TẠP CHÍ KHOA HỌC
TRƯỜNG ĐẠI HỌC SƯ PHẠM TP HỒ CHÍ MINH
Tập 17, Số 3 (2020): 467-475
ISSN: 1859-3100
HO CHI MINH CITY UNIVERSITY OF EDUCATION
JOURNAL OF SCIENCE
Vol. 17, No. 3 (2020): 467-475
Website: *http://journal.hcmue.edu.vn*

Research Article

DESIGNING REALISTIC PROBLEMS FOR ASSESSING STUDENT PROBLEM SOLVING COMPETENCY IN TEACHING PLANE GEOMETRY AT GRADE 9

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Received: October 12, 2019; Revised: November 09, 2019; Accepted: March 25, 2020

ABSTRACT

In the trend of international integration, the new Vietnamese Mathematics general education curriculum has focused on forming and developing learners' qualities and competencies. Especially, Mathematics education in school will concentrate on mathematical applying in real life. The article aims to present some basic issues of designing realistic problems to assess problem-solving competency of secondary school students in teaching grade 9 Plane geometry.

Keywords: problem-solving competency; realistic problem; Plane geometry; grade 9 students

1. Introduction

In the new education curriculum towards the development of learners' capacity (Ministry of Education and Training, 2018a, 2018b), the real problems solving competency plays an important role. In grade 9, the content of the plane geometry curriculum has many applications in life. It helps learners to solve real problems systematically. Therefore, grade 9 plane geometry has a lot of potential to assess students' competency to solve real problems. The article mentions designing realistic problems to assess secondary students' competency to solve practical problems.

2. Basic theories

2.1. The level of complexity of realistic problem

According to Ha (2017), the level of complexity of the problem with real situations is based on 5 factors: context, information, converted factors, calculation skills, and hints.

Cite this article as: Le Thai Bao Thien Trung, & Tran Minh Man (2020). Designing realistic problems for assessing student problem solving competency in teaching Plane geometry at grade 9. *Ho Chi Minh City University of Education Journal of Science, 17*(3), 467-475.

Table 1. *The level of competency of the realistic problem (Ha, 2017, p. 45)*

Factors	Level 1	Level 2	Level 3
Context	Real situations are familiar to students, they are associated in daily life and learning	Real situations are not common, students rarely meet in daily life and learning	Real situations which students have never met
Information	The information of realistic problem is little, simple and clear	The information of the problem is moderate, clear and not complicated	The realistic problem has a lot of complicated information
Converted factors	Little, simple and clear	Moderate, clear and not complicated	Many, complicated
Calculation skills	Simple, few operations, easy and familiar mathematical forms with students	Not too complicated, not too much amount of operations	Complicated, many operations, rarely see
Hints	Clearly, specific	There are hints; sketchy guide	Do not have any suggestions or instructions

2.2. Designing the realistic problems

Designing realistic problems from an existing realistic problem is based on the following ways:

- Changing factors, phenomena, things, relations… which are mentioned in the problem;
- Changing relations and properties of objects in the problem;
- Changing the hypothesis or conclusion in the problem.

2.3. The scale to assess students' real problem-solving competency in teaching grade 9 plane geometry

Table 2. *The scale to assess students' real problem solving competency in teaching grade 9 plane geometry (Tran, 2019, P39)*

Elements of competency	**Criteria for Assessment**	**Level**			
		Level 0	**Level 1**	**Level 2**	**Level 3**
1. Defining the real problem	Understanding of the real problem	*Completely misunderstanding of the real problem*	*Understanding only correct part of the real problem*	*Part of the real problem misunderstanding*	*Complete understanding of the real problem*
2. Establishing mathematical model	Knowing how to convert information from real situation to a mathematical model	*Don't convert information from real situations to a mathematical model.*	*Converting only the correct part of the information from real situation to a mathematical model.*	*Converting only error part of information from real situation to mathematical model.*	*Converting* full and accurate *information from* real *situation to mathematical model.*
3. Developing a plan and carrying out the plan	Developing a plan to solve a mathematical model	*Don't show* Knowledge *and* solving strategy to solve a mathematical model	*Showing only correct part of* knowledge *and* solving strategy to solve a mathematical model	*Showing Only error part of* knowledge *and* solving strategy to solve mathematical model	*Showing* full and accurate Knowledge *and s*olving strategy to solve mathematical model
	Carrying out the plan	*No solution or wrong solution.*	*Presenting isn't full, accurate and the solution isn't logical.*	*Presenting is inaccurate, incomplete and non-logic*	*Presenting is full, accurate and logical.*
4. Evaluating and reflecting the solution	Knowing to move from the result of solving mathematical models to the result of the real problem	*No answer or wrong answer requirements of the realistic problem*	*Giving an only partially correct answer to the requirements of the realistic problem*	*Answer only wrong a part requirements of the reaisticl problem*	*Correct answer requirements of the realistic problem*

3. Main results

3.1. Designing realistic problems in grade 9 plane geometry curriculum

Based on the problems inspired from Alexander and Koeberlein (2014) and the current mathematics 9 curriculum, we design realistic problems in grade 9 plane geometry curriculum with the following forms:

Type 1. *Familiar situations, little information and simple calculation skills*

Exercise 1. The sun rays and the ground surface make an angle which is approximately equal to 62^0 and the shadow of a light pole on the ground is 4 meters long (Figure 1). Calculate the height of the light pole (rounding to meters).

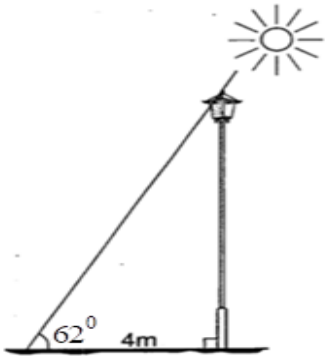


Figure 1

Exercise 2. When an airplane is descending to land, the angle of depression is 5^0. When the plane has a reading of 30 meters on the altimeter, what is its distance x from touchdown? (Figure 2)

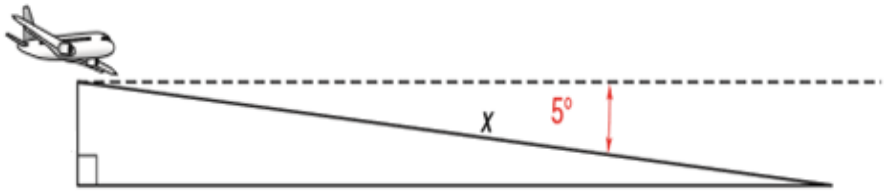


Figure 2

Exercise 3. From a cliff, Nam observes an automobile through an angle of depression of 23^0. If the cliff is 15 meters high, how far is the automobile from Nam? (Figure 3)

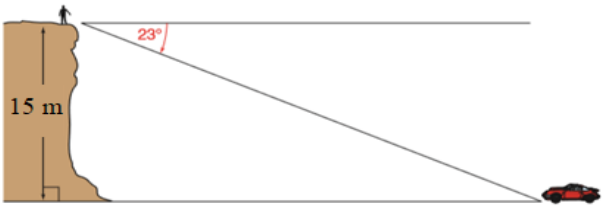


Figure 3

Type 2. *Rare situations, moderate information and relatively complicated calculation skills*

Exercise 4. Two apartment buildings are 12 meters apart. From a window in her apartment, Lan can see the top of the other apartment building through an angle of elevation of 47^0. She can also see the base of the other building through an angle of depression of 33^0. Approximately how tall is the other building? (Figure 4)

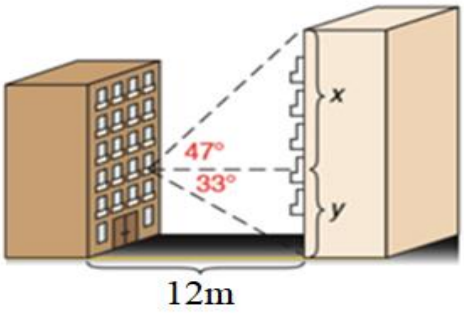


Figure4

Exercise 5. While a helicopter hovers 300 meters above the water, its pilot spies a man in a lifeboat through an angle of depression of 28°. Along a straight line, a rescue boat can also be seen through an angle of depression of 14°. How far is the rescue boat from the lifeboat? (Figure 5)

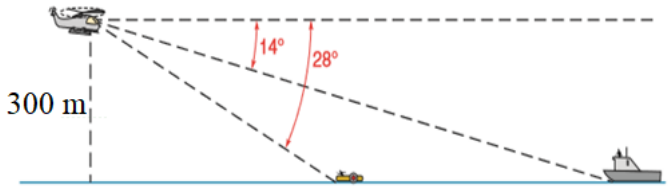


Figure 5

Type 3. *Strange situations, a large amount of information and complicated calculation skills*

Exercise 6. From the top of a building, Minh sees the top of an antenna mast through an angle of elevation of 34^0. He also sees the base of an antenna mast through an angle of depression of 62^0. Calculate the distance from the building to the antenna mast, knowing that the antenna mast is 68 meters high. (Figure 6)

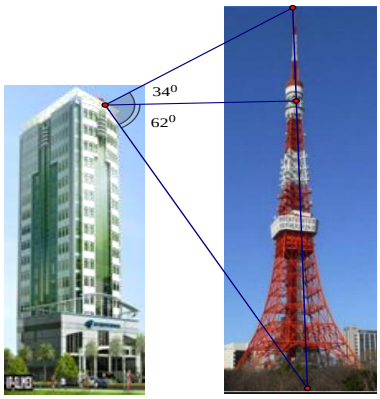


Figure 6

Exercise 7. From atop a 60 m lookout tower, a fire is spotted due north through an angle of depression of 12°. Firefighters located 300 meters due east of the tower must work their way through heavy foliage to the fire. By their compasses, through what angle (measured from the north toward the west) must the firefighters travel? (Figure 7)

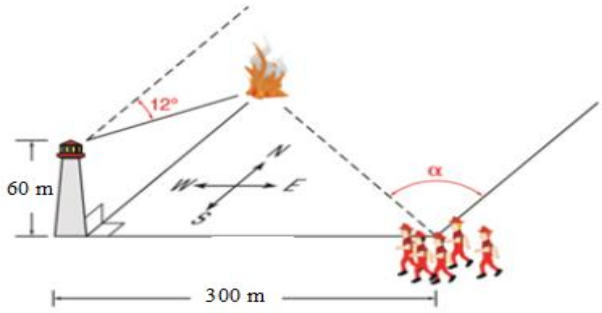


Figure 7

3.2. Practicing assessing students' real problem-solving competency in teaching grade 9 plane geometry

We present one illustrated example as following:

From a cliff, Nam observes an automobile through an angle of depression of 23^0. If the cliff is 15 meters high, how far is the automobile from Nam? (Figure 8)

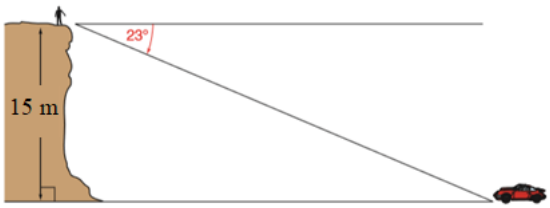
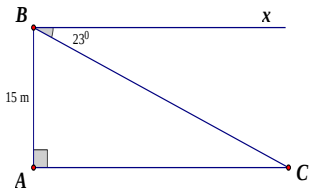


Figure 8

Table 3. *Assessing students' real problem solving competency in teaching grade 9 plane geometry*

Elements of competency	**Criteria for Assessment**	**Solution**	***Assessment***	
			Level	***Content***
1. Defining the real problem	Understanding of the real problem	*Hypothesis:* *+ Nam observes an automobile through an angle of depression of 23^0.* *+ The cliff is 15 m high.* *Conclusion:* *+ How far is the automobile from Nam?*	*3*	*Students do all three items.*
			2	*Students do two out of three items.*
			1	*Students do one out of three.*
			0	*Students do wrong thing items or do nothing.*
2. Establishing mathematical model	Knowing how to convert information from real situation to mathematical model	 ***Figure 9*** *- Given a triangle ABC with right angle A có: B is Nam; C is the automobile.* *- Calculate the length of BC.*	*3*	*Students draw figure 9 and do all two items*
			2	*Students draw figure 9 and do one out of two items*
			1	*Students draw figure 9*
			0	*Students don't draw figure 9 or draw wrong Figure 9*
3. Developing a plan and carrying out the plan	Developing a plan to solve mathematical models	** Knowledge:* *- Properties of two parallel lines.* *- Some identities relating to sides and angle of right triangles.* ** Solving strategy:* *- Calculate C $\rightarrow$ Calculate BC*	*3*	*Students show all three items*
			2	*Students show two out of three items*
			1	*Students show one out of three items*
			0	*Students do wrong thing or do nothing*
	Carrying out the plan	*- We have:* $Bx//AC \Rightarrow C = xBC = 23^0$ *(Since being a pair of alternate interior angles)* *- According to the identities related to sides and angles of a right triangle, we have:* $AB = BC.\sin C \Rightarrow BC = \frac{AB}{\sin C}$. *- This gives* $BC = \frac{15}{\sin 23^0} \approx 38,39\,(m)$	*3*	*Students do all three items*
			2	*Students do two out of three items*
			1	*Students do one out of three items*
			0	*Students do wrong thing or do nothing*
4. Evaluating	Knowing to	*The distance between Nam and the*	*3*	*The distance between*

and reflecting the solution	move from the result of solving mathematical models to the result of the real problem	*automobile 38,39 m*	*is*	*approximately*		*Nam and the automobile is approximately 38,39 m*
					2	*The distance between Nam and the automobile is 38,39 m*
					1	*The distance between Nam and the automobile is 38,39*
					0	*Students can't answer or answer wrongly*

3. Conclusion

The system of realistic is a tool to help teachers to assess the problem-solving competence of students. Therefore, in teaching mathematics according to the orientation of developing learners' capacity after 2018, teachers need to design a system of suitable and effective realistic problem to contribute the implementation of educational goals in the new program, aimed at forming and promoting learners' qualities and competencies. In the context of teaching to develop learners' qualities and competencies, the article presented a way to help teachers design practical problems in three levels from easy to difficult. Furthermore, the application of the rating scale proposed in the paper allows students to observe student performance and interpret it with scores different from the current student assessment.

❖ ***Conflict of Interest:*** *Authors have no conflict of interest to declare.*

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THIẾT KẾ NHỮNG BÀI TOÁN THỰC TIỄN NHẰM ĐÁNH GIÁ NĂNG LỰC GIẢI QUYẾT VẤN ĐỀ TRONG DẠY HỌC HÌNH HỌC LỚP 9

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Ngày nhận bài: 12-10-2019; ngày nhận bài sửa: 09-11-2019; ngày duyệt đăng: 25-3-2020

TÓM TẮT

Trong xu thế hội nhập, Chương trình Giáo dục phổ thông Việt Nam mới tập trung vào việc hình thành và phát triển các phẩm chất và năng lực học sinh. Đặc biệt, Giáo dục Toán học ở phổ thông đặt trọng tâm vào việc ứng dụng toán trong thực tiễn. Trong bài báo này, chúng tôi chúng tôi sẽ giới thiệu một số vấn đề về thiết kế các bài toán thực tiễn nhằm đánh giá năng lực giải quyết vấn đề hình học phẳng trong dạy học ở lớp 9 trung học cơ sở.

Từ khóa: năng lực giải quyết vấn đề; bài toán thực tiễn; Hình học phẳng; học sinh lớp 9