Situational Map: A Strategy to Develop Critical Thinking in the Teaching of Scientific Research

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Abstract

The objective of the study is to support students in the rational, logical, and analytical process that they perform when faced with a scientific problem. This study uses qualitative methodology as its purpose is to present the strategy as learning stemming from the process of analysis, which is rooted on how to detect scientifically the research problem in the field of social sciences. A statistical analysis is made on the use and application of the diagram in a sample of 27 undergraduate students who have used the situational map in the elaboration of their theses. The trend shows that 92.6% of respondents achieved concluding their research processes of thesis work, at the planned time, and their results were consistent with their hypothesis and/or purposes. The creation of this strategy is a support for students, who have not developed their ability to think critically and establish relationships between concepts and theories in the execution of scientific research.

Keywords: cognition, epistemology, information and communication, writing, research work.

1. Introduction

University students have weaknesses in the execution of information processing, their deficit to perform abstractions in the reading of theoretical documents and the creation of constructs is very high, therefore, the work to explain the scientific findings is precarious in the process of the written transfer. It is necessary to teach students, who begin the study in scientific processes, to think in a hypothetic-deductive way, to establish discussions concerning the theories, so that they can analyze and create axioms about the studies approached in their investigations. For this, critical thinking must be applied: “Critical Thinking is characterized by being a higher-order thinking skill, in which knowledge, experiences, dispositions (attitudes or habits of the mind) and intellectual abilities are involved” (Carbogim, Oliveira & Püschel, 2016: 5), such skills are identified as analytical capacity, judging based on criteria or standards, evaluation of the credibility of the evidence, focus on accurate results.

We must teach according to how our brain learns, that is, establishing connections through, the processing of information which performs cognitive thinking tasks of higher-order. If they are properly stimulated, students will be able to implement advanced processes such as critical thinking, which is the ability to process and rework the information received for an adequate resolution of problems and decision making; demonstrating, in turn, a creative thinking,
which is recognized as the ability to generate alternative ideas and divergent solutions. It should be noted that, from this perspective, understanding concepts, theories, and constructs helps to advance problem-solving processes to create new knowledge in the different areas investigated. (Marambio, 2017: 86).

1.1 Neuroscientific studies that underpin the Situational Map Model

Life is conceived without the need for a nervous system and a brain, as for example in unicellular organisms, the biological structures in their evolution become more complex and acquire distinctive features. In the case of the human being, his brain has as a distinctive feature the ability to create maps. When the brain produces maps, it is informing itself. This information guides its motor behavior, registers its experiences and archives them to be used when required, to carry out a successful action in front of a certain stimulus.

When the brain creates maps, it conceives them as images applied to reasoning. These images are not photographic records but mental patterns of abstract thought, therefore, when we talk about mental pattern, neuronal pattern or map, we refer to the activity in the brain.

By achieving mastery of learning, maps are constructed, because interactions between the cognoscent object and the cognoscent subject are needed. The brain registers and mimics everything that happens outside of it and archives it inside. The construction of maps never stops and the mind passes to an internal reserve the experiences of the neuronal pattern, they become internal experiences that only the subject can know and interpret. “When maps are entrusted to memory and can be revived through imaginative memory, it is possible to plan and invent better answers” (Damasio, 2012: 123). In this way, the brain activates mental and neuronal processes that allow the subject to think and rationalize his actions to later concretize in learning that will allow him to generate knowledge.

Words are mental patterns that transmit ideas, they are auditory and visual images. For Damasio (2012), language flows under this neural map structure: “Likewise, printed letters […] are first processed by the reader as verbal images (visual images of written language), before the action it exerts on the brain promotes the evocation of other non-verbal images” (p. 120), which allows the mind to expose concepts that correspond to words with an understandable meaning. The mind builds itself, through the combination of real and remembered images, which are always changing, because they correspond to events taking place in the outside world.

This complex process of training cognition is favored by the appearance of neurons, which are described as body cells that carry signals and are capable of transmitting and receiving messages, developing increasingly complex and evolved mental processes that act by emitting electrical impulses to transmit the acquired information.

Figure 1. Human Neurons (Source: The Human Brain Proyect, 2020)
What is known today about the functioning of human neurons is found in the HBP registry (2020). Damasio (2012) explains about their function, the neurons evolved in their functioning and they were multiplying, making complex in the actions until generating mental processes that progressed to the conscience: “Today we know that the secret of this tendency to a growing complexity is closely related to the number of neurons available in a certain organism, and what is not less important, with the patterns according to which these neurons are organized forming circuits whose scale is increasing” (Damasio, 2012: 427), as it can be observed in Figure 1.

These studies provide knowledge about how the brain learns, and how it is possible to enhance thinking skills from the structure of a mental pattern, which allows the creation of pedagogical processes focused on cognition, generating the construction of mental maps to make higher education students who are developing research processes, enhance their scientific critical thinking.

1.2 Design of the Situational Map

The objective of the study is to support students in the rational, logical, and analytical process that they perform when faced with a scientific problem, as well as in the development of writing their inquiries. A mental pattern for the organization of ideas on the phenomenon to be investigated called “situational map” is designed. This mental pattern is composed of key elements of the structure of observation of the phenomenon under study and supports the descriptive realization of constructs, which have been elaborated from the same research to generate new knowledge.

The situational map is a mental pattern designed by the researcher, to structure research focusing on the applications that affect the interactions of the subject under observation. The application of this strategy provides a formula for analyzing reality to identify, with certainty, the central theme of the phenomenon that will be analyzed in the research, with the possibility of giving varied solutions to the problem referred to by designing development projects. Its design responds to an adaptation of the technique “The Tree of Problems” also called “Tree Diagram” (Martín, 2001: 112), a technique that is used for the analysis of the realities of social systems to identify authentic problems that affect an organizational structure, in order to develop solution strategies. Why is this diagram designed with a map structure? It is because it is proven that the brain maps out everything that learns and establishes internal relationships: “The activity of mapping is not limited to visual patterns, but applies to any pattern of sensory type in which the brain intervenes building it” (Damasio, 2010: 116).

The Situational Map is synthesized in a mental pattern that provides a structured and graphic view on the systemic development of the use of means and actions to identify the problem to be investigated, as well as to determine its solutions or achieve study objectives, allowing to organize the research process to give a logical and semantic structure. From this perspective, it is understood that logic represents the structure of human knowledge, but not reality, and semantics is interested in organizing, through language, the constructs that explain reality and thus is also at the service of the development of human knowledge (Bungue, 2004). In this way, the situational map becomes an instrument that helps the researcher to think critically about what and how to approach the research process to make its design and subsequent development.

In the situational map, the itinerary of research work to develop each instance of investigation in a precise way and without distorting the central focus of the study is captured.

Below, the Situational Map is presented, where the research project is defined and the beliefs of the context about the problem to be studied are established. The beliefs generate customs that take root in the educational communities causing authentic problems, which the researchers
will have to detect through a retrospective analysis. They will then point out the criteria that allow improvements to be made to the phenomenon under study. From this perspective, they will indicate the possible products that from the process of investigation will be contributed to overcome the problems. Then, from a prospective analysis, they will outline the innovation or renewal of the context under study.

Figure 2 shows the structure of the Situational Map and the mental process that the students must undertake to approach their research problem, following steps 1 to 6 as a sequence that allows them to construct the mental map of their research and focus on the real problem of the situated context.

![Situational Map](image)

**Figure 2. Situational map (Source: Own elaboration)**

(1) This is a mental pattern that helps the student to think scientifically about how to define the problem under study by critically analyzing the context to be investigated.

(2) They must think and reflect on the beliefs of the environment in relation to the problem they are going to study.

(3) They then identify the real problems; usually the problems arise from false beliefs that are embedded in the community under study.

(4) The criteria for improvement are the philosophical ideas or theoretical constructs, which will support the search for the solution to the problem.

(5) To consider all the possible ways to solve the problem under study.

(6) The researchers reflect and analyze critically on the context projecting the solution of the problems, exposing; how it would be? Prospective vision of the research result.
2. Method

This study uses qualitative methodology as its purpose is to present the strategy as learning stemming from the process of analysis, which is rooted on how to detect scientifically the research problem in the field of social sciences. To this end, a retrospective analysis of the teacher’s diary was carried out, since she has applied this strategy since 2009 to date in its Seminar classes. The purpose of applying this research teaching strategy is for students to focus their problem of inquiry and, in the course of the research process, not to defocus their initial problem. This allows them to advance more quickly in the course of the investigation, be accurate in their hypotheses, and specify their exploration product in a concrete proposal of innovation to the reality in the study of the field of Social Sciences.

2.1 Research design

The research design is exploratory and descriptive, because it focuses on providing new knowledge in a new model of development of scientific thought for students in higher education, who begin their research work in their undergraduate thesis. The model called Situational Map is created by the researcher to support her undergraduate students, therefore, it is a new study that does not have reports of previous studies since the researcher is developing with her research theoretical contributions, also, it seeks to “develop a concept, a model, a hypothesis for future research” (McMillan & Schumacher, 2007: 403).

2.2 Population and sample

The sample is purposeful, applying the strategy of Scenario Selection (McMillan & Schumacher, 2007), which implies that the space where the survey and observation were applied was selected by the researcher. In this case the scenario consisted of 27 students who developed their thesis in the years 2017 to 2020 at the Santiago Campus of the Andrés Bello University in the Early Childhood Education Program.

The total population corresponds to 50 students who applied the Situation Map in the Thesis work, and to whom the survey was sent. 27 of them answered, corresponding to 54% of the total population.

Table 1 specifies the number of students per year who completed the Seminary Degree in the Nursery Education Program, corresponding to the researcher’s courses.

| Year | Nº of students |
|------|----------------|
| 2017 | 12             |
| 2018 | 15             |
| 2019 | 16             |
| 2020 | 7              |
| Total| 50             |

Fuente: Elaboración propia

2.3 Data collection instrument

In order to know the students’ perceptions about the application of the Situational Map in the process of their thesis research, a mixed opinion survey with 6 indicators is designed and answered under the Likert scale, where the respondent must rate his or her answer from “Totally agree” to “Totally disagree”, an item where he or she must rate the use of the Situational
Map from 1 to 10 being 10 excellent and 1 very deficient, as well as an open question, where the student must express his or her reflective opinion about the usefulness of the Situational Map. The survey is applied via email through Google Documents.

The instrument was validated by expert judgment understanding that this process is a consultation as explained below: “instrument will be submitted to expert judgment. Experts are people whose specialization, professional, academic or research experience related to the topic of research allows them to evaluate, in content and form” (Soriano, 2014: 25).

The characteristic features of the validating judges are the following:

Table 2. Validating judges

| Judge | Degree | University                  | Position                             | Years of experience |
|-------|--------|-----------------------------|--------------------------------------|---------------------|
| 1     | Phd    | UMCE                        | Formación Integra Program Coordinator | 6                   |
| 2     | Phd    | UCSH                        | Academic Secretary                   | 1                   |
| 3     | Phd    | Durango University, México  | Research Director                    | 20                  |
| 4     | MA     | UNAB                        | Early Childhood program Director     | 25                  |
| 5     | MA     | UDLA                        | Early Childhood program Director     | 13                  |
| 6     | MA     | UDP                         | Diploma Coordinator Center for Cognitive Development | 9                   |

Source: Own Elaboration

Judges were asked to evaluate each indicator by the criteria of relevance and pertinence, according to the following table of values:

Table 3. Validation protocol for judges

1.- Does not meet the criteria
2.- Meets poorly
3.- Partially Meets
4.- Meets criteria in its main features
5.- Completely meets criteria in all its main features

Source: own elaboration
Obtaining the following result:

On average, judges validate \( r \) by 4.5, with a maximum value of 5.

Figure 3 shows the average value of each indicator, which fluctuates between 4.1 and 4.8, with indicators 9 and 10 being the most relevant.

![Mean Value of Pertinence](image1)

Figure 3. Pertinence criteria validation (Source: Own elaboration)

On average, judges validate pertinence by 4.74, with a maximum value of 5 for the entire instrument. Figure 4 shows that each indicator is evaluated by an average of 4.5 to 5, according to the evaluation table, with indicators 9 and 10 getting a higher score on relevance than on pertinence.

![Mean Value of Relevance](image2)

Figure 4. Relevance criteria validation (Source: Own elaboration)

3. Results

Below, the most relevant data obtained from the opinion survey of the students who applied the Situational Map in the elaboration of their degree thesis is presented. These students contribute their perspectives of construct in the use of the mental pattern created to support them in their processes of critical thinking in the definition of the problem to be investigated.

3.1 Opinion survey results

The results of the survey are analyzed by frequency of responses, identifying the trends of the surveyed population in relation to their opinion on how the Situational Map contributed to their thesis research work.

In response to the questions, 92.6% of those surveyed expressed complete agreement with the fact that it allowed them to organize their ideas at the beginning of the research process,
as can be seen in Figure 5. It is noted that students concentrated their response tendencies on the “Agree and Strongly Agree” options, leaving the other options blank.

![Figure 5](image)

Source: Own elaboration

Figure 5. Question 1: The construction of the map allowed you to organize your research ideas

In response to the question whether in the process of working on the Situational Map they activated their processes of critical thinking, carrying out logical analysis of realities, which implies questioning the situated context in order to accurately define the problem to be investigated, 81.5% of the population surveyed expressed that they were in total agreement with this indicator, that is, they did achieve processes of logical and critical analysis. The response trend also moves between the “Agree” and “Strongly Agree” options only, as can be seen in Figure 6.

![Figure 6](image)

Source: Own elaboration

Figure 6. Question 2: In the process of preparing the situational map, a logical and critical analysis of the reality to be investigated was carried out
One of the objectives of the situational map is to help students focus on the specific problems of the research, so that when they advance in the development of the reference framework and application of the instruments, they do not lose focus on their main research objective, and thus respond to the needs of the reality under study. In the consultation, 74.1% of the participants stated that they “totally agree” that the Situation Map allowed them to focus the search for information on the problem detected in their critical analysis, as shown in Figure 7.

Source: Own elaboration

Figure 7. Question 5: In the development of the theoretical framework, the situational map made it possible to focus the search for information on the specific problem

The participants were asked about the value they assign to the Situational Map. According to their experience of application in the construction of their degree thesis, 81.7% of the students rated it as excellent. The tendency of the population is to rate the Map between 8 and 10, with positive ratings regarding the vision of the Situational Map as a contribution to their work on the thesis. The R index indicates at its value of 0.2073 that there is a positive correlation, but with a high dispersion in the trend.

Source: Own Elaboration

Figure 8. Question 9: According to the scale of 1 to 10, how do you evaluate the situational map in the support given in the construction of your thesis? 1 being very deficient and 10 excellent
In indicator 10 an open-ended question is asked: Explain why you rated the Situation Map in that way, provide reasons. The answers are analyzed by iteration and the most frequent ones are represented in the following student records:

**E1.** Because it was a tool that made it easier for us to organize the research from the very beginning, it allowed us to point out the path we had to follow in order not to lose the research focus.

**E3.** Because the situational map was fundamental to guide us in our research and to focus on our research topic and not to deviate from the central theme.

**E4.** Because it gave us an order, allowed us to organize ideas and guide our research, from where to investigate and the limits to stay within the research topic.

**E6.** It is an excellent method to plan an investigation, it organizes ideas and key processes for the execution of the investigation.

**E7.** Although it is true that in order to sort out our thesis it was of great help to us, even so, there were many moments when we got a little lost in terms of the theoretical framework.

**E8.** The situational map is a tool that allowed us from the beginning to organize the ideas that will carry out the development of the research.

**E13.** Because the structure was very clear to the reader, and to follow a behavioral line of construction for the thesis.

**E19.** The situational map, which I have used for the third time, allows me to observe the reality and context of study from an external and objective viewpoint. In this way, the problematization is generated in an easy way, through a logical order, eliminating distracting concepts from the object of study.

**E20.** First, it helped us to identify the problem to be studied. To order the ideas, beliefs, to think which are the problems that would be authentic in our research. To search for strategies, improvements and to reach a final product. It is a very good instrument to be able to organize a research since it guides step by step.

**E21.** Because when researching, a lot of information is collected, therefore, it is easy to lose the initial direction of the research. The situational map allows you not to deviate from your central theme of study.

In the expressions supported by the participants, the usefulness in focusing and identifying the research problem, the organization of ideas and the planning of the research structure stand out.

### 3.2 Performance of students in degree seminar

The evaluations of the students achieved in the final process of the completion of their degree thesis, where they applied the Situational Map, corroborate that the mental pattern allowed them to advance in their research in the estimated time, submitting it on the planned dates. Likewise, their grades reach a percentage of achievement of 80 to 90% in a scale from 1 to 7, being the grades from 6 to 7 the maximum of approval and the grade 4 the minimum of approval. Between 1 and 3.9 are failing grades.

In 2017 the application of the Situation Map was carried out with 2 groups of graduate seminar students. Only one of them is applied the Mental Pattern of the Situational Map and is taught to work on critical thinking in the categories of perspective analysis and argumentation. The result is that the group that worked on their research process with the application of the Situational Map obtained a final grade of 6.4 (outstanding), and the control group where the mental pattern was not applied or taught had a high failure rate, as can be seen in Figure 9.
A synthesis of the averages per year is made, with the grades obtained by the 50 students between 2017 and 2020 in the Grade Seminar subject, with which it can be determined that the application of the Situational Map, as a mental pattern helps to develop scientific thinking in higher education students. This is evidenced in the achievements of their evaluations that are increasing as students acquire mastery of critical thinking skills strengthened in the application of the situational map.

Figure 10 shows that the scores increase to 6.61 in the year 2020, and the R index of correlation corresponds to 0.9907, which indicates that it shows a positive correlation, with a strong trend among the variables and a lower dispersion.
4. Discussion

According to Barrera (2019), establishing an epistemic turn involves rationalizing all the theories exposed and analyzed with a proper approach to generate a model of change or innovation in the processes being investigated. In the deepening of this analysis, a conceptual turn will be established that implies the ways of interpreting research, considered as a process susceptible of being known and of giving access to significant variants referred to its scientific constitution and of interest to create, construct and propose extensions of new studies, generate new knowledge in this case in the matter of the development of scientific thought in students of higher education. The aim is to strengthen critical thinking, to lead the student to elevated processes of his or her cognition mainly for the development of research in all areas, for which it is explained that:

With the progress of the sciences linked to education, especially the development of neuroscience, a multiplicity of theoretical analyses on learning can be found; today it is understood as mastery, the modification and use of this knowledge with the aim of transforming reality (Marambio, 2017: 85).

Marambio (2017) confirms that learning processes are conducive to the development of new knowledge and as stated by Damasio (2010), subjects learn from the progress of their brain when faced with the plasticity and modification that occurs in mental processes when the person is exposed to new information and the brain records it by creating mental maps. In this way, the brain has acquired the ability to store information in formats called mental patterns, which allows access to all knowledge accumulated throughout his life and are indelible as they are part of a metacognitive learning, processed for a long time. For this reason, the researcher modeled the Situation Map to induce the stimulation of critical thinking and make the brain of her students evolve into mental processes that generate a mental pattern of cognition and mastery of scientific research thinking.

Research results show that the mental pattern manages to give scientific focus to the mental process of students who apply the Situational Map in their undergraduate thesis research, evidenced in their high grades.

5. Conclusions

As a result, this strategy, called Situational Map, allows the researcher to achieve a continuous progression of the inquiry that produces a rigorous analytical study with internal and external validity (Reguera, 2008). The trend shows that 92.6% of respondents have achieved that their research processes of their thesis work, concluded at the planned time, their results were consistent with their hypothesis and/or purposes, and the grades obtained were between 6, 0 and 6.61. They observed that their abilities to perform data interpretation and critical analysis of the results evolved.

The creation of this strategy is a support for students, who have not developed their ability to think critically and establish relationships and analysis between concepts and theories in the execution of scientific research. Latin American schools are not training students on this field; therefore, they reach higher education with this deficit in the development of their cognitive skills.

Pedagogues raise the relevance of developing critical thinking with skills of perspective analysis, comparison and abstraction in order to generate scientists who contribute new knowledge in all areas of life and sustainability.
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