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# ANALYZING PHENOMENA OF TEACHING MATHEMATICS TROUGH PERSPECTIVE OF DIDACTICAL CONTRACT

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**ABSTRACT**

This article is a theoretical study of the didactical contract and the application of this theory in teaching analysis, especially the teaching mathematics. Didactical contract is an indispensable subject in the Theory of Didactical Situation. The Didactical contract regulates the responsibilities of teachers and students in a lesson that is supported by a didactic situation to achieve the learning objectives and link the process of adaptation and acculturation. The process of devolution and institutionalization was then introduced to relate the dimensions of acculturation and adaptation of educational endeavor even though they were under the responsibility of the teacher. This contract is an excellent means for teachers in communicating with students in accordance with the achievement of learning at the time. The type and level in the didactical contract can be used as a theoretical framework in identifying teaching mathematics so that the quality of mathematics teaching activities in the classroom can be improved in the future

## INTRODUCTION

Mathematics learning is a process of learning and teaching interaction between teacher and student that involves the development of thinking patterns and processing logic in a learning environment that deliberately created by the teacher. Good interaction between teacher and student describes the learning process can be done well. The interaction of teacher and student is a social activity that does not escape the obstacles that come from both. The greatest role of mathematics teachers in the formation of new knowledge is to live math lessons through the design of situations in which teachers can show students about the use, interests, and other aspects of the mathematics they will teach (Sarrazy & Novotna, 2013). Teaching means creating conditions in which something new arises. This creation is very important for the work of teachers: designing a problem and situation that allows students to find new ways to solve the problem.

As a social interaction, teaching and learning activities do not escape from the obstacles of the students and teachers in the educational context. Brousseau (2002: 82) refers to obstacles from the theories conveyed by Bachelard (1938) and Piaget (1975) on "*errors*", that mistakes and failures play a role that is not simple. This type of mistake is unpredictable that, called *obstacles*. This error is part of the acquisition of knowledge. It is also the underlying theory of the didactical situation, obstacles. The analysis of this problem becomes important to be expressed in order to better optimize the construction process of new knowledge and reduce the obstacles that occur.

Analysis of problem in learning during this time is more emphasized on result or student achievement. The analysis of how teachers teach has not received more attention when

both of these analyzes can synergize in designing the learning in accordance with the conditions and needs of students. Analysis of teaching can improve the teacher's strategy in future teaching, priority material emphasis, more replication of time for a concept, the type of task to be assigned to the student, to anticipate questions and responses that may arise, and what Teacher control to know the extent to which the learning objectives have been achieved. It is the teacher's responsibility to plan effective learning.

Teachers and students have their respective responsibilities that cannot be exchanged. This responsibility regulates their respective obligations so that the learning goals that understanding of a lesson can be achieved. Student responses to ongoing learning require teachers to anticipate by creating a didactical situation (Suryadi, 2013). This is what in didactical situation is called didactical contract. This didactic contract regulates the interaction between teacher-student-knowledge. Therefore, analyzing the teaching of teacher is considered necessary to review how teacher teach and how students respond to the lesson that presented by teacher. This analysis is expected to identify the characteristics and needs of students in understanding a concept and improve the quality of subsequent teaching.

## THEORETICAL FRAMEWORK

Didactic contract was an important idea in *Theory of Didactical Situations in Mathematics* (TDSM) initiated by Brousseau in 1986. In a didactic situation, Brousseau (2002) identifies implicit contracts between teachers and students, together with the elements involved in the set Rules. The main argument in TDSM, according to Balacheff (Kislenko, 2005), is that every situation demands a part of a student's behavior which is an indication of his knowledge. The TDSM construct consists of two types of processes: independent *adaptation* through the notion of *adidactical situations* and *milieu*, and *acculturation* through the notion of *didactical situations* and *didactic contract* (Artigue et al, 2014: 49). The *adidactical situation*, according to Laborde and Perrin-Glorian (2005), was designed with didactic intention to minimize teacher involvement in teaching students. Students can build their knowledge through experience, interaction with their *milieu*, and learn by looking at the world (Brousseau 2002: p.30). In the theory of didactical situation there are three main situations: 1) *situation of action*, 2) *situation of formulation*, and 3) *situation of validation* (Brousseau, 2002; Kislenko, 2005; Perrin-Glorian, 2008). These three situations are tied in the interaction between teachers and students called by didactical contract. Didactic contract was described by Brousseau as a set of rules that determine what students and teachers "have a responsibility to proceed and each is accountable in a variety of ways". The rules of didactical contract are generally implicit / implied, unlike regular contract, and are sometimes seen when the contract is unsuccessful or broken for various reasons (Brousseau 2002: 32). Some researchers make *institutionalization* the fourth situation of a didactic situation, a process by which teachers assist students in connecting knowledge that students already have with the new knowledge they want to be intended.

Didactical contract has the notion that 'teachers are obliged to teach and students are obliged to learn', teachers assign tasks and students perform these tasks (Brousseau & Otte, 1991). A didactical contract is an interpretation of the commitments, expectations, beliefs, means, results, and punishments imagined by one of the protagonists of the *adidactical situation* (student, teacher, parent, community) for himself and others (Brousseau et al., 2014) . Extending the definition of the didactic contract Brousseau, Sadovsky (Arias and Araya, 2009) describes this contract as an excellent means for teachers to communicate "sometimes explicitly and mostly implicitly, through words and also through gestures, attitudes and silences, and the aspects related to mathematics learning in the classroom". Brousseau (2002: 225)

stated that the contract refers to "teacher behavior (specifically for the knowledge being taught) expected by students and student behavior expected by teachers".

> *In a teaching situation, prepared and delivered by a teacher, the student generally has the task of solving the problem she is given, but access to this task is made through interpretation of question asked, the information provided and the constraints that have been imposed, which are all constants in the teacher's method of instruction. these habits of the teacher are expected by the student and the behaviour of the student is expected by the teacher, this is the didactical contract*

Didactical contract is divided into two categories: devolution contracts, the teacher organize mathematical activities of students who respond or respond to them, and institutionalization contract, the students suggest the outcomes they get and teachers provide directions that match the knowledge reference (Brousseau et al. 2014, Hersant & Perrin-Glorian, 2005). The process of *devolution* and *institutionalization* was then introduced to relate the dimensions of acculturation and adaptation of educational endeavor even though they were under the responsibility of the teacher. According to Artigue et al. (2014: 53) the *devolution* process is the process of negotiating with teachers through didactic contracts which temporarily allow for the transfer of responsibilities regarding the teacher's knowledge goals to the students. Through *devolution*, teachers make their students accept math responsibility to solve problems without ignoring didactic goals, and maintaining them, creating conditions that should be a means of learning through adaptation. Through *institutionalization*, teachers help students to connect their contextual knowledge has been built in an adidactical situation in accordance with the target knowledge to be achieved and thus the teacher re-assigns decontextualization and transforms into "*savoirs*". If teachers direct students about what they should do, then students will not be able to learn. In TDSM, this devolution paradox relates to another important part, the didactical contract, found in a study developed by Brousseau on students who fail in math (Artigue et al., 2014: 53).

In TDSM, didactical contract differ for each mathematical concept. In addition, different didactic contract for different students. Therefore, it is difficult to describe a didactic contract straightforwardly. The relationship between teachers and students in certain situations is one of the important ideas in TDSM. Didactical contract are contacts that define the responsibilities of students and teachers and manage their interaction in the learning process (Miyakawa & Winslow, 2009). However, according to Brousseau (2002: 32), 'infraction of contract' is an important thing. Brousseau explain that in the didactical situation, if the teacher feels a failure in the learning process, the student does not meet the expected learning objectives, so the teacher is implicitly said not to meet student expectations. Students 'complain' because they can not solve the problem given by the teacher. This situation leads to a conflict in the teacher, why this can happen. Conflict experienced by teachers, negotiation, and the search for a new contract will continue the didactic relationship through a new didactic situation. In this case the teacher assumes that previous learning and new conditions bring students to new learning possibilities.

The idea of a didactical contract has been developed further to distinguish several types of contracts. Situational changes allow for the modification of contracts in which new situations occur (Brousseau, 2002: 31). The level of didactic contract structure proposed by Hersant and Perrin-Glorian (2005) is: *macro-contract, meso-contract,* and *micro-contract. Macro-contracts* primarily relate to the purpose of teaching, *meso-contract* with the realization of an activity, such as exercise resolution, while the *micro-contract* corresponds to an

episode focused on the unit of mathematical content, eg concrete questions in practice.

The process of posing a problem to construct new knowledge (which will later be used to solve a problem) sometimes does not guarantee a didactic situation under a didactical contract fully undertaken (Hersant and Perrin-Glorian, 2005). In the ordinary of learning process, an *adidactical situation* is sometimes rare, but some situations have potential to occur (*adidactic potential*). The presence of *milieu* in an *adidactical* situation is a means of feedback in student activities, but it is may not be enough for students to build a new knowledge of their own. In this case, it is necessary for teacher intervention to modify the *milieu* so that the student can improve his understanding of a concept. It is said to be 'potential' because teachers can get involved managing the situation, evaluating students' answers without waiting for students to react to feedback from the *milieu*.

Chevallard and Barquero et al. (Arias & Araya, 2009) introduced different interactions characterizing the *adidactical potential* practice in *potential adidactical contract*. This type of contract offers new responsibilities to the student, an important responsibility to identify. This form of responsibilities requires students to explain their suggestions and contribute to rebuilding the cognitive path that leads them to the learning objectives. Teachers do not need to answer all questions and they must contribute to ask questions to students. They must also develop the skills to argue, in properly communicating ideas and knowing about learning in other ways (*metacognition*). An important aspect set in the *potential adidactical contract* is that teachers (with students) make clear rules in applying these skills in other contexts.

## DISCUSSIONS

The didactical contract analysis conducted by Arias and Araya (2009) as part of a field study of doctoral thesis, one of the authors of the article made a series of observations over five months, in four classes of grade 10th. This study emphasizes two types of didactic contracts (*ostension* and *Mayeutic socratic contract*) were identified with teachers in the classroom who characterized the practice of teaching in the city of Costa Rica, Italy. They describe and analyze the interactions that occur during teaching on the topic of polynomial factorization through the method of multiplication of factors and crossbreed Arias and figured there is a possibility that class interactions develop with the types of changes described by didactic contracts. Finally, this refers to some conclusions from the analysis performed.

As a theoretical basis, didactic contract analysis by Arias and Araya rests on several types of didactic contracts based on *theory of didactical situation* by Brousseau:

*1. Ostention Contract*

During the practices where teacher shows an object (property, technique or example, etc.) and the students accept to see it “as a representative of a type, in which, they must recognize their elements in other circumstances” or objects; the exchanges between the actors are ruled by the ostension contract. As the author indicates, the contract permits the teacher to communicate knowledge, avoiding the situations of action and formulation.

2. *Mayeutic Socratic contract*

In learning activities, teachers do not fully dominate but help the child's learning process through the provision of key questions exploring the experience and early knowledge of students to bring the linkage to the concepts to be studied..

3. *Potential Adidactical Contract.*

This contract offers new responsibilities to the student, an important responsibility to identify. For example, in dynamic *adidactical potential*, students describe the question and do not wait for the answer. Also, students are called to answer other students' questions, so teachers are not the only ones who have the right answers. Students should explain their suggestions and contribute to rebuilding the cognitive way that leads them to a result. In addition,

they should be able to explain the way and propose verification of the strategy.

At the end of their study, Aria and Araya concluded that some of the elements of didactical contract organize student responsibilities in such a way that students should assume responsibilities such as: complex questions, answering other student questions, explaining their suggestions and contributions, rebuilding the cognitive that they are on the results, justify the technique, propose verification strategies, and others. This didactical contract is a *Potential Adidactical Contract*. The theory of didactical contract confirmed that this contract is not fictitious but important, that it is impossible for the teacher to withdraw from certain obligations and therefore radical constructivism may not be fully practiced.

Another study was conducted by Putra (2016) who analyzed didactical contract in teaching activities with Realistic Mathematics Education. The study was conducted on 26 grade 1 students and a mathematics teacher at one of elementary school in Palembang, Indonesia. In this research, *theory of didactical situations of mathematics* was used to analyze teaching and learning practices which can be challenges when we use them to analyze the design of specific teaching and learning activities such as the teaching activities of realistic mathematics. All learning activities were analyzed based on the characteristics of the didactic contract, the investigation of the formulation and validation situations that occurred during the teaching and learning practices, and characterized the mathematical events at the *meso-contract* and *micro-contract* level.

The characteristic that found in this study, as also expressed by Putra, the teacher had an important role to assist students in the process of institutionalizing knowledge. The process of *vertical mathematization* or *adidactical contract* occurring by a group of students do not affect other students, but we cannot completely blame the teacher because the students never had some experience in realizing their thinking in classroom discussions themselves. We can say that this is a common situation in traditional teaching and learning practices and sometimes needs to turn them into interactive. On the other hand, when teacher ask questions to validate student answers, students can communicate their ideas. In this process, they are able to "breaking" the contract agreement at the micro-contract level. They are also keen to engage in individual production processes and collective production (*micro-contract* level). Thus, the application of the principle of interactivity contributes to "breaking" the didactic contract. Other findings indicate that some situations such as formulation and validation arise during the learning process. Students are able to produce a combination that produced number ten individually and collectively, and also makes a deal for the combination. Teacher has an important role to guide students in the institutionalization of knowledge process.

Brousseau et al. (2014) suggests observations and experimental and theoretical studies of didactic contracts make it possible to understand and predict the cumulative effects of teacher decisions. This is revealed by the student's reaction to teacher intervention, and can be classified as follows:

a) Abandonment. The teacher does not react to an error made by the students (e.g., because it would be too complicated to explain it), or she repeats the question identically or she gives the complete solution.
b) The progressive reduction or manipulation of the students' uncertainty, using a great variety of means:
    - Bringing in mathematical, technical, or methodological information
    - Decomposition of the problem into intermediate questions (decomposition of the objectives)
    - Use of various extra-mathematical rhetorical means: analogies, metaphors, metonyms, or mnemonic minders (the "Topaze effect")
c) Critical commentary on the errors, the question, the knowledge, or the material.
d) A trial of the student and its

consequences: penalties, discrimination, and individualization.

To avoid mistakes in teaching, teachers are required to try again by renewing the contract. The new effort replaces the previous one or criticizes and corrects it, making it a new teaching object (a meta-process) (Brousseau et al., 2014). This is the reason why analysis of didactical contract needs to be done by the teacher in teaching the students. Experiments on the teaching of rational and decimal numbers (Brousseau, 2002) or statistics and probabilities (Brousseau et al., 2002) proved that it is possible to organize efficient processes and can be transmitted with the help of didactical contract based on the nature of knowledge to be obtained.

## CONCLUSSION

Didactic contract are a rule or strategy in mathematics lesson which designed based on TDS. Didactic contract arrange a teacher in managing learning so as to create an interaction between teachers and students in their respective responsibilities. In a teaching and learning activity when the teacher gives the problem and gives a way to solve it then the students are given the exam, and follow the procedures given by the teacher, then in that process can be said there is no didactic contract. Didactic contract allow students to achieve their obligation of getting knowledge. If this does not happen, then the contract is broken so the teacher must create a new didactic situation. This is where the role of teachers to facilitate a knowledge that already exist in students with new knowledge to be attended.

The application of TDS through the design of didactical situation that created by teachers in learning activities taking place in the classroom is expected to develop student potential, meaning that students are given the opportunity to understand the concepts of science through a series of abstraction processes. Action and feedback through a strategy will the building of a new knowledge enable.

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