Implementation of a Study and Co-Disciplinary Research Course: Management of the Dialects on "Theme and Out of Theme"

Verónica Parra
Núcleo de Investigación en Educación en Ciencia y Tecnología (NIECyT)
Universidad Nacional del Centro de la Provincia de Buenos Aires (UNCPBA)
Tandil, Argentina

María Rita Otero

María de los Ángeles Fanaro

Núcleo de Investigación en Educación en Ciencia y Tecnología (NIECyT)
Universidad Nacional del Centro de la Provincia de Buenos Aires (UNCPBA)
Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET)
Tandil, Argentina

Abstract

The Anthropological Theory of Didactics (ATD) that suggests a new scholar epistemology called of research and questioning of the world that is developed through out a research and study course (SRC) we have presented here the results of the implementation of a SRC that involves mathematics and microeconomics in the last level of the argentine secondary school with student's between17 and 18 years old. The implementation was performed in a usual mathematics class, not extracurricular or out of school. The starting points of the SRC theory refers to a balance point from a model of offer and demand. We analyzed and described how the dialect called theme and out of theme worked.

Keyword: The Anthropological Theory of the Didactic; Study and Research Course; dialect theme and out of theme, simple model of offer and demand.

1. Introduction

This paper is part of a research which goal is to develop a teaching of mathematic by study and research course (SRC) (Parra, Otero, Fanaro, 2013). They are defined in the frame of the Anthropological Theory of the Didactics (Chevallard, 2004, 2013) as a potentially capable device that allows the study of mathematics with questions. SRC is very different to traditional teaching, mainly characterized by proposing the study of finalized mathematical knowledge, monumental, in which only strange uses are attributed to it, without sense or reason to be.

This theory wants to face a phenomenon called *monument of knowledge* (Chevallard, 2007). This didactic phenomenon is proper of the current pedagogy called *inventory of knowledge* (Chevallard, 2007) because it causes few functional relations with the mathematical knowledge. Knowledge is not justified, nor what is allowed to do is studied or problem as that can be solved. SRC allows access to a new type of pedagogy called *research and questioning of the world* (Chevallard, 2007).Within this pedagogy, knowledge is constructed as an answer to problematic situations. SRC establishes that the starting points of mathematical knowledge are questions called *generative questions*. These questions are considered strongly because its answers do not end in a simple quest for information but in the construction of a group of mathematic organizations (MO). The question is generative (from the wordto generate) because its study should generate new questions called *derivative questions*. Teaching with SRC is complex and demands a change of didactic contract of great magnitude because, among other factors, it affects strongly the responsibilities of the professor and the students in regards to knowledge.

2. Study and Research Course (SRC)

The search of answers to a certain question *Q* generates, around it, a didactical system *(S)* formed by a group of people that are going to answer question *(X)* and by help to the study *(Y)*. In the case of a math class, *X* would be represented by the group of students and *Y* not only by the professor but by any other media or instrument that allows to help in the search of answers to Q, since the professor is not the only person to be consulted but other professors of other disciplines can be consulted as well as books, internet etc. This way, the didactic media or media of study of *Q* is composed of different knowledge, expressed and differentiated by $R_i^{\diamondsuit}, Q_j$ and O_k. The first ones correspond to any exiting answer or accepted by the study group, by the school culture, by the institution, a "socially accepted answer". The second ones correspond to different questions that come from the generative question and the last ones, the O_k, to any other knowledge that has to be studied in order to be able to move forward in the construction of answers.

The didactic system then will make a media of study in order to achieve the making or the construction of the response to the generative question, expressed by R. The R answer is a relative answer, since in a wider path, that same answer can be part of a didactic media from that SRC, it means that it can turn, if necessary in a Type $R_i^{\diamondsuit}$ answer.This, Chevallard (2013) structures it in the so called *developed herbartian model*:

$$\left[S(X;Y;Q) \rightharpoonup \left\{R_1^{\diamondsuit}, R_2^{\diamondsuit}, R_3^{\diamondsuit}, \dots, R_n^{\diamondsuit}, Q_{n+1}, \dots, Q_m, O_{m+1}, \dots, O_p\right\}\right] \hookrightarrow R$$

SRC can be co disciplinary (if more than one discipline is involved) or mono disciplinary.

The co disciplinary SRC demand the development of a group of forms to do or of proper gestures of study and research which ATD calls dialectics. The search of answers to a co disciplinary issue, requires to get out of the "theme" in which that issue belongs initially, even getting out of mathematics to reenter after. For example: if the issue is: *How to obtain the point of balance in a simple model of offer and demand of a sole property?* It is important to enter the macro economy, investigating the relative issues to the point of balance and to the models of offer and demand. Then, we have to go back to mathematics because the point of balance is found solving a system formed by equations of offer and demand.

At the same time we have to get out of the "point of balance" to study about the equation systems and the characteristics of the equations that conform it. This form of study is called *dialect of theme and out of theme.* This dialect is opposite to the school habit of transiting by the shorter path, as all and each answer is known previously and the perfection. Along with the dialectic of the theme and out of theme, Chevallard (2013) defines others, than in group should allow to carry off ATD. These are: *dialect of the skydiver and truffles; of theme and out of theme, black boxes and clear boxes, from textual description and textual interpretation;* dialect of *media-means*, of *production and reception*, of *the individual and collective*, from *study and research* and the dialect of *praxeology analysis- synthesis* and *didactic of analysis- synthesis.*

3. Research Methodology

The research is qualitative of an ethnographic type. We have to describe the process of study performed by a group of students of last year of secondary school in Argentina (students between 17 and 18 years old) by SRC teaching, within the usual course of mathematics. The researcher was also the professor observing the participants, taking field notes, registering the development of the class in audio and recollecting the productions from the students. The classes are performed in two weekly sessions of 2 hours each. SRC began the first day of school year, this means that the students did not know with which mathematical organization (MO) they could use the issues laid out. The general issues of SRC are referred to micro economy, specifically to the behavior of laws of offer and demand of the market formed by the price of one sole property.

This is a 28 student course, in which 6 groups are distributes of 5 students each. A number from 1 to 6 is assigned to each student (G), (G1, G2, G3, G4, G5 y G6) and at the same time each study member (A) of the group was identified with A1 thru A 28. The protocols introduces in this work correspond to prototype of representatives of the groups. The professor introduced initially the questions, each group of students had to give answers, communicate it to the rest of the members and defend it. The questions that came up from the different groups of students were considered by the study community. The dialectics were analyzed from indicators. In this work some moments were described from the study process that indicates the functioning of the dialectic of theme and theme out.

4. The Dialectics of in and Out of a theme in the Implementation of SRC

The path performed was designed considering certain relative hypothesis to the microeconomics, specifically the models of offer and demand:

***H*₀:** State of balance exists and is accessible.

***H*₁:** The balance in the market reaches if and only if the excess demand is cero. This is: $Q_d - Q_o = 0$, being Q_d the function of demand (amount of demand of merchandise) and Q_o the offer (amount of merchandise offered).

***H*₂:** Functions Q_o and Q_d are linear and depend of the Price of a sole merchandise.

The issues given to the students under this proposal were:

***Q*₁**: Lest suppose that a product is being elaborated with the intent to sell and collect money. Give an essay on previous sales, previously this information was offered in the following charts:

Amountoffered	Price per unit (in $ARG)
155	10
307	18
98	7

Amount of demand	Price per unit (in $ARG)
330	7
250	15
270	13

What linear model would allow studying the behavior of the offer and demand in this market?
How to determine at what price per unit there is no unsatisfied demandor excess of offer?

***Q*₂:** How could the behavior laws of offer and demand be studied for any of the linear functions of any pair offer and demand? How can the point of balance be found in this case?

***Q*₃**: Let's suppose that the function of offer of a market of a property is given by function $Q_o(p) = 3p - 2$ and the demand function by $Q_d(p) = -4p + 6.$ How do we describe the variation of the point of balance if the value of the initial amount of demand is modified? And if the value of the initial amount is modified instead?

***Q*₄**: Let's keep considering the same functions of offer and demand of the previous case. How to describe the variation of the point of balance if now the value of the pending of the function of demand is modified?

***Q*₅**: Up to here we have been able to determine how the price will change and the amount depending on how the pending and ordered (initial amounts) of the functions of offer and demand. But how much does the point of balance change exactly in each case?

To answer these questions referred to micro economy implies to investigate the aspect so f this discipline and also mathematics. For example; answer the first part of the question. *How to determine at what price by unit there is no unsatisfied demand or excess of offer?* This implied to investigate what is a market model, how it works and what does unsatisfied *demand* means and previously, what demand and offer meant. These questions were answered by the students throughout internet search, books and asking the professor of economy of the institution. Several groups of students not only worked on the characterization of the economic mode but also researched about the factors that cause an increase or decrease of the demand; factors that cause an increase or decrease of the offer, among other.

These actions are considered proper gestures of the dialectic of *theme and theme out*, because the students left pending the initial questions to answer derivate questions. On the other hand, the question *what linear model will allow to study the behavior of offer and demand in the sale market*? Implied to get out of the questions to study and investigate *what is a model?* How does the offer and demand behave? And of course the question: how to build a model? Here, there is a way out to the aria of micro economy, but also to the area of mathematics, since to build a model there has to be a way to study how to find the equation of a straight line that goes through two points or more, how to solve a system of two equations with two unknown answers and how to represent that situation. In order to answer the derivate questions of mathematics, the professor acted in some cases as a source of information as well. For example he reminded the students that this model because it linear, it could behave as linear functions that schools have studied ears before. Here a "get out or exit" of the linear functions and resolution of the equation system with two unknown answers was needed. Once researched and studied they had to get back to the initial question and build an acceptable answer, at least for the study community (students and professors).

Figure 1 represents the partial answers of the second part of Q_1given by two students (A13 de G4 y A14 de G1). The chart on the left corresponds to the mode where the amounts are represented in a horizontal axis and the price is shown vertically. This case corresponds to the model where the price depends on the amount of demand and offers. The chart on the right represents the inverse, where the demanded and offered amounts depend on the price of the property. Both models as shown in chart 1 came from the group of students. In both cases the point of balance was determined from the chart obtaining that corresponds to pair $(250; 15)$for the first case, and$(15, 250)$for the second.

The previouse groups achieve, from the chart, to answer the question Q_1. Frquently during SRC it was necessary to get out of the question to invesitgate and study different knowedge and then return to the question to finaly build a answer. The questions Q_3, Q_4 and Q_5 correspond to the study of the variations in the point of balance depending on the parameters of the model modifying. The decision to change only one parameter each time gives an account that the official program of the argentine secondary school prescribes to study only the derivate of functions of a variable and not the partials. The students answered the questions to the variations of a parameter and at the same time build different modes calculating the point of balance (annalistically or software *GeoGebra*®) in each case. They achieved to determine how that variation was performed and answered questions like: *how does the price of balance changes if one of the parameters increases or decreases?* Without answering to answer quantitate questions $Q_3$and Q_4. The communication of this type of answer on behalf of the groups took to consider the use of boards to summarize the information. Figure 2 presents the board and conclusion gathered by the student A20 (G3), who along with his groups answered how and how much the point of balance changes. The first column of the first table of this figure contains different values of arranged as the demand, the second column, the price of balance and the third column, the quantity of balance. To the right of the table, the conclusion written by the students is the following one: “In the demand, as it diminishes the value of the tidy one the price diminishes 0, 14 units and the quantity diminishes 0, 43 units”. The first column of the second table contains different values of arranged as the offer, the second column the price of balance and the third one, the quantity of balance. To the right of this table, the conclusion of the students is: “In the offer, as it diminishes the value of the tidy one the price increases 0, 15 units and the quantity diminishes 0, 57 units”.

The study of the questions referred to the variations developed during several classes until the concept emerged and the use of derivate functions as a useful tool to describe reason of change between two variables. This required to study the limits of functions to define the derivate of the functions, a new exit or way out of the theme. Figure 3 presents some questions made in nonsense of the whole group in regards to the limits of functions. The questions of this figure are the following ones:

1. Which is the “intuitive idea” of limit?
2. Be $g(x) = \frac{x^3+1}{x-1}$ with $Dom(g) = \mathbb{R} - \{1\}$ if $g(1)$ does not exist does it imply that the limit of $g(x)$ when x tends to 1 does not exist?
3. Does the limit of a function exist always?
4. Can function have two different limits?
5. What does mean that a function is constant?
6. Which are the properties of the limit?
7. Which are the infinite limits?
8. Which are the limits in the infinite?
9. How many indeterminations we find? How can theybe “saved”?

The questions were agreed upon and were left written on the blackboard and each group could add ideas to the list, any relative question to the limit of functions and all of the groups had to answer. After studying the limit of functions, we continued to study the derivate and we returned to the start that consisted in determine the reason of change in the point of balance in accordance to the mode of parameters changing. This is another representative gesture of the dialectics of the theme and theme out that consists in a way out or exit from another exit or way-out, that complicated very much to return to the theme. This is a natural and positive gesture in the context on using SRC but not a traditional teaching.

5.Conclusions

The implementation used shows that it is possible to study mathematics starting form questions coming from microeconomics. The mathematical knowledge arose in regards from answers to different question referred to modes of offer and demand of one asset. The professor directed the whole process study in accordance with what is established with SRC and left the pace of universal media and guarantor of knowledge. The students took the place as actors in formulating questions in the search of its answers.

Some gestures of the dialectal of theme and theme out have been documented and in conjunctions with other eight dialects SRC is conducted. The described dialect here conduces to study different mathematical organization and microeconomics as a need, instead of a simple enumeration generating relations between them.

The derivate and limit of functions were studied in a functional way, opposite to the traditional teaching that rules out questions and the sense of knowledge. The knowledge arises from answers from a group of questions. In the case of a derivate, as an answer to the calculation of the reason of change of two variables and the limit, from a definition of a derivate.

It is evident the phenomenal called dilatation of time of the clock, because a questions is researched and studied trough a long period of time. This characteristic is very different to the traditional teaching where knowledge is studied sequenced and during brief periods of time.

It is important to mention some difficulties when doing SRC such as the levee of depth in which the mathematical organizations are studied rebuild in the classroom, the difficulties to fulfill requirements of certification of students, numerous contents proposed to study in the official curriculum among others.

References

Chevallard, Y. (2004), Vers une didactique de la codisciplinarité. Notes sur une nouvelle épistémologie scolaire. [Online] Available:http://yves.chevallard.free.fr/(July 10, 2013) Chevallard, Y. (2007),Passé et présent de la théorie anthropologique du didactique.[Online] Available: http://yves.chevallard.free.fr/(February 4, 2013)

Chevallard, Y. (2013), Journal du seminaire TAD/IDD. Théorie Anthropologique du Didactique & Ingénierie Didactique du Développement. [Online] Available: http://yves.chevallard.free.fr/spip/spip/IMG/pdf/journal-tad-idd-2012-2013-1.pdf(March 3, 2014)

Parra, V.,otero, M. R.,Fanaro, M. (2013). Los Recorridos de Estudio e Investigación en la Escuela Secundaria: resultados de una implementación. Revista Bolema, 27(47), 847-874.

Figure1: Representation of the Model Made by the Students A13 (G4) y A14 (G1)

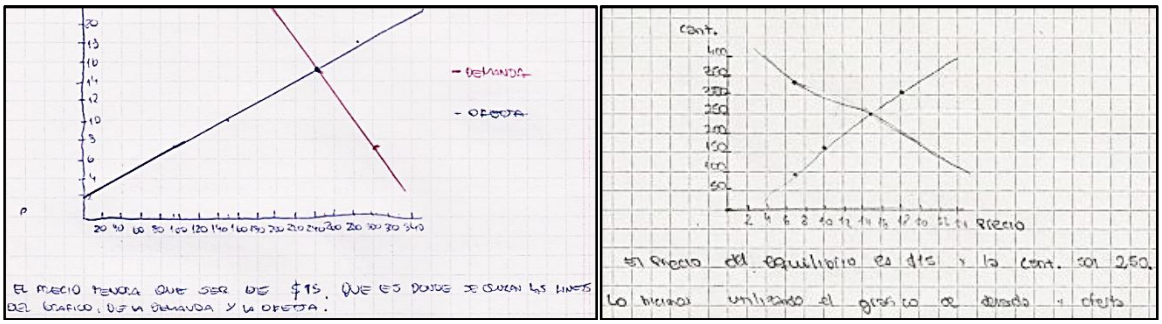

Figure 2: Answer from G3 to the Question of How and How Much the Point of Balance Changes

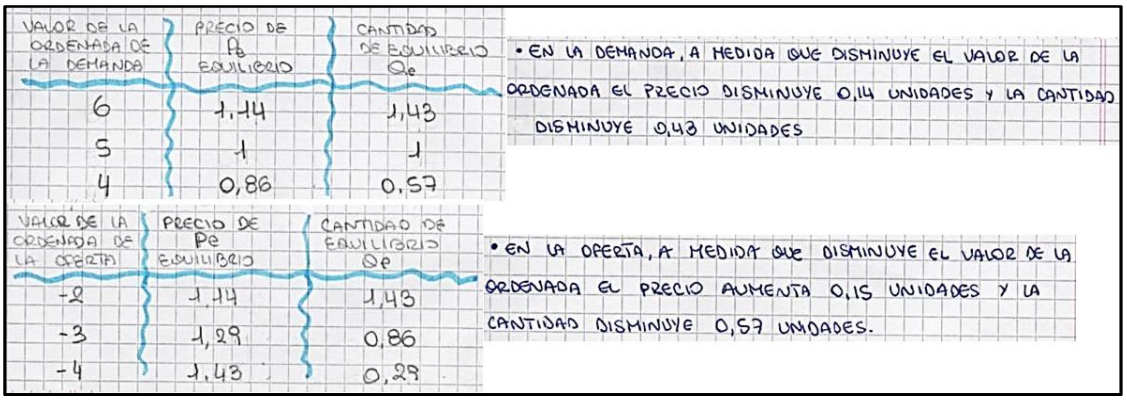

Figure 3: Some Questions Made to Study the Limit of the Functions