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### **ABSTRACT**

Biochemistry takes an important place in the curriculum of life science students, as well as medical students, because it forms an essential basis for understanding the mechanisms of life at the molecular level. However, most university students still have more difficulties in learning this subject. The objective of our study is to identify perceptions of students about the difficulties encountered during the learning of biochemistry. In order to realize this investigation, we led an exploratory study with a group of students of the first year of medicine at the FMPT about this topic. We used the nominal group technique (TGN) and the questionnaire. Actually, the results of the present study prove that students encounter difficulties to understand some chapters (structural biochemistry, biological interest of biomolecules and enzymology) because their complexity especially with the overload of the program and the insufficiency of the time allocated to teaching this subject. In addition, they have difficulty in assimilation and memorization, which may be related to the teaching method used and the lack of tutorial sessions, preventing any active involvement of the student in the learning process. In conclusion, this study helped us to discover the problems that affect the quality of biochemistry learning for the students interviewed. On their part, they suggested some alternative solutions that reside in the adoption of new teaching methods promoting active learning as well as the integration of new communication and information technologies (ICT).

**Keywords:** TGN - Biochemistry - Teaching method - Learning difficulties - ICT

### **INTRODUCTION**

Teaching and education are essential foundations for the development of a country. They essentially aim to develop citizens who properly assume the future of their society, aware, empowered and responsible for their humanity (Ghallab et al., 2017; Timonen, 2020). Adding that Nelson Mandela considers education, "the most powerful weapon we can use to change the world". Moreover, the strengthening of science education, has become a necessity to move towards a knowledge society (Higher Council for Education, Training and Scientific Research "CSEFRS", 2019). For this reason, the improvement of the quality of education has been the subject of many reforms.

In this context, many countries around the world made commendable efforts to develop their education system and constantly improve the quality and efficiency of education (primary, secondary and higher). In this logic, Morocco has engaged in a vast program of reforms to improve the performance and quality of education.

The Moroccan government initiated the reforms by adopting the National Charter of Education and Training in 1999, which aimed primarily to place the learner at the center of pedagogical reflection and action also to transform the Moroccan school (MEN, 1999).

Many years later, the Higher Education Council presented an alarming report on the Moroccan education system. The general state of classrooms and schools has led to close 9,000 classrooms and more than 1,000 schools. Also the report published in 2017 by the Court of Auditors of the Moroccan Kingdom on the quality of the educational system of this country, highlights some flaws hindering the quality of education: in particular the lack of teachers, overcrowded classrooms and a dilapidation of classrooms and services in schools. (Malouli, 2018).

To this painful observation is added that Unesco ranks Morocco among the 25 least advanced countries in the world from the point of view of schooling, occupying the 136<sup>th</sup> place, with an illiteracy level about 30% (Malouli, 2018). Moreover, the TIMSS study "Trends in Mathematics and Science Study" considered among the most revealing indicators of the quality of teaching and learning, ranked Morocco in the last three countries with a score of 393 in science. (CSEFRS, 2015)

This catastrophic situation of the school system is only the result of an accumulation of multiple failures inherited. Education, which should be a real lever for the economic growth of a country, suffers from all the ills in Morocco.

This has pushed officials to introduce an emergency program for education in order to catch up with the country's heavy backlog and accelerate the implementation of reforms. It lasted from 2009 to 2012. However, the Moroccan school still suffers from chronic dysfunctions, and these reforms have not been able to produce the desired improvements on the ground (Biyouda and Zahid, 2020).

Three years later, the Higher Education Council (CSEFRS) proposed a new reform "the strategic vision (2015-2030)", which aims to improve the performance of the education system and the quality of teaching and learning. (Bourqia, 2016).

In the same context, the Moroccan government has promulgated the major choices of this strategic vision in a framework law 51-17 (August 9, 2019) which constituted the first legal framework in our country in terms of reforming the system of education, training and scientific research. This law aims mostly to improve the governance of the higher education system and the quality of training, as well as to promote scientific research and innovation. (Official Bulletin, MEN, 2020)

Despite all the reforms implemented and the significant efforts made by the State, the Moroccan education system still suffers from various constraints. This is the case for higher education where the challenges are diverse; especially the large percentage of failure (64%) and abundance with an average rate of loss that exceeds 50% in the first cycle (CSEFRS, Analytical Report, 2014; Mansouri & Moumni, 2017; Alagui, 2019).

For the student, the first year of university studies is considered a delicate period, since it is a transition phase between secondary and higher education. Indeed, it can be a major obstacle for some students who fail to adapt. This can contribute to a situation of failure or even abandonment (Jarmouni, Bellaihou & Boulahfati, 2021).

### Problem and research question

In the last years, many researches in science didactics have focused on the difficulties encountered by university students during their learning in different disciplines "mathematics, physics-chemistry, organic chemistry and biochemistry ..." (Alibi, 2021; Benzidia et al., 2021; Bouhafs & Karam, 2020; Djarmouni et al., 2021; Faska & Majidi, 2019; Harabi & Ben Kilani, 2019). For understanding the origin and the causes behind this academic failure, in order to propose solutions and remediation tracks.

Our turn, we organized a research on the difficulties encountered by university students during their learning of biochemistry, because it presents a high failure rate. The majority of students (64.2%) still have many difficulties in biochemistry and do not succeed this subject easily (pre-survey). They thus share a feeling of dissatisfaction and discontent with science teaching in general and biochemistry in particular.

This discipline has always taken an important place in the curriculum of biology students, as well as for medical students, because it forms an essential basis for understanding the mechanisms of life at the molecular level. It also plays an important role in the screening, diagnosis, monitoring and treatment of pathologies (Djarmouni, 2017). This science is primarily concerned with the study of living things. It provides an example of synthesis between different areas.

Indeed, biochemistry combines various techniques of chemistry, physics, and molecular biology in order to explain the mysterious functioning of the body. It has applications in various areas (food industry, health, agronomy...). In medicine, it helps to explain the causes of diseases and consequently to propose treatments and adequate methods of diagnosis (Mayer, 2016). Moreover, biochemistry and medicine are closely related. On one side, biochemical studies clarify several physiological and pathological aspects; on the other side, the study of different healthy and pathological situations opens new areas of study and exploration in biochemistry (Rodwell et al., 2017, p.1).

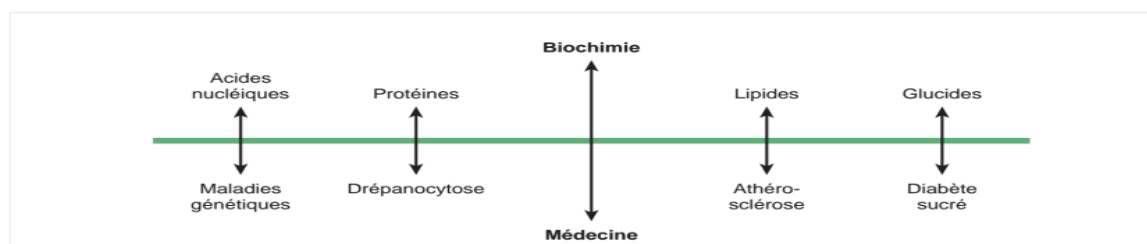


Figure. 1: Relationship between medicine and biochemistry (Rodwell et al, 2017, p.2).

The knowledge of biochemical constituents (carbohydrates, lipids...) helps to understand some diseases (diabetes, atherosclerosis...). Reciprocally, the study of these diseases has advanced many fields in biochemistry (Rodwell et al., 2017, p.2).

Therefore, in view of the importance of biochemistry in the medical curriculum, and in order to enable our students to learn this subject properly, at their institution, we formulated the research question like that: "What are the difficulties and problems that Moroccan students have during the learning of biochemistry? Case of first year medical students"

## **METHODOLOGY**

In an order to answer our question, we conducted an exploratory study with first year students of the Faculty of Medicine and Pharmacy, Tangier (FMPT). We used the nominal group technique (TGN) and the questionnaire.

### **Sampling**

The sample selected for the questionnaire included 115 students. All students present during the last session of the biochemistry course were invited to participate in this study. Absent students were excluded.

The sample used for the TGN includes 18 students in the first year of medical school (FMPT) who voluntarily participated in this workshop.

The sample is part of a population that corresponds to all 1st year medical students at the FMPT in the academic year 2021/2022 (255 students). It is valid because there is a relationship between the sample and the population. The participants in this study received the same training with the same didactic tools and under the same conditions as the student population.

### **Data Collection Tools**

#### **Nominal group technique**

In order to realize this survey, we opted for the nominal group technique (TGN). This method was introduced by Delbecq and Van in 1971. This technique is based on a decision-making process that leads a group to have a collective idea on a specific subject. Indeed, it is a more structured form of brainstorming that aims to lead a group of people (10 to 20 people) to express themselves freely on a common topic, to identify problems or to propose and suggest solutions (Manera et al., 2019).

This technique proves to be very useful since it regroups individual work (each participant expresses his or her point of view) and group work (in the end, a collective point of view is obtained without having a consensus) (El Hassouny, 2016). Initially, this technique was applied in management and then expanded to address problems in different areas like health, education, industry, and administration ... (Foth, 2016; Joannot et al., 2018; Søndergaard, 2018). This method consists to answer an open question called the nominal question which must be clear, precise and univocal (Grenier and Lagarde, 2000 cited by Chmanti-Houari, 2017).

### **Process**

We exchanged with a group of medical students on the subject by the nominal group technique. The goal of this technique is to make a weighted list of difficulties related to learning biochemistry.

We proceeded with the different steps in conformity with what was described in the literature (Grenier and Lagarde, 2000; McMillan et al., 2016; Manera et al., 2019; Naik, 2020):

First, we assembled our sample of 18 students who voluntarily agreed to participate in this workshop. Then, we explained to these students the purpose of this technique as well as the different steps to follow.

#### **Step 1: Idea generation**

We wrote on the board the nominal question: "What are the difficulties and problems that you find in learning (studying) biochemistry? Then, we tried to clarify the question by using simple language in order to be understood by everyone. We encouraged the students to answer and express themselves freely in an individual way in a sheet of paper (sheet 1). This step took approximately 15 minutes.

#### **Step 2: Sharing and clarifying ideas**

Each participant presented his or her idea and made sure to clarify and explain his or her point of view to the group. This step produced 19 responses. (Table 1)

**Table 1 : List of student answers**

| <b>List of student responses to the nominal question</b>   |
|--|
| Difficulty to identify the important concepts of the course; structural biochemistry is more difficult<br>Unclear explanation of structural biochemistry; difficulty to understand structural biochemistry; the complexity of structures<br>Amino acid structure; carbohydrate nomenclature<br>A large quantity of biological interest of the molecules; biological interests are difficult to learn<br>Metabolic pathologies contain a lot of details<br>Difficulty to learn all metabolic biochemistry<br>Misunderstanding of enzyme classes of each enzyme; nomenclature of enzymes is very difficult; difficulty to differencing between enzymes,<br>Complicated words of enzymes in metabolic biochemistry<br>Amino acid metabolism; urea cycle.<br>Carbohydrate metabolism; complexities of the studied cycles<br>I can't assimilate all the information; assimilation of cycles<br>Memorizing different structures; enzymes are difficult to memorize; names of some enzymes catalyzing reactions are difficult to remember.<br>Difficulty to understand many concepts in a short period; the time volume for metabolic biochemistry was not sufficient, insufficient time volume<br>Insufficient tutorial and review sessions; lack of exercises sessions,<br>Lack of tutorials and practical sessions<br>Heavy program; too much information.<br>Structures of molecules; too much information to take in, too much detail; vitamins are too detailed,<br>Details of each molecule; details of metabolic biochemistry cycles,<br>The complexity of the concepts ... |

**Step 3: Categorization**

Next, we moved to categorize the results by grouping together answers with the same or similar ideas into the same category. Answers that are considered redundant or irrelevant to the problem can be eliminated. The student's responses are grouped as follows:

**Table 2: Categorization of results**

| <b>Category</b>   | <b>Suggestions of student</b>  |
|---|--|
| Category 1: Difficulties in structural biochemistry       | - Structural biochemistry is very difficult<br>- Carbohydrate nomenclature<br>- Complexity of structures   |
| Category 2: Complexity of biological interest             | - Complexity of concepts<br>- Biological interest is difficult   |
| Category 3: Difficulties in enzymology                    | - Misunderstanding of enzyme classes<br>- Nomenclature of enzymes is very difficult  |
| Category 4: Difficulties in amino acid metabolism         | - Amino acid metabolism<br>- Urea cycle  |
| Category 5: Difficulties in carbohydrate metabolism       | - Carbohydrate metabolism<br>- Metabolism  |
| Category 6: Difficulties in memorization and assimilation | - I can't assimilate all the information   |
| Category 7: Insufficient hourly volume                    | - The hourly volume for metabolic biochemistry was not sufficient.<br>- Insufficient time volume<br>- Difficulty to understand a lot of concepts in a short period |
| Grade 8: Lack of exercises and remediation sessions       | - Insufficient tutorial sessions<br>- Lack of exercises and practical work sessions  |
| Grade 9: Heavy program                                    | - Too much information<br>- A lot of details about each molecule   |



#### Step 4: Weighting and ranking of categories

In this step, each student is invited to classify, in order of priority, the difficulties by giving each category a score (a weight) from 1 to 9. The highest score (9) is given to the difficulty classified first (most important). This score decreases until the last answer (Sheet 2).

Then, we ranked the results in a decreasing order based on the total of the scores given to each item, which made it possible to draw up a weighted list of difficulties. (Table 3)

#### Questionnaire

In order to support these results, we adopted a questionnaire approved by experts of the support center of the University of Lausanne. It was distributed to 125 students on first year medical at the end of the first semester of 2022.

It consists two sections. The first part is focused on the general organization of the teaching (five closed questions with Likert scale). While the second part includes four open questions about the following points: the student's difficulties, the presentation of the teaching, the learning rhythm and suggestions for improvement.

The aim of this study is to evaluate the teaching of this subject and to focus on different weaknesses hindering the learning of biochemistry as well as to identify some ways of improvement.

#### Data processing

The questionnaire was anonymous in order to optimize the number of returns. We had a response rate of 92% (115 responses out of 125 administered).

The student's responses were processed and analyzed with EXCEL software. The percentages that appear in the various tables and graphs are calculated according to the number of respondents.

## RESULTS

### TGN

The analysis of the table indicated that students attributed their difficulties in biochemistry primarily to the complexity and misunderstanding of certain parts of the course, especially biological interest, structural biochemistry, enzymology, amino acid and carbohydrate metabolism. This can be in relation with the teaching method based on the transmissive model especially with the overload of the courses and the time spent on teaching this discipline as well as the lack of exercises and remediation sessions.

**Table 3: Weighted list of difficulties**

| Order | Suggestions                                   | Σ of score (weight) |
|-------|---|---------------------|
| 1     | Complexity of biological interest             | 145                 |
| 2     | Difficulties in structural biochemistry       | 118                 |
| 3     | Heavy program                                 | 117                 |
| 4     | Difficulties to memorization and assimilation | 95                  |
| 5     | Insufficient hourly volume                    | 83                  |
| 6     | Difficulties in enzymology                    | 69                  |
| 7     | Difficulties in amino acid metabolism         | 68                  |
| 8     | Difficulties in carbohydrate metabolism       | 58                  |
| 9     | Lack of exercises and remediation sessions    | 57                  |

#### Pareto chart

To give another representation of the difficulties encountered by these students during their learning of biochemistry, we used the Pareto chart.

The Pareto chart is a simplified graphical representation of causes to determine the most important elements that explain a situation (Benmehdi, 2021). It takes the form of a histogram (bars) that ranks the causes of a problem in decreasing order (Nasser and Tijane, 2020). The principle of the 20/80 law is attributed to the Italian economist Pareto, who noted that only 20% of the population has 80% of the wealth. The application of this law makes it possible to represent the relative importance of different facts (20% of the cause produce 80% of the effects, 20% of the product gives 80% of the turnover ...). This law could be applied and adapted in different fields (marketing, maintenance, management, teaching ...) (Tian, 2018; Kaur, 2019)

Calculation of percentages and cumulative percentages

Table 4

| Difficulties                          | Total of score | Percentage | Percentage cumulative |
|---------------------------------------|----------------|------------|-----------------------|
| Biological Interest                   | 145            | 17,90%     | 17,90%                |
| Structural biochemistry               | 118            | 14,57%     | 32,47%                |
| Heavy program                         | 117            | 14,44%     | 46,91%                |
| Difficulty to memorize and assimilate | 95             | 11,73%     | 58,64%                |
| Insufficient hourly volume            | 83             | 10,25%     | 68,89%                |
| Enzymology chapter                    | 69             | 8,52%      | 77,41%                |
| Amino acid metabolism chapter         | 68             | 8,39%      | 85,80%                |
| Chapter on carbohydrate metabolism    | 58             | 7,16%      | 92,96%                |
| Lack of TD and remediation sessions   | 57             | 7,04%      | 100,00%               |
| Total                                 | 810            | 100,00%    |                       |

Realizing graphic

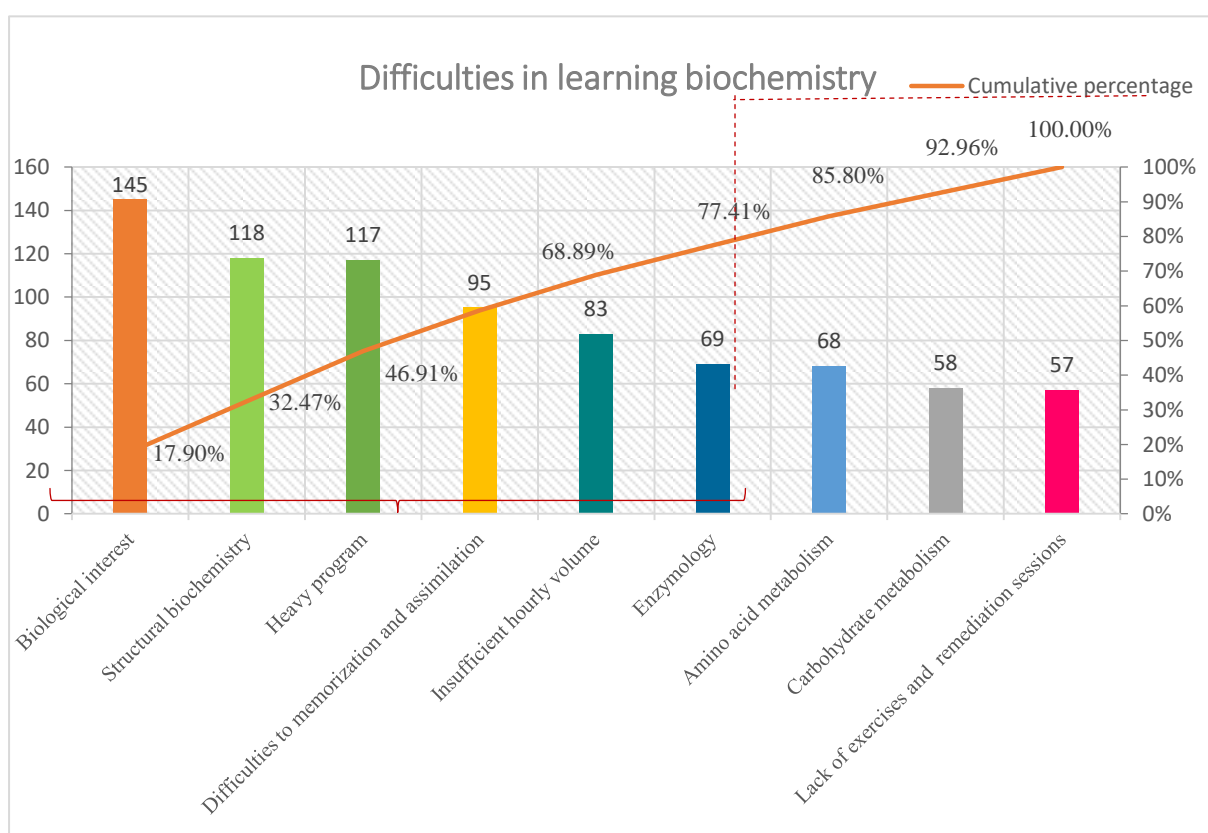


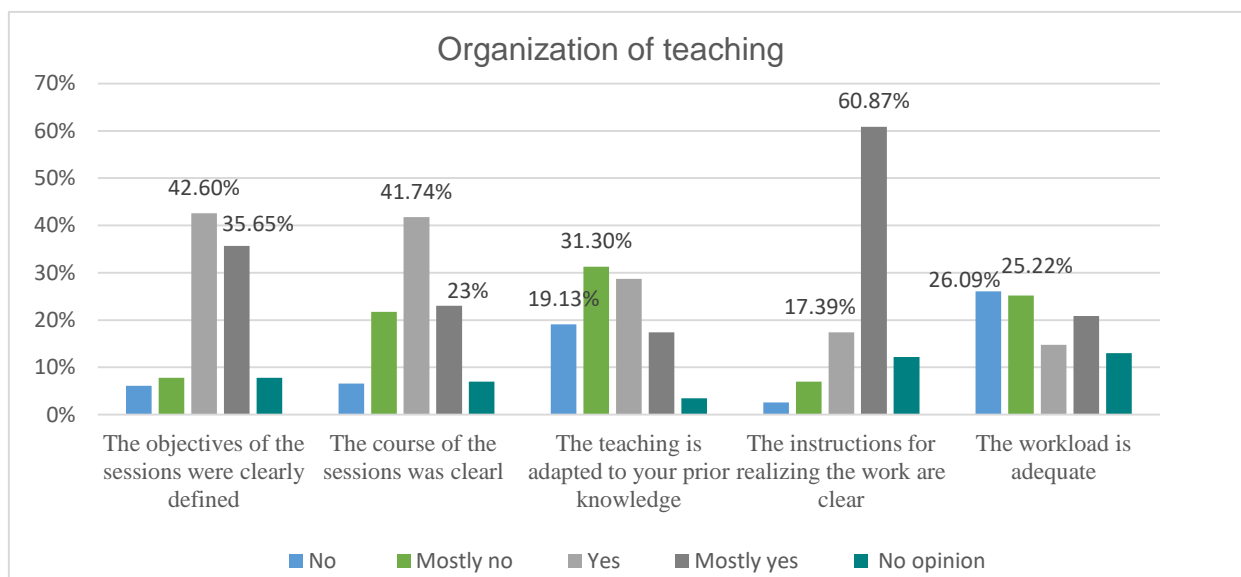
Figure. 2: student's perception of difficulties in learning biochemistry 2017, p.2

The bars represent the weight of each category and the curve represents the cumulative percentage.

We can deduce that if we work on the six categories presented, we will be able to eliminate 80% of sources of student difficulties:

- The complexity and misunderstanding of some parts, especially the chapter of biological interest, enzymology and structural biochemistry;
- The heavy program and insufficient time volume;
- Difficulties in memorization and assimilation.

## Questionnaire



**Figure. 3: graphic of organization of teaching**

The majority of the participants said that the objectives of the sessions (78,25%) and the way they were presented is clear (64,74%). However, they indicated that the teaching of this subject is not adapted to their prior knowledge (pre-requisites) (50,43%) and the workload is very high (51,31%).

In addition, these students affirmed that the content of some parts of the course is difficult and very loaded with many details (35,65%). Also, they reported that the pace of teaching is very fast, which prevents the assimilation of various concepts (54,78%) especially with the lack of exercises (26,96%) and interactivity (9,56%).

However, these students have suggested some ways to improve the teaching and learning of this subject. They are listed as follows:

- Decrease the load of content and pace of teaching ;
- Restructure and organize the handbook;
- Increase the number of exercises and organize practical sessions;
- Have more interactivity and make reviews and revisions at the end of each chapter;
- Use more diagrams, videos and animations...

## DISCUSSION AND CONCLUSION

Following the analysis of the collected results, we found that most medical students encounter difficulties when they learn biochemistry.

- On the one hand, the complexity of some concepts in biochemistry can be a source of difficulties especially with the overload of the program and the insufficient time allocated to teaching this subject.

- On the other hand, the classical teaching method (lecture) based mainly on the transmissive model, as well as the lack of exercises and remediation sessions also the absence of practical work (Covid-19), preventing any involvement of the student in the learning process.

These conclusions converge with the results of the questionnaire where the students find the content of this subject relatively heavy and complex (35.65%) as well as the pace of learning is accelerated (54.87%). These students added that the lack of practical work and revision sessions aggravated the problem and hindered the assimilation of biochemical concepts.

These problems can be related to the nature of the subject taught and her inter-disciplinary character, which requires knowledge in different subject (general chemistry, organic chemistry, biology, mathematics, thermodynamics...) (Yoho et al., 2019). Thus by the classical teaching methods which prevent the interaction between students, the transmission of a large quantity of knowledge in a limited time promotes a superficial, fragmented and isolated learning (just to pass the exam). (Escoto et al., 2015; Minasian-Batmanian et al., 2006, Rowland et al., 2011). This fragmentation of knowledge as well as the absence of the connections between the different chapters could build an additional factor of difficulties for students who are not even aware of the purpose and importance of teaching this subject in their curriculum.

Although some concepts in biochemistry are basic for other courses, such as analytical techniques and clinical biochemistry where renal and hepatic functions are explored from a simple dosage of some biomolecules



(creatinine, urea, ASAT “aspartate aminotransferases”, ALAT “alanine aminotransferases”, total protein, bilirubin...). They also make it possible to evaluate the quality of functioning of other organs and detect anomalies (anemia, diabetes, atherosclerosis...).

Indeed, biochemistry is a key science in itself, but it is also a crucial science for other scientific and medical fields. (Rowland et al, 2011). A good assimilation of the basic biochemical concepts by the learners is necessary for the deepening of the later lessons (Baaziz). In other words, biochemistry is a crossroads discipline, a necessary base that participates in the structuring of other disciplines (clinical biochemistry, physiology, pharmacology, immunology, toxicology, microbiology...). His study is very important, at all levels, in order to extend the understanding of natural phenomena (Lang, 2020). Consequently, today teaching biochemistry at the university needs a profound adaptation of the methods, contents and attitudes of both teachers and students.

In conclusion, we identified at the end of this study, the principal difficulties and obstacles hindering the learning of biochemistry that are listed as follows:

- Specific to the subject taught (complexity of notions, many structures, and abstract concepts)
- Nature of the training (overload of the program and insufficient hourly volume)
- Also the teaching method (misunderstanding of certain parts of course, difficulties of assimilation and memorization, lack of exercises, practical and revision sessions).

Generally, the problems specific to the nature of the subject taught and their concepts are the principal causes that hinder this learning. This situation is also aggravated by the teaching practices and methods, especially with the program load and limited time.

The students have suggested some alternative solutions to improve the teaching of this subject, which are the adoption of new teaching methods promoting active learning, the integration of new technologies of communication and information (ICT) the adaptation of the content of this subject with a sufficient time and increase of the sessions of exercises, practical work and remediation.

In this context, many researches try to evaluate the impact of the introduction of new pedagogies and the use of ICT in improving the quality of learning (Céci et al., 2017; De Aquino et al., 2021; De Oliveira Silva et al, 2016; Espinosa, 2019; Hamdani, 2021; Karamanos et al., 2018; Karamanos et al., 2019; Lietart, 2015; Nafidi, 2018; Zhou, 2021). Today, pedagogical innovation is more than choice, but a necessity (Hamdani, 2021).

In fact, ICT, active pedagogies, the integration of animations, video and serious games can be useful and help to overcome these difficulties. We are currently experimenting some of these methods.

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