**

***Gain of Students Conceptual Understanding.*** A test was done to test different increase (gain normalized) of conceptual understanding. Results from the

analysisi showed that the gain of conceptual understanding was from normal distribution but not homogeneous. So, a non-parametric statistical test was used at significant level  $\alpha = 0.05$ . With  $H_0$  testing criteria that there was no significant difference between the gain score of conceptual understanding of the experimental group and student of the control groups was acceptable if  $t_{\text{comp}} < t_{\text{table}}$  whereas in other circumstances  $H_0$  rejected. The following table is the results of t- test calculation.

**Tabel 1. Mean Difference Test of the Gain of Conceptual Understanding**

Aspect	Experimental group	Control group	$T_{\text{comput}}$	$t_{\text{Table}}$	Summary
	$\bar{x}_e$	$\bar{x}_k$			
Mean gain of conceptual understanding	0,668	0,532	4,82	1,65	Reject $H_0$

Based on the above test results obtained  $t = 4.82 \geq t_{\text{table}} = 1.65$ , so rejected  $H_0$ . Means that the gain score of students' conceptual understanding of the experimental group (0,67) was higher than those of the students' score in the control group (0,53).

**Classical Mastery of Conceptual Understanding.** The average classical gain score of the students' understanding of the concept of quadratic functions for the experimental group and the control group are summarized in the Table below.

**Tabel 2. Mastery of Conceptual Understanding**

Group	Aspects				
	Pretest	Posttest	Gain	Number of Students Mastery	% of mastery
Experiment	34,3	77,74	43,44	67 dari 73	91,78%
Control	32,2	66,66	34,46	44 dari 71	61,97%

From Table 2 above, it can be seen that the mean increase (gain) score of the experimental group was higher than those of the control group, and classically the

experimental group students have met the completeness criteria. It showed that the use Autograph software assisted by guided inquiry could further enhance the conceptual understanding and helped students achieved mastery rather than the conventional approach.

**Student Activity.** The results of analysis showed that the average score of students activity who received guided inquiry aided with software Autograph was 4.15 or 83%, which means that students moved well. While the average score of the conventional approach was 3.44 or 68.78%, which means that students move pretty well. The above results indicated that an increase in students' understanding of concepts and the activeness of student learning through guided inquiry approach aided software Autograph was higher than those who learned using conventional approach.

### **Conclusions**

Based on the findings of this study, some conclusions can be made. First, students who obtain a guided inquiry approach aided with Software Autograph was significantly better on understanding of the concept when compared with students who learned using conventional approach. Second, the mastery learning level of the students and students learning activities who received guided inquiry approach aided Software Autograph was higher than those of students who learned using conventional approach. According to the criteria of classical completeness of students who received guided inquiry approach aided with Autograph software had achieved mastery level, while students who received conventional approach had not yet achieved mastery level.

### **REFERENCES**

Ahmad, B. (2011). *Penerapan Model Pembelajaran Berbasis Masalah Sebagai Upaya Meningkatkan Kemampuan Pemahaman Konsep Matematika dan Komunikasi Matematik Siswa Sekolah Menengah*. Tesis. Program Pascasarjana Program Studi Pendidikan Matematika, UNIMED.

Ansari, B.I. (2009). *Komunikasi Matematik*. Banda Aceh : Yayasan Pena.

- Arsyad, A. (2000). *Media Pengajaran*, Jakarta : PT Raja Grafindo Persada.
- Dahar, R.W. (1998). *Teori-Teori Belajar*. Jakarta: Erlangga.
- Direktorat Pembinaan Sekolah Menengah Atas. (2006). *Kumpulan Permendiknas tentang Standar Nasional Pendidikan (SNP)*. Jakarta
- Driver, R dan Leach, J. (1993). *A Constructivist view of learning : Children's Conception and Nature of Science. What Research Says to The Science Teacher*. Washington : National Science Teacher Association.
- Ikhsan, M. (2006). Prinsip Pengembangan Media Pendidikan Sebuah Pengantar, diunduh dari <http://muhamadikhsan.info/?p=5>, diakses pada 15 Desember 2009.
- Irawan, J. (2009). *Penerapan Penemuan Terbimbing (Guided Inquiry) Untuk Meningkatkan Pemahaman Konsep Sinus Dan Cosinus Jumlah Dan Selisih Dua Sudut Siswa KeSAS Xi Ipa Sma Al-Ma'hadul Islami Pasuruan*. Tesis. Program Pascasarjana Program Studi Pendidikan Matematika, UPI.
- Kuhlthau, C. C. (2007). *Guided Inquiry: Learning in The 21<sup>st</sup> Century School*. Wesport, CT : Libraries Unlimited.
- Markaban. (2006). Model Pembelajaran Matematika dengan Pendekatan Penemuan Terbimbing, diunduh dari [http:// p4tkmatematika.org](http://p4tkmatematika.org), diakses pada 25 Maret 2010.
- Maryati, Y. (2007). *Perbandingan Peningkatan Prestasi Belajar Matematika Antara Siswa SMP Yang Mendapat Pembelajaran Model Penemuan Terbimbing Dan Model Treffinger*, Tesis. Program Pascasarjana Pendidikan Matematika, UPI.
- Mame, S. (2008). *Kemampuan Komputer Literasi Masih Rendah*, diunduh dari <http://www.pikiran-rakyat.co.id>, diakses pada 22 Maret 2008.
- Latjompoh, M. (2003). *Pengembangan Perangkat Pembelajaran Ipa Sd berorientasi Metode Inquiry (Penemuan) Pada Konsep Hubungan Antar Makhluk Hidup*. Tesis. Program Pascasarjana Pendidikan Matematika, UPI.
- National Council of Teachers of Mathematics. (1989). *Curriculum and Evaluation Standard for School Mathematics*. Reston, VA : NCTM
- National Council of Teachers of Mathematics. (1991). *Professional Standar for Teaching Mathematics*. Reston, VA : NCTM.
- Reys, E.R. (2001). *Helping Children Learn Mathematics*, John Wiley and Sons, Inc, United States of America.

Saragih, S. (2007). *Mengembangkan Kemampuan Berpikir Logis dan Komunikasi Matematik Siswa Sekolah Menengah Pertama Melalui Pendekatan Matematika Realistik*. Disertasi. Bandung : Pendidikan Matematika UPI Bandung.

Suriadi. (2006). *Pembelajaran dengan Pendekatan Inquiry yang Menekankan Aspek Analogi untuk Meningkatkan Pemahaman Matematik dan Kemampuan Berpikir Kritis Siswa SMA*. Tesis. Program Pascasarjana Program Studi Pendidikan Matematika, UPI.

Yunan, I. (2006). Komputer untuk Pembelajaran Matematika, diunduh dari <http://www.suaramerdeka.com/harian/06/04/03/agam03.htm>, diakses pada 25 juni 2008.



THE  
*Character Building*  
UNIVERSITY

## APPENDIX

### How to Use Autograph in Learning Quadratic Function

The TPACK is needed to prepare for teachers to teach mathematics using technology with certain method or strategy. The combination of learning mathematics using guided inquiry approach (Pedagogical Knowledge) with media *software* Autograph (Technological Knowledge) can be done with teacher guidance to help students discover concept by themselves and to draw or to read graph of quadratic function (Content Knowledge). Teacher needs to develop student activity sheets to help students doing experiment and do exploration and develop modules of learning with Autograph on topic quadratic functions.

Next paragraphs explained the steps of using Autograph in learning Quadratic Function.

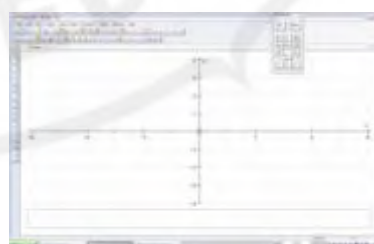
1. Each group of students using computers that have installed Autograph software
6. To draw graph, right click => **ENTER EQUATION**, or click

2. Each student gets SAS as a guide for conducting experiments

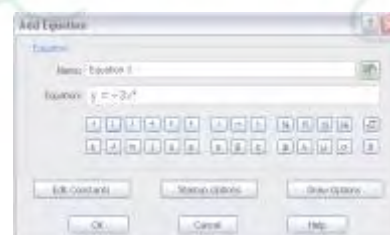
3. Double click Autograph icon on the desktop or click **START => PROGRAMS => AUTOGRAPH**

3.0. Will appear 2D worksheet as follows.

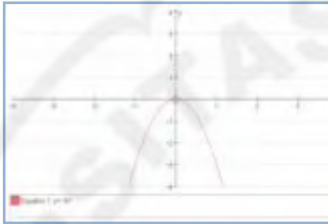
4. To change axes, click axes => edit axes => to change to max or min range as you need, e.g. x from -4 to 4 and y from -4 to 4
5. Click OK, will see sheet as follows:



7. Type equation  $y = -3x^2$ , then click OK



8. Will appear graph of  $y = -3x^2$  as follows.



9. Students practice to do the same things for  $y = -2x^2$ ;  $y = -x^2$ ;  $y = x^2$ ;  $y = 2x^2$ ;  $y = 3x^2$

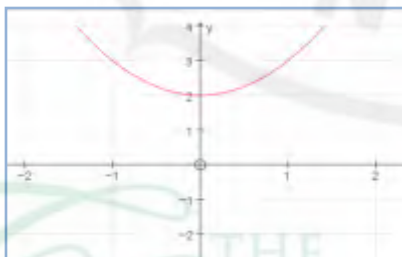
10. Students open new worksheet by clicking file => 2D graph file

11. To draw other graph, right click => **ENTER EQUATION**, atau klik




12. Students writing equation  $y = x^2 + 2$  then click OK

13. On the worksheet will appear graph of  $y = x^2 + 2$  as follows





14. Students use SAS to discover the generalization based on the equations given, e.g:  $y = x^2 + 1$ ,  
 $y = x^2 - 1$ ;  $y = x^2 - 2$ ,  
 $y = -x^2 + 2$ ;  $y = -x^2 + 1$ ;  
 $y = -x^2 - 1$ ;  $y = x^2 - 2$

15. By observing the graphs they make, students are asked to get conclusion how to draw graph  $y = x^2 + c$

- Ask students to experience a graph of  $y = ax^2$
- Type the equation and click OK. First attempt will appear a graph  $y = ax^2$  for  $a = 1$
- Click **CONSTANT CONTROLLER** 

Will appear box as follows

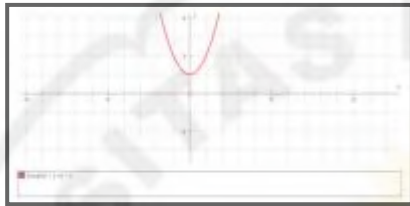


- Click button  to get the value of  $a$  become bigger
- Click tombol  to reduce value of  $a$  to become smaller.
- Students are helped to get conclusion that the bigger the value of  $|a|$  then, the tapper the graph and the smaller the value of  $|a|$  then the wider the graph
- Put the pointer in the equation left below, right click => **EDIT EQUATION**
- Type  $y = x^2 + c$  on the box

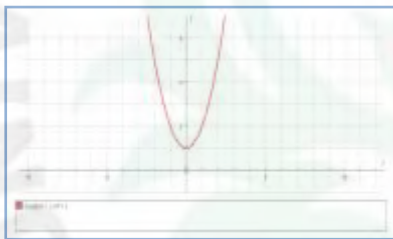




Will appear graph of  $y = x^2 + c$   
with  $c = 1$



- Click Hand tool to drag , and move the axes down and will appear graph as follows

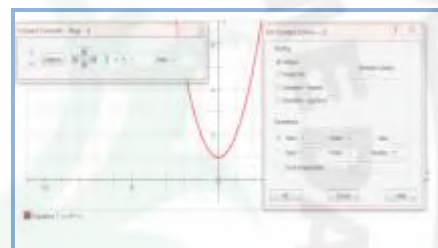


- Click CONSTANT CONTROLLER
- Click to get bigger value of  $c$
- Click to reduce the value of  $c$
- Students can conclude the bigger the value of  $c$ , then the maximum of the graph moving above . The smaller the value of  $c$  the maximum of the graph moving down.

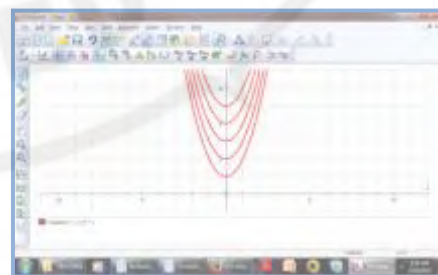
16. To draw family plot, Click the graph until the graph turn black

- Click CONSTANT CONTROLLER

17. Click Option, will appear graph as follows



18. Click family plot for  $c$  from 1 to 5, and then press print script. The graph will appear as follows



19. To animate object, click animation, and then click animation repeat or manual

**LETS TRY!!!!**



THE  
*Character Building*  
UNIVERSITY