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ERRORS OF STUDENTS IN SOLVING PROBLEM "*WRITE THE EQUATION OF A STRAIGHT LINE THROUGH A POINT AND PARALLEL TO A GIVEN STRAIGHT LINE*": A STUDY BASED ON THE CONCEPT "*DIDACTICAL CONTRACT*"

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Abstract:
The paper presents the result of a research based on the concept "didactical contract" which was introduced by G. Brousseau in 1980. On the basis of this concept, we predicted students' errors and verified by the investigation of 60 students who are studying in the "Long Phú" high school – Tam Binh District, Vinh Long Province. These results indicated that the rules of didactical contract could be reasons for students' errors in solving mathematical problems.

Keywords: didactical contract, problem solving, error in mathematics learning, mathematics education

1. Introduction

Errors in solving problem which was defined as follows:

> *"Error in solving problem is an error caused by improperly implementing mathematical rules; by applying the incorrect mathematical formulas, mathematical theorems; or by misunderstanding concepts, theorems; by misunderstanding an assignment, or by making mistake in calculation and presenting problem solution"*
>
> (Loc & Hoc, 2014; Loc & Kha, 2015)

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There were researchers publishing works on errors in solving mathematics problem and mathematics learning. Loc and Hoc (2014) showed errors of students in learning Calculus, Loc and Kha (2015) investigated learners' mistakes when approached to analytic geometry. Besides, Loc and Uyen (2016a-b-c) determined some errors which students made in solving three types of task in geometry textbooks of Vietnam.

In this study, we based on the concept of didactical contract which G. Guy Brousseau described in 1980 as follows:

> *"..students tend to make any information or limitation clear using what the teacher, whether consciously or unconsciously, produces in his teaching activity. We think about the most common habits in teaching, and we define a didactical contract as the specific behaviour that students expect from teachers and teachers expect from students too".*

According to G. Brousseau, the didactical contract gives rules involving expectations and behaviour of students and teachers towards knowledge. It points to what students and teacher have to do, their roles and their responsibilities one to another, in an implicit way. A didactical contract has the following properties:

1) The didactical contract is about knowledge.
2) There is a didactical contract for every kind of knowledge.
3) To acquire knowledge you always have to break the contract.
4) It is implicit, and never fully explained.
5) A contract fully based on acting rules of teachers and students, totally explicit will lead the didactical relation to a failure.

In mathematics education of schools, some errors happen to students because of rules related to didactical contract. This paper will point out such a case.

2. Statement of research problem

In the textbook "Hình học 12" (Geometry 12) of Vietnam, there is a type of problem:

"In the space Oxyz, write the equation of straight line (L) passing through point $A(x_0;y_0;z_0)$ and parallel to straight line (d)" (I).

Strategy (S) for solving the problem (I). In general, as follows:

Step 1: Check whether A is on (d) or not.

In the case of A on (d): conclude that there exists no straight line satisfying the given conditions.

In the case of A not on (d), continue to step 2 and step 3:

Step 2: Let $\vec{u}(u_1;u_2;u_3)$ be direction vector of (d). Because of (L) // (d), $\vec{u}(u_1;u_2;u_3)$ is also direction vector of (L);

Step 3: The parameter equation of (L) is:

$$\begin{cases} x = x_0 + u_1 t \\ y = y_0 + u_2 t \quad (t \in \square \\ z = z_0 + u_3 t \end{cases}$$

The answer to the problem is that there exists one and only one straight line satisfying the give conditions whose equation is (L).

In all cases in the textbook, the point A is not on d. Therefore, *the strategy (S')* for solving the problem which both teacher and students apply consists of step 2 and step 3. From this fact, we formulated hypothesis as follows:

H: ***For solving (I), there exists a rule of didactical contract: Students don't verify whether the point A is on the straight line (d) or not; therefore, students will commit errors when solving the problem (I).***

3. Methodology

3.1 Problem used to verify the hypothesis

In order to verify the above hypothesis, we assign students to solve the following problem:

Problem II: "In the space Oxyz, write an equation of straight line (d') passing through point $A(x_0; y_0; z_0)$ and parallel to straight line d" (II) in the following cases:

a. $A(1;0;2)$ and $d: \begin{cases} x = 1 + 2t \\ y = -1 + 3t \\ z = 2 - t \end{cases}$

b. $A(1;-1;3)$ and $d: \begin{cases} x = -1 + 2t \\ y = -4 + 3t \\ z = 2 + t \end{cases}$

Remark:

- *In the case of II.a:* A is not on (d), applying strategy (S') to give the correct solution, but not strict in terms of logic because S' does not include Step 1 (show A is not on (d))
- *In the case of II.b:* A is on (d), applying strategy (S') to give wrong solution.

Participants:

Subjects: 60 grade 12th students (academic year 2016 -2017) from the High School Long Phu, Vinh Long province.

Data collecting and analyzing: These participants were assigned the problem (II) to solve.

After the students finished doing the above problem, we analyzed their written solutions to the problem (II) on basis of the concept "didactical contract".

4. Results and discussion

The results of analyzing the written answers of students, we summarized and classified strategies used by participants as in Table 1 and Figure 1.

Table 1: The students' results of solving problem

Problem II	Solving strategy	The number of students	% students
a	Strategy S': Because (d') passes through $A(1;0;2)$ and has $\overrightarrow{u_{d'}} = \overrightarrow{u_d} = (2;3;-1)$ to be a direction vector, the parameter equation of d' is: $d': \begin{cases} x = 1+2t \\ y = 0+3t \\ z = 2-t \end{cases}$	48	80%
	Strategy S: - (d') passes through $A(1;0;2)$ and has $\overrightarrow{u_{d'}} = \overrightarrow{u_d} = (2;3;-1)$ to be a direction vector; -Prove that A is not on d. -So, the parameter equation of d' is: $d': \begin{cases} x = 1+2t \\ y = 0+3t \\ z = 2-t \end{cases}$	0	0%
	Not know how to solve	5	8.3%
	No answer	7	11.7%
b	S': Because (d') passes through $A(1;-1;3)$ and has $\overrightarrow{u_{d'}} = \overrightarrow{u_d} = (2;3;1)$ to be a direction vector, the parameter equation of d' is: $d': \begin{cases} x = 1+2t \\ y = -1+3t \\ z = 3+t \end{cases}$	44	73.4%
	S: + Show that $A \in d$ + So, there does not exist d'.	0	0%
	Not know how to solve	8	13.3%
	No answer	8	13.3%

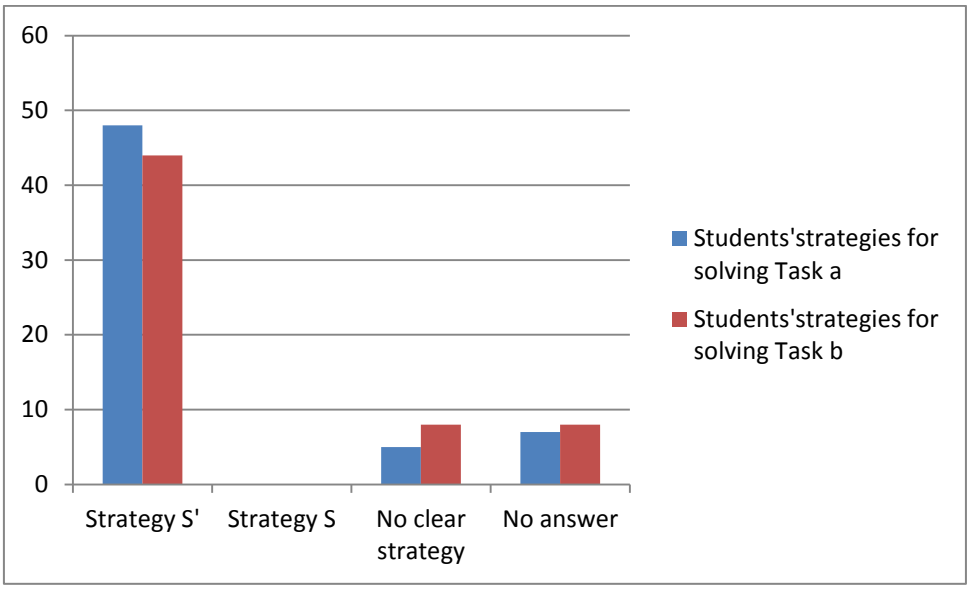

Figure 1: The students' results of solving problem

Table 1 and Figure 1 showed that in case of II. a and II.b, almost students (II.a- 80%; II. b – 73.4% students) used the strategy S' to solve (see Figure 2 - the written solution of a student with strategy S'). It meant that they did not check whether A is on d or not; in addition, no any students applied the strategy S to solve both II.a and II.b. Therefore, the hypothesis H was true.

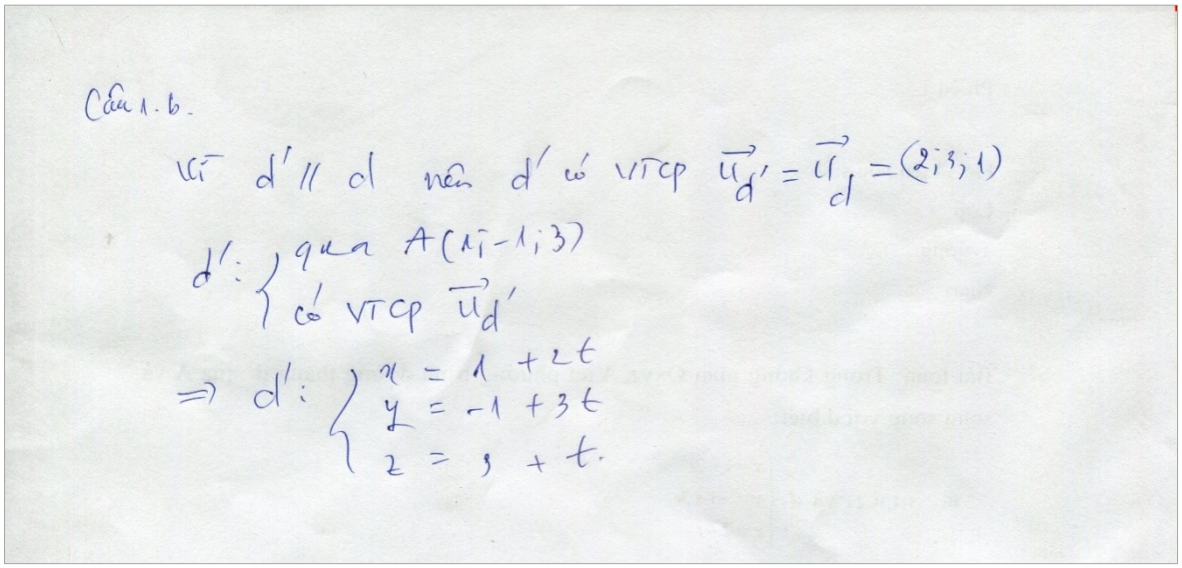

Figure 2: The written solution of student N.H.K (High School Long Phú, Vinh Long)

5. Conclusion

From the results of the above investigation, we could draw conclusion that in most learning process, students often tend to do how their teachers and textbooks to do or to

present. For the problem I, the teacher and his students solved it according to strategy S' which was wrong in reasoning and led to wrong solution if the point A was on the straight line d. Therefore, it is easy to occur that the student will commit errors when solving this problem. In order to prevent students' errors in solving problem, the teacher should predict wrong things which could happen to his students and to create measures to help them learn effectively. For instance, in process of guiding students to solve the problem I mentioned as above, the teacher usually use the strategy S, and show students errors if using the strategy S'.

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