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The Effect of Practical Activities on Scientific Initiation Students' Understanding of the Structure of Scientific Articles: An Experience Report

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During the university term, in addition to graduation, some Brazilian science undergraduate students have the opportunity to join Scientific Initiation Programs (SI). Students are expected to be able to develop scientific writing skills. Based on these goals, this descriptive study aimed to investigate the efficacy of practical activities for SI students on the topic of the structure of scientific articles, using a qualitative approach via a case study. Five female students, who were aged between 20 and 30 years and enrolled in a Food Engineering undergraduate course, participated in the study. The students attended two meetings. In the first, texts that dealt with the structure of scientific articles were distributed, followed by a scientific bingo game. The second meeting focused on the creation of concept maps. The activity methodologies used allowed the SI students to remember their previous knowledge about the subject and generate new knowledge. The association between the two activities provided a better understanding of the subject. It was concluded that educators should seek new ways to introduce the understanding of topics that are part of the student's daily life and that practical activities usually generate a positive result because they are dynamic, interactive, and undertaken in groups.

Introduction

Schooling plays a central role in human development, with the educator as an intermediary in this process (Berbel, 2011). Demo (2011) describes the educator as an individual who has scientific knowledge yet can still perform those activities specific to teaching. The educator, therefore, should be a research education professional, as this is the basis of the emancipatory proposal, that is, to seek to build self-sufficient, critical, self-critical and participatory individuals through research. Furthermore, according to Berbel (2011), scientific research activities in Brazilian universities, such as the Scientific Initiation (SI) and Course Completion Works (CCW), are types of active methodologies, which comprise ways to develop the learning process in order to solve problems or challenges in scientific learning. These types of experiences are very important to enable students to grow beyond "common sense" and develop intellectual skills, from the simplest to the most complex. As stated by Seung, Choi, and Pestel (2016), scientific research activities, such as chemistry investigations, are often performed in laboratories. When introduced to this space for the first time, students can begin to understand what professionals do in this environment and what skills they will need to develop. When undertaking research, students under supervision have to acquire new knowledge and come to be able to conduct original investigations (Seung et al., 2016).

The purpose of scientific research programs is to solve the everyday problems of students or the community to which they belong. These processes aim to enable students to be active, learn new techniques and methods, and acquire permanent knowledge (Bolat, Türk, Turna, & Altinbas, 2014), as well as to be able to observe, investigate, formulate hypotheses, and collect and interpret data (Seetee, Coll, Boonprakob, & Dahsah, 2016). Franco and Pimenta (2016), based on studies by Freire (1996) and Charlot (2000), confirm that teaching activities generate better results when based on research processes. This process consists of problematizing the proposed topic, while taking into account the reality of the student, in order to provoke reflection and critical thinking. The educator, as a mediator of the learning process, should consider the student's curiosity, since this attitude can trigger questions, knowledge, and reflection.

For Capalonga and Wildner (2018), education plays the role of preparing students for the world of work. Given this fact, there is a need to consider the reality of students and the education-work relationship to create individuals who are well adapted for both their personal and professional lives. Vocational education is attuned to this perspective, offering training in both theoretical and practical skills.

However, the experience of carrying out scientific work usually happens after a student graduates. In this phase of the student's school life, there is often a lack of preparation for reading and writing scientific texts (Yamaguchi & Furtado, 2018), and Oliveira, Batista and Queiroz (2010) state that these difficulties are usually recurrent, pointing out that, frequently, not even educators have been instructed in this practice during their own academic training. Even in graduate school there are gaps in scientific writing, research, and the publishing process (O'Hara, Lower-Hoppe, & Mulvihill, 2019).

In light of this issue, the objective of this study is to examine how students may identify and learn the appropriate structure of scientific articles, based on a theoretical foundation and obtained through practical activities. Volpato (2015) brings that the publication of scientific articles in reputable journals is a way for the researcher to divulge their ideas around the world. Matte and Araújo (2012) also consider the valuable weight of article production to the resumé in standing out from other productions such as projects, summaries, and reports. However, the ability to write is still a scientific barrier in all levels of educaion. Considering this issue, can educational games and concept and mind maps contribute to teaching and learning? This type of resource in the classroom favors knowledge-building by the students themselves, in which previous knowledge is related to new knowledge (Grübel & Bez, 2006). To this end, students participating in SI were studied in the laboratory of a Brazilian public institution while reading scientific articles and creating a bingo game and concept maps.

Method

This descriptive research study utilized a qualitative approach via a case study. According to Godoy (1995), qualitative research places value on the contact of the researcher with the environment and the situation investigated, thereby taking interest in the process and not only in the results or product. Case studies can be defined as the study of particular individuals, professions, conditions, institutions, groups, or communities with the aim of establishing generalizations (Lakatos, 2017). Observation was used as the data collection technique in accordance with the author, who stated that the purpose of this technique is the acquisition of information in order to have a vision of the aspects of reality.

Five students who were linked to the Scientific Initiation Programs of a Brazilian public institution and who had developed projects in the Biocomposite and Bioprocess laboratory were invited to participate in the present study activities. In this institution, research focusing on the field of food is carried out by students at the Scientific Initiation, Master, and Doctorate levels. The profile of the participant group was composed only of females aged between 20 to 30 years. One student was undergoing her first experience with SI, while the others had previously been involved. All participants were studying Food Engineering.

Two meetings took place at the research lab itself, on May 30 and June 6, 2019, and lasting one and a half hours each. The subject matter and location of the research were chosen through an informal conversation with the campus SI coordinator and the lab supervisor, who provided the space for the activities to take place. When the supervisor was asked about the main difficulties experienced by the students in the research environment, scientific writing was mentioned, which confirmed the findings of previous research by Yamaguchi & Furtado (2018) and Oliveira and colleagues (2010).

First, an electronic questionnaire was sent to confirm the difficulty that had been expressed by the supervisor. The questionnaire comprised the following question: "What are your biggest difficulties in relation to scientific writing?" and answer options: a) "structure of the scientific article;" b) "structure of abstracts;" c) "tables;" d) "graphics;" e) "other, please describe." In this questionnaire, most respondents indicated that they found that the structure of the scientific article was their main obstacle.

Consequently, it was established with the participating students that the structure of scientific articles would be considered during the two meetings, based on the book *Scientific Articles: How to write, publish and evaluate* by Maurício Gomes Pereira (2011), and with the aim of contributing to the writing up of research carried out through SI projects. When asked about undergraduate subjects that address this type of topic, it was found that the students were offered only one module that focused on writing, and scientific methodology, which is taught in the first period of the course. Based on the initial contact made with the students, three activities were proposed: 1) a brainstorming session; 2) the creation of a scientific bingo game, and; 3) the construction of concept maps. The proposed activities sought to verify student learning through games and concept maps. Zabala (1998) emphasized that learning activities should provide different ways to relate and interact and, as an example, cites the discussion and communication parts of such activities.

First Meeting: Presentations, Brainstorming and the Creation of a Scientific Bingo Game

The first part of the data collection involved a presentation by the researcher to the students, the examination of the structure of a scientific article, and the creation of the bingo game. On this occasion, the importance of undertaking the SI experience during the undergraduate course, the benefits and knowledge it provided for comprehensive student education in the sciences, and possible future referrals, either in the job market or in graduate education, were discussed. Participation in other colleagues' research was also discussed, where new concepts, changes, and perceptions could often only be generated through the knowledge of that group of individuals.

Each student was initially asked to introduce herself by stating her name, identifying her course, and stating whether or not this was her first time attending the SI. It was found that although the undergraduate students were more involved in the practical part (experiments) than in the writing of scientific texts, they were interested in learning more about the basic concepts of the structure of scientific articles and contributing more effectively to its writing.

The researcher then informed the students about the purpose of the study and that participation was voluntary, and the five students present provided informed consent to take part in the activities. The students also signed an image use authorization form, to give consent to the images featured in this experience report.

Five articles by Maurício Gomes Pereira, published in the *Epidemiology and Health Services Journal*, were distributed. The areas of focus in each article were the summary (Pereira, 2013a), introduction (Pereira, 2012), method (Pereira, 2013b), results (Pereira, 2013c), and discussion (Pereira, 2013d) sections of scientific articles, which were chosen and divided among the participants for reading.

After reading their individual texts, the brainstorming session began, which consisted of each one of the five students exposing and explaining to the others present what they had read. This allowed each student both to express what most caught their attention and their doubts and to interact with their colleagues about their thoughts. This activity sought to investigate the reading, comprehension, and interpretation of the text in question, as well as to allow each individual to express themselves.

Following the group presentations, each student wrote five questions and answers on the topic she had presented on an A4 sheet. The researcher's guidance at this stage was for participants to ask questions that had objective answers (one word) about the section of the scientific text that had been given to them. Collective work was observed during the execution of the tasks, where those who finished first volunteered to help those who were having difficulties in carrying out the activity. All the materials needed, such as paper, rulers and pens, were made available. Subsequently, cardboard sheets were provided to make the scientific bingo game. Participants were asked to divide the space into six squares and write in each a response that was included in the list of questions and answers.

Once finished, the questions and answers were placed in a box, and the researcher began the draw of the questions. As each question was drawn and read, the students were required to mark the answer on their card in order to check if they had understood what was said in the brainstorming session sufficiently to choose the correct answer. At the end of the activity, there was one winner who had completed the entire card correctly.

Second Meeting: Construction of Concept Maps

Between meetings, the students were tasked with undertaking some research on what a concept map is and with creating their own map according to the topics of the article section they had discussed in the first meeting. The students were informed that they could research and construct the map as they preferred. One week later, a second meeting was held with three of the students in order to discuss what a concept map is, the kind of tools they had used to create their maps, whether there was a need for extra information after the presentations, and if they understood the objectives of map-making.

During this meeting, the concept maps on the structure of the scientific article were presented and discussed and a questionnaire with three open questions was distributed to identify how students evaluate the educational practices they had performed during the meetings. Open-ended questions provide freedom for research subjects to respond with their own language and voice their opinions as individuals. This questionnaire was designed to extract from the participants what they thought of the activities performed, how they conducted the steps of the activities, what were the main difficulties they encountered, and if the activities had contributed to the understanding of the structure of scientific articles. The students were asked not to identify themselves in the questionnaire to ensure confidentiality and privacy.

Results and Discussion

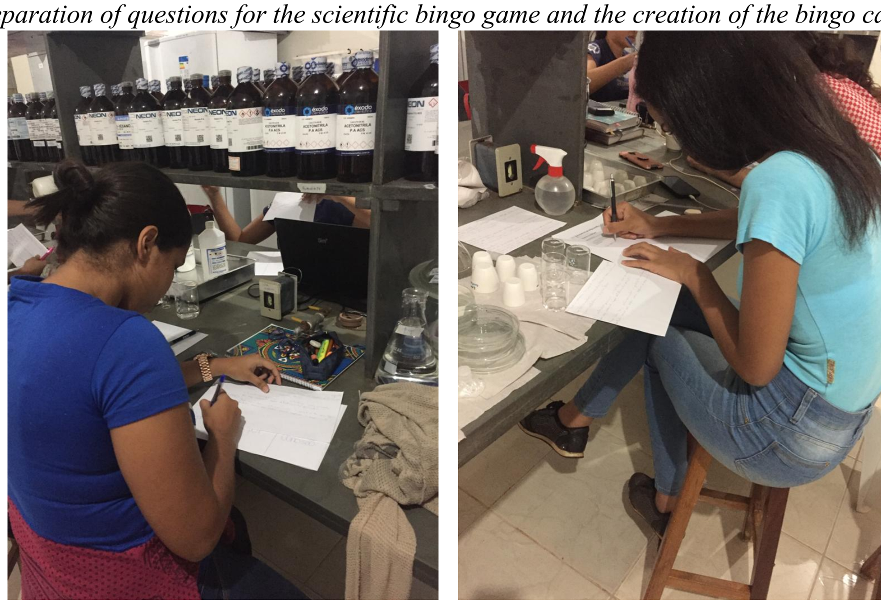
This experience report aimed to provide an understanding of the development of knowledge about the structure of scientific articles by using a target sample of undergraduate students of SI who have undertaken research in a Biocomposite and Bioprocesses laboratory. As mentioned in the method, two meetings were proposed for the appropriate development of the activities. Of the six students who were linked to the SI in the lab setting of our research, five participated in the first meeting and three in the second.

In the first activity, the brainstorm, it was observed that the session’s objectives were achieved: the students showed a good understanding of the subject matter, were able to express themselves in public, and were able to relate what they read to past experiences (Figure 1). During the initial presentation, recaps of everyday situations emerged, and the students’ previous ideas on the subject of scientific writing were confronted with new knowledge. This is in accordance with Zabala (1998), who recognized that it is essential for students to express their ideas, and from that standpoint, review their previous ideas, and allow themselves to expand their knowledge while recognizing their limitations, and if necessary, modifying it.

In the second activity (Figure 2), the preparation of the questions and answers for a scientific bingo game and the creation of the bingo cards took place. The biggest difficulty reported during the production of Q&A was consolidating each answer into a single keyword in order to be transcribed to the bingo card. During the game, moments of concentration were observed as the students attempted to understand what was being asked

Figure 1
Reading of texts on the appropriate structure of scientific articles.

Figure 2
Preparation of questions for the scientific bingo game and the creation of the bingo cards.



and to interpret the correct answer to mark on the card. Moments of relaxation and competition to complete the bingo card first were also noted.

In the second meeting, the presentation and discussion of the conceptual map of the structure of each section of a scientific article took place. Each student presented her constructed map and explained how she had made it. The following characteristics were observed in this activity: construction of both a conceptual (Figure 3) and a mental map (Figure 4 and 5), manual creation of maps, and student collaboration, even though the activity was performed outside the lab. The students explained that they had searched the Internet to obtain information on what a concept map is, but that they had also made mind maps simultaneously. Regarding the use of maps, the students mentioned that they rarely or never used conceptual or mental maps in the subjects they were studying but could understand the purpose and importance of such learning instruments.

Figure 3
Concept map on the introduction of a scientific article

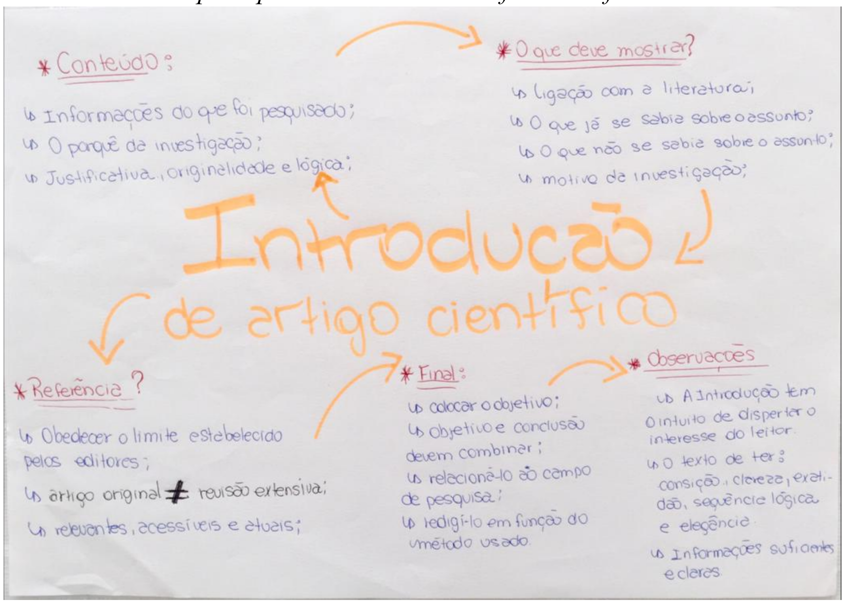
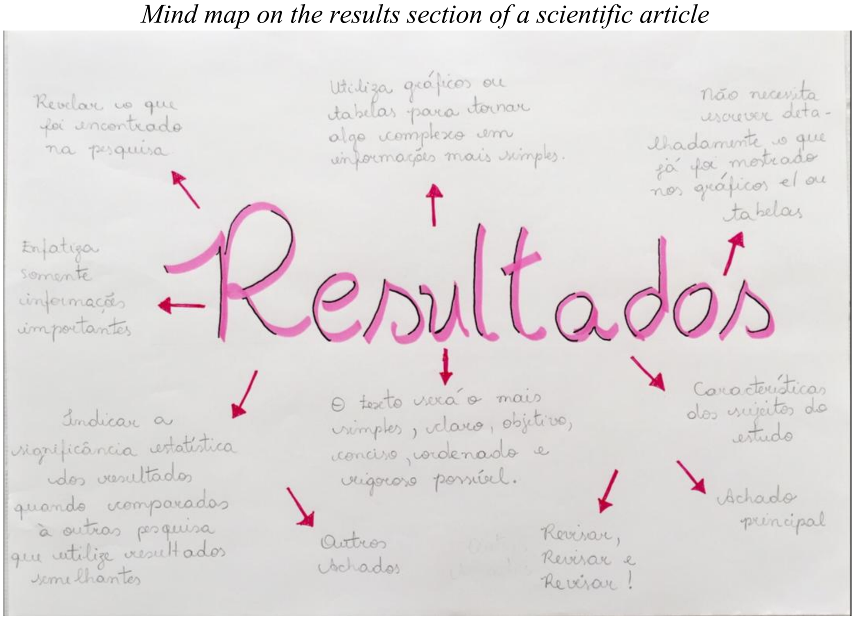


Figure 4
Mind map on the results section of a scientific article



Recognizing the differences between a concept map and a mind map is important for students since different goals can be achieved through each tool. Mind maps are graphical representations intended to express how a given subject is thought of in a quick manner and with a well-defined central topic. The central idea should be placed in the middle, and the others should be linked to the initial word only by a keyword, forming a kind of "web". This type of map is more closely related to the memorization of a topic than to the effective understanding of the subject (Silva, 2015).

Concept maps, on the other hand, are graphic constructions that aim to show the relationship that unites two concepts. To construct the concept map, students must have knowledge about a certain topic (Ministério da Educação Brasil, 2014). Silva (2015) lists some ways in which concept maps can be useful for students and educators alike. For example, for students, they can assist in the process of studying for an assessment through the process in which the student organizes and hierarchizes the subject. For educators, concept maps can be helpful when teaching something new about a subject where it is necessary that students start from a position of previously understood knowledge, seek to make connections, and establish hierarchies of concepts.

The concepts represented in the concept maps come from scientific definitions; however, Silva concluded that there is no right or wrong map, but that more elaborate maps demonstrate more detailed knowledge about the relationships between the concepts presented. Good concept maps are those that establish a relationship of concepts from the main topic while also presenting a large number of connections (Tavares, 2007).

Also, according to Tavares (2007), the act of constructing a concept map can reveal more clearly a student's difficulties with a subject, and the student will, as a result, seek other ways to answer their queries so that they can create their map. This favors the creation of meanings, and constant practice in developing concept maps will provide students with autonomous learning. To support the construction of maps, theorist David Ausubel, a North American psychologist, presented his contributions to education with the Meaningful Learning Theory (MLT), which can be taken into account in the creation of the concept map.

Ausubel emphasized learning from the cognitive perspective, which comprises the organized absorption of information in the mind of the individual that is learning. Based on this, he dedicated his attention to learning in the school environment, reinforcing the idea that student learning starts from already established knowledge, and that the understanding or proposition of a concept cannot be merely obtained through the verbalization of concepts or their fundamental elements (Moreira, 1999). An example of Ausubel's theory through the creation of concept maps in the room was the study of Aquino and Chiaro (2013), who used the construction of maps with high school students on the subject of radioactivity. After the creation of the maps by the students and discussions on the subject, it was observed that the preparation of the maps helped the students in teaching and learning concepts, in addition to directing the pedagogical practice of the teacher. This study confirms what Ausubel's theory says through other classroom studies, establishing that concept maps are an effective means of developing understanding about new topics, with specific reference to science education.

Figure 5
Mind map about the discussion section of a scientific article

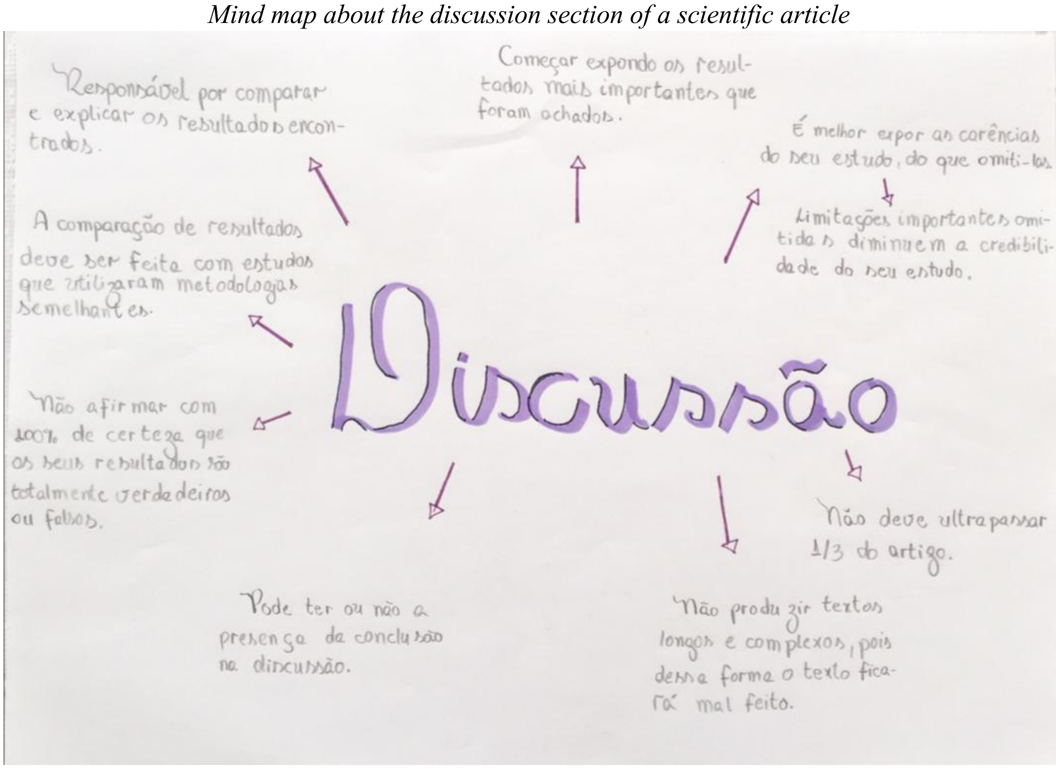


Table 1
Did the Activities Performed (Educational Practice) Help You Learn About the Structure of a Scientific Article?

Student	Comment
Student 1	"Yes, because when we discuss something in a group, we can better solidify the information exchanged, and it will be difficult to forget it so easily. In addition, I got a simpler and clearer view on how to "assemble" an article."
Student 2	"Yes, because through group discussion it is possible to better assimilate the subject. The article was easy to read and understand. [The activities] also made it possible to create a didactic concept map."
Student 3	"Yes, these activities have helped me to clarify doubts I previously had about writing and also helped me to pin down information [I had already learned]."

Table 2
What is Your Opinion on the Way (Methodology) in Which the Activities Were Conducted?

Student	Comment
Student 1	"Intelligent. When you put a group together to discuss a particular subject and to examine and memorize topics that add to our academic life, for example, we become more efficient. Congratulations!"
Student 2	"The activities were conducted in a dynamic and integrated manner. Everyone in the group participated and reviewed what was learned."
Student 3	"The methodology used in these activities was simple to carry out. It was not boring or tiring and without realizing it, we had learned new things."

Table 3
What Were the Methods for and the Difficulties of Carrying out the Proposed Activities?

Student	Comment
Student 1	"Methods: talking and discussing issues. Difficulties: the concept map, given the fact that it is not something I often use."
Student 2	"In the first activity, when asked to formulate questions about the text which needed to be answered with just one word, there was great difficulty. Understanding the subject and creating the concept map were the easiest parts."
Student 3	"The reading and the bingo dynamics were easy. The biggest difficulty was in making the map since I had never done one before, but even this was not difficult to do."

Throughout the observation of the activities in this study, a good relationship between the students was seen, and when the tasks were proposed, they demonstrated not only an understanding of what was requested, but also initiative and a spirit of cooperation. To finalize the research, a questionnaire was distributed to examine the students' perceptions of the activities carried out. Three students answered the questionnaire, and the answers obtained are in agreement with the observations made. Tables 1, 2 and 3 show the questions formulated and a transcript of the answers.

It was also observed that the students were able to work in groups and that they considered the exchange of information important. As for the way the activities were performed, the students used words such as "intelligent", "dynamic", and "simple". Regarding the methods and difficulties, it was observed that some had the faculties to expose and discuss the proposed subjects, while some found difficulty in the synthesis of a single word to make the bingo card and in the construction of the concept map.

It is observed that for the practical activities to happen the researcher teacher of the group must look for ways to interact with the students and also search for alternatives to solve basic barriers, such as scientific writing. Rushton and Reiss (2019) evaluated the changes from teacher to researcher teacher in the UK, in total 17 participants. The changes were positive because they demonstrated that teachers involved in research can be beyond the classroom professional to being a scientist, mentor and coach. They emphasize the relationship between teachers and students involved in scientific research projects, where the research teacher sees the research experience as a valuable opportunity to develop skills and knowledge with students, as well as the possibility of developing an authentic project. Therefore, the teacher has a crucial role for the engagement of students in the scientific research and the students in the teacher's life, contributing to the search for real problem solutions.

Final Considerations

The activities carried out in this study allowed SI students to understand the theory-based structure of scientific articles and to subsequently apply it in practice. Given the observations made during the study's activities and the answers obtained through the questionnaires, it can be inferred that the objective of learning the stages of scientific article construction through the bingo game and the concept or mental map was achieved successfully, in addition to being well accepted by the students.

This study might be useful for teachers who are looking for new ways of teaching content to students. The exploration of knowledge through practical activities on topics considered by some as being difficult, such as the writing of scientific articles, can be accomplished through mental and conceptual maps, as well as brainstorming in the Scientific Methodology classes.

During such activities, students feel at the center of knowledge production while actively talking and exchanging information, therefore building an environment of learning and cooperation. The activity methodologies are well accepted because they take the educator/advisor from the main role and place the student as the protagonist of their teaching and learning process.

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