

“Modernizing the Learning of Biology, Particularly Endocrinology, Through Interactive Technology: Points of View from Moroccan University Students”

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Abstract: This study aims to discover the constraints or obstacles encountered by Moroccan students in their learning of endocrinology. Students from several Moroccan universities enrolled in life and earth sciences as well as those enrolled in other fields where this subject is taught collaborated in the realization of this research. To list the concepts or chapters likely to pose learning problems in endocrinology, we used the Nominal Group Technique (NGT). In fact, in our context, the NGT consisted of a method of generating ideas allowing to have a specific view on the difficulties and the obstacles encountered by the learners in the course of endocrinology. The conclusions resulting from this NGT, made it possible to develop the questionnaire published online on Google Forms. Indeed, the results showed that Moroccan students encounter several constraints in their learning of endocrinology. Thus, the insufficiency of its hourly volume, the non-realization of practical work and tutorials as well as the complexity of the content of this course are the real constraints preventing our students from adequately learning this subject. These results also illustrated that the absence or low use of ICT in class does not facilitate the understanding of this course by students. In addition, the results of this survey show that the students consulted have difficulty understanding several concepts in the endocrinology course relating to: cell signaling and communication, modes of signal transmission and hormonal regulation.

Keywords: Teaching Method, Learning Difficulties, Endocrinology, Life and Earth Sciences, ICT and NGT

1. Introduction

Endocrinology is a scientific discipline, which aims to study the structure, functions of the endocrine glands as well as the diagnosis and treatment of disorders of the endocrine system (Kahal, 2020). From a historical point of view, there are several stages in the evolution of this discipline, which can be summarized in three main periods.

Indeed, the first stage took place around the middle of the 19th century. It was especially characterized by the definition of the nature and physiological action of the main endocrine glands: adrenal, pituitary, thyroid... (idelman and verdetti, 2000). According to these authors, it was in fact the period of classical endocrine physiology (ablation, grafting, opotherapy using glandular extracts...). Moreover, it was during this same period that Bayliss and Starling coined the term hormone in order to designate a substance, secretin, which is produced by the duodenal mucosa, during the passage of the food bolus, in order to remotely excite the secretion of pancreatic juice enzymes (Ibid.).

The second stage, meanwhile, took place around the first half of the 20th century. It was essentially dominated by endocrine biochemistry (idelman and verdetti, 2000). Indeed, it was during this period that several hormones (adrenaline, oxytocin, insulin, etc.) were highlighted. It should also be noted that it was always during this period that we managed to isolate and specify the structure of these hormones (Ibid.).

According to the writings of our source, the third stage was around the second half of the 20th century. In fact,

this stage was marked by research on the mode of action of hormones, in particular adrenaline and glucagon, then other polypeptide hormones, which explain the role of cyclic AMP.

From a pedagogical point of view, endocrinology is one of the subjects of SVT whose content aims to provide learners with the various basic notions of general endocrinology such as, for example, the notion of the endocrine and regulation glands. It should be specified that the teaching of this subject aims precisely to allow learners to assimilate the functioning of the endocrine system of humans and that of animals.

So, given the complexity of the concepts or even the content of this subject, the rapid evolution of technology and the importance of this scientific discipline in our society; teaching it can represent a real pedagogical challenge for the teacher. Learning this discipline can also prove to be a great problem for the learner. (Azzi et al., 2022)

This is why in the present study, through our various surveys carried out with Moroccan students, we dwelt on the question of the determination of the various flaws and constraints encountered by these respondents in their learning of endocrinology.

In short, this research will lead us to propose some didactic solutions that will ensure that our students learn their endocrinology course effectively. We will also make techno-pedagogical suggestions that will allow teachers to better run this course.

2. Problem

Given its importance for society, endocrinology is an essential subject in the scientific knowledge of pupils or students. It generally allows learners to understand how the human body works.

In Morocco, precisely at the university level and even at the college level, students and pupils have great difficulty in assimilating this subject well. We made such a finding during our various scientific investigations undertaken as part of the preparation of this study (this was during the pre-survey phase leading to this study). We actually discovered this problem during our interviews with 19 SVT students from the École Normale Supérieure in Tetouan during the 2021-2022 academic year.

Indeed, according to the final results of these interviews, we were able to observe that our students encountered many difficulties in assimilating the concepts of endocrinology. In addition, we noticed through the analysis of the comments of these interviewees that the endocrinology course given to these learners was too heavy. On this specific point, some students underlined, for example, the high number of hormones to be studied as well as the difficulty in mastering their functioning, especially since this learning should be done in a short period, in one semester. Which is a sea to drink for them. "(...) Hormones are numerous and you need to know in detail the role and place of production of approximately 27 hormones (...)".

These results also allowed us to note the absence of practical work in this course as well as the absence of the use of ICT in class by teachers.

These few observations prompted us to initiate this study. We wanted to verify the tangibility of these findings at the national level. That is to say, to make an inventory of the teaching and learning of endocrinology in Morocco. To do this, the central question of this survey is formulated as follows: what are the different flaws and constraints that confront students in learning endocrinology? So, to better dissect the problem of our research, we have set the following objectives:

- Determine the percentage rate for tutorials and practicals carried out in the context of each chapter taught in endocrinology;
- Collect respondents' opinions on the question of learning the different concepts of each chapter of this subject;
- Determine the alternatives or possible solutions which, according to the students, can help improve the teaching and learning of this subject by our respondents;
- Make recommendations to designers of endocrinology programs in Morocco to improve its quality and efficiency.

3. Methodology

This study was carried out in three phases. The first phase was essentially based on collecting data from students, graduates of a bachelor's or master's degree in life and earth sciences from the École Normale Supérieure in Martil. Indeed, it was for us a pre-survey based on interviews with our students (n1=19) to collect their impressions on the way they learn endocrinology in their school. The final results of this investigation made it possible to constitute the main matrix of our working session on the technique used by the nominal

group (abbreviated NGT). We carried out this investigation with students from the Faculty of Medicine and Pharmacy of Tangier.

- The Nominal Group Technique (NGT)

According to the authors Johanne Grenier and Michèle Lagarde (2000), the NGT can be defined as: "A technique for collecting perceptions which aims to bring a group of people to express themselves freely on an issue that concerns them directly. Although it requires a lot of discipline, this technique is very useful in research. (p.1). It is also defined as: "The nominal group (or multi-vote) technique helps teams reach consensus on a question or on a proposed solution, taking into account the ranking by degree of importance made by each person. (nccmt.ca). Indeed, the NGT is a very useful method allowing the researcher to achieve several ends such as: the identification of the problems, the needs, the objectives, the resources of a target population (Jean-Marc Meunier, 1994). It also allows the latter to exhaustively list ideas, opinions and solutions to simplify decision-making (Etudier.com).

With regard to the present study, we used this method to properly list the difficulties generally encountered by our students in their learning of endocrinology. In other words, we worked intensely with a group of students (n2=25) from the Faculty of Medicine of Tangier on the following theme or nominal question: "What are the difficulties you encounter when studying endocrinology? ". At the end of this fruitful session, and on the basis of the results arising from our reflection with the participants of the said session; we were able to establish in order of importance, a complete list of the difficulties mentioned above.

In addition, the results of the NGT enabled us to produce our first version of the research questionnaire. This was finally validated using a Brainstorming session carried out with the members of our ERIPDS¹ research team. This is how we obtained the final version of our research questionnaire.

- Attendees

This study allowed us to associate 106 (N= n1+n2+n3) Moroccan students who are distributed as follows:

- 19 (n1) candidates for interviews;
- 25 (n2) participants for the NGT;
- 62 (n3, including 77% of women and 23% of men.) respondents for the online questionnaire.

- Collection of data

The collection of data for this publication was facilitated by the questionnaire published on Google Forms. The content of this questionnaire essentially revolved around the question relating to the discovery of the various flaws and constraints that students face in their learning of endocrinology. The questions posed in the said document focused on two points:

- General information (Gender or sex of respondents, type of license unchecked by our respondents, etc.);
- Learning of endocrinology (the progress of the course of endocrinology, the teaching aid used for the learning of this subject, the assimilation of the concepts of endocrinology, the realization of the TP and TD within the framework of the learning above named, etc.).

Note that in this questionnaire, we opted for multiple-choice questions. Because this type of question facilitates the task of data processing. For this purpose, we used the Likert scale. This is a scale comprising a gradation of 4 to 7 levels (Example: "never", "rarely", "from time to time", "often" and "always") (quint-essenz, 2008).

- Results analysis

In order to present pleasantly and professionally the various data that we collected from the questionnaire, they were analyzed and processed using the SPSS 26 software.

4. Results

- The number of hours allocated to the teaching of endocrinology

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The results of our survey show that more than half (70%) of our respondents indicated that the number of hours allocated to the teaching of endocrinology in Morocco is insufficient. Only 18.3% of them considered it sufficient.

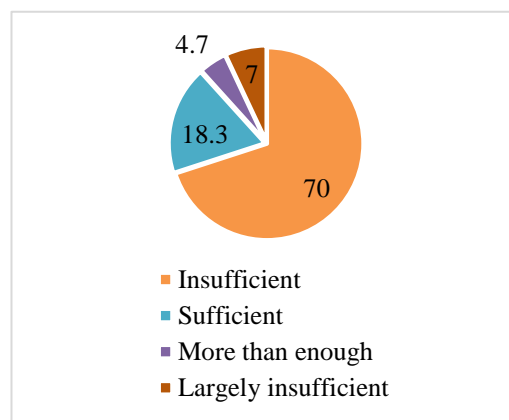


Fig. 1. Opinion of respondents on the number of hours allocated to the teaching of endocrinology.

- Learning about endocrinology

A significant percentage (78.3%) of respondents found the endocrinology course difficult to learn. Only 18% of them consider it easy.

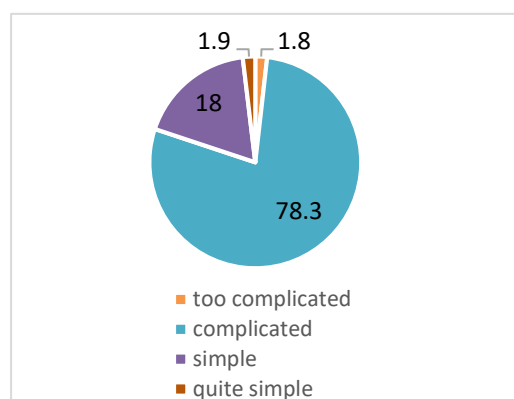


Fig. 2. Opinion of respondents on learning endocrinology.

Several (53.4%) participants in our survey believe that the educational material (handout) used in their learning of endocrinology is user-friendly. On the other hand, 41.3% of the latter consider it difficult to use.

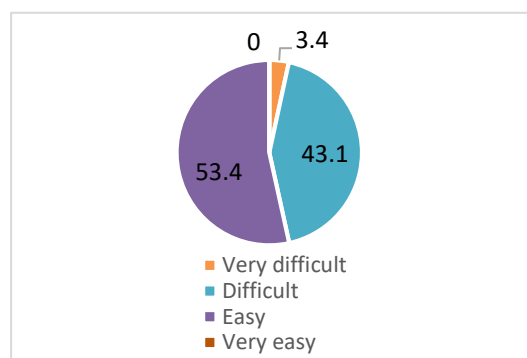


Fig. 3. Participants' opinions regarding the use of their handouts from the endocrinology course.

When asked whether the concepts in the cell signaling and communication chapter are easy or difficult to assimilate, a lot (78.8%) of the participants in this study indicated that the assimilation of these concepts is

complicated. Only 16.2% of participants believe they are easy to understand.

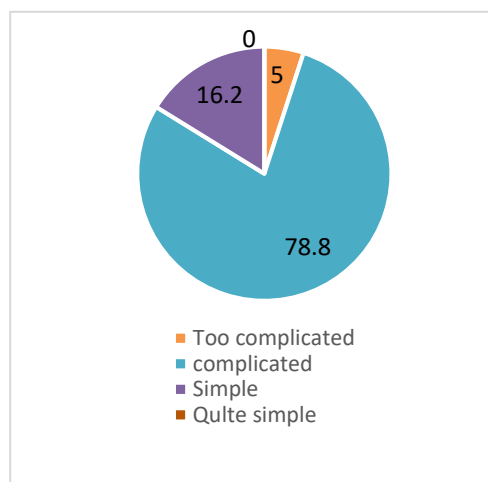


Fig. 4. Opinion of the respondents on the assimilation of the concepts of the chapter of cell signaling and communication.

For the vast majority (65.8%) of respondents, they do not carry out tutorials and practical work as part of their learning of the concepts of the chapter on cell signaling and communication. While 20% of the participants only attested to the effectiveness of the organization of practical work in this sense. However, 14.2% of the respondents to the present study rather confirmed the effective realization of the TDs.

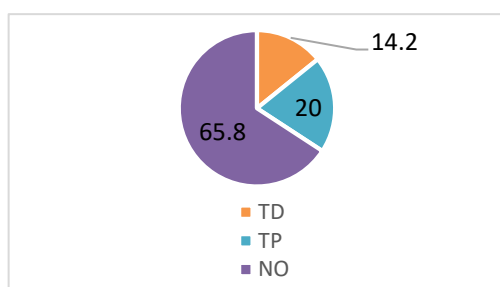


Fig. 5. Opinion of the respondents on the realization of the TD and TP as part of their learning of the concepts of the chapter of signaling and cellular communication

To the question of whether they encountered difficulties in understanding the concepts of the chapter related to the different modes of signal transmission.

In a proportion of 68.3%, the students confirm that these concepts are complicated to grasp and 21.7% of the students consider them very complicated.

On the other hand, only 8.3% of the answers indicate that the latter consider them easy to understand.

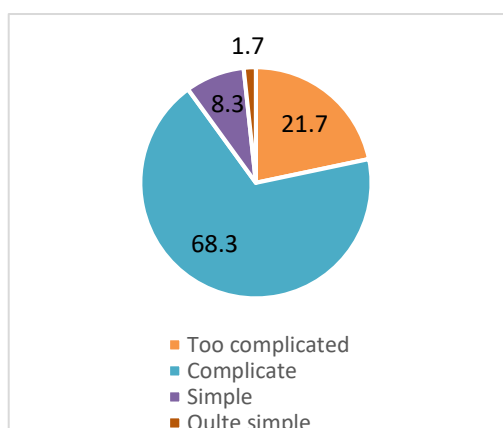


Fig. 6. Opinion of respondents on the concepts of the chapter related to the different modes of transmission of signals.

In addition, a large majority (n=62) of the participants confirmed that they did not carry out either TD or TP in the context of their learning of the concepts of the chapter related to the different modes of signal transmission. On the other hand, 5% (n=62) of them acknowledged having carried out these practical exercises. While 28% (n=62) of these participants conceded having performed these TDs.

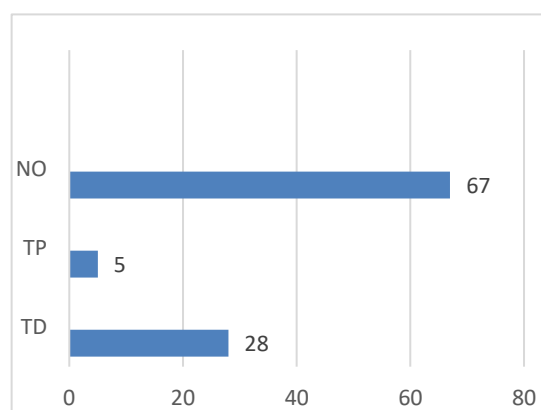


Fig. 7. Opinion of the participants on the realization of the TD and TP relating to their learning of the concepts of the chapter related to the various modes of transmission of the signals.

For a large part (23, 3%) of our respondents, the concepts of the chapter relating to the mechanism of hormonal action are complicated for students to assimilate. While 71, 2 % of these respondents confirm that they are easy to grasp by those concerned.

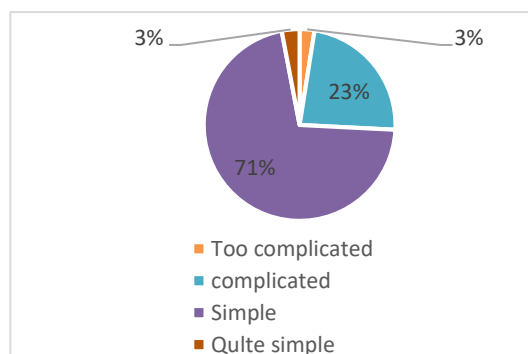


Fig. 8. Opinion of respondents on their learning of the concepts of the chapter relating to the mechanism of hormonal action

Moreover, out of all the participants, 64.4% (n=62) indicated that they had not carried out either the tutorial or the practical work as part of their learning of the concepts of the chapter relating to the mechanism of hormonal action. Only 11.9% (n=62) of the students consulted confirmed having carried out the said practicals. On the other hand, for the question of the TD realization, only 23.7% (n=62) of the people questioned answered it affirmatively.

Fig. 9. Opinion of the participants on the realization of the TD and TP relating to their learning of the concepts of the chapter related to the mechanism of hormonal action.

Most (68.4%) of the students who were interviewed in this study noted that the various concepts associated with the endocrine glands are easy to understand. Only 27.7% of these people said that these concepts are difficult to learn.

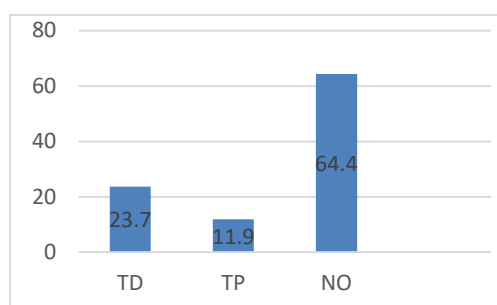


Fig. 10. Opinion of respondents on their learning of the concepts of the chapter relating to the endocrine glands

Always in the context of their learning of the different concepts associated with the endocrine glands:

- 61.7% (n=62) of the students underlined the non-realization of TP and TD;
- a tiny part of 15% (n=62) of these respondents indicated that they had done the practical work related to learning this subject;
- 33.3% (n=62) of these participants revealed that they had actually done the tutorials related to this subject.

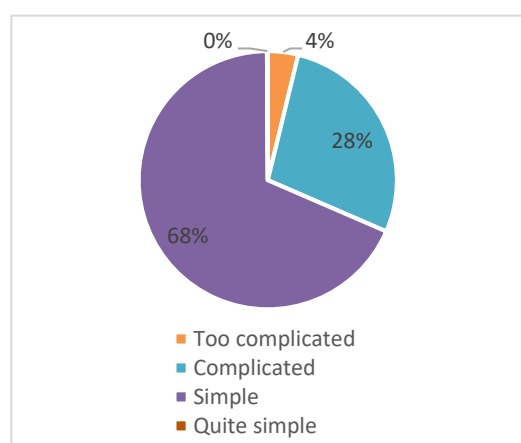
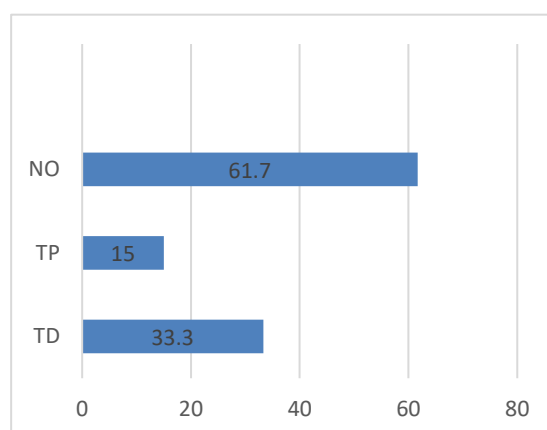


Fig. 11. Opinion of the participants on the realization of the TD and TP relating to their learning of the concepts of the chapter related to the endocrine glands.



Most participants (65.8%) noted that the concepts of hormonal regulation are complicated. And hence, they cannot be easily assimilated by the learners. On the contrary, 11.2% of these respondents consider them easy to master.

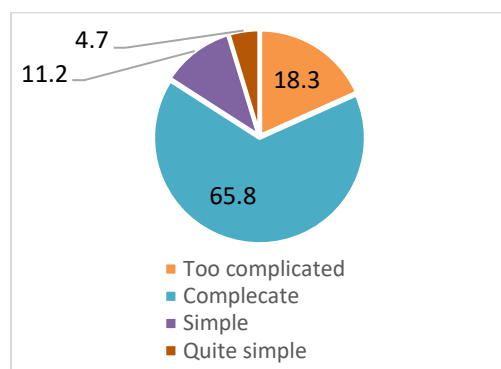


Fig. 12. Opinion of respondents on their learning of the concepts of the chapter relating to the hormonal regulation

Concerning the realization of tutorials and practical exercises related to the concepts of hormonal regulation, the results of our survey show that 62.7% ($n = 62$) of our students have carried out these tutorials. These results also show us that only 8.5% ($n=62$) of these participants carried out the Practical Work in question.

While a non-negligible rate of 35.6% of these students specifies that they have not carried out TDs and TPs as part of this learning.

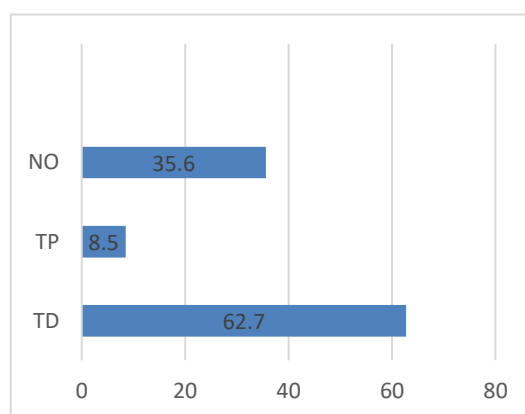


Fig. 13. Opinion of the participants on the realization of the TD and TP relating to their learning of the concepts of the chapter related to the chapter of hormonal regulation.

Nearly all (79.7%) of our students declare that resorting to the use of TDs and TPs can enable them to resolve the difficulties encountered in their learning of endocrinology. While 20.3% of the latter do not share this opinion based on the use of tutorials and practical work as an effective means of overcoming obstacles.

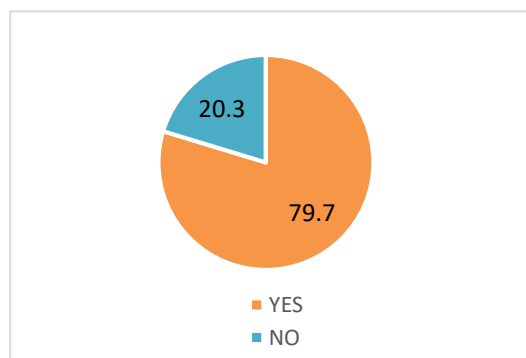


Fig. 14. Opinion of respondents regarding the use of practical work and tutorials as a means of circumventing their difficulties encountered in their learning of endocrinology.

As for the question on the proposal of a good alternative that could allow them to better understand the endocrinology course, the participants respectively proposed these different solutions: the use of animations 50% (n=62), Presentations (MS Power Point, Libre Office Impress, Sway, etc. 19.2% (n=62), the use of interactive videos 57.7% (n=62) and ICT 53.8% (n=62).

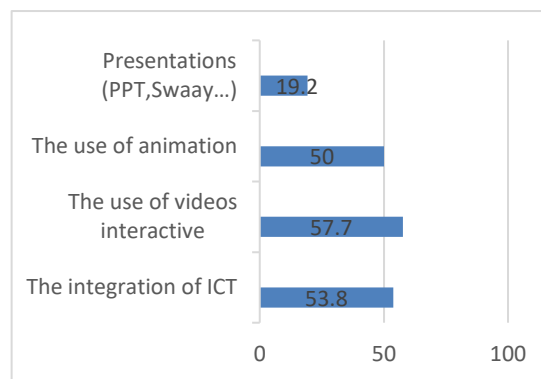


Fig. 15. Students' opinions on the alternatives that can help them better understand the endocrinology course.

5. Discussion

In this section of our study, we successively analyze the numerical results of our survey. This discussion will allow us to precisely determine the multiple flaws and constraints that confront our respondents in their learning of endocrinology. It will also allow us to formulate some appropriate recommendations with a view to improving this learning. Indeed, our research showed the following results:

A large majority (60%) of our respondents revealed that the number of hours allocated to the teaching of endocrinology in Morocco is insufficient. We think that this problem is due to the constraints of the curriculum, precisely, to the overload of the teaching program. This observation is the same in almost all schools in the world. This was already underlined by Philippe Perrenoud in his article entitled "The indispensable and impossible reduction in school curricula" (1990).

Most (58.3%) of the students who participated in our study believe that the course of endocrinology is complicated to study. This result seems quite logical to us given that the structure and content of this course are complex. In this sense, we can also mention the lack of teaching time reserved for this subject. All these elements combine to explain the difficulties experienced by the latter with regard to the study of endocrinology. Respondents (53.4%) also confirmed that the educational support (handout) made available to them as part of their learning of endocrinology is easy to use. These answers are indicative of a good didactic transposition of the content of endocrinology carried out by their teachers. Indeed, Lucien Marandola, (2017) affirms that the didactic transposition occupies a central place in the process of the elaboration of a support for a course. Therefore, it is this transposition of said knowledge that would implicitly be the basis of the satisfaction expressed by our respondents on this question.

Respondents also specified that the concepts elaborated in the chapters dealing with cellular signaling and communication, modes of signal transmission, mechanism of hormonal action and hormonal regulation are complicated to assimilate. Still in the context of their learning of these notions, the results show that these students did not carry out tutorials and practical work. This lack of experimental activities recommended in the context of this learning explains the difficulties encountered by the students. This is also what Maryline Coquidé (2022) expresses by affirming that these activities are really important since they facilitate the appropriation of the concepts studied by the learners. As for the non-realization of these experimental activities, these could be explained by the fact that the teaching-learning environment in which our respondents evolve is not well endowed materially. This situation leads teachers to multiply lectures or to purely theorize their teaching to the detriment of experimental manipulations. Consequently, learners encounter difficulties in learning and often show a lack of an empirical referent capable of helping them to better conceptualize the concepts (Babela, 2012).

Given the proven importance of these experimental activities, the students surveyed are in the majority (79.7%) asking for the use of tutorials and practical work. Indeed, they believe that the regular organization of practical work and tutorials would be a good solution that could help them learn endocrinology better. These activities are of paramount importance to students. Practical work, for example, allows learners to reach a more concrete level of understanding of the natural and technological phenomena learned in class and at the same time sharpen their

experimental faculties. The tutorials in turn offer them the opportunity to train and better acquire the concepts and techniques taught (prepas.org, nd).

So, from that point of view, the students are right to demand them.

Faced with this situation, the integration of ICT in the teaching of endocrinology proves to be a good alternative to facilitate the understanding of this subject by students. This is why they specifically suggest the enhanced use of animations and interactive videos in this regard. This proposal made by our respondents is therefore very relevant. Indeed, this digital tool at the service of teaching, makes it possible to improve the effectiveness of courses and to assimilate their content more easily (Elouardani, 2015

and Mohammed Mastafi, 2015). These results are in line with those of several studies (My M'hammed DRISSE, 20220; Aicha Tarichen et al., 2017; Cosentino, 2018 and El Hammoumi, 2022) which have shown the effectiveness of the use of digital and multimedia in the science education in Morocco and around the world.

6. Conclusion and Perspectives

Final results of this study illustrate that the teaching and learning of endocrinology in Moroccan universities faces many difficulties. Indeed, these results allow us to certify the effectiveness of our findings made in the pre-survey phase related to the development of this study. Thus, the lack of organization of practical work, tutorials and the complexity of the content of the endocrinology course have proven to be the major problems that hinder the smooth running of the teaching-learning of this subject in our faculties. To these difficulties are added other minor problems such as the non-regular use of ICT in class during the hours of teaching of the subject in question and its hourly volume. Therefore,

- Also, in order to overcome all the difficulties encountered by our students during their learning of endocrinology, we have thought deeply. We thoroughly analyzed the results obtained at the end of this research and found that the remedy to correct the situation could be:
 - A real didactic transposition;
 - A real simplification of the content and concepts of this subject to be taught;
 - An increase in the number of hours allocated to the teaching of endocrinology in our academic institutions;
 - A regular organization of experimental activities in class, namely, practical work and tutorials.
 - An effective integration of ICT, particularly animations and interactive videos.

Furthermore, it would be ideal for the Moroccan state to properly equip the learning environment offered to students in the various faculties and schools in the country.

This would allow these young people to properly learn life and earth sciences and become really very useful to Moroccan society.

To those who are in charge of designing SVT programs, especially that of the discipline concerned by our study, we ask them to develop an endocrinology program whose content would be less dense and which would place particular emphasis on manipulations. in class. This would allow teachers of this subject to better articulate theory and practice. This theory-practice articulation could also enhance the teaching and learning of this scientific discipline in Moroccan universities.

In short, we believe that this work is well worth pursuing. Indeed, the effectiveness and relevance of its final results could be useful for other researchers wishing to work on the same subject covered in this publication. This is why it seems important to us to make this work available to them.

That said, the next stage of our research will consist in developing graphic animations and designing educational scenarios capable of helping our students to fully grasp the concepts of endocrinology.

- Conflict of interests

The authors declare no conflict of interest.

- Availability of data and material

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

- Funding

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