American International Journal of Research in Science, Technology, Engineering & Mathematics

Available online at http://www.iasir.net

ISSN (Print): 2328-3491, ISSN (Online): 2328-3580, ISSN (CD-ROM): 2328-3629

AIJRSTEM is a refereed, indexed, peer-reviewed, multidisciplinary and open access journal published by International Association of Scientific Innovation and Research (IASIR), USA

(An Association Unifying the Sciences, Engineering, and Applied Research)

Analogies in Geometry Textbooks for 12th Grade Students in Vietnam

Assoc. Prof. Dr. Nguyen Phu Loc[a*], Bui Phuong Uyen[b] (Msc)

[a]School of Education, Can Tho University- Vietnam.

[b]School of Education, Can Tho University- Vietnam.

Abstract*: This paper presents the results of the investigation on analogies in two geometry textbooks for 12th grade students in Vietnam. The findings are that analogies in the textbooks are used for the below purposes: using analogy (analog) is to introduce new lesson as a extension of analog; using analogy as a visual tool is to help students understanding the meanings of new knowledge in an easier manner; using analogy is to introduce a new formula without its proof and using analogy is to motivate students. However, analogies used in the textbooks are mainly simple, verbal and structural, and are not used to enhance students' learning activities.*

Keywords*: Teaching with analogy; analogy in textbook; mathematics education; teaching geometry; secondary education.*

I. Introduction

On the use of analogical reasoning in teaching geometry for 12th grade students at secondary schools in the Mekong Delta region of Vietnam, we have finished three investigations:

- The first one was to study whether mathematics education students prefered to use analogical reasoning in teaching mathematics or not (see [3]).
- The second one was to find out mathematics education students' opinions on difficulties of the use of the TWA model in teaching mathematics (see [4]).
- The third one was to figure out status of the analogy use of mathematics teachers of secondary schools at the Mekong Delta – Vietnam (see [5]).

For subjects being surveyed, the results of the above investigations showed that analogies were not paid much attention to applying to teaching mathematics. In order to continue our studies on using analogies in mathematics instruction in Vietnam, we have done the research on analogies in two 12th grade geometry textbooks of Vietnamese authors with the following two research questions:

1. How often did "Geometry 12" textbook authors of Vietnam use analogies to present mathematics contents in their books?
2. How did the authors of textbooks present analogies in their books?

To find out the answer to the above questions is necessary because, from our experiences of observation of mathematics classroom, the teaching strategies that teachers have used to give lessons replied much on the pedagogical ideas of the textbook authors. In other words, teachers' the attention to using analogical reasoning in their teaching depended much on analogies in textbooks.

II. Background

Definition of analogy

Definition: "An analogy is a comparison between two objects, or systems of objects that highlights respects in which they are thought to be similar". [12]

According to Glynn (1994), "an analogy is drawn by identifying similarities between two concepts" [1]. In this way, ideas can be transferred from a familiar concept (analog) to an unfamiliar one (target). Both the analog and the target have common features or share similar features, an analogy can be drawn between them. [1]

The role of analogy

Analogies are widely recognized as playing an important *heuristic* role, as aids to discovery. They have been employed, in a wide variety of settings and with considerable success, to generate insight and to formulate possible solutions to problems. [12]

According to Glynn (1994), teaching with analogy benefits from students' relevant existing knowledge and connects new knowledge to known knowledge; therefore, it motivates students' learning [1]. However, Thagard (1992) believed that "when students overgeneralize and map noncorresponding features of concepts, misconceptions can result in". [9]

Analogies in textbooks

For the study of analogies in science textbooks, there were many authors with remarkable studies. In this study, we learned how to conduct a research on analogies in textbooks much from [8], [10], and [11]. In [11], Yener (2012) showed that in physics textbooks, analogies are often used more for abstract target concepts, "analogies could be configured as a functional analogy, verbal analogy, concrete-abstract analogy, embedded activator type analogy or simple analogy". In [8], Sendur (2011) revealed that although the analogies in chemistry textbooks were used to teach abstract concepts like mole concepts; however, many of these analogies were simple, verbal and inadequate.

III. Methodology

Content analysis

At present time, in Vietnam, there are two different curriculums for secondary schools: (1) Basic (standard) curriculum; (2) Advanced curriculum. In general, for each subjects for each grade level (10^{th} Grade, 11^{th} Grade, 12^{th} Grade), both the above two curriculums consist of the same topics, but in the advanced curriculum, each topic could contain some contents deeper than the one of the basic curriculum. For geometrical subject for 12^{th} grade students, there are only two different textbooks which all mathematics teachers at Vietnamese secondary schools use for their teaching: (1) "Hình Học 12" (Geometry 12) for the basic curriculum [2]; (2) "Hình Học 12– Nâng cao" (Advanced Geometry 12) for the advanced curriculum [7]. In this study, we analyzed the analogies in the above two textbooks by category - based content analysis.

How to classify analogies in textbooks

Analogies have been divided into categories according to the different classification systems developed by many international authors. Based on analogy classification frameworks which were reviewed from works [6] and [11], in this study, we classified the analogies in each geometry textbook according to the following categories as follows.

The analogical relationship between analog and target

Structural: The analogies in which analog and target concepts share only similarities in external features or object attributes.

Functional: The analogies in which analog and target concepts share similar relational structures – in which the function or behavior of the analog and target are the same.

Structural-Functional: The analog and target concepts in the analogy share both structural and functional attributes.

The presentational format

Verbal (in words): The analogy is presented in the text in a verbal format only.

Pictorial-Verbal: The analogy is presented in a verbal format along with a picture of the analog.

The level of abstraction of the analog and target concepts

Concrete-Concrete: Both the analog and the target concepts that students might see, hear, or touch with hands

Abstract-Abstract: Both the analog and the target concepts are abstract.

Concrete-Abstract: The analog concept is concrete but the target concept is abstract.

The position of the analog relative to the target

Advance organizer: The analog concept is presented before the target concept in the text.

Embedded activator: The analog concept is presented with the target concept in the text.

Post synthesizer: The analog concept is presented after the target concept in the text.

The level of enrichment

Simple: A simple analogy is a simple sentence that analog is similar to target concepts

Enriched: An enriched analogy is an analogy statement which is accompanied by explicit statements mapping some attributes in the analog concept to the target concept.

Extended: Extended analogies are either those for which there are multiple explicit mappings or those which are used multiple times in the same book.

The limitations of the analogy: Misunderstandings are showed

IV. Results and Illustrations

A. Results

Analogies in the textbook "Geometry 12" (G12).

In the G12, there were five cases in which the authors used analogies in presenting new knowledge (see Table 1)

Table 1. Analogies in G12

Case	Target	Analog (source)
1G	Prism, Pyramid, Truncated pyramid	Cube
2G	Geometric transformation in space	Geometric transformation in plane
3G	Intersection of a sphere and a straight line	Intersection of a sphere and a plane
4G	Prove: $\vec{b}.\vec{n} = 0$	Prove: $\vec{a}.\vec{n} = 0$
5G	The parametric equation of a straight line in space	The parametric equation of a straight line in plane

Analogies in the textbook "Advanced Geometry 12" (AG12)

In the AG12, we found that there were nine cases in which the authors used analogies to assist the presentations of new mathematics contents (see Table 2).

Table 2. Analogies in AG12

Case	Target	Analog
1AG	Geometric transformation in space	Geometric transformation in plane
2AG	Homothetic transformation in space	Homothetic transformation in plane
3AG	Convex polyhedron	Convex polygon
4AG	The volume of a polyhedron	The area of a polygon
5AG	The relative positions of a sphere and a straight line	The relative positions of a sphere and a plane
6AG	System of coordinate axis in space	System of coordinate axis in plane
7AG	The area of a spherical surface	The area of a polyhedron
8AG	The area of a spherical surface	The area of a rectangle
9AG	The formula for calculating the distance from a point to a plane	The formula for calculating the distance from a point to a straight line

Classification of analogies in G12 and AG12

After analyzing content of each analogy in G12 and AG12, we classified these analogies as follows:

(See Table 3)

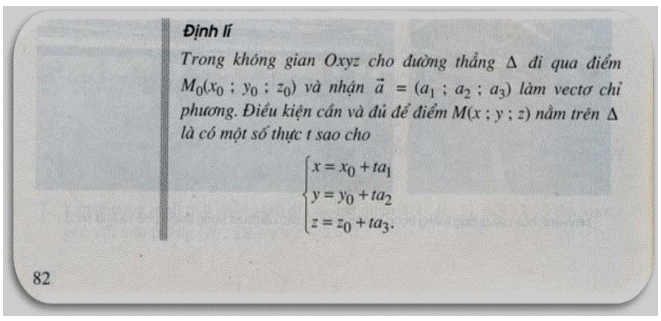
Table 3: Classification of analogies in G12 and AG12

Category		Textbook	
		G12	**AG12**
Analogical Relationship	Structural	1G, 4G, 5G	3AG, 4AG, 5AG, 6AG, 7AG, 8AG
	Functional	2G	1AG, 2AG
	Structural-Functional	3G	9AG
Presentational Format	Verbal	1G, 2G, 3G,4G	1AG, 2AG, 3AG, 7AG, 8AG, 9AG
	Pictorial-Verbal	3G, 5G	4AG, 5AG, 6AG
Level of abstraction	Concrete- Concrete	-	-
	Abstract-Abstract	All of cases	1AG, 2AG, 3AG, 4AG, 5AG, 6AG, 8AG, 9AG
	Concrete-Abstract	-	7 AG
Position in Text	Advance organizer	All of cases	1AG, 2AG, 3AG, 4AG, 5AG, 6AG, 7AG, 8AG
	Embedded activator	-	9AG
	Post synthesizer	-	-
Level of Enrichment	Simple	All of cases	All of cases
	Enriched	-	-
	Extended	-	-
Limitation	Stated	-	-
	Not stated	All of cases	All of cases

B. Illustrations

In order to illustrate how to present analogies in two textbooks of Geometry for 12th Grade in secondary schools of Vietnam, we discuss the following six cases in which, in our opinion, analogies were used in a good way.

The case 5G (*in G12)*



Định lí

Trong không gian Oxyz cho đường thẳng Δ đi qua điểm $M_0(x_0 ; y_0 ; z_0)$ *và nhận* $\vec{a} = (a_1 ; a_2 ; a_3)$ *làm vectơ chỉ phương. Điều kiện cần và đủ để điểm* $M(x ; y ; z)$ *nằm trên* Δ *là có một số thực t sao cho*

$$\begin{cases} x = x_0 + ta_1 \\ y = y_0 + ta_2 \\ z = z_0 + ta_3. \end{cases}$$

82

Figure 1: The parametric equation of a straight line in space (G12)

In the case 5G, before presenting theorem on the parametric equation of a straight line in space (see Figure 1), authors of textbook used the parametric equation of a straight line in plane as an analog to pose problematic situation for motivating students as follows:

> *As you knew, in the system of coordinate axis Oxy, the parametric equation of a straight line with the form:* $\begin{cases} x = x_0 + ta_1 \\ y = y_0 + ta_2 \end{cases}$, *where* $a_1^2 + a_2^2 \neq 0$. *In a similar way, in the space Oxyz, what is the form of the parametric equation of a straight line? " (see Figure 2).*

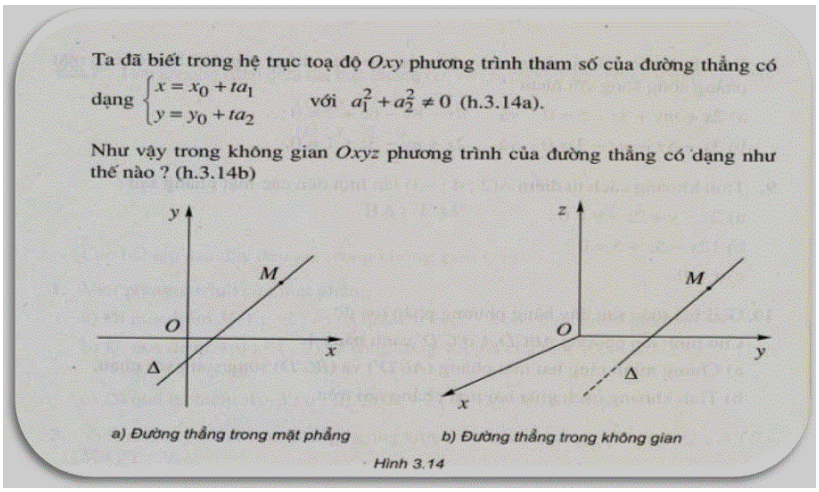


Figure 2: A problematic situation for teaching the parametric equation of a straight line in space (G12)

With analogy used in the case 5G, we recognized that the textbook "Geometry 12" restating the parametric equation of a straight line in the plane is help students review knowledge learned, and also by which the textbook created a problematic problem to stimulate students' curiosity. In teaching process, the teacher should make use of the idea of the authors of the textbook to offer opportunities for his students to make predictions on what the parametric equation of a straight line in space is before stating theorem on the parametric equation of a straight line in space.

The case 1AG *(in AG12).* When introducing the new concept "The volume of a polyhedron", the authors chose a learned concept "the area of a polygon" as an analog, from which, they wrote as follows:

> *As we know, in the plane, each polygon has an area. It is a measure of the portion of plane which the polygon takes place. Similarly, the polyhedrons also account for a large or small space differently. The volume of each polyhedron is a measure of the space that it occupied". (see Figure 3)*

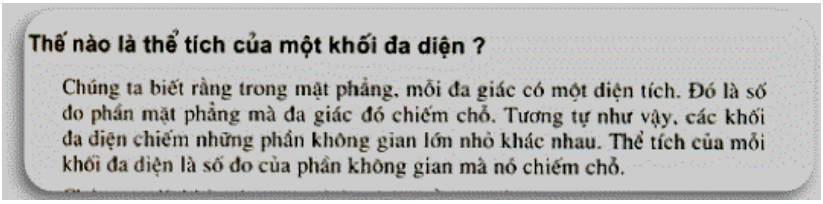


Figure 3: The volume of a polyhedron similar to the area of a polygon (AG12)

The case 2AG *(in AG12):* In order to present the relative positions of a sphere and a straight line. The authors of textbook introduced it as a similar case of the relative positions of a sphere and a plane. Next, the textbook presented three cases of relative positions of a sphere and a straight line without any reasoning to prove the results obtained (see Figure 4)

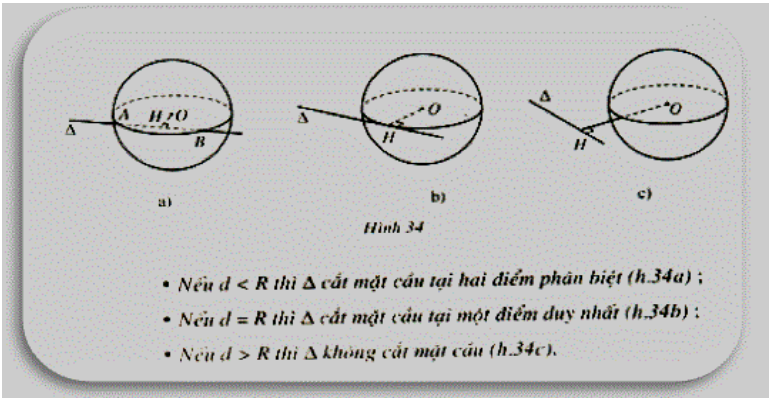


Figure 4: Three relative positions of a sphere and a straight line (AG12)

The cases 4AG, 5AG *(in AG12)**:***

- In the case of 4AG, before defining the concept " the area of a polyhedron", the authors recalled the area of a plane polygon as follows:"We already know how is the area of a plane polygon. We define the area of a polyhedron as the total area of its surface." (see Figure 5)
- In the case 5AG, in order to help students understand what the area of a sphere, the authors made comparison between the area of a sphere and the one of a rectangle through using the same paint water:

> *Although a sphere is not like polyhedron because it is not made up of several polygons, but, obviously, it also has any area. If to paint a sphere we use 1 kg of paint water, and also with 1 kg of paint water, we paint a rectangle as the same thin we did for the sphere, then we can say the area of the sphere is equal to the area of the rectangle". (see Figure 5).*

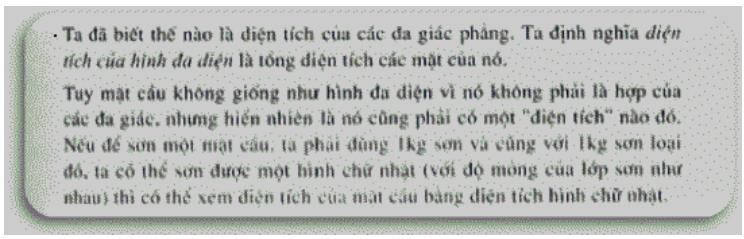
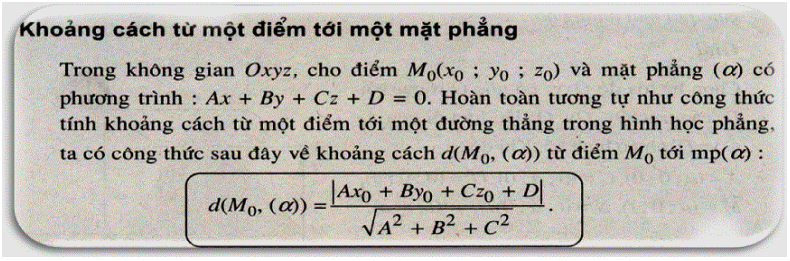


Figure 5: How to describe the area of a sphere by analogy of AG12

The case 6AG *(in AG12)**:***

In the AG12, the formula of distance from a point to a plane was introduced as the same formula of the distance from a point to a line in plane without explicitly presenting the how to construct the formula for calculating distance from a point to a plane. Particularly, the textbook wrote:

> *In space Oxyz, given a point M(x_0; y_0; z_0) and a plane: Ax + By + Cz + D = 0. Completely similar to the formula of distance from a point to a straight line in plane geometry, we have the following formula of the distance d (M_0, (α)) from M_0 to mp(α):*



$$d(M,(\alpha)) = \frac{|Ax_0 + By_0 + Cz_0 + D|}{\sqrt{A^2 + B^2 + C^2}}.$$ " *(see Figure 6)*

Figure 6: How to present the formula of distance from a point to a straight line in AG12

Towards cases of the use of analogies in the textbook "Advanced Geometry 12" which were illustrated as above, we recognized that these analogies in the textbook were used for the below purposes:

1. Using analogy is to introduce new lesson as an extension of analog.
2. Using analogy is a visual tool to help students understanding the meanings of new knowledge in an easier manner.
3. Using analogy is to introduce a new formula without its proof.

Due to using analogies, many mathematics contents in the textbook were presented in a more intuitive and shorter way.

V. Conclusion

Vietnamese authors of textbooks made use of analogies for differently objectives. However, the analogies were used to present abstract concepts, and they were mainly simple, verbal and structural; the analog concepts were often presented before the target concepts in the texts. The authors did not show any misunderstandings possible to occur if using these analogies. What is more, the authors have not used any analogies to suggest tasks in which students must implement learn activities to discover new knowledge. Therefore, in teaching process, the secondary school teachers of mathematics should enhance learning activities with analogies for their students, and should recognize teaching with analogies as an effective strategy for teaching mathematics in secondary schools.

VI. References

[1] Glynn, S.M. (1994), *Teaching Science With Analogy: A Strategy for Teachers and Textbook Authors*, National Reading Research Center, Reading Research Report No.15, Office of Educational Research and Improvement, Washington, DC.

[2] Hao, T. V. et al (2007), *Hình học 12 (Geometry 12).* Hanoi: Publishing house (in Vietnamese)

[3] Loc, N.P. & Uyen, B.P. (2014). Using Analogy in Teaching Mathematics: An Investigation of Mathematics Education Students in School of Education - Can Tho University. *International Journal of Education and Research*, Vol. 2 No. 7 July 2014 (Australia).

[4] Loc, N.P. & Uyen, B.P. (2015). A Study of Mathematics Education Students' Difficulties in Applying Analogy to Teaching Mathematics: A Case of the "TWA" Model. *American International Journal of Research in Humanities, Arts and Social Sciences*, 9(3), December 2014-February 2015, pp. 276-280

[5] Loc, N.P. & Uyen, B.P. (2015). Using Analogical Reasoning in Teaching Mathematics: A Survey of Mathematics Teachers at Secondary Schools in The Mekong Delta – Vietnam. *International Journal of Sciences: Basic and Applied Research* (IJSBAR) (2015) Volume 21, No 1, pp 90-100

[6] Orgill, M. (2013). *How Effective Is the Use of Analogies in Science Textbooks?*.In Khine, M. S. (editor) (2013). Critical Analysis of Science Textbooks-Evaluating instructional effectiveness. London: Springer.

[7] Quynh, D. et al (2007), *Hình học 12 - Nâng cao (Advanced Geometry 12)*, Hanoi: Publishing house (in Vietnamese)

[8] Sendur, G., et al . "An analysis of analogies used in secondary chemistry textbooks". Procedia Computer Science 3 (2011) 307–311 311

[9] Thagard, P. (1992). Analogy, explanation, and education. *Journal of Research in Science Teaching*, 29, 537-544

[10] Thiele, Rodney B.; Treagust, David F. (1992) *Analogies in Senior High School Chemistry Textbooks: A Critical Analysis*. The Paper presented at the ICASE Research Conference in Chemistry and Physics Education(Dortmund, Germany, June 10-12, 1992).

[11] Yener, D. (2012) . A study on analogies presented in high school physics textbooks. *Asia-Pacific Forum on Science Learning and Teaching*, Volume 13, Issue 1, Article 5 (Jun., 2012)

[12] http://plato.stanford.edu/entries/reasoning-analogy/

