Study and Analysis of Students' Representations Regarding the Concept of Cellular Respiration

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Abstract: - In the discipline of life and earth sciences, so many concepts such as the case of photosynthesis, digestion, blood circulation, and respiration have seen their multidisciplinarity and complexity, which makes it difficult for students to learn them. This problem is aggravated when the initial conceptions of learners are neglected by teachers in their classes. This study aims to study the concept of learning of cellular respiration. To do this, we conducted an epistemological analysis using a written questionnaire highlighting the difficulties encountered by second-year bachelor's students from two fields (life sciences and earth and physical sciences) in mastering this concept. These analyses also allow us to obtain descriptions of the effectiveness of the didactic transposition processes (external and internal) as well as the constraints that create in the construction of scientific knowledge among learners and classify them according to different levels of the didactic codetermination scale. Based on the results, there is no doubt that the teacher has heavy responsibilities both in and outside the classroom. In this work, we emphasize the need to assess the tenacity of the most frequent misconceptions among learners. The use of design inventories seems to be effective for this evaluation to draw up an assessment of the need for training.

Key-Words: - Science Teaching, life sciences Learning and Teching, Cellular Respiration, didactic transposition, Didactic Transposition in Biology, depersonalization of knowledge, programmability of knowledge.

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1 Introduction

The problem of science teaching and learning has several facets that are epistemological (in relation to the knowledge of teachers and students), didactic, and pedagogical (transposition of knowledge in the school environment, passage of knowledge in the extracurricular environment, learning difficulties, motivation ...) and socio-cultural, [1], [2], [3], [4], [5]. These problems raised are more particularly manifested in the field of biology with all the sub-disciplines that it encompasses, due to the peculiarities of this science, the specificity of its objects of study, and the complexity of its concept.

This paper deals with the notion of perspectives of curricula of scientific disciplines, through the case study of learning cellular respiration. This personal interest joined a scientific interest. Research on the life sciences has helped to explain the difficulties of teaching such concepts, especially those due to their epistemological nature. However this research is still poorly developed for cellular respiration. For this, the students who learn it notice problems. We have grouped them around some major themes, namely the problems related to the nature of scientific knowledge, the problems arising from the gap between school knowledge and scholarly knowledge, the problems that represent for both the teacher and the student the many difficulties related to science learning, the problems related to the role of the school as well as the content and organization of school programs. Our goal is certainly not to report on it exhaustively, but to highlight the complex and multidimensional nature of the problem of learning and teaching science, [6], [7], [8], [9].

Results on science learning difficulties at Sttat show that most teachers do not start their lessons with a reminder about the prerequisites that are related to the new course. Indeed, teachers declare that they have worked with the problem-solving method, while some of them no longer follow the scientific approach to build scientific concepts with the learner. Also all teachers explain the course again in case of a request from the students but by

the same teaching method. Thus, teachers carry out the experiments programmed in the textbook and the minimum of them use information and communication technologies (ICT) when necessary. Teachers argue that the cumbersomeness and structure of the curriculum constitute obstacles to the use of pedagogical approaches to arouse and maintain their students' interest in the subject. These obstacles are related to the constraints of the curriculum. Since school time has not increased in proportion to the expansion and diversification of content, there has been a tendency to overload the programs, [10], [11].

The obstacles that teachers encounter will create a learning disability in the learner. Indeed, the majority of students come with initial representations about the concepts studied, which are often erroneous and must be corrected by the teacher since he has the most influence on student learning. It is noted, according to the students, that these representations are very little modified by the teacher, and many students find it difficult to use the scientific knowledge acquired at school in contexts other than the formal context in which they were acquired. In everyday life, these representations usually take precedence over the knowledge taught at school, so the student has difficulty appropriating the scientific knowledge taught to him at school because he cannot make sense of it from his previous knowledge or from these spontaneous conceptions. Besides, Learners encounter misunderstandings because of the broad curriculum, the implicit models of science, and difficulties related to the interdisciplinarity of concepts. The student has difficulty constructing deductive thinking, has difficulty anticipating, formulating hypotheses, decontextualizing the acquired knowledge and reusing it in another learning context, reinvesting the knowledge acquired during learning activities in a more complex task, and does not understand the course taught. Thus modeling can also generate false representations in students, and we can talk about the psychological side of students that plays an important role in learning because they never ask the teacher questions and do not ask him to explain the course again so they will find difficulties because of the fear or criticism they may receive from him.

Rare studies have been carried out on the difficulties of elaborating the concepts of cellular respiration in students. This work was an opportunity for us to have more data on the students' conceptions of this subject. We have seen that this concept (cellular respiration) poses a problem since it is the first unit in the school curriculum and especially since some students join their class late because of orientation problems so the class becomes heterogeneous and that is how learners find it difficult to continue the course and even the teacher cannot explain the course again because of the overload of the program.

This work is structured around 2 major parts :

Theoretical framework, in which we will shed light on the role of history and the environment in the construction of conceptions and the didactic transposition of time as well as the transformations that a learned or expert knowledge undergoes, in order to be taught and acquired by the learner.

Practical framework, this part is subdivided into two axes; the first is devoted to materials and methods, the second axis exposes the results and the questionnaire discussion that we used.

This work ends with a general conclusion in which we discuss the solutions to be asked to improve the learning of the concept of "cellular respiration".

2 The Research Problem

The problem of science teaching and learning has several facets which are epistemological (relation to the knowledge of teachers and students), didactic, and pedagogical (transposition of knowledge in the school environment, passage of knowledge in the extracurricular environment, learning difficulties, motivation ...) and socio-cultural, [12], [13], [14], [15]. These problems are manifested more particularly in the field of biology with all the subdisciplines that it encompasses, due to the peculiarities of this science, the specificity of its objects of study, and the complexity of its concepts.
In this work, we are interested in the learner subject as a main pole of the teaching-learning process insofar as his individual experience, his personal history, and his worldview, explain his behavior. We then propose to bring out and study the conceptions of young Moroccans relating to cellular respiration. The choice of this concept is motivated by its complexity and its multidisciplinarity as well as by the difficulties that students face in learning it.
We will then try this work to answer the following questions: What representations or conceptions do Moroccan students have about the concept of cellular respiration? What are the proposed solutions to deal with these difficulties?

3 Material and Methods

The framework of the didactic transposition will allow us to model and study the teaching of the concept of cellular respiration in high school. This thesis presents elements for reflection on the obstacles related to didactic transposition and highlights the problems related to the presentation of the knowledge taught through two fields: graphic representations, the complexity of scientific notation, and some overloaded diagrams. All this leads to blockages, and erroneous representations, and even reinforces some false conceptions among students. In our study, we were also able to point out their frequent confusion between reality and the model that describes it. In the sense of understanding the obstacles, it is essential to clarify as much as possible our transmission of scientific concepts and allow optimal appropriation of knowledge by students.

3.1 The Chain of Didactic Transposition

In order to prevent the scarification of knowledge, the didactic transposition works in stages, each step being carried out by an expert (Figure 1 in Appendix). Thus, we often find the term chain. And for good reason, a chain refers to a series of links linked to each other. Transposition also expresses this connection between two or more states of knowledge. Authors who are interested in didactic transposition agree by using as a basis an elementary version of the chain that looks as follows, [16], [17].

Types of knowledge :

- Scholarly knowledge: is the scientific knowledge produced by a community.
- Know how to teach: all that is written in official texts =formal curriculum.
- Knowledge taught: all that the teacher has built and will implement in the classroom.
- Assimilated knowledge: all the knowledge acquired by the learner.

3.2 Didactic Transposition of the Concept of Cellular Respiration

In the discipline of life and earth sciences, there are many notions that are characterized by their multidisciplinarity and complexity, which makes it difficult for students to learn them.

As anexample, photosynthesis, the immune system, biological evolution, respiration, heredity, etc are the difficult concepts learned by students, [18], [19]. This problem is aggravated when the initial conceptions of learners are neglected by teachers in their classes as various research has shown [20], [21]. In this work, we have noted the transposition of the concept of cellular respiration in students of the preparatory cycle and the secondary cycle of education in Morocco. It then appears that this concept is complex, that it evolves with age, recalling the historical evolution of the representations of this concept, and above all that some of them strongly resist change and constitute obstacles to learning.

4 Methodology

In order to study and analyze the students' representations regarding the concept of cellular respiration, we need to be closer to what they are learning and the factors that have an impact on the students' representations. We used methods to collect information first of all we presented the methodological tool (content analysis) which brings together the set of techniques, applicable to various information media (discussions, graphic documents, photographs….) which aim to extract and process this information in order to interpret them, of which we will try to make a comparison between the notions relating to metered cellular respiration in learners of 2 bachelor's degrees in life and earth science (SVT) and physical sciences (PC). Secondly, we will try to introduce our data collection tool (questionnaire), which we will try to base the problems encountered by the Moroccan student in understanding cellular respiration.

4.1 Questionnaire

In research work, many methods can be used, namely the interview, the observation the questionnaire represents the third major method for collecting data to be used in academic or professional research.

And in our study, we chose to use essentially a questionnaire written on paper in order to collect in an easy way the maximum amount of information concerning the learning difficulties of the concept "cellular respiration".

Questionnaires are indeed a valuable tool in research, allowing researchers to gather data efficiently and systematically. By structuring questions in a logical way and ensuring they are clear and relevant to the research objectives, questionnaires can yield quantifiable data that can be analyzed statistically. The size of the population sampled is crucial to ensure the results are representative and can be generalized to the larger population. This method is commonly used in

various fields such as sociology, psychology, market research, and more.

4.2 Sample Selection

The sample was selected after communicating with the principal of ERRAZI high school and the teacher who accepted that their students participate in this study. We chose to interact with 2 second-year bachelor's degree classes, one of life and earth sciences and the other of physical sciences including:

24 participants in life sciences and earth
32 students of the physical sciences

4.3 The Data Collection Tool

After their collection, the students' answers were subjected to a qualitative analysis in order to bring out their ideas about cellular respiration. It is a content analysis based on prerequisites and modeling. The students' answers to the questionnaires are then classified in Excel because it is judicious in relation to the objectives of this research, and make it possible to collect information and represent the results quickly and easily. The grouped ones differ in theme, then the interpretation of the results from the scientific description including quantitative analysis and qualitative analysis.

5 Results and Discussion

In this part we tried to deal with each theme that contains questions, starting with the analysis of the answers obtained and then moving on to the discussion in which we built an idea about the students' conceptions regarding the learning of the concept of cellular respiration, make a classification according to the big ideas that emerge in them and identify if they keep the original representations. In order to bring out the problems that prevent learners from fully grasping the notions of this biological phenomenon. Themes and pbjectives are illustrated in Table 1 (Appendix).

To get a general idea of the target population, the sample was divided into two groups. Knowing that our study is composed of a large number of students with a background in physical sciences 57% and a percentage of 43% of students with a background in life sciences and earth. The sample of our study for life sciences and earth is made up of 75% of girls and 25% of boys. And for the physical sciences are made up of 37% of girls and 63% of boys, Themes and objectives are depicted in Table 1 (Appendix).

5.1 First Theme: Understanding the Concept of Cellular Respiration

Based on student answers (Table 2) to the first question we have noticed that only 88% of the students answered that cellular respiration is an energy production process so they master the cytological and biochemical aspect of cellular respiration to synthesize energy.

On the other hand, 12% see cellular respiration as gas exchange or a process linked to the life of living beings, so these students only master the representations of first knowledge or common knowledge, so they have forgotten the knowledge learned in the third year of college and second year of bachelor's degree.

Table 2. Student Responses on Understanding Cellular Respiration

Answer	Percentage (%)	Description
Correct Understanding	88%	Students understand cellular respiration as an energy production process, mastering the cytological and biochemical aspects.
Misconception	12%	Students view cellular respiration as a gas exchange or a process linked to the life of living beings, mastering only basic or common knowledge.

For the second question (Table 3), we noted that only 42% of the students have a correct answer so we can say that they understand well the process of cellular respiration which goes through two phases, the first in the cytoplasm and the second in the mitochondria. About 25% of students have a false answer, the thing that can affirm that they believe that since the mitochondria are the basis of this process, therefore it is the place from which it takes place. Also, 33% of them did not answer the question so we can say that they have no idea.

Based on this theme we note that most students of the two streams know that cellular respiration is the process of energy production. They keep the original representations. Based on the student's background subject, we notice that physical science students know that cellular respiration begins at the cytoplasm and ends in the mitochondria, unlike the life sciences and the earth, which have difficulty determining where it takes place.

Table 3. Student Responses on Cellular Respiration Phases

Answer	Percentage (%)	Description
Correct Answer	42%	Students understand that cellular respiration occurs in two phases: one in the cytoplasm and one in the mitochondria.
Incorrect Answer	25%	Students mistakenly believe that since mitochondria are central to the process, they are the sole location where it occurs.
No Answer	33%	Students did not answer the question, suggesting a lack of understanding of the process.

5.2 Second Theme: Mitochondria

In question, only 71% of the students (Table 4) gave a correct but not complete answer among them we have: Students know the name of the organelle and its components this affirms that they memorize the scheme of the mitochondria well. Others know about the existence of an organism called mitochondria, but they do not know its components so they have forgotten them. Others know the name of the organelle, but they used the names of the components of the cell to name the components of the mitochondria, so we can say that they consider the latter to be a cell. Only 29% of the students did not answer the question either about the name of the organization or their components and on the other hand did not give the name of the organization, they gave the name of the organizations so we can say that they have no idea about the lesson.

Table 4. Student Understanding of Mitochondria Components

Answer	Percentage (%)	Description
Correct but Incomplete Answer	71%	Students know the name of the organelle and its components, indicating they have memorized the mitochondria structure. Others only know the name of the organelle but not its components, while some use names of cell components for mitochondrial components, suggesting they confuse the organelle with the entire cell.
No Answer or Incorrect Response	29%	Students neither provided the correct name of the organelle nor its components. Instead, they mentioned other organelles, indicating a lack of understanding of the lesson.

71% of the students (Table 5) answered correctly on question 4, they have a good command of the role of the mitochondria and know that glucose does not penetrate directly into the mitochondria but is transformed into pyruvic acid and that the reduced transporters oxidize at the level of the respiratory chain. About 12% of them have a false answer so they chose that the mitochondria are able to oxidize glucose so it is likely that they believe that glucose gives energy when it enters the mitochondria directly. Only 17% of them did not answer the question because they did not have an idea about the role of the mitochondria.

Table 5. Student Understanding of Mitochondria's Role in Energy Production

Answer	Percentage (%)	Description
Correct Answer	71%	Students understand the role of mitochondria, knowing that glucose is converted into pyruvic acid before entering the mitochondria and that reduced transporters are oxidized in the respiratory chain.
Incorrect Answer	12%	Students mistakenly believe that mitochondria can directly oxidize glucose, suggesting they think glucose provides energy when it enters the mitochondria.
No Answer	17%	Students did not answer the question, indicating a lack of understanding about the role of mitochondria.

We can conclude from the abovementioned discussion on theme two that each of the two channels knows the name of the organelle, so they still memorize the scheme of the mitochondria and the role it plays in cellular respiration. Analyzing and comparing them, we concluded that physical science learners still remember the names of the components of the mitochondria and do not use the names of the components of the cell to describe it.

5.3 Third Theme Glycolysis

Regarding the fifth question, we note that 17% of the students (Table 6) provided the correct answer, which indicates that they have mastered the prerequisites well. More than half of the students (75%) claim that glucose is a disaccharide or polysaccharide their answer seems to be justified by the existence of misconceptions or the teacher did not mention it or he mentioned it orally but they did not take it into account. Only 8% of the students did not answer the question that states that they have no idea about the nature of glucose.

If 83% of the students (Table 7) answered the question correctly on question six, this leads us to deduce that they know the location of glycolysis or they believe that glycolysis takes place at the cytoplasm level, but they do not know that it ends at the mitochondria level, which is appropriate for the data of the second question, in which the majority of students believe that cellular respiration takes place at the cytoplasm level only this confirms the probability of the third question in which they consider the mitochondria to be a cell. While 13% of the respondents chose the wrong answer, this may be because the students think that the mitochondria are the place where all the reactions take place. 4% of them did not answer the question.

Table 6. Student Responses on Glucose Nature and Misconceptions

Answer	Percentage (%)	Description
Correct Answer	17%	Students demonstrate a good understanding of the prerequisites related to glucose.
Incorrect Answer	75%	Students mistakenly identify glucose as a disaccharide or polysaccharide. This suggests misconceptions, possibly due to the teacher not addressing it or only mentioning it orally, which students may not have fully grasped.
No Answer	8%	Students did not answer the question, indicating a lack of understanding about the nature of glucose.

Table 7. Student Responses on Glycolysis Location

Answer	Percentage (%)	Description
Correct Answer	83%	Students correctly identify that glycolysis occurs in the cytoplasm, but may not be aware that it ends in the mitochondria. This is consistent with earlier responses, where many students believed cellular respiration occurs only in the cytoplasm.
Incorrect Answer	13%	Students mistakenly believe that glycolysis takes place in the mitochondria, possibly thinking all reactions occur there.
No Answer	4%	Students did not answer the question, suggesting a lack of understanding about the location of glycolysis.

For the seventh question, we notice that: 71% of the students (Table 8) managed to answer the question, which explains that they are well versed in the products of glycolysis. Only 17% of the learners chose the wrong answer about the glycolysis products maybe they didn't understand the question or they forgot the glycolysis products. 12% of students have no idea about this issue.

If we notice that the students of both courses do not know that glucose is a monosaccharide, this means that the teacher did not mention it. Regarding the question of where glycolysis takes place and the products that result from it, we notice that they have mastered them well, but we observe that students of life sciences and earth excel in choosing the right answer.

Table 8. Student Understanding of Glycolysis Products

Answer	Percentage (%)	Description
Correct Answer	71%	Students demonstrate a good understanding of the products of glycolysis.
Incorrect Answer	17%	Students selected the wrong answer, possibly due to misunderstanding the question or forgetting the products of glycolysis.
No Answer	12%	Students did not answer the question, indicating a lack of knowledge about the products of glycolysis.

5.4 Fourth Theme: The Krebs Cycle

Regarding the fifth question, we note that 17% of the students (Table 9) provided the correct answer, which indicates that they have mastered the prerequisites well. More than half of the students (75%) claim that glucose is a disaccharide or polysaccharide their answer seems to be justified by the existence of misconceptions or the teacher did not mention it or he mentioned it orally but they did not take it into account. Only 8% of the students did not answer the question that states that they have no idea about the nature of glucose.

In the second part of theme fourth only 29% of the students (Table 10) answered the question correctly by choosing the correct answer "acetyl coenzyme A is formed at the level of the mitochondrial matrix this can be explained that they understood the question well and mastered the course. The majority of learners 46% have a false presentation regarding the place of formation of acetyl coenzyme A perhaps they believe that it is formed at the level of the intra-membrane space and then enter to use it in the Krebs cycle so they do not master the lesson. About 25% of them have no idea about the answer.

Table 9. Student Responses on the Krebs Cycle Understanding

Answer	Percentage (%)	Description
Correct Answer	67%	Students have a general understanding of the Krebs cycle and its location, suggesting familiarity with the cycle's scheme.
Lack of Knowledge	21%	Students were unable to name the Krebs cycle, indicating they may not have mastered this part of the course.
No Idea	12%	Students did not answer the question, showing a lack of understanding of the Krebs cycle.
Misconception (Krebs Cycle in Cytoplasm)	17%	Students mistakenly believe that the Krebs cycle occurs in the cytoplasm, suggesting confusion between the cytoplasm and mitochondria.
No Answer	8%	Students did not answer the question, indicating a lack of understanding of the Krebs cycle.

Table 10. Students' Understanding of Acetyl Coenzyme A Formation in the Mitochondrial Matrix

Theme	Percentage (%)	Description
Correct Answer (Acetyl Coenzyme A Formation)	29%	Students who correctly identified the formation of acetyl coenzyme A in the mitochondrial matrix, showed they understood the concept.
Incorrect Answer (Acetyl Coenzyme A Formation)	46%	The majority of students with misconceptions, believing acetyl coenzyme A is formed in the intra-membrane space before entering the Krebs cycle.
No Answer	25%	Students who had no idea about the formation of acetyl coenzyme A.

If 29% of the students (Table 11) chose the correct answer, they could say that the Krebs cycle products were well learned, or they returned to question 8 to answer this question. And the majority of students 54% chose the wrong answer this means that they do not understand how to extract it at the level of the Krebs cycle, or they are the forgotten ones. Only 17% could not answer this question.

Table 11. Students' Understanding of the Krebs cycle

Theme	Percentage (%)	Description
Correct Answer (Krebs Cycle Products)	29%	Students who correctly identified the Krebs cycle products, suggesting good understanding or revisiting of previous material.
Incorrect Answer (Krebs Cycle Products)	54%	The majority of students gave the wrong answer, indicating confusion or lack of understanding about extracting the products from the Krebs cycle.
No Answer	17%	Students who could not answer the question, suggested a lack of knowledge about Krebs cycle products.

5.5 Fifth Theme: The Respiratory Chain

The observation done on theme five shows that out of a total of 54% of the questioned (Table 12) students ticked the correct answer, this affirms that they have an idea about the scheme of the respiratory chain. Although 13% of learners have false representations. Only 33% of them have no idea about the scheme or they have forgotten its name.

Table 12. Students' Understanding of the Respiratory Chain Scheme

Theme	Percentage (%)	Description
Correct Answer (Respiratory Chain Scheme)	54%	Students who correctly identified the respiratory chain scheme, showed they have a general understanding.
Incorrect Answer (False Representations)	13%	Students who have misconceptions or incorrect representations of the respiratory chain scheme.
No Answer (Lack of Knowledge)	33%	Students who did not know the respiratory chain scheme or have forgotten it.

We notice from the analysis that each of the two sectors knows the model of the respiratory chain, but they do not know the place and the role of the pedunculated spheres. As for the role of oxygen, only the majority of students of physical sciences master it.

5.6 Sixth Theme: Energy Balance

For the most part of the students, 75% chose the correct answer (Table 13). This means that they memorize well the number of ATP synthesized from the consumption of a glucose molecule. And although 17% have chosen 34 ATP as an answer to the question probably they have forgotten the exact number. Only 8% could not answer this question. We note that the majority of students know the number of ATP synthesized from the consumption of a glucose molecule and the others chose 34 ATP as an answer to the question. But the question remains what is the reason behind this answer?

Table 13. Students' Knowledge of ATP Synthesis from Glucose

Theme	Percentage (%)	Description
Correct Answer (ATP from Glucose)	75%	Students who correctly identified the number of ATP synthesized from glucose, indicated good retention.
Incorrect Answer (34 ATP)	17%	Students who chose 34 ATP, likely due to forgetting the exact number of ATP produced.
No Answer	8%	Students who could not answer the question, possibly indicating a lack of understanding or recall.

5.7 Seventh Theme: The Difficulties Envisaged in Cellular Respiration

Students answers on this theme shows that 27% of the students (14) answered that they find difficulties in the glycolysis part 38% in the Krebs cycle and 35% in the respiratory chain. And so we can say that with the progression of the course become unable to master and, especially when they enter the Krebs cycle exactly from question number 10 until the end of the questionnaire, the content becomes complicated (it talks about reactions, describes the interior of the mitochondria...) Which causes the students to fail to answer correctly. Based on the results, we find that students of life and earth science have difficulties using data and analyzing them to build a conclusion as well as using models to extract reactions and reinvest the knowledge acquired during learning activities in another field.

It is noticed from table 14 that the students of the physical sciences find difficulties in the Krebs cycle and the respiratory chain. This may be due to the complication of information or due to the fact that they are not able to understand all the interactions that occur and despite their knowledge of the patterns, they are unable to use them and extract the role of each element.

Table 14. Students' Difficulties in Mastering Glycolysis, Krebs Cycle, and Respiratory Chain

Theme	Percentage (%)	Description
Difficulties in Glycolysis	27%	Students report difficulties in understanding the glycolysis part of the course.
Difficulties in the Krebs Cycle	38%	Students face challenges in mastering the Krebs cycle, particularly from question 10 onward.
Difficulties in the Respiratory Chain	35%	Students struggle with the respiratory chain, especially as the course content becomes more complex.

6 Discussion

In this work, we tried to explore the difficulties encountered by students in learning cellular respiration. The analysis of the learners' answers, especially in the general sector, allows us to group the questions in two axes:

1) Questions that affect knowledge and pre-acquired knowledge.

It is very clear that most students have initial representations about cellular respiration from the first knowledge or common knowledge, which may be erroneous, and must be corrected by the teacher since he has the most influence on student learning, these representations usually take over the knowledge taught at school, the student therefore has difficulty appropriating the scientific knowledge that is taught to him at school because he cannot make sense of it from his previous knowledge or from these spontaneous conceptions. Learning is like an active and selective process consisting not simply in accumulating the information transmitted by the teacher, but in processing and modifying it based on the knowledge already acquired.

2) Issues that affect interdisciplinarity and that may be implicitly related to the issues.

Most of the content taught in "Life Sciences" is based on concepts from biochemistry, a discipline born from the meeting between biology and chemistry To comply with the instructions of school curricula, biology teachers inject into their teaching chemistry knowledge supposedly known to learners (chemical

reactions, glycolysis, decarboxylation, oxidation-reduction, etc.). This leads us to say that if interdisciplinarity is important, the fact remains that teachers must know how to explain it during their teaching. The involvement of a chemical approach, adopted as a pedagogical approach, for teaching/learning concepts in life sciences, constitutes one of the obstacles encountered by students either during the course or during the realization of the exercises. When comparing the learners of the two streams, we do not notice a difference in level, despite the fact that physical science students are more likely to know how to combine chemistry and life science to understand reactions and use them to their advantage.

3) Issues that affect modeling :

Modeling is the linking of two worlds: a world of models and theories and a world of objects and events. It is in the establishment of links between these two worlds that learning and the construction of the meaning of a given concept are based. The register of the model is also built by the student. It contains the elements related to an organization and/or to a more or less imagined functioning. Indeed, we can affirm that the use of the model in the classroom allows a better understanding of an astronomical phenomenon and makes it possible to move from an erroneous conception to the conception that explains the phenomenon studied. However we have found that, by improving understanding, modeling can also lead to false representations among students, because due to the simplified aspect of the model, there is a risk of confusion between the elements of the model and reality or with another model.

It emerges from our research that the difficulties experienced by students in acquiring the concept of cellular respiration are often attributed to the structure and content of the school curriculum, which is both a resource for teachers in preparing their lessons and a point of support for students who can refer to it for clarification, complete what was seen in class, solve the exercises listed at the end of the chapter. The absence of students during the course must also be taken into account because it highlights shortcomings in the mastery of the course.

4) The consequences of didactic transposition

The translation of knowledge into text is for the teacher the essential tool of his practice; it is established as a preparation of the content that will be worked on in the school system and its realization is placed under the control of determined rules that have as their objective the structuring of a didactic form. Any educational proposal necessarily presupposes the existence of such preparation. Among these rules that structure the textual presentation of knowledge, we can highlight:

- The desyncretization of knowledge: "division of theoretical practice into delimited fields of knowledge giving rise to specialized learning practices"
- The depersonalization of knowledge: "separation of knowledge and the person"
- The programmability of knowledge acquisition: "The programming of learning and controls according to reasoned sequences allows a progressive acquisition of expertise, that is to say, the programmability of knowledge acquisition"
- The decontextualization of knowledge: Often in order to move from being a scientist to knowledge to be taught, we are forced to decontextualize it.(Julien Cordelois, n. d.).

7 Conclusion

This work has highlighted some obstacles to learning a complex concept "cellular respiration". It is therefore very important to take into account the students' conceptions in class practices and to think of didactic situations that allow overcoming the underlying obstacles, for a better construction of scientific concepts. The teaching of life and Earth sciences must simultaneously give all students the knowledge and the mode of reasoning essential to understanding a constantly changing world, so it is up to the teacher to motivate his students to learn science well by diversifying teaching methods, designing teaching strategies adapted to the student's level of understanding and adapted to the material conditions of the school, carrying out experimental activities according to the availability of didactic materials, recommendation of a reward system and use of ICT to complement the experiments and simplify the real systems studied. They understand the essentials to know and offer many games and exercises, as well as mental maps or visual summaries conducive to stimulation, motivation, and concentration. There is no doubt that the teacher has heavy responsibilities to take on both in the classroom and outside the classroom. To effectively assume them, the teacher himself needs assistance (continuing education, supervision, recognition and award of prizes, social benefits .....).

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Conflict of Interest

The authors have no conflicts of interest to declare.

APPENDIX

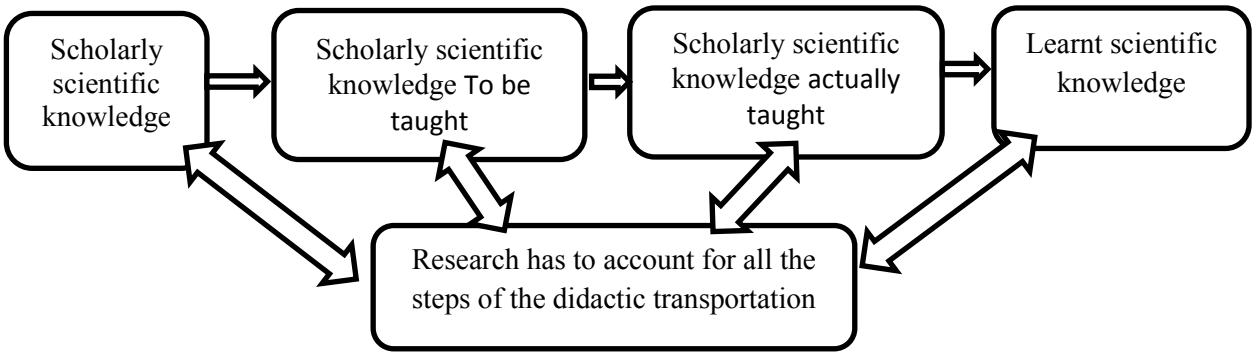

Fig. 1: Chain of didactic transposition

Table 1. Themes and objectives

Questions	objectives
General theme: general information about students. **1. Sex** **2. Stream**	Have a general idea about the target population. Compare the results of the two streams. Have a general idea about the target population. Compare the results of the two streams.
The first theme: the concept of cellular respiration. **1. What does cellular respiration mean to you?** **2. Cellular respiration is a phenomenon?**	To find out if the students know the essential role of cellular respiration. The purpose of this question is to find out the place of cellular respiration.
The second theme: is mitochondria. **1. What is the name of this organization and schematize the model.** **2. Mitochondria are considered organelles**	Determine whether students are familiar with the model of the mitochondria, its role, and the fact that glucose does not enter the mitochondria.
Third theme: glycolysis. **1. Glucose is a.** **2. Glycolysis takes place in.** **3. Glycolysis reactions.**	Have the students know the glycose and the place of glycolysis as well as their products.
Fourth theme: the Krebs cycle. **1. name this model.** **2. The Krebs cycle is unfolding.** **3. Acetyl coenzyme A is formed in.** **4. During the Krebs cycle.** **5. Oxidative de-carbonization requires.**	To know if the students measure the model, the place, and the products of the Krebs cycle. Have learners know the place of formation of Acetyl coenzyme A. To find out if the students know the role of Pyruvic acid in de-carbonization.
Fifth theme: the respiratory chain. **1. name this model.** **2. Oxygen is necessary for the functioning of mitochondria, as it is involved in.** **3. The pedunculated spheres.**	To find out if the learners are familiar with the scheme of the respiratory chain, the place and role of the peduncle spheres as well as the function of oxygen in the respiratory chain.
The sixth theme: is energy balance. **1. The number of ATP synthesized from the consumption of a glucose molecule**	To find out if the learners have an exact idea about the number of ATP synthesized from the consumption of a glucose molecule.
Seventh theme: the difficulties envisaged in cellular respiration. **1. What are the reactions that you find difficult to understand?** **2. What is the kind of problem you are facing?**	Know the difficulties of students in the concept of cellular respiration.