

## “TSEWG” Model for Teaching Students How to Solve Exercises with GeoGebra Software in the Classroom

<sup>1</sup>Nguyen Phu Loc, <sup>2</sup>Nguyen Thien Tuan

<sup>1</sup>Associate Professor in Mathematics Education, School of Education, Can Tho University, Vietnam

<sup>2</sup>Master Student in Mathematics Education (2013-2015), Can Tho University, Vietnam

### ABSTRACT

The paper introduces the TSEWG model which can be used to guide students how to solve mathematics exercises in the classroom with the help of the dynamic software GeoGebra. From field test of the model, we found that two remarkable utilities of TSEWG were: (1) to help students predict the answer of an exercise; (2) to help students discover strategies for solving the exercise. Therefore, teaching mathematics with TSEWG can improve the quality of mathematics education in secondary schools.

**Keywords** - ICT, mathematics education, SPWG model, teaching with GeoGebra, TSEWG model

Date of Submission: 02-May-2015



Date of Accepted: 15-May-2015

### I. INTRODUCTION

Van Voorst (1999) reported that technology was “useful in helping students view mathematics less passively, as a set of procedures, and more actively as reasoning, exploring, solving problems, generating new information, and asking new questions” [1]. Because of the above strong points of educational technology, in Vietnam, integrating technology into teaching mathematics has been encouraged by Ministry of Education and Training for a long time ago. As teachers of mathematics, we have had some experiences of teaching mathematics with technology. In the paper, we introduce the “TSEWG” model, which could be used to teach mathematics exercises in the classroom, together with the results of field test for verifying this model.

### II. GEOGEBRA – A DYNAMIC MATHEMATICS SOFTWARE

#### *GeoGebra- A dynamic mathematics software*

##### *Characteristic of GeoGebra*

GeoGebra is a dynamic mathematics software, it “combines dynamic geometry, algebra, calculus, and spreadsheet features (which other packages treat separately) into a single easy-to-use package”. [2]

##### *For teacher*

Thanks to its dynamic property, Loc (2014) believe that it is helpful for us to teach or learn all disciplines of mathematics in secondary schools; it allows us to learn mathematics through experiments, or to be able to solve mathematics problem from conjectures. These strong points makes it comfortable for learning and teaching mathematics in Vietnamese secondary schools. Teachers and students can use the software for teaching and learning all topics of mathematics in schools. [3], [4].

##### *For the students,*

GeoGebra can help students grasp experimental, problem-oriented and research-oriented learning of mathematics, both in the classroom and at home. Students can simultaneously use a computer algebra system and an interactive geometric system; by doing this, they can increase their cognitive abilities in the best way (Diković, 2009) [5].

##### *Solving problem with GeoGebra*

Applying dynamic property of GeoGebra, in [3], Loc (2014) developed the model “SPWG” (Solving Problem With GeoGebra), which includes the following steps (see Figure 1).

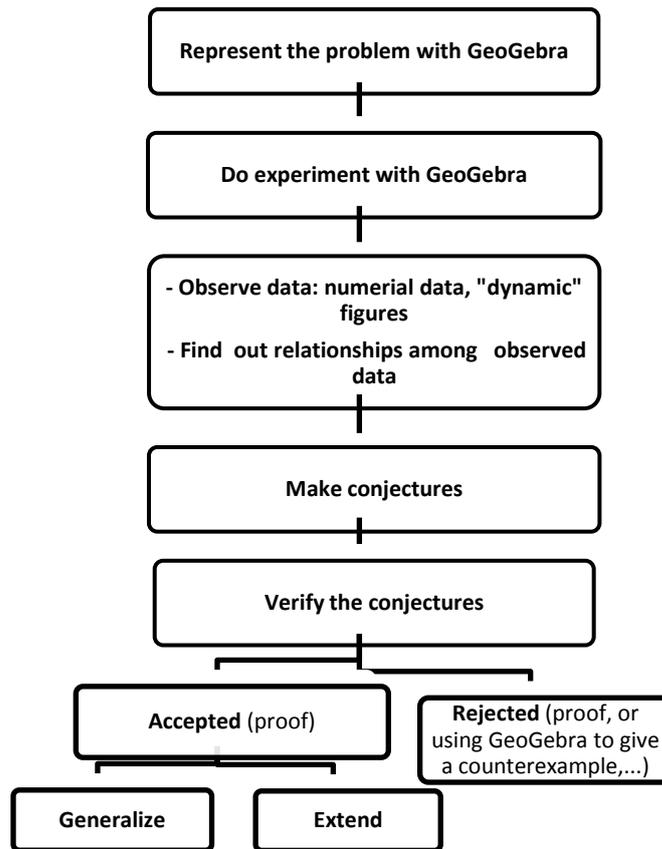


Figure 1: Model “SPWG” - Problem solving with GeoGebra (Loc, 2014) [3]

Step 1: Use GeoGebra as a tool to represent the problem;

Step 2: Do experiment with GeoGebra by using dynamic property, tools for computation, spreadsheets...;

Step 3: Observe data to find out relationships among observed data;

Step 4: Formulate conjectures (make prediction);

Step 5: Verify the conjectures;

Step 6: Check the solution, generalize or extend the problem.

The model was used successfully in guiding students to solve mathematics problems by Loc [3], Loc & Triet [4], [6].

### III. A MODEL FOR TEACHING EXERCISE SOLVING IN THE CLASSROOM

On the basis of SPWG, we developed the “TSEWG” model for teaching exercise solving in the classroom with the help of GeoGebra as follows (see Table 1):

Table 1: “TSEWG” model for teaching exercises in classroom with GeoGebra

<p><b>Step 1.</b> Students analyze to understand the exercise;</p> <p><b>Step 2.</b> Teacher uses GeoGebra to represent the exercise and uses dynamic function and other tools of GeoGebra to ask students to investigate geometrical objects and collect data related;</p> <p><b>Step 3.</b> Students make predictions on the answer to the exercise;</p> <p><b>Step 4.</b> Students to find out the strategies for solving or verifying the predictions;</p> <p><b>Step 5.</b> Students write the solution to the exercise;</p> <p><b>Step 6.</b> Teacher and his students check the solution and generalize the exercise.</p>
--

In order to distinguish the SPWG model and TSEWG model, we had conceptions on two concepts of exercise and problem as follows:

- *Exercise* is a task which is designed to help student learn a particular skill.
- *Problem* is a task or a situation difficult to resolve.

Therefore, the SPWG model can be used to find out how to solve mathematics situations at highly difficult level with assistance of GeoGebra . For TSEWG model, the teacher can apply it to guide students to solve exercises in the classroom at aim of training a certain mathematics skill for his students.

#### IV. FIELD TEST OF “TSEWG” MODEL

In order to examine actual responses of students to the TSEWG model, we carried out field test for the model in academic year 2014 -2015.

**Field – test class:** Class 10A1 of 31 students which belongs to Tay Do Secondary School, Long My district, Hau Giang province, Vietnam. These students already have learned theory on the equation of a circle according to geometry curriculum for 10<sup>th</sup> grade students in secondary schools in Vietnam.

**Exercises used:**

*Exercise 1:* In plane Oxy, given (C<sub>m</sub>):  $x^2 + y^2 - 2mx - 4(2m - 1)y + 5 = 0$ .

1. Find m so that (C<sub>m</sub>) is a circle.
2. Find the set of the centers of circles (C<sub>m</sub>) when m changes.

*Exercise 2:* Write the equation of a circle (C) in each below case:

1. (C) passes through A(3; 1) and its center is I(1; 3).
2. (C) is tangent to the line  $2x + y - 1 = 0$  and its center is I(-2;0).

*Exercise 3:* Give the circle (C):  $(x - 2)^2 + (y - 1)^2 = 25$ .

1. Write the equation of the tangent to (C) parallel to the line  $d_1 : 5x - 12y + 2 = 0$ .
2. Write the equation of the tangent to (C) perpendicular to the line  $d_2 : 3x + 4y - 7 = 0$ .

The above three exercises assigned to students is to help them learn skills as follows:

- Determine conditions so that a given equation is a equation of a circle;
- Write the equation of a circle with some given conditions;
- Write the tangent to a circle with some given conditions.

**Handout:** In teaching process of field test, we assess the ability to discover and apply knowledge of students through handouts generated for 31 students following step by step teaching process in classroom.

#### V. THE RESULTS OF THE FIELD TEST

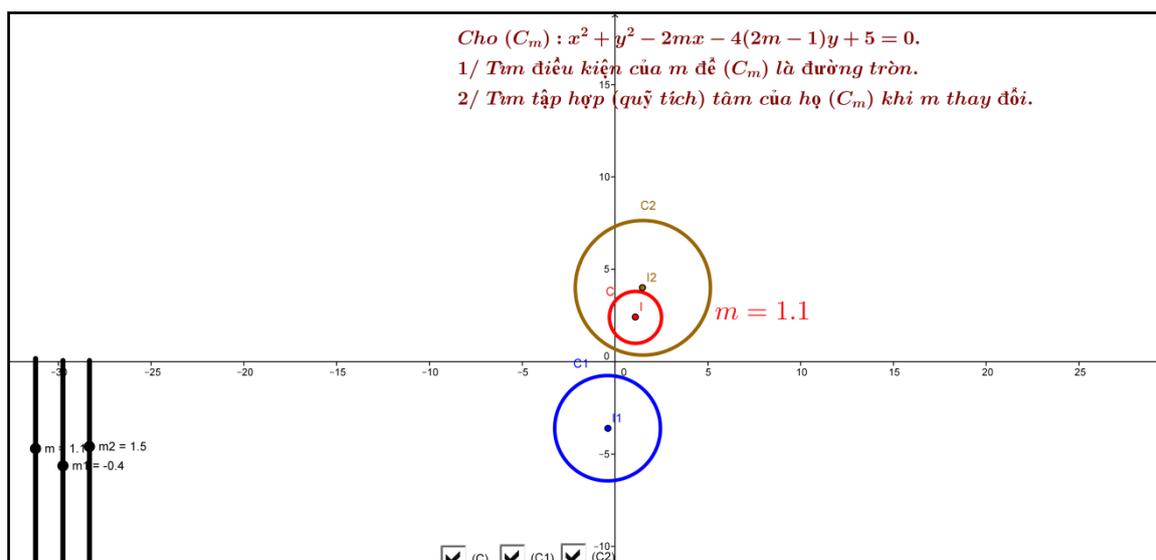


Figure 2: GeoGebra presentation for the Question 1 of Exercise 1

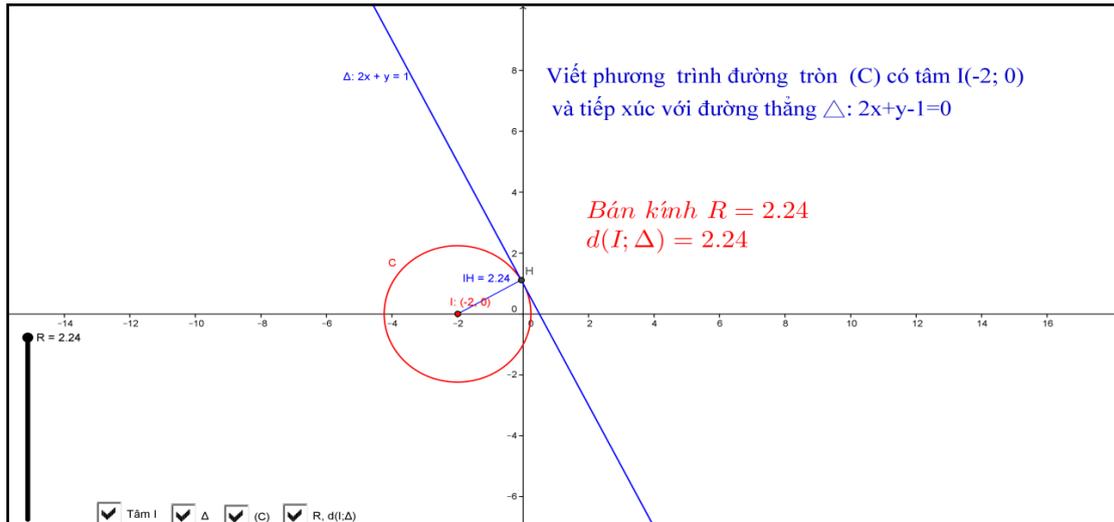


Figure 3: GeoGebra presentation for the Question 2 of Exercise 2

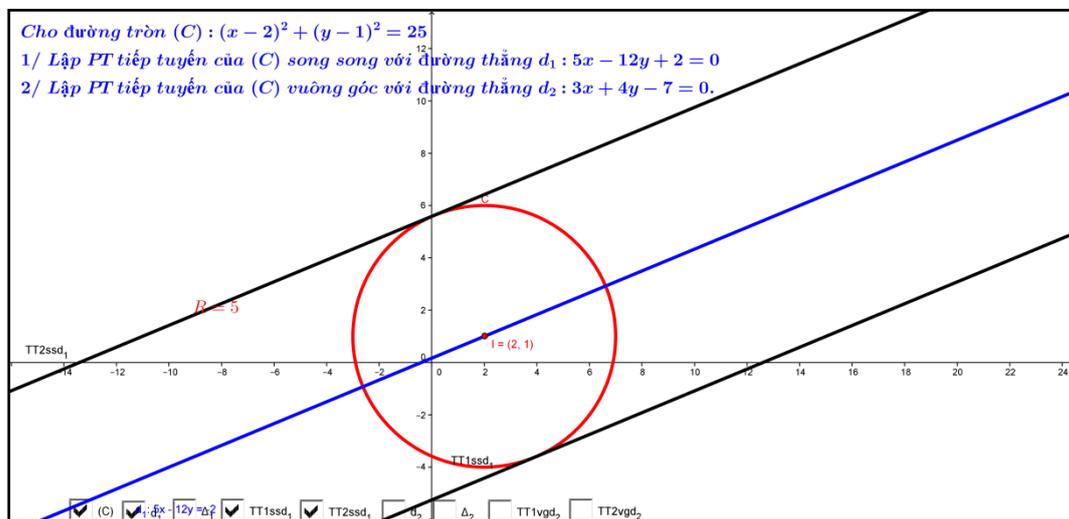


Figure 4: GeoGebra presentation for the Question 1 Exercise 3

After applying the model to guide students to solve the above three exercises (Figures 2, 3 and 4 illustrate teaching process in the classroom), we obtained the results of predictions on the answers and suggestions on strategies for solving the exercises, which were made by students, as follows:

**Results of predictions on the answers to the exercises**

Table 2 showed that the majority of students made correct predictions as a result of the support of software GeoGebra. However, there were some mistakes of students when stated predictions. For example, see figure 5, some students predicted that (C<sub>m</sub>) was a circle if only if  $m \leq 0.6$  or  $m \geq 1$  (Question 1 of Exercise 1).



Figure 5: The error of a student in doing exercise 1

When asked why  $m$  could equal  $-0.6$  or  $m = 1$ . Their answer was that “If  $m$  obtains one of the above values, then (C<sub>m</sub>) is still a circle with its radius equal to 0”. The teacher adjusted: “According to theory on circle, we already know, a circle’s radius is positive number ( $R = \sqrt{a^2 + b^2 - c} > 0$ )”. Due to mistakes of students, the teacher had opportunities to consolidate knowledge and prevent mistakes of students.

**Table 2:** Results of predictions on the answers to the exercises

Prediction	Right	Wrong	No idea
The values of $m$ : $(C_m)$ is a circle (Question 1 of Exercise 1)	23 (74.19%)	5 (16.13%)	3 (9.68%)
The set of the centers of $(C_m)$ (Question 2 of Exercise 1)	22 (70.97%)	7 (22.58%)	2 (6.45%)
The radius of $(C)$ (Question 1 of Exercise 2)	26 (83.87%)	4 (12.90%)	1 (3.23%)
The radius of $(C)$ (Question 2 of Exercise 2)	27 (87.10%)	3 (9.68%)	1 (3.23%)
The number of tangent to $(C)$ and their equations (Question 1 of Exercise 3)	31 (100%)	0 (0%)	0 (0%)
The number of tangent to $(C)$ and their equations (Question 2 of Exercise 3)	31 (100%)	0 (0%)	0 (0%)

**Results of strategies for solving the exercises**

Table 3 indicated that for the exercise 1, about 50% of students had right strategies for solving exercises. But thereafter, capacity of building exercise – solving strategies of students with the support of GeoGebra gradually became better.

**Table 3:** Results of strategies for solving the exercises

Strategy	Right	Wrong	No idea
Strategy for solving (Question 1 of Exercise 1)	15 (48.39%)	12 (38.71%)	4 (12.9%)
Strategy for solving (Question 2 of Exercise 1)	16 (51.61%)	12 (38.71%)	3 (9.68%)
Strategy for solving (Question 1 of Exercise 2)	18 (58.06%)	10 (32.26%)	3 (9.68%)
Strategy for solving (Question 2 of Exercise 2)	21 (67.74%)	8 (25.81%)	2(6.45%)
Strategy for solving (Question 1 of Exercise 3)	23 (74.19%)	8 (25.81%)	0 (0%)
Strategy for solving (Question 2 of Exercise 3)	26 (83.87%)	5 (16.13%)	0 (0%)

**VI. CONCLUSION**

Thanks to multi-functional property of GeoGebra, we can use this software to increase the effectiveness of teaching mathematics in classroom. In particularly, teaching mathematics with TSEWG model can help students carry out mathematics solving activities in an active way. They have many opportunities to do some jobs of a mathematician such as making and verifying prediction. Gradually, the mathematical abilities of them will be developed better.

**REFERENCES**

- [1] Van Voorst, C., *Technology in mathematics teacher education* (from <http://www.icte.org/T99 Library/T99 54.PDF>), 1999.
- [2] Hohenwarter, M. & Preiner, J., Dynamic mathematics with GeoGebra. *Journal of Online Mathematics and its Applications*. ID 1448, Vol 7, March 2007.
- [3] Loc, N.P., Dynamic software “GeoGebra” for solving problem: A try - out of mathematics teachers. *Journal of international academic research for multidisciplinary*, Volume 2, Issue 9, October 2014.
- [4] Loc, N.P & Triet, L.V.M., Dynamic software “GeoGebra” for teaching mathematics: Experiences from a training course in Can Tho University. *European Academic Research*, Vol II , Issue 6 /September 2014.
- [5] Diković, L. “Applications GeoGebra into Teaching Some Topics of Mathematics at the College Level”. *ComSIS* Vol. 6, No. 2, December 2009, UDC 004.738, DOI: 10.2298/csis0902191D.2009
- [6] Loc, N.P & Triet, L.V.M., Guiding Students to Solve Problem with Dynamic Software “GeoGebra”: A Case of Heron’s Problem of the Light Ray. *European Academic Research*, Vol II , Issue 7 /October 2014.