THE USE OF CONCEPT MAPPING BY STUDENTS ENROLLED IN A SCIENCE PROGRAM: A DIAGNOSTIC STUDY

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ABSTRACT

The concept map is one of the learning tools widely used in the most developed educational systems around the world. In order to assess the use of this tool in the Moroccan context, we conducted a diagnostic study with students of a scientific field in the Faculty of Science in Rabat. Following a qualitative approach, we measured the level of mastery of this tool through a diagnostic test. To support this approach, we tried to verify the use of the concept map as a teaching tool and as a learning tool. At the same time, we attempted to conduct a concept map training to verify its impact on students. The results revealed several findings on the level of knowledge, use and mastery of the concept map by science students. These results seem to be largely exploitable in order to create a specific training device likely to favor the use of the tool on the computer support in order to reinforce the methodological competence of the students registered in the scientific fields.

Keyword: - *Concept map, Teaching, Learning, Educational technology, Metacognition.*

1. INTRODUCTION

The concept map is a tool that facilitates the organization and representation of knowledge. It is composed of concepts, usually nested in circles and boxes of various types, and relationships between concepts illustrated by lines between two concepts. On the line, words or phrases designate links that specify the relationship between the two concepts. The concept, which is designated by a label, is defined as a perceived regularity in events, objects, or records of events or objects. For most concepts, the label is a word, although sometimes we use symbols like + or %, or multiple words. Propositions are statements about an object or event in the universe, whether natural or constructed. Propositions contain two or more concepts connected by linking words or phrases that form a sentence that makes sense.

The importance of using a concept map is manifold: it allows note taking, linking concepts, and structuring thinking to achieve meaningful learning. For teachers, concept maps provide an insight about the state of a learner's learning process. These point representations can be useful in analyzing and assessing learning from one state to the next.

2. THEORETICAL FRAMEWORK

Several researchers have been interested in the use of the concept map as a learning and teaching tool. According to Audet, M (2003)[1], the concept map is often used as a tool for creativity and responsiveness. It is a tool that is]increasingly used from the primary to the university level. Moreover, this simple, accessible and flexible technique facilitates meaningful learning for learners in a variety of ways and for numerous of reasons [2]. Dansereau, D.F, (2005) [3]; Kinchin, I.M et al, (2000) [4]; Novak, J.D (2002) [5] demonstrate that students' use of concept mapping adds depth to learning. As an illustration, Akinsanya, C and Williams, M (2004) [6] used concept mapping to promote deep learning. They argue that concept maps provide a view of the understanding of a main concept through the way concepts are presented in a network of relationships rather than the isolated one. The mapc consequently, provides a schematic summary of the learning that has taken place. As mentioned by Peters, M et al. (2016) [7], the learner is therefore able to become more aware of the existing connections between concepts and thus achieve deep learning. Eppler, M.J (2006) [8] emphasizes the usefulness of the concept map as a teaching tool and in many applications. An experimental study conducted by Blackwell, S and Pepper, K (2008) [9] reveals that curriculum planning using concept maps would improve teachers' reflective practices.

3. METHODOLOGY

The objective of our study is to undertake a diagnosis on the use of concept maps by students enrolled in a scientific field.
The approach that we followed implies, firstly, a diagnostic test on the use of concept maps is intended for our target population; secondly, a questionnaire on the use of concept maps as a teaching and/or learning tool; thirdly, a training module on concept maps for the students who volunteered to take it. In order to encourage students to participate, a description of the training and the link of the registration form were sent to all students beforehand.

3.1 Target population

The target population of our research concerns an enrollment of 400 students registered in the sixth semester of the life sciences stream "plant production" at the Faculty of Sciences in Rabat during the academic year 2019-2020. All students took the diagnostic test on the use of the concept map.
We sent the questionnaire on how to use concept maps to one hundred students among the 400 of the target population mentioned before and we collected ninety-six.
Concerning the training module on the use of concept maps, we provided training on the use of the concept map using the computer tool to a sample of forty-eight students, who volunteered to follow the training. This training was given in distance.
To encourage students to participate, a description of the training and the link to the registration form were sent to all 400 students in the target population."

3.2 Description of the research tools

3.2.1 Test diagnostic

The diagnostic test consists of designing a concept map from a scientific text dealing with the subject of energy metabolism. For the evaluation of the concept maps, we used the evaluation grid developed by LaBilllois, D. (2009) [10].
The evaluation grid includes five criteria, namely: 1- the structure of the map, 2- the identification of information and concepts presented, 3- the creation of links between concepts, 4- the indication of linking words, 5- the presence of misconceptions.
The definitional domains of the above elements are as follows:
‣ The structuring of the map corresponds to the organization and hierarchization of concepts in relation to each other.
‣ Identifying information and concept correspond to the ability to locate key information and concepts at the initial media level and present them in the concept map.

‣ Creating the links between concepts corresponds to the identification of the relationship that exists between concepts.
‣ Indicating the linking words consists of specifying the nature of the verb with the link that connects the concepts.
‣ The presence of misconceptions corresponds to a misunderstanding of certain information at the concept map level.
It is important to note that there are cues that are offered to assess each criterion:

Table-1: Evaluation grid for a concept map [10]

Item rated	Excellent	Satisfactory	Unsatisfactory	Insufficient
Structure of the map	The structure is easy to understand, both by the presence of a horizontal, vertical or spiral hierarchy	The structure is easy to understand, but some parts of the map lack a hierarchy	The diagram is minimally structured.	The diagram is not structured
Identification of information and concepts	All the information and concepts presented in the document are found	Most of the information and concepts presented in the document are found in the schema	Only the minimum of the information and concepts presented in the document are found in the schema.	Several essential information or concepts are missing.
Creation of links between concepts	All links are present	The majority of links are present.	The minimum number of links that allow the understanding of the schema are present.	Several important links are missing.
Use of linking words	The linking words allow a clear and precise understanding of the concepts.	Linking words allow for a clear and precise understanding of the majority of concepts.	Linking words allow for minimal understanding of the concepts. concepts.	Inappropriate choice of linking words.
Presence of misconceptions.	There are no false or mistaken elements in the diagram . All the designs are correct.	There is one element wrong.	There are two wrong elements and this implies wrong relations.	There are more than two elements false and this implies several incorrect relations..

3.2.2 The questionnaire on the current use of concept maps in Higher education

In order to verify the modalities of use of concept maps as a teaching and/or learning tool and the knowledge of some computer tools allowing their conception, we have elaborated a questionnaire which was composed of 4 axes, namely:
Axis 1: characteristics of the population;
Axis 2: use of concept maps as a learning tool by the students;
Axis 3: use of concept maps as a teaching tool;
Axis 4: use of concept map software.
The questionnaire was administered online via Microsoft Forms.

3.2.3 Training module on concept maps

The distance learning module, is spread over a duration of ten hours divided into five sessions of one and a half hours in synchronous mode and 2h30 in asynchronous mode. The module was delivered in two weeks between April 05 and 16, 2020 via the Google Meet application.

Our "concept maps" training module was based on the template proposed by Bachelet, R (2020) [11]. The module is composed of 5 chapters (1- Memory and learning, 2- Concept map fundamentals, 3- Design approaches, 4- Implementation tools, 5- Mind Map). Each session focused on a specific chapter. A formative evaluation in the form of a quiz was proposed at the end of each chapter, with the aim of fostering learning development and informing us and the students about adjustments that should be made. The asynchronous evaluation activity consisted in the elaboration of a conceptual map related to the students' specialty. Thus, at the end of each session, the students had to answer a quiz and complete the activity in question.

The first chapter "Memory and Learning" deals with how the nervous system acquires new information, secondly, it deals with the different types of memory and lastly, it presents the different learning strategies. The main objective of this chapter is to allow the student to learn about the learning process so that he or she can perceive the interest of using a learning tool such as the concept map.

The second chapter, "Concept Map Fundamentals", first deals with the definition of a concept map, then presents the key notions of concepts, graphic language, links and propositions, and finally describes the different typologies of concept maps. The objective of this chapter is to understand what a concept map is and to recognize the types of concept maps.

The chapter on the "design process of a conceptual map" exposes the different steps of the design of a conceptual map, namely: 1, the starting question or topic, 2, the listing of concepts related to the starting question, 3, the validation of concepts, 4, the organization of concepts by level, 5, the formation of proposals by linking concepts, 6, the proposal of a prototype of the map, 7, the revision of the map. The purpose of this chapter is to provide students with a methodical process for designing a concept map.

The fourth chapter "implementation tools" presents the software and web applications for the implementation of a conceptual map: CmapTools, the software we chose to work with, Visual UNDERSTANDING and the web applications creately and Lucidchart. This chapter aims to allow students to get to grips with the software and web applications for implementing a conceptual map, it aims mainly to handle the software CmapTools as well as the design of authentic concept maps: made for sequences of specialized courses.

The fifth chapter, "Mind Mapping", presents a comparison of the concept map and the mind map. It presents some tools for implementing a mind map and aims to explain the difference between these maps in order to allow students to choose the tool according to the nature of the content to be treated and the relevance of the production.

4. RESULTS

4.1 Presentation and analysis of the diagnostic test results

It should be taken into consideration that the evaluation of the concept maps was based on an evaluation grid consisting of five criteria: - structure of the map – identification of information and concepts presented - creation of links between concepts - indication of linking words – existence of misconceptions.

4.1.1 Structure of the map

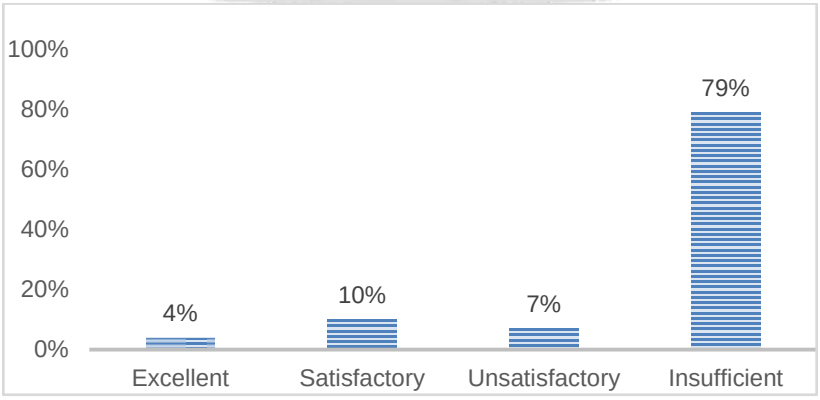

Chart - 1 : Structure of the map

We observe that 316 of the students, or 79%, have an insufficient structuring of the map. 28 students, i.e. 7%, present an unsatisfactory structuring. However, 40 students, i.e. 10%, propose a satisfactory organization and only 4% excellent.

4.1.2 Identification of information and concepts

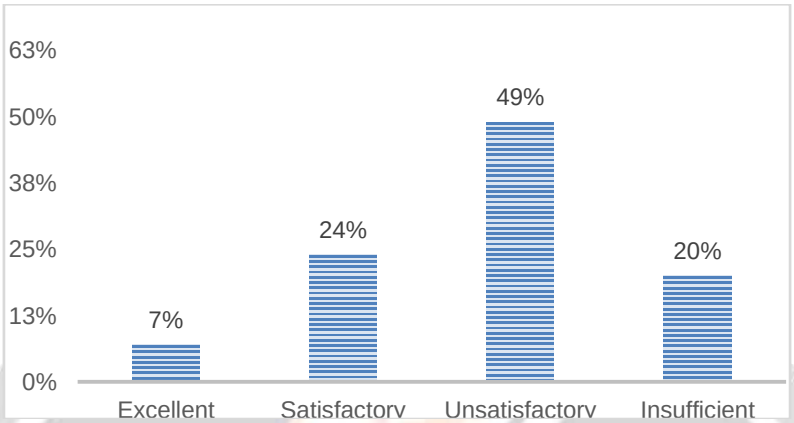

Chart - 2: Identification of information and concepts

We find that 28 students, or 7% identify the information and concepts presented in the material with an excellent level, followed by 20% with a satisfactory level, while 49% are unable to identify the connections between concepts.

4.1.3 Creation of links between concepts

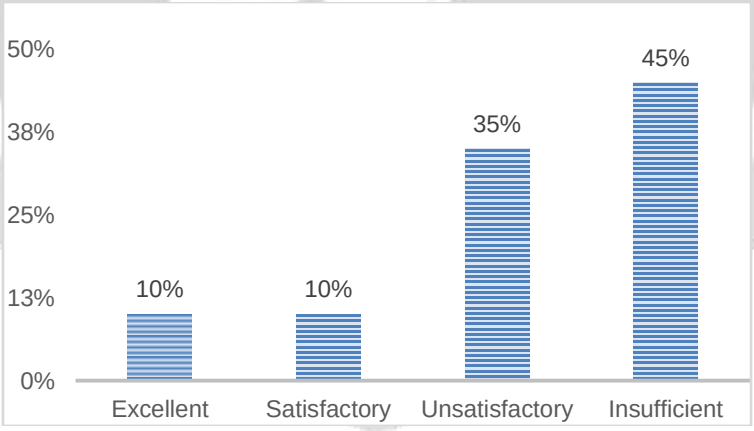

Chart - 3: Creation of links between concepts

According to the chart, almost half of the students, 45%, fail to present necessary connections between the concept (insufficient), 35% present unsatisfactory connections. On the other hand, only 10% manage to make satisfactory and excellent connections.

4.1.4 Use of linking words

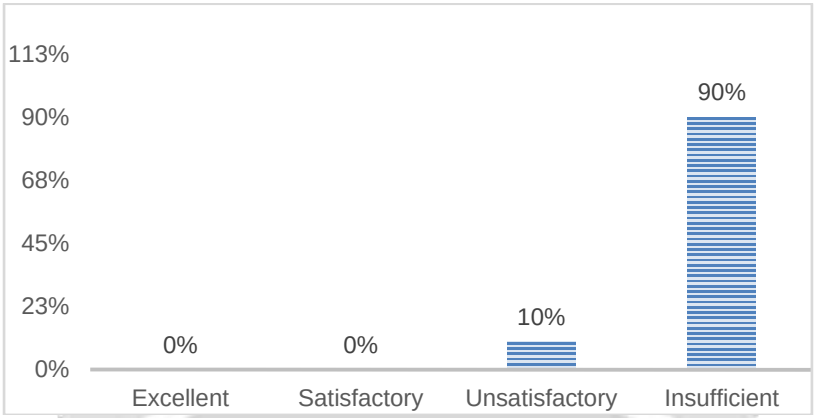

Chart - 4: Use of linking words

The results show that 90% do not present the necessary linking words (insufficient), while 10% manage to indicate some linking words (unsatisfactory). On the other hand, no student manages to present the necessary linking words in a satisfactory or excellent way.

4.1.5 Presence of misconceptions

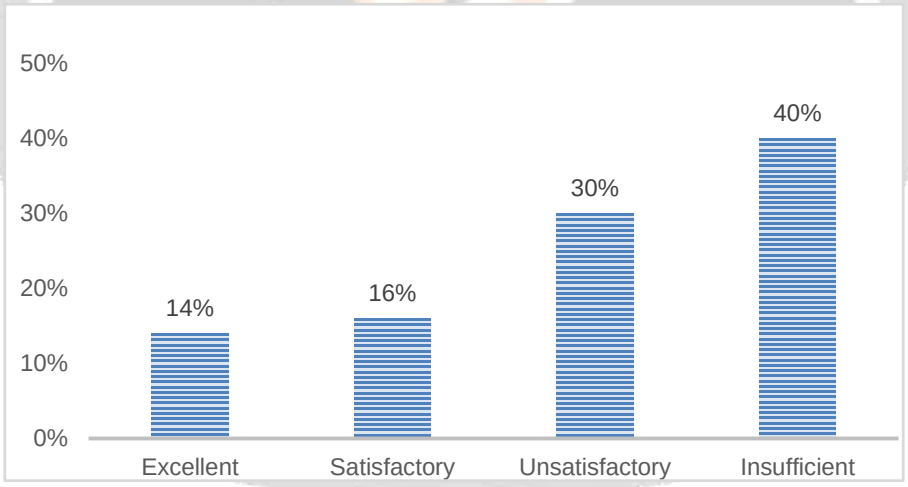

Chart - 5: Presence of misconceptions

The results show that 40% of the students had at least three mistaken designs in their map (unsatisfactory level); 30% had two erroneous elements in their design (unsatisfactory level); 16% had only one erroneous design (satisfactory level); 14% had no erroneous design or element (excellent level).

4.2 Presentation of the results of the questionnaire

4.2.1 Use of concept maps

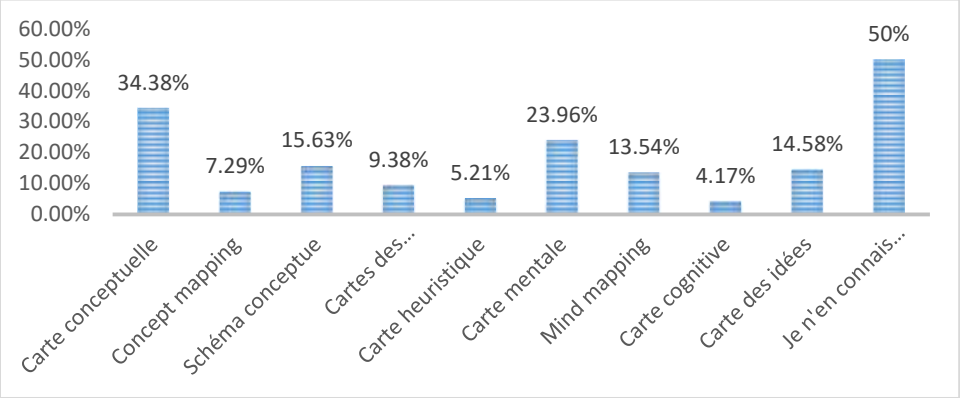

Chart - 6: Distribution of responses to the question: Do you know one or more of these tools?

The results obtained show that 50% of the students do not know any term related to the conceptmap. Among those who do know a synonym: the most known term is concept map**.**

4.2.2 Using concept maps as a learning tool

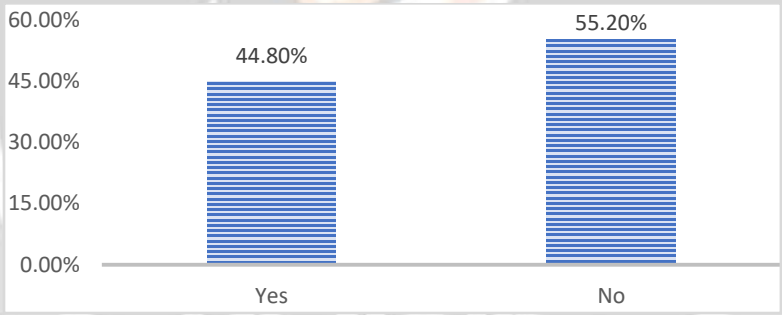

Chart - 7: Distribution of responses to the question: Have you ever used a concept map as a working (study) tool?

55.2% of the interviewed students stated that they had never used a concept map in their studies. However, 44.8% mentioned that they had already used the concept map.

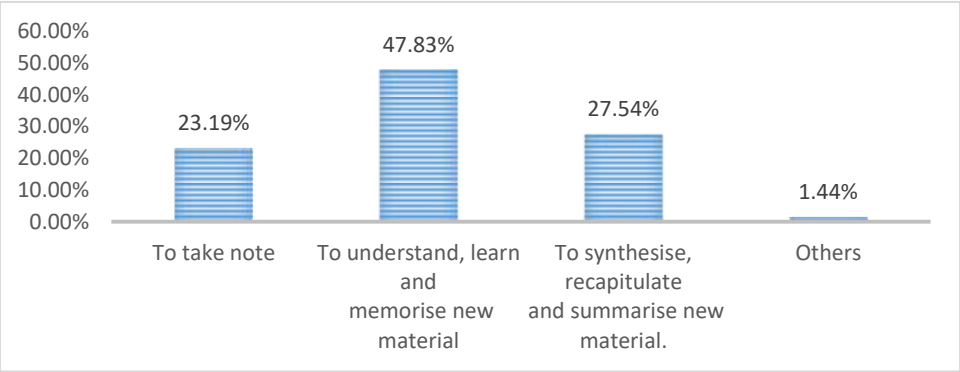

Chart - 8: Distribution of responses to the question: When do you use this tool (concept map)?

Of the students who claimed to have used the concept map, 47.83% stated that they used the map to understand, learn and memorise new material, 23.19% stated that they used it for note-taking, while 27.54% stated that they used it to synthesise, recapitulate and summarise new material.

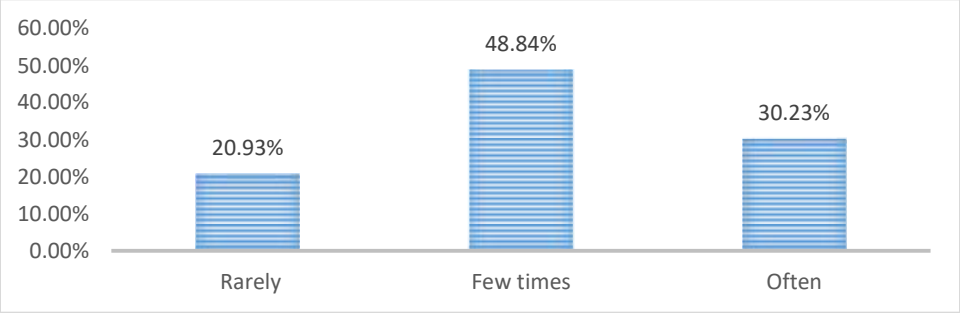

Chart - 9: Distribution of responses to the question: How often do you use this tool (concept map)?

The frequency of use of the card is occasional (a few times) for most students 48.8%.20.93% use it rarely. The mention "often" is present in 30.23% of students.

4.2.3 Using concept maps as a teaching tool

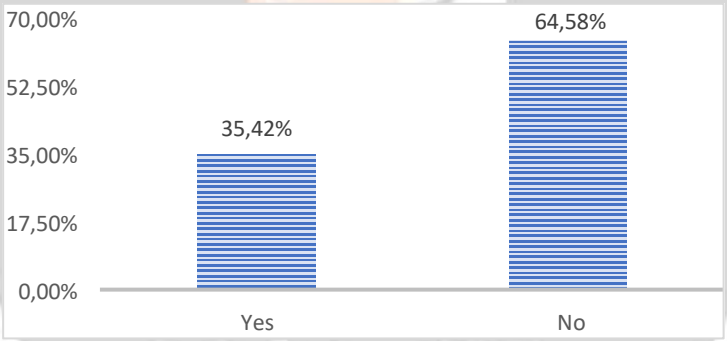

Chart - 10 : Distribution of responses to the question: To your knowledge, are there any teachers who use concept maps as a teaching tool in their lessons?

Regarding the use of concept maps in teaching, 35.42% of the students stated that some teachers use the concept map as a teaching tool in teaching. However, 62 of the students (64.85%) stated that the tool was not used by teachers in their teaching modality.

4.2.4 Use of software to develop concept maps.

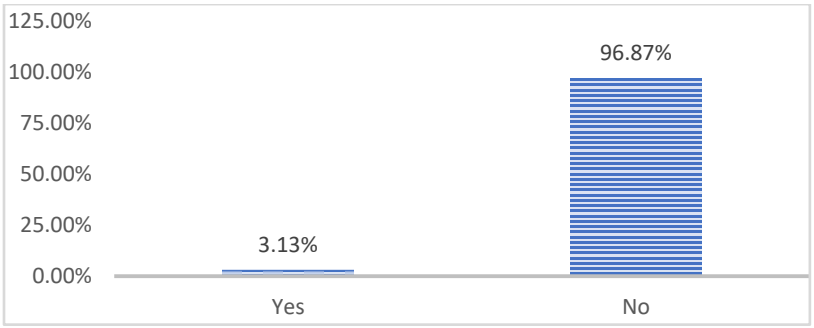

Chart - 11: Distribution of responses to the question: Do you know some software that help you create a concept map?

According to the results obtained, 96.87% of the students did not know any software to help them draw up a conceptual map. Only 3 students (3.13%) claimed to know some software.

4.3 Presentation and analysis of the test results after the concept map training-3

After delivering the training module, we achieved the following results:

4.3.1 Structure of the map

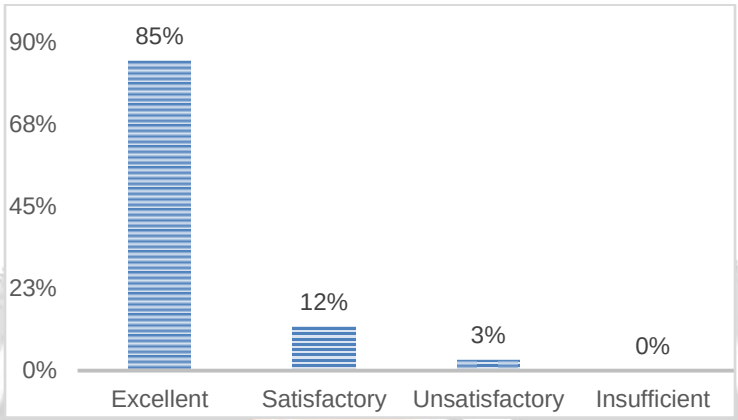

Chart - 12: Structure of the map

The results show that 85% of the students have an excellent structuring of the map; 12% of the students have a satisfactory structuring; 3% have an unsatisfactory structuring while no student has an insufficient level.

4.3.2 Identification of information and concepts

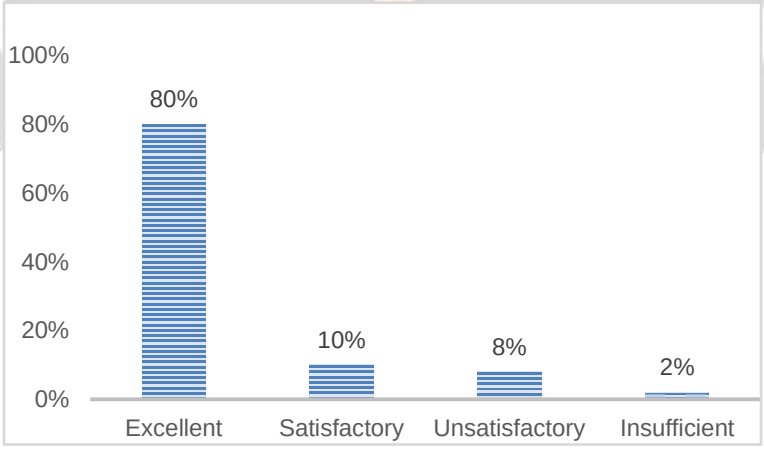

Chart - 13: Identification of information and concepts

The results show that 80% of the students manage to identify all the information and concepts presented in the initial material; 10% of the students do so with a satisfactory level. While only 8% identify the said concepts unsatisfactorily and 2% show the insufficient level.

4.3.3 Creating links between concepts

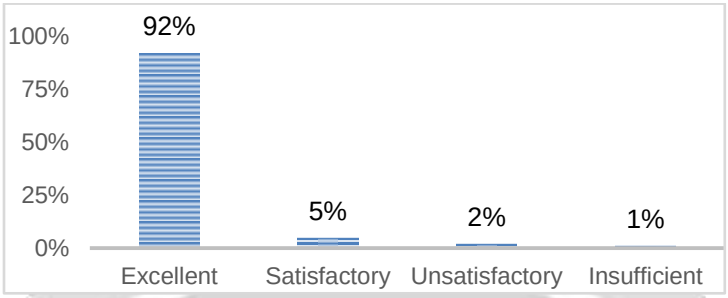

Chart - 14: Creating links between concepts

The results show that 92% of the students manage to present a well established links between concepts (excellent); 5% present that the links are satisfactory. On the other hand, only 2% fail to make a minimum of links (unsatisfactory and insufficient).

4.3.4 Indication of linking words

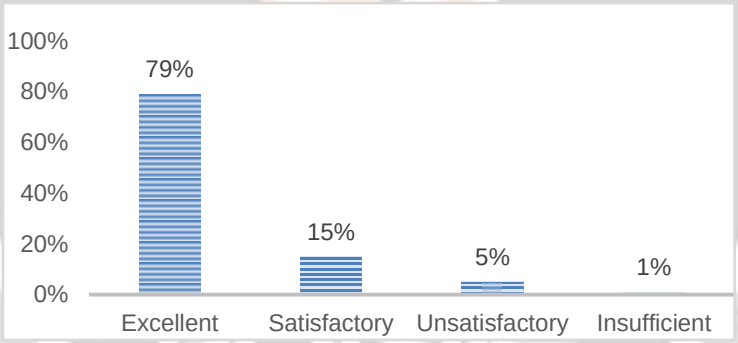

Chart - 13: Indication of linking words between concepts

According to the results, 79% have an excellent ability to present linking words, 15% have a satisfactory ability. However, 5% are unable to present linking words. Only 1% of the students were unable to suggest linking words.

4.3.5 Presence of misconceptions

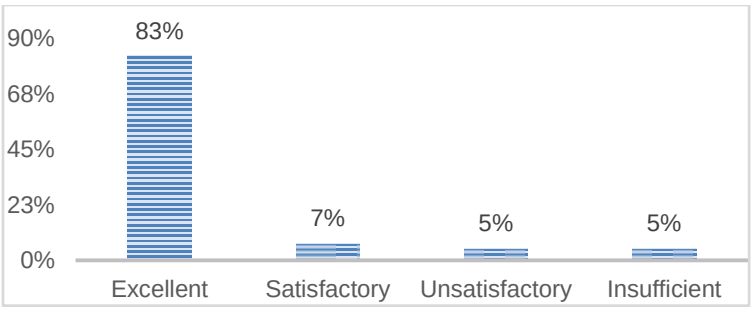

Chart - 16: Presence of misconceptions

The students had no misconceptions with a percentage of 83% (excellent level); 7% had one misconception (satisfactory level); 5% had two misconceptions (unsatisfactory level); 5% had three or more misconceptions (insufficient level).

5. DISCUSSION

With regard to the diagnostic test, the following points should be noted:
The vast majority of students in our target population, from a scientific background, do not seem to have mastered the basic elements of designing a conceptual map and this is found in all the evaluation criteria established in this sense, namely: 1- structuring of the map, 2- identification of information and concepts presented, 3- creation of links between concepts, 4- indication of linking words, 5- presence of erroneous conceptions.
The survey questionnaire in this study has found little use of the concept map both as a teaching tool and as a learning tool. In the few cases where it is used, it is limited to the comprehension dimension and hardly reaches the degree of depth that involves the synthesis mindset and thus the cognitive and metacognitive dimensions of meaningful learning [12, 13, 14, 15].
With regard to the training offered to introduce students to the use of the conceptual map, we recognize a clear improvement in map design skills for all of the above-mentioned evaluation grid criteria with the use of specific software.

6. CONCLUSION

Through this research, we have attempted to establish the state of play regarding the mastery of the conceptual map tool among a target population from a scientific course of study at a higher education level.
In the course of this work, we took the opportunity to offer a training module on concept map design which proved to be significantly beneficial to the acquisition of the basic elements of this tool.
Facing the poor knowledge, the lack of mastery and absence of integration of the concept map in the teaching methods in higher education; it is imperative to try to introduce a refined training module on computer support in order to enhance the value of this tool and to exploit it, to the extent possible, for the improvement of the learning strategies of students in scientific fields.
The main recommendations and perspectives of our work are as follows:

- Training on concept maps should be offered at the beginning of the academic year or the teacher training year.
- The organization of the training in face-to-face mode, or alternating face-to-face and distance learning.
- Increased time for familiarization with the tool and for application exercises.
- Promoting interaction during interventions.
- Proposal of practical applications on several themes.

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