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Didactical Conditions And Difficulties Of Construction Of Problematic Knowledge In Life Sciences

Study of the putting into text of knowledge and teaching practices in ordinary sequences concerning mitosis

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Abstract
Reasons (needs related to models, explanatory principles mobilized) are an essential part of scientific knowledge which can't be limited to simple propositions accounting for the results of science. For this, we have relied so far on, examples corresponding to debates of ordinary sequences: work of a question and debate from models built in response to this question.
It is in this general context that we are interested in the putting into text of the knowledge related to mitosis among students of the class of scientific and literary terminus in Benin. We are more specifically interested in the constraint spaces built by the targeted students.
In this article we adapt a double didactic approach or we try to highlight the relation that exists between empirical register and the explanatory register in the students for the putting in text of the knowledge and the problematization.
In fact, the students we observe are subject to the constraints of developing explanatory texts based on a research question.
Key words: *Problematization, mitosis, text of knowledge,duplication of DNA-constraint space*

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I. Introdution.

Many of the work done in the context of science education in the laudable concern of answering the question: How to make science teaching work? It is in a position that avoids both dogmatism and relativism that we must put the students if we want them to access a scientific culture. Science education must avoid the dogmatic image of science.

In our opinion, the dogmatic presentation of synthetic knowledge comes from a confusion between formal knowledge and functional knowledge. Formal knowledge corresponds to assertorical knowledge, consisting of a set of independent propositions. Functional knowledge maintains a dynamic relationship with the problems that underlie it (Bachelard, 1993, P.14, 1998, P.35) Canguilhem puts forward the apodictic nature of knowledge when it states that "knowing is not so much abutting on the real than validating a possible by making it necessary "(2003, P.58); scientific knowledge therefore has a character of necessity. Orange (2002, P.30) designates it as a knowledge with apodictic value. It is to "Know why it can't be otherwise" that we must lead students rather than "Know that" because, as Redoul says, "reduce teaching to learn that it is dedicate the mind to remain passive, to learn without understanding "(1995, P.27). We can conclude with Fabre that if "the explanations lose any character of necessity", they are not scientific knowledge, but "simple factual answer that succeeds randomly" (Fabre, 1999, P.94).

It is within the framework of the problematization that has been mobilized (Fabre, 1999, 2005, Orange, 1997, 2000, 2002, 2005). That we are interested in the students confronting the production of explanations in the science of life to clarify and understand the difficulties. It is then necessary to question the problems raised and the knowledge at stake.

For the very purpose of our study, our research focuses on texts of knowledge (oral or written) produced by the students during the ordinary and forced sequences in terminal class in the field of cell division by mitosis and on their relations between them. teaching practices. It aims to identify the difficulties and didactic conditions of access to knowledge problematized texts. In Benin, the deep renewal of science education

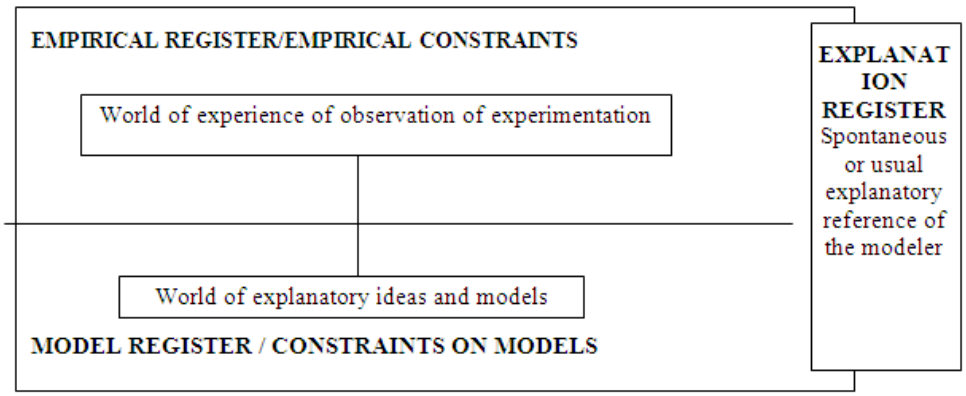
in secondary schools, undertaken with the programs, continues today with the institutionalization of a program based on the "skills-based approach".

There is a need for us to study the teaching practices involved in the construction of knowledge and texts in class in order to identify the difficulties and didactic conditions of access to problematized knowledge. We are interested in what happens in the classroom, particularly the practices of texting teachers and conditions of access to knowledge problematized in life science. Our study mobilizes the theoretical framework of the problematization developed by Christian Orange et al. Our work is in a socioconstructivist framework of learning. We are conducting the study of problematized textualization of the concept of mitosis. Historical and epistemological lighting with emphasis on problematization.

1- Problematization in the science of Life: didactic theoretical framework for historical and epistemological analyzes of mitosis.

The history of mitosis can be examined according to the didactic theoretical framework of problematization (Fabre, 1999, Orange, 1997). This is defined as "the exploration of possible articulations between model register and empirical register: it leads to the identification of constraints and conditions of possibilities of solutions (necessities)" Orange (2006, p.78). The explanation, which represents the solution to the problem posed, is constructed from the linking of the empirical register, "that of the facts and phenomena that we seek to explain" and the register of models, "that of the elaborations explanatory explanations constructed as attempts at solution "(Orange, 2003, p.86). This description is based on work done by Martinand (1986) on modeling and Orange (1994) introduces a third register that he names the explanatory register. The latter corresponds to the "spontaneous or usual explanatory references of the modeller" which give the meaning and explanatory power to the model (Orange, 2000, p.25). The tension between the empirical register and the register of models, under the organization of the explanatory register, leads to highlighting the reasons (or the necessities) which constrain the explanatory models, which gives the knowledge an apodictic character. This tensioning of the registers characterizes the problematization and distinguishes it from the simple linking of the modeling: "In the tensional approach between the registers, the model is no more than a solution realizing the necessities" (Orange Ravachol, 2003, p.73). The dynamics of problematization and the construction of problems can be represented in a "constraint space" which highlights the constraints and necessities organizing the possible solutions of the problem (figure 6). Specifically, this representation has the advantage of characterizing, describing the products of problematization activity and highlighting the construction of a reasoning - whether by scientists or by students - by locating it on its empirical poles. and models. Since experiences and models complement one another to build knowledge, the links between empirical and model registers are not oriented and are thus represented by simple features.

Historical and epistemological study of mitosis in the context of problematization.



The space of constraints constitutes, for us, a precious tool of representation of the different problematization of the magmatism by the scientists during the history. It will provide us with indications that will be very useful for further analysis of the explanations given by the students. Indeed, problematization appears as an appropriate means for comparing the knowledge of scientists to that of students. In geology, Orange Ravachol (2003, 2005) has already compared the problematization of current researchers with those of high school students concerning some problems of historical and functional geology. His studies have shown that the problematization of students differs from that of geologists both in terms of constraint spaces constructed and in terms of proposed solutions. Our work proposes to develop the historical and current explanatory models of magmatism.

II. Methodology Of Research

In accordance with our problematic, the main purpose of which is to study the difficulties and the conditions of construction of knowledge and texts problematized in earth science, we present in this chapter the methodological principles followed for the collection and data analysis of this research. As a first step, we set the objectives to be achieved. Then, we specifically explain the choice of empirical data - situation, object of study and level of class - retained in relation to our research question as well as the corresponding analysis tools. We specify in what way the implemented methodology will help us to progress in the study of the relations between problematization, knowledge practices, put in text and construction of problematizing knowledge. At the end of this chapter, we summarize the two moments of data collection and analysis.

1) EXPLICITATION OF RESEARCH OBJECTIVES

Our research is in line with most of the work to address the process of problematization across the entire teaching / learning / evaluation sequence in order to follow beyond the phrases of scientific debate. We will look for reasons for the difficulties and conditions of construction of non-propositional knowledge in the field of mitosis. The methodological approach put in place to answer our problematic, should allow us to reach the following fixed objectives:

a) Analyze the texts of knowledge produced during sequences (ordinary and forced) teaching / learning on mitosis.

b) Identify the knowledge practices implemented by the teacher leading to the construction of the texts of knowledge along a regular sequence addressing the concept of mitosis.

c) Identify the knowledge practices put in place by teaching in a text setting that takes into account the apodictic nature of mitotic knowledge during a forced sequence in the science of life.

d) Determine the difficulties and the conditions of possibility of a textualization of mitotic knowledge that is problematized and non-propositional.

After having recalled the research problem and set the objectives to answer it, it is a question of specifying and exposing the studied study objectives, class levels and work situation.

2) STUDY OBJECTIVES, CLASS LEVELS AND WORK SITUATIONS

This study was conducted in Benin republic (Figure1). The concept of cell division by mitosis, of which we will only deal with the functionalist aspects, is at the heart of our research. The related phenomena/aspects are of paramount importance for understanding the following question: "Explain how we move from an egg cell to the millions of cells that form an adult organism". This is purely a matter of structural and functional dynamics. Students are asked to do a modeling, reduced to the prototypical case of dividing a mother cell into two daughter cells. The concept of cell division by mitosis also represents a theoretical interest and a remarkable epistemological richness pointed out during our theoretical developments. In addition, the aspects studied are for the most part well known to the students and accessible directly through the media, their own curiosity.

Considering that our research is part of the theoretical framework of problematization which gives importance to explanatory problems, we pay particular attention to the explanatory approach pole in the study of cell division by mitosis. We are also studying this concept because it occupies an important place in the context of the formulation of the concept of genetic information in the terminal classes of our programs. The notion of mitosis is described as follows in the official program.

Genetic information is transmitted in a consistent fashion during cell divisions. Cell division (or mitosis) is the process by which an initial cell gives birth to two new cells identical to each other and identical to the initial cell from which they originated. Before each cell division, the DNA molecules contained in the cell are duplicated according to a semi-conservative mechanism that ensures the correct reproduction of the genetic information.

The behavior of chromosomes during cell division defines several successive phases that characterize the mechanism of transmission of genetic information from cell to cell. The different phases of mitosis include four times (prophase, metaphase, anaphase, telophase), preceded by a change of chromosome state and a replication of the DNA (interphase).

The term "cell cycle" refers to the succession of different phases through which the cell passes, from the beginning of an interphase to the beginning of the next interphase; the duplication of the chromosomes that occurs during this phase makes it possible to obtain two identical sets of chromosomes, then distributed in the two daughter cells.

The different phases of the cell cycle are conventionally designated by the letters G1, S, G2 and M. In this research, we will focus on sequences in a final year A class (25 students), in a final year class D (18 students) for an exploratory study and in another class of final D (35 students), during ordinary and forced sequences. The three (3) teachers in these classes are experienced and have participated in many didactic

reflections in the field of research. We place ourselves through this choice, under the conditions to answer our problematic especially the intervention of the teachers answering the theoretical framework of the problematization; «Scientific knowledge does not reveal true and false, it is critical knowledge»

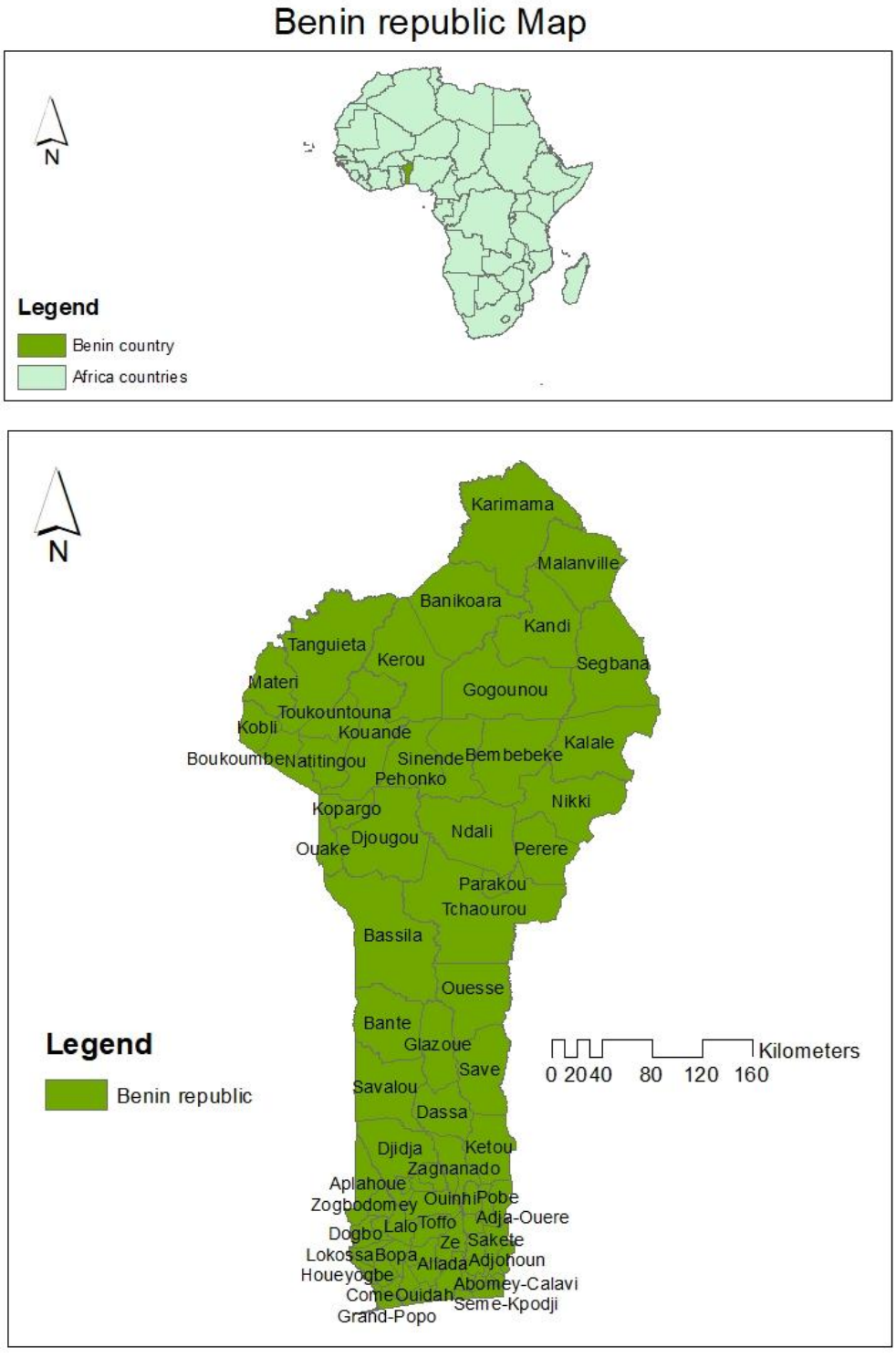


Figure 1: Study area

Presentation of the studied case

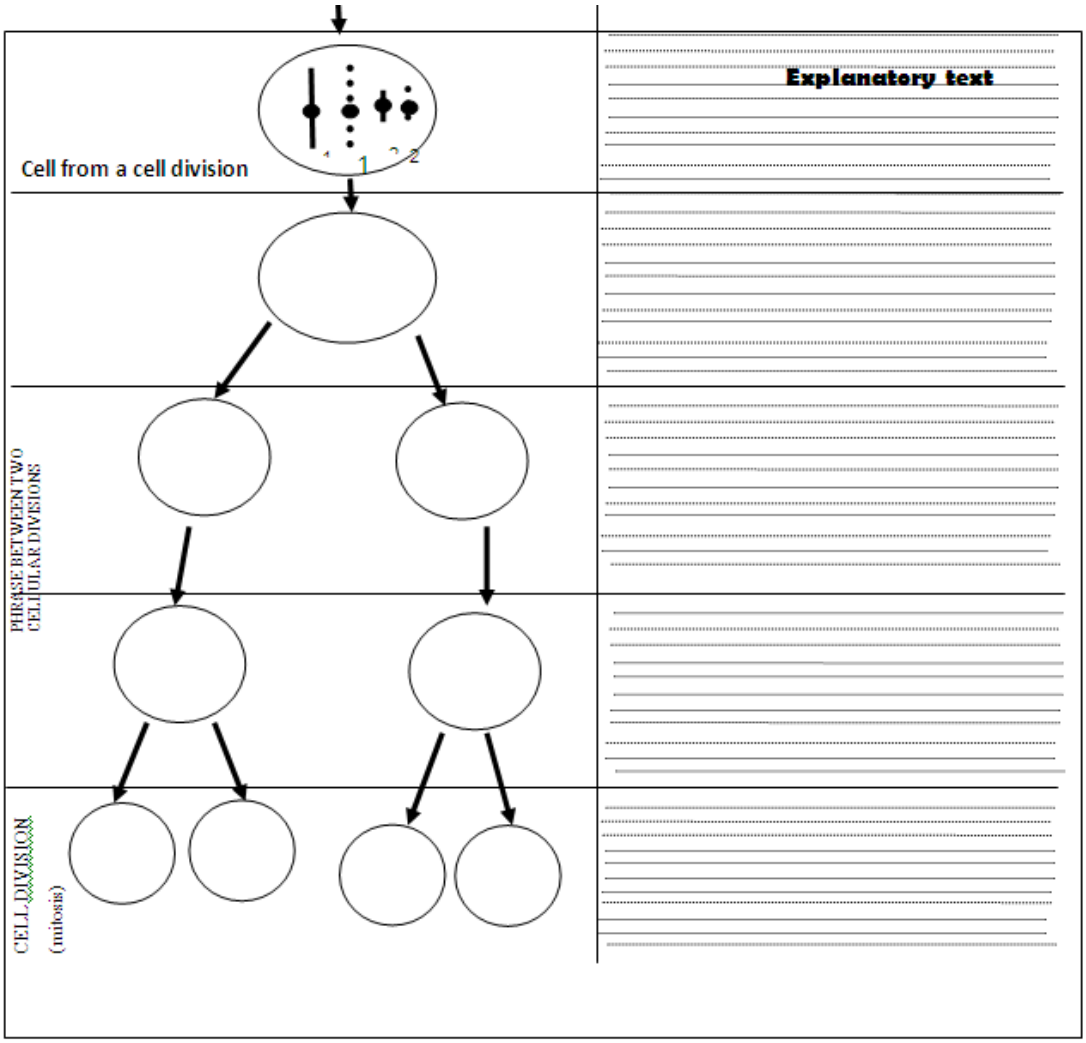
	Literary Terminale(A) class		Scientific Terminale (D) class	
Biological problem	Integral transmission of genetic information from one cell to another by cell division, mitosis.			
Level of the class where this problem has already been addressed by students	The problem is addressed by students for the first time.			
Sequences studied (Sequences in total)	An ordinary sequence in a Tle A class Une séquence ordinaire dans une classe T^{le} A		An ordinary sequence in a terminal D class (exploratory study)	A forced sequence in a class of terminalD
Number of students per class	25		35	18
Educational institution	January 2014	February 2014	November 2013	December 2013
Automatic maintenance confrontation with the teachers concerned	Cours GAMA	CEG1 of Abomey-Calavi	CEG1 of Abomey-Calavi	
Productions analyzed	Transcription des séquences ordinaires et forcées et des entretiens d'auto-confrontation. Productions écrites/orales individuelle et de groupe. Textes produits lors de la séquence.			

Our approach is qualitative and builds on four case studies. Thus, the results obtained may not be generalized but the conclusions formulated, with a great deal of precision, will highlight more the difficulties encountered by students and teachers with regard to the problems dealt with.

The device implemented in class.Following the analysis of knowledge in play, we constructed the following device, bearing different representations relating to various phases of the life of a cell during two cell cycles. It is an individual work of modeling the transmission of genetic information from a mother cell to two daughter cells and the production of knowledge texts followed by debate. Taking into account the prior analysis of knowledge, we have proposed to the elements that belong to two levels: the chromosomes for the material dimension (for the pair of homologous chromosomes, one in solid line and the other in dash). We have coupled this classical activity to a scientific debate because it seems necessary to us that "besides" practical "activities, students, from school to high school, have the opportunity to develop explanatory ideas that are not limited to production of one or two hypotheses quickly collected by the professor but which gives rise to real scientific debates in the classroom "(orange, 2002, p.20). These debates will not have the function to validate one or the other students' proposals, but to allow students to build the problem of mitosis as part of a problematization activity. The construction of the concept of mitosis is the articulation between these different necessities which are not situated exactly on the same epistemology level. Indeed, the need to maintain the number of chromosomes is at a material level whereas the need for the integral transmission of genetic information is at an informational level and we have made the hypothesis that taking into account these different levels independently of each other by students could be an obstacle to accessing the problem of the transmission of genetic information (Lhoste& Roland, forthcoming).

	Terminales (A and D)
Goal	« Explain how we move from one mother cell to two identical daughter cells?»We is proposed to do both a modeling reduced to the case of cell division by mitosis of a mother cell into two daughter cells and to elaborate an explanatory text. Students must represent from two pairs of chromosomes homologous to one chromatide each, how one mother cell gives two daughter cells.
Constraints of the situation	Representation of the two homologous chromosome pairs n°1 and n°2 with two chromatids at the phase between two cell divisions (interphase). Representation of the two homologous chromosome pairs n°1 and n°2 with a chromatide when the cell is in cell division (mitosis). All the cells of the same individual have the same karyotype, the same genetic information. The egg cell is the origin of all other cells by successive divisions (mitosis).

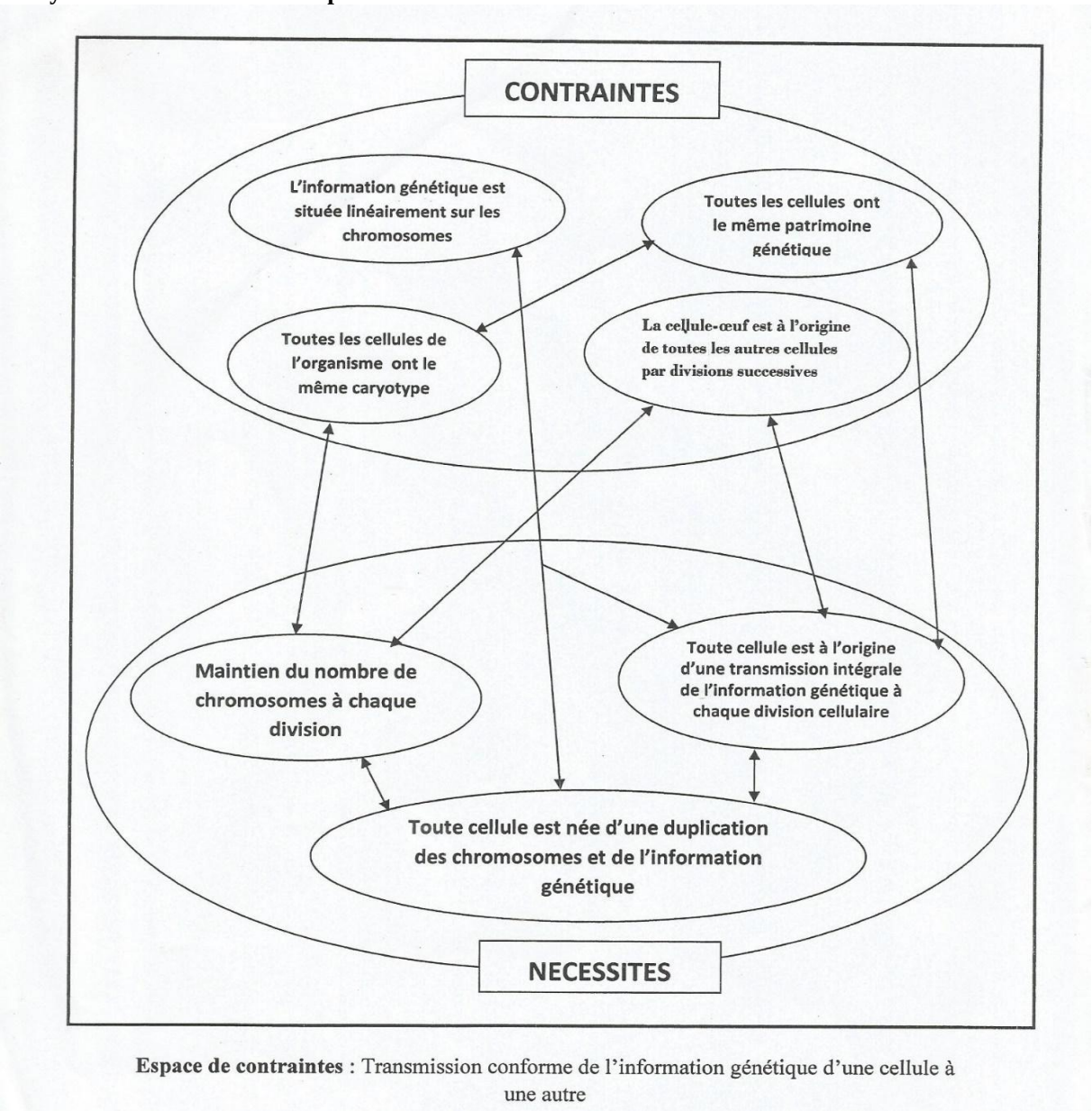
These different representations relate to various phases of the life of a cell during two cellular cycles



The methodology of analysis of the results.

The devices were implemented in the classes planned, the individual productions of the students were collected. Scientific debates were recorded and transcribed. The results we will present are based on the analysis of scientific debates. We will present how students construct the problem of transmitting genetic information from a mother cell to two daughter cells.

Analysis of students' individual productions.



Espace de contraintes : Transmission conforme de l'information génétique d'une cellule à une autre

Categorization is based on three criteria:

• The state of the chromosomes/

• The distribution of chromatids / chromosomes in daughter cells.

The initial individual representations obtained will be categorized.

Analysis of group productions and discussion points about these posters.

Analysis of the scientific debate

The works to which we refer to analyze the scientific debate (Orange 2000) have shown that during the exchanges between students, they will engage in a problematization activity, that is to say that they will put in tension the facts to be explained, which come from the empirical register with possible explanations which come under the register of models.

III. Analysis Of The Results

• ANALYSIS OF INDIVIDUAL PRODUCTIONS OF STUDENTS

Categorization is based on three criteria:

-The state of the chromosomes/the distribution of chromatids/chromosomes in the daughter cells.

-The initial individual representations obtained will be categorized.

• ANALYSIS OF GROUP PRODUCTIONS AND DISCUSSION POINTS ABOUTTHESE POSTERS
• ANALYSIS OF THE SCIENTIFIC DEBATE

The works to which we refer to analyze the Orange 2000 scientific debate) have shown that during the exchanges between students, these students will engage in a problematization activity, that is to say they will put in tension the facts to explain, which are empirical register with possible explanations that fall within the register of models. The controversies here make it possible to construct the problem and to emerge obstacles to the construction of the concept of gene and its transmission during cell division.

Category 1

The mother cell gives two daughter cells with a chromosome of each pair of chromosomes re-glued during the second mitosis, that is to say, half of which is in dash and the other in full line.

Category 2

The mother cell gives two daughter cells, with intermediate separation of the four pair chromosomes without chromosome duplication. The daughter cells therefore have a chromosome of each pair of homologous chromosomes.

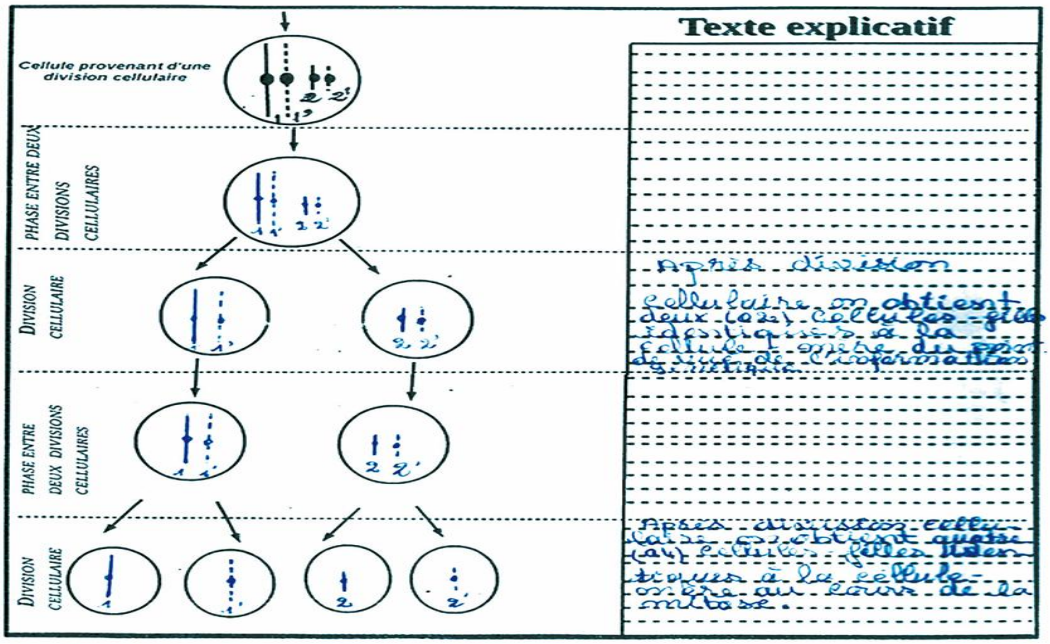
Category 3

This is the expected answer but does not explain the intermediate steps leading to the two daughter cells.

Category 4

These are the expert students who not only give all the steps, but who anticipate the transmission of genetic information during cell division.

Ces différentes représentations sont relatives à diverses phases de la vie d'une cellule au cours de deux cycles cellulaires



Vous essayerez de schématiser les chromosomes dans les celles pendant la phase entre deux divisions ulaire et pendant la division cellulaire (mitose). Exprimez un texte explicatif qui justifie votre représentation à chaque fois

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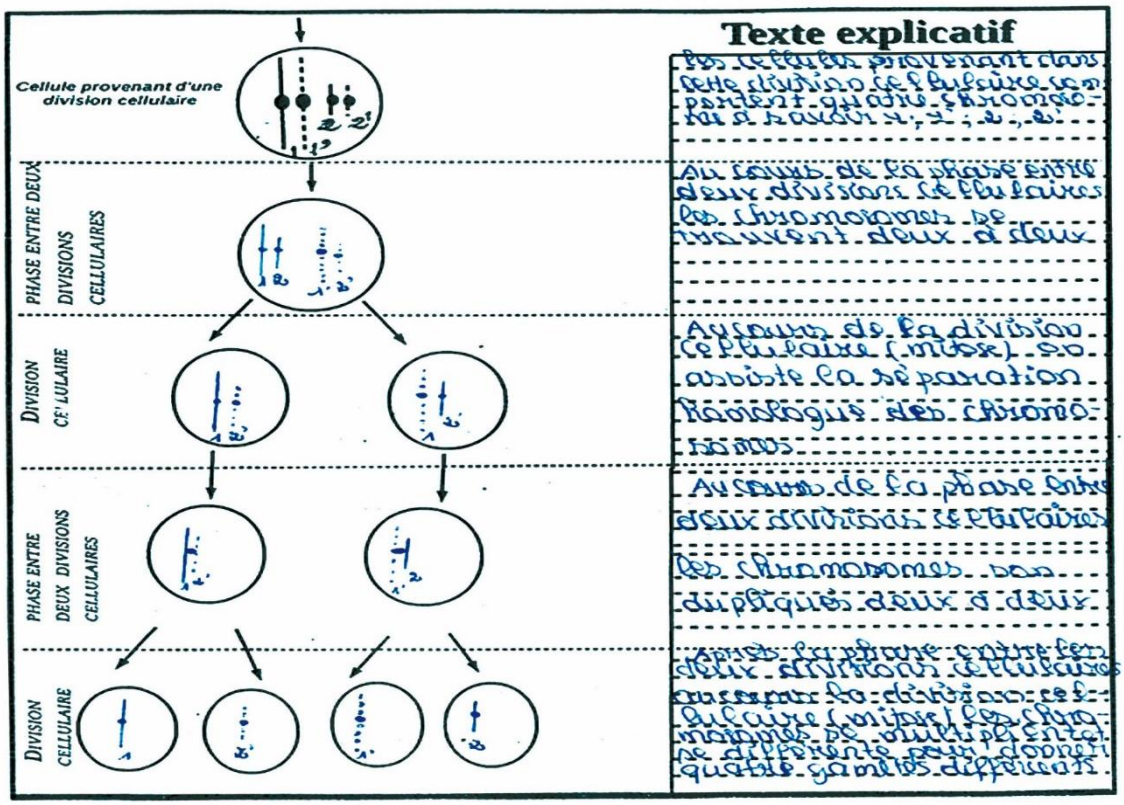

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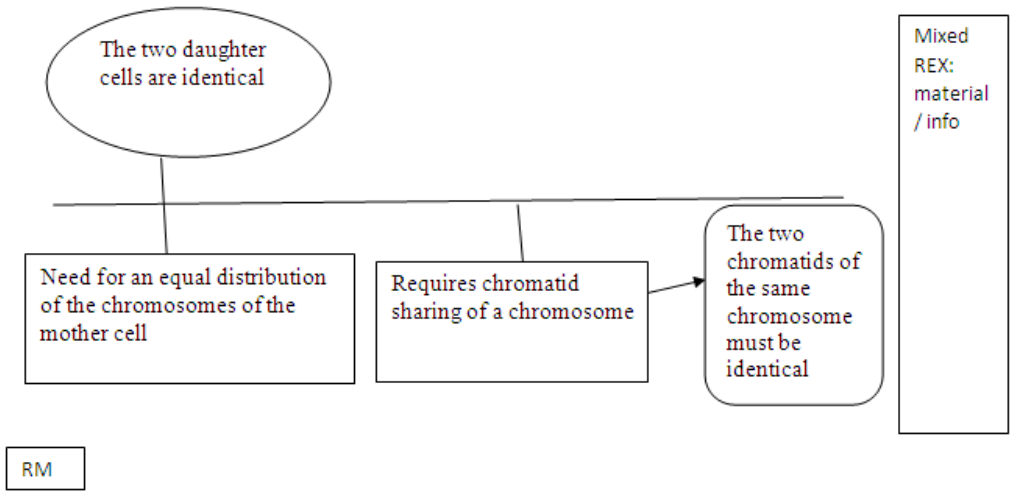
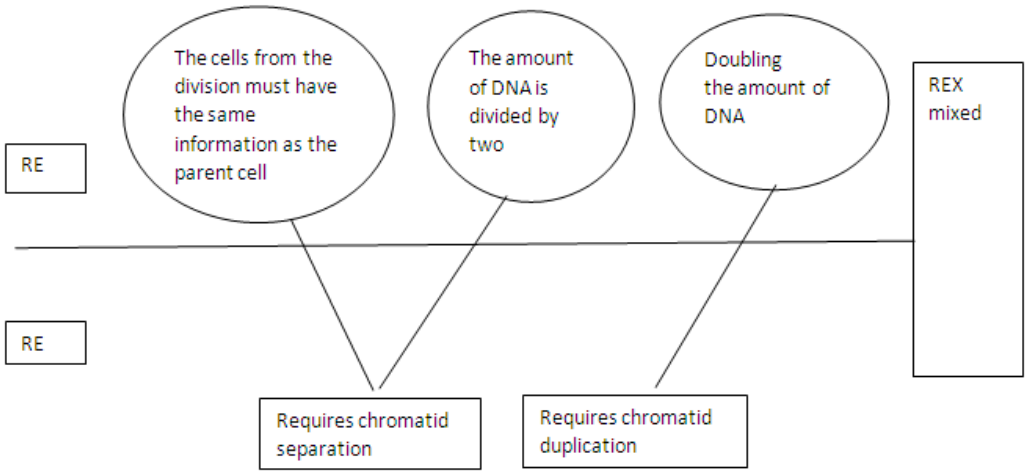


Constraints Space Representing the Problem Constructed by Students in the $T^{le}L$ Class



Constraints space representing the problem constructed by students of the T^{le} S scientific class

IV. Conclusion

This study based on the students' productions confronted with the classical activity of modeling the genetic information of a mother cell with two daughter cells, allowed us to propose different analyzes concerning:
-the definition of the problem of the transmission of genetic information in the form of a reference constraint space that translates this scientific concept in terms of constraints and necessities;
-the relationship between the procedures used by the students to perform the requested task and the conceptions of the genetic information/gene.
This has led us to propose that only a mixed informational/material conception of genetic information, a preliminary stage for accessing a functional conception of genetic information, will enable students to construct the principles of the chromosomal mechanisms of conformal reproduction. Taking one independently of the other, the material conception or the mechanistic conception of the genetic information constitutes an obstacle to access to the problem of the transmission of the genetic information.
This study should be continued by analyzing the scientific debates that followed this modeling activity. This will test the different proposals put forward here.

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