Journal of Elementary Education
Volume 33, No. 2, pp.21-42

The Contributions of The Pedagogical Resources In Learning In Microbiology In Elementary Education

Jorge Gomes Goulart Ferreira*, Sirlene de Souza Coelho**, Fernanda Cristina Abrão da Rocha***,

Abstract

Practical classes are important methodological resources to promote the teaching-learning process of subjects in the area of natural sciences. Through experimentation, theory and practice are combined to promote the development of research and problematization in the classroom, stimulating students' curiosity and interest. Given the above, this study aimed to verify the contributions to the learning of students with the insertion of pedagogical resources linked to practical classes, compared only to the realization of theoretical classes. The study totaled a sample of 60 students, aged between 13 and 15 years, divided into two classes of the 8th grade of elementary school, belonging to Emília Esteves Marques State School, Carangola-MG. The classes taught were elaborated on the theme microorganism. Students in the eighth-grade class 01 were submitted to lectures presented in the form of slides, use of mockups, practical and experimental classes in the laboratory and a dynamic related to a didactic game, while students in the eighth-grade class 02, attended theoretical classes, which addressed the same content, but without making use of any kind of pedagogical resources. A prior questionnaire and a post-intervention questionnaire were used for data collection. It was noted that the use of pedagogical resources contributed positively to the teaching of microbiology, where students obtained satisfactory results compared to those who had only the theoretical. It was noted that the use of pedagogical resources made the students present more interest and curiosities, arousing greater attention, making the classes more interactive, which favored teaching-learning.

***Keywords*:** *Basic Education, Microbiology, Pedagogical Resources, Teaching-Learning*

*Professor at FAMINAS University

*** Professor and coordinator of the EAD Nucleus at UNIFAMINAS and FAMINAS universities.

Introduction

Microbiology is defined as the area of science destined to study morpho-biological aspects of organisms which are invisible to the eyes. Based on this concept, microbiology takes care of a wide group of tiny organisms, which can be found as isolated or grouped cells in different arrangements, where they present harmonic and disharmonious relationships, resulting from the interaction of these organisms with each other and with other living beings. About their cells, microorganisms can be classified as prokaryotes, highlighting the bacteria, or eukaryotes such as fungi, algae and protozoa, in addition, acellular beings such as viruses are included. These microorganisms are able to inhabit different ecosystems, some having the ability to develop even in environments with conditions that would be considered extreme and even fatal for most organisms [1,2, 3].

In elementary school, the subjects' approaches are diverse, including microbiology. The study of viruses, bacteria, fungi and protozoa stands out, reaching their biology, the ability of some species to cause diseases, the important roles they play in the environment and their usefulness for humans in various processes industrial, since, according to the National Curriculum Parameters (PCNs), students must be able to identify the different roles of microorganisms in relation to man and the environment in which they are [4,5].

Although it is part of our daily lives, the microbiological world can be extremely abstract for elementary school students, in which it cannot be perceived more directly through the senses. Probably, this apparent lack of connection between relating microbiology to our daily lives makes it difficult to learn this topic, which is of great importance [6]. However, basic knowledge about microbiology is significant to our daily lives, and this is an area that covers health, our personal hygiene, as well as issues related to the environment. It serves as a basis for making individuals more conscious. Thus, the theme deserves special attention in basic education [7].

Despite its importance, students' real understanding of the issues of microbiology is often neglected by the school community. One of the possible causes of this phenomenon refers to the complexity for the development of more dynamic and attractive teaching-learning methods [6]. It is observed that theoretical classes are still the most used teaching methodologies, in which teachers are concerned with meeting schedules, and very little with practical classes and field research [8].

The lack of adequate and more comprehensive material regarding the study of microbiology are some of the reasons for the complex development of this topic in the

context of school education, and this condition may lead to less interest on the part of the students. Several studies have shown that teaching resources are pedagogical tools capable of promoting learning in a playful and interesting way, providing teachers with current and efficient instruments, promoting significant gains in the teaching-learning relationship [9].

Studies on teaching methodologies applied to microbiology in elementary education are incipient. However, current studies on education demonstrate that teaching should not be based only on theoretical concepts obtained from textbooks, or expressed in traditional proposals for memorization, that do not contextualize knowledge theoretical with practice. It is necessary to promote the search for knowledge and stimulate the students' curiosity [9]. Applying this premise to the development of basic knowledge in microbiology by elementary school students, it is likely that practical activities in microbiology are essential for the development of learning [10,11].

Given the above, this study aimed to evaluate the contributions of pedagogical resources and realization of practical classes in the teaching-learning process of the microbiology in 8th grade classes of elementary school, at the School State Emília Esteves Marques, located in Carangola/MG.

Materials and Methods

Study design

For its execution, this study received approval from the research ethics committee: CAAE – 40941920.0.0000.5105.

To assess the contributions of the insertion of pedagogical resources linked to practical classes for student learning, in comparison with theoretical microbiology classes only, an analytical experimental study was carried out, in a sample of 62 students, aged between 13 and 15 years, divided into two classes of the 8th year of elementary school, belonging to the State School Emília Esteves Marques, in Carangola-MG, which is a public school of teaching.

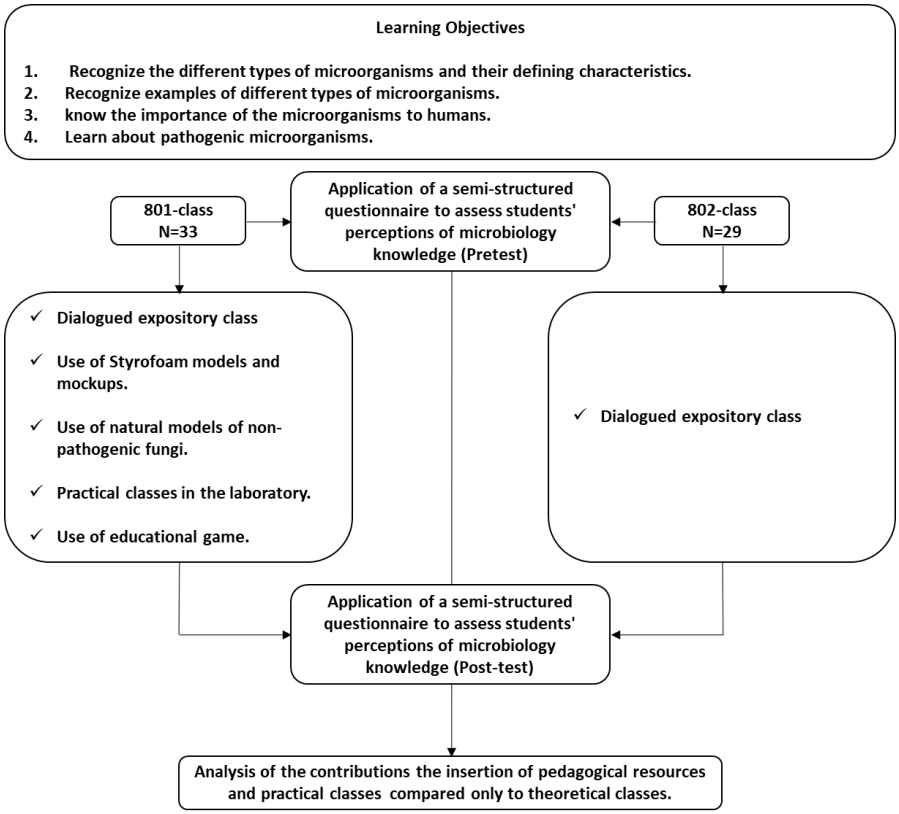
The classes were classified as 801-class, composed of 33 students and 802-class, composed of 27 students. The classes taught were developed on the theme of microorganisms: bacteria, viruses and fungi. 801-class students were submitted to expository classes presented in the form of slides, the use of models, practical classes in the laboratory and dynamics related to a didactic game. Students from 802-class attended only theoretical classes with dialogued expository class, which covered the same contents, but without making use of any kind of pedagogical resource. To assess the

students' perception of the themes discussed, a previous semi-structured questionnaire (pretest) and a questionnaire after the end of the content (post-test) were applied. A schematic of the methodology applied to achieve the objectives of this work is available in Figure 1.

The research on the teaching of microbiology was carried out at the State School Emília Esteves Marques, located in the Santo Onofre neighborhood, in Carangola-MG, which is a public school. The school has an average of 710 students enrolled in the morning period, aged between 12 and 18 years. The research was introduced in two groups of the eighth year of Elementary School, presenting a sample number of N=62 students, aged between 13 and 15 years, addressed both male and female, distributed in two groups.

Figure 1

Schematic representation of the flow designed to investigate the contributions of inserting pedagogical resources linked to practical classes for learning microbiology.



Questionnaire Application

A model of a semi-structured questionnaire was applied, addressing issues related to the discipline of microbiology for the two groups of the eighth year of elementary school, this one containing ten questions to validate the level of general knowledge of students on the microbiology. The contents covered in the questions seek information regarding concepts, basic knowledge about microorganisms and the importance of practical classes, according to the students' perception. It is reinforced that the questionnaire was previously applied to any approach to the content dealt with in the research.

Afterwards, the research was submitted to a comparative analysis between the didactics elaborated through theoretical classes together with the help of low-cost pedagogical resources, all these resources were applied only in an 8th grade group room 01 (801), and in the second group, this being the 8th grade group room 02 (802), only theoretical classes were applied. The purpose was to compare the importance of using pedagogical resources designed for students' teaching-learning. At the end of the research, the questionnaire containing the same questions as the initial questionnaire was applied again, to validate the study.

Content applied for teaching microbiology: Theoretical class with the assistance of pedagogical resources in the 8th year room 01 (801)

Following the application of the questionnaire, the steps related to the applicability of contents for the teaching of microbiology began, focused on the theme of microorganisms: bacteria, viruses and fungi. Following a schedule of activities proposed for each class.

To introduce the proposed contents on microbiology, the theoretical classes were prepared based on a material focused on the theme, Microorganisms: bacteria, viruses and fungi, and presented to students in the form of slides. As an aid to didactics in this room 01 (801), they were made with modeling clay, Styrofoam ball, colored E.V.A and gouache paints, morphological and structural forms of the bacteria, which are a support material for the teaching of microbiology. The theoretical class had the help of representative mockups for structural observation of bacteria and viruses. During the class, a microscope model was also presented to the students and its purpose was detailed, explaining each part corresponding to its functions.

In addition, the students of the eighth grade 01(801) had the opportunity to carry out practical classes and experiments, which are considered to be of low cost and easy access, covering the performance of three sequential activities, "Discovering the microorganisms", "Observing the fungi" and the dynamic "Pair-on with diseases".

The experiment entitled: "discovering microorganisms" students had the opportunity to use the school laboratory. The proposal was to cultivate bacteria in a solid non-selective culture medium [06, 27] in order to observe the growth of bacteria after a period of seven days. It can be seen that theoretical and practical classes must always go together, as a two-way street [27]. For the culture medium used in this activity, the following materials were used: Water; broth cubes; colorless unflavored gelatin; cotton swabs; and Petri plates. For the preparation, the following steps were carried out: Dissolve the broth in 100 ml of water in a pan, add the gelatin, bring to low heat and stir until the gelatin melts, do not let it boil. Cover the bottom of the Petri plates.

After the procedure to obtain the culture medium, the plates were refrigerated for two consecutive days. After this period, with the culture medium ready for use, it was then taken to the classroom and the students were responsible for choosing five places where they believed there were microorganisms. The places chosen were: "mouth", "pen", "cell phone" and "shoe´s sole" and the control group used was "clean hands". With the help of a cotton swab, it was passed in each chosen place and smeared in the culture medium. Subsequently, the plates were left at room temperature and sealed in the school laboratory, waiting for bacterial growth to carry out the practice.

In carrying out the practice "observing the fungi" students were stimulated to observe the proliferation of fungi and molds. In the classroom, students observed examples of fungi, such as wooden ears and mushrooms. For the experiment, the materials used were: Orange and a plastic container. After the seven-day period, the students made the observation and were able to analyze the growth of these microorganisms' forming molds in the orange flavedo.

Students were also invited to participate in a dynamic entitled "pair-on with diseases". The purpose of the game is for students to be able to associate correctly the diseases that are caused by bacteria, viruses and fungi with their causes, symptoms, treatments and precautions. The game contains a total of 40 booklets where 20 are the names of each disease and the other ones the characteristics. The purpose of the game is for students to be able to tabulate the diseases, respectively, forming the pairs correctly.

Content applied for teaching microbiology: Theoretical class in the 8th year room 02 (802-class)

At this stage, only theoretical classes were taught, covering the same theoretical contents as the study group, on the theme, Microorganisms: bacteria, viruses and fungi, taught for a period of two classes. This group being the research control group. The class was taught through slides, but without the aid of any other pedagogical resources for didactics.

Results and discussion

Science teaching consists of a school subject, an area of great importance for the deepening of knowledge and the connection with practices and experiences reaching the environment, human development, technological changes, among other contents [12]. According to the National Curriculum Parameters for Natural Sciences the objective of teaching Natural Sciences in Elementary School is to enable scientific and technological knowledge by developing skills that direct the student to act as a critical citizen, understanding the environment in which they live. For this, the contents must be adequate to the students' intellectual development, as well as social and cultural development, so that understands and achieves the teaching-learning [13].

Teaching practice in science and biology has always been focused on technical rationality. The professional activity guided by technical rationality had as its main objective the solution of problems through the rigorous application of scientific theories and techniques. Thus, the teaching activity was based on prioritizing the mere transmission of content to the detriment of methods that valued reflection and participation, both by teachers and students [14].

The investigative process has the role of changing the students' way of knowing about microorganisms and the teacher's practice in relation to the teaching of Microbiology: Several concepts in microbiology are abstract and therefore are considered difficult to learn in biology. This way, empirical activities using the method by investigation enable the demystification of the information that microorganisms are only pathogens, and raise awareness about the existence and importance of other microorganisms uses in everyday life [14]. In the traditional teaching model, there is very low interaction of knowledge between teachers and students, as well as it is low among students themselves, followed by the exclusive use of textbooks as the only source of effective knowledge. What prevails among teachers is a very simple view of teaching and being a teacher, which consists of transmitting scientific truths considered unalterable, which must be assimilated by students, without any concern for historical, philosophical

and/or sociocultural contexts [15]. Students need to have greater participation, interaction, and exchange of experiences within the classroom, which consequently influences and directly reflects on the teaching-learning process [16].

The National Curriculum Guidelines (DCN) define that education professionals must be able to use new technologies that encourage students to develop a critical, reflective and creative posture, considering political, social, economic, environmental and cultural aspects [17]. The development of innovative didactic strategies presents itself as important alternatives for the students´ needs. These, seen as unique and singular beings, depend on multiple learning possibilities so that they are able to solve problems [18]. On the other hand, the expansion of the range of didactic pedagogical options for the teacher leads to greater attraction of students for the contents covered, improving learning.

Faced with the difficulties found, some researchers in the field of science education have developed didactic-pedagogical materials capable of increasing students' interest in the topic, based on their use as auxiliary tools for pedagogical practice. It has been shown, for example, that by using low-cost materials, found in everyday life, it is possible to make classes more charming and motivating, including students in the construction of knowledge, favoring the assimilation of the contents taught [19].

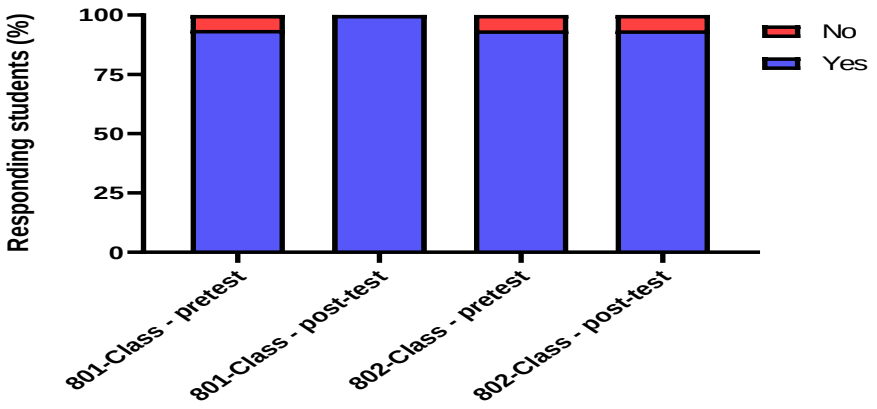
It is extremely important that teachers recognize the way of teaching has improved and that, that way of learning only through repetition does not have the expected effect on students, often resulting in failure in learning. Reflecting on this aspect, it is of great value that teachers begin to integrate new pedagogical proposals and alternatives to their teaching techniques that complement it and arouse greater interest from students. Amidst these proposals, the application of games as a didactic purpose to bring a foundation to the taught content becomes of great importance [20].

To assess the contributions of the insertion of pedagogical resources and practical classes in the teaching of microbiology in elementary school, the students' prior knowledge was initially assessed, questioning whether they knew what microorganisms are, the results did not differ considerably between the two Classes. In the pre-test, 93.75% of the students in the 801-class and 93.54% in the 802-class answered “yes” to the question. When evaluating the post-test condition in which the 801-class undergoes theoretical classes associated with the use of low-cost teaching resources and practical classes, this percentage grows to 100% of students who answered "yes" to the question, while the same 93, 54% of students in the 802-class who had only theoretical classes continued to answer “yes” to the question (Figure 02), with no change in the percentage. These results corroborate those obtained by Campos; Bortoloto and Felício in 2014 [21], since teaching resources are essential instruments that are characterized as relevant and

possible alternative to assist the teaching-learning process, providing the construction of knowledge, through search and reasoning.

Figure 02

Response of elementary school students to the question "Do you know what a microorganism is?"



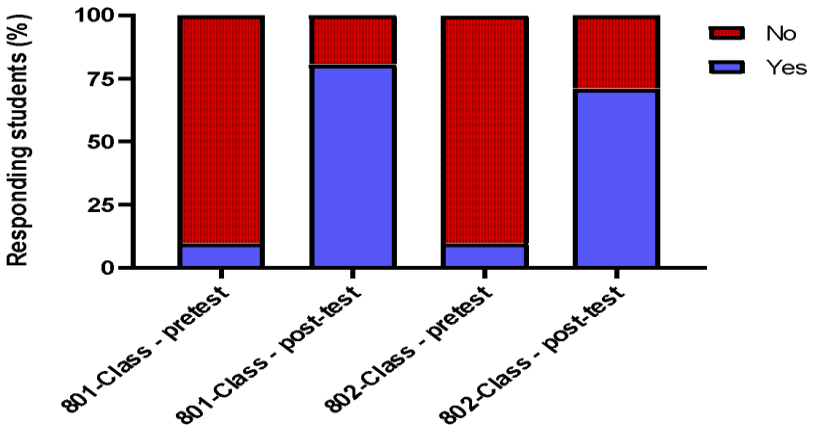
The Graph shows the percentage distribution of positive (Yes) and negative (No) responses from students in 801-class (group in which dialogued expository classes, pedagogical resources and practical classes were used for the teaching of microbiology) and 802-class (group in which only dialogued expository classes were used in the teaching of microbiology), before (pretest) and after (post-test) completion theoretical classes associated with the use of low-cost teaching resources and practical classes.

The results obtained in the pretest regarding knowledge about the different classes of microorganisms, suggest that most students have difficulty in recognizing and differentiating the different classes of microorganisms. In the pre-test, 90.33% of the students in 801-class could not mention the different classes of microorganisms or exemplify some type of microorganism, and despite 9.67% of the students claiming they knew the classes of microorganisms, only 3.33% responded correctly. In the 802-class, 90.32% answered "No" to the question, only 9.67% said they knew, however, when analyzing the answers, none of the students answered correctly (Figure 3). In a similar study carried out in 2015, Souto et al., through the application of an investigative questionnaire, observed insecurity and difficulty of students in relation to knowledge about microbiology [22]. Analyzing the post-test, students from the 801-class had a positive result, reaching 80.64% of the percentage of students who answered "yes" and correctly cite what was asked of the question. This result can be influenced by the application of the theoretical class and the help of practical resources where the contents were explored in a more playful way, the students had access to examples of viruses,

mockups of bacteria and fungi, which were introduced in the class. Compared to the 802-class, which also showed an improvement, but less than 801, the percentage was 70.96%. The main citations were “bacteria”, “fungi” and “virus” in both classes.

Figure 03

Response of elementary school students to the question “Do you know which classes of microorganisms are part of the microbiological world?”



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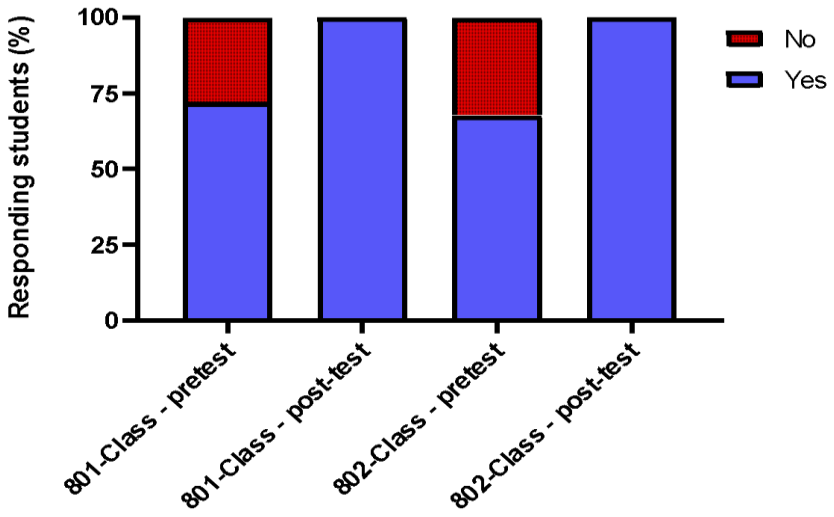
When asked about the ubiquity of microorganisms, 71.87% of the students in the 801-class and 67.74% in the 802-class in the pre-test condition, believed that microorganisms everywhere. This percentage changes when students are exposed to classes, with the results going up to 100% in both classes. This way it is possible to verify that applied didactics were able to teach students those microorganisms are ubiquitous; that is, they are present almost everywhere (Figure 04).

Figure 04

Response of elementary school students to the question "There are microorganisms everywhere?"



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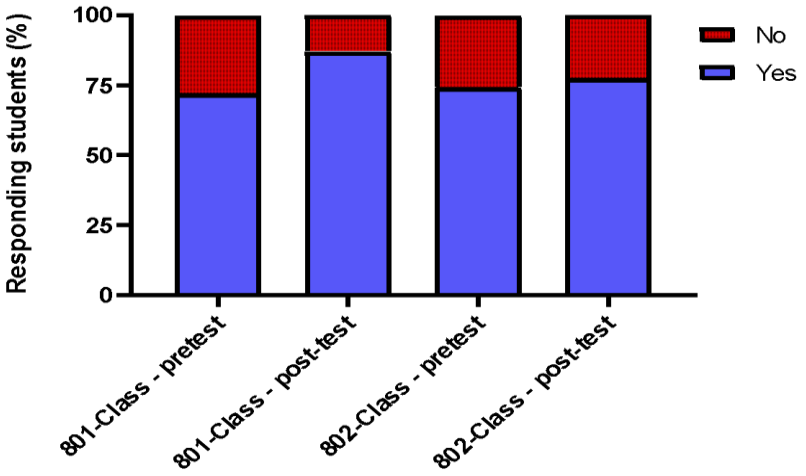
When asked if they knew if microorganisms are important for health, 71.87% of students from 801-class and 74.17% from 802-class in the pre-test condition answered "yes" to the question. When evaluating the post-test condition where the 801-class was submitted to theoretical classes associated with the use of low-cost teaching resources and practical classes, 87.10% of the students answered yes to the question, while 77.42% of the 802-class students who had only theoretical classes answered "yes" to the question (Figure 05).

Figure 05

Response of elementary school students to the question "Are microorganisms important for human health?"



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In sequence, the students were approached to answer the following question in a discussion manner: Do microorganisms have important functions in everyday life? Justify your answer. Before any approach, students from both classes had similar responses regarding the pre-test, highlighting the answers: "Yes, because they are good", "yes, because they are important", others contradict "No, because they cause diseases", "No, because they are bad", and some did not even answer the questions. However, when analyzing the responses in the post-test, it can be observed that students who were submitted to practical classes in the laboratory with insertion of pedagogical resources started to have more elaborate answers, as you can analyze in the class (801) when describing: "Yes, because microorganisms act in the decomposition of substances". "Yes, because they are present in our body and not all of them cause illnesses".

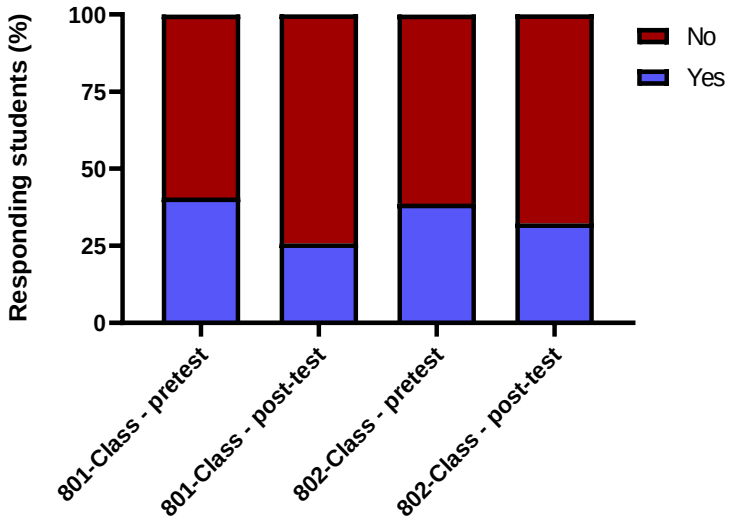
Despite the more elaborate answers, some of the students continued to report that microorganisms are not important when they describe: "No, because microorganisms are

bad, because they cause diseases". In class-802, the answers were based, "Yes, microorganisms are good", "not because not all bacteria cause diseases", however others continued to describe that "No, because microorganisms are causing diseases". However, there was no response in which it was described that microorganisms act on decomposition, which is an important characteristic and not mentioned.

When asked "Do all microorganisms cause disease in humans?" reveals that in the pre-test, 59.37% students from the 801-class and 61.29% of the 802-class with, believe that not all bacteria can cause diseases. Therefore, most students are correct, and this result improves when analyzing the post-test, increasing to 74.2% answering "no" from 801-class and 67.75% answering "no" from 802. Both groups now have the same perception, but 801 had a better command of the answer, what we can say that the theoretical class was able to expose the content, but with the help of didactic resources this can bring better results (Figure 06).

Figure 06

Response of elementary school students to the question "Do all microorganisms cause disease in humans?"



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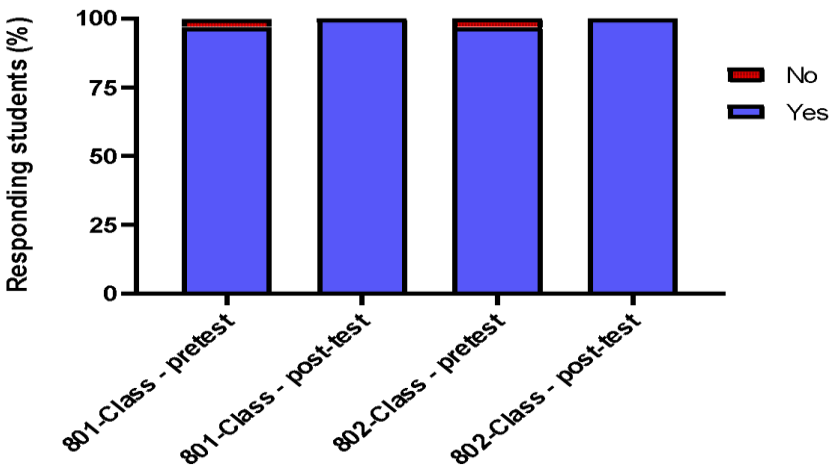
(pretest) and after (post-test) completion theoretical classes associated with the use of low-cost teaching resources and practical classes.

When questioned if they were concerned about personal hygiene, such as washing their hands and brushing their teeth, it was verified that 96.87% of the students from the 801-class and 96.77% from the 802-class in the pre-test condition answered "yes" to the question. However, this result was worrying despite being a minimum percentage of 3%, both groups answered "no" to the question, indicating that they do not have hygiene habits. When evaluating the post-test condition, 100% of students from both classes stated that they were concerned about this aspect (Figure 07). This reveals that the classes taught were important for raising students' awareness of the needs seen in their daily lives to avoid contamination and prevent certain types of illnesses. It is essential that, with the teaching of microbiology, students understand that there are microorganisms that can cause diseases, and that hygiene habits are important to prevent them [23,24].

Figure 07

Response of elementary school students to the question "Do you worry about your personal hygiene?"



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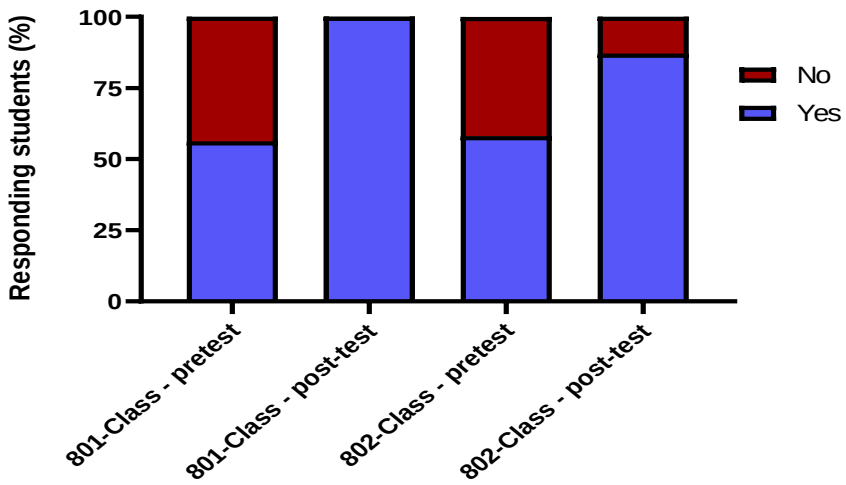
By analyzing student interest in microbiology classes, the two classes kept a percentage very close to the beginning. The classes 801 and 802 presented a result of 56.25% and 58% respectively. This result demonstrates that practically a little more than half of the classes said “yes” to the question. However, this number changes considerably after the applicability of the classes. Note that the 801-classnow has a result of 100% of interest, being of great importance for the final result in the post-test. It shows that the classes taught with all the resources used in the methodology were of great importance. In class-802, 12.9% of students still continued to answer “no” to the question (Figure 08). These data suggest that classes focused only on theoretical content can contribute to demotivation and lack of interest, preventing the development and participation of students and resulting in learning difficulties.

Figure 08:

Response of elementary school students to the question “Are you interested in microbiology classes?”



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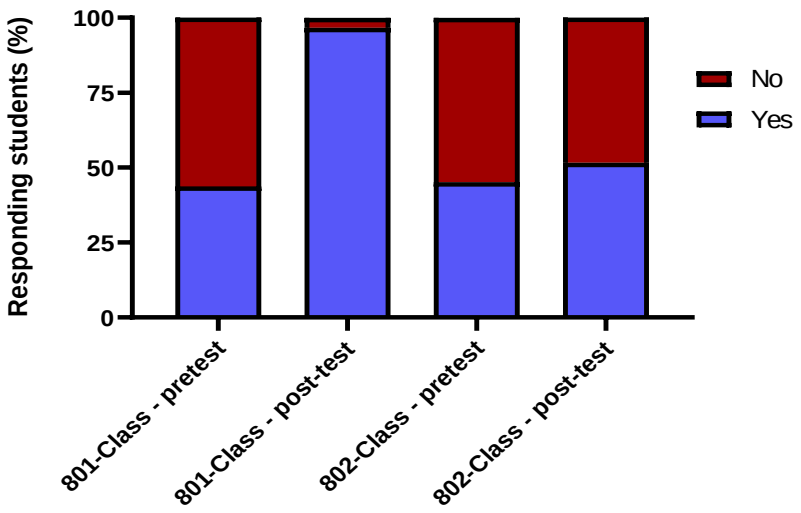
When analyzing the question where the function of a microscope is addressed, in the pre-test the two rooms showed similar results with 56.25% of the 801-class and 54, 83% of the class-802, stating that they do not know the function of a microscope. The results invert when analyzing the post-test, where the 801-class that had the applicability of a practical class in the laboratory, showed a significant improvement, reaching 96.66% of knowledge and the 802-class that only had the theoretical class still held up very lower than expected, with only 51.61% (Figure 09). These results suggest the importance of carrying out laboratory practices and the use and handling of materials, such as the microscope, for student learning.

Figure 09

Response of elementary school students to the question "Do you know the importance of the microscope?"



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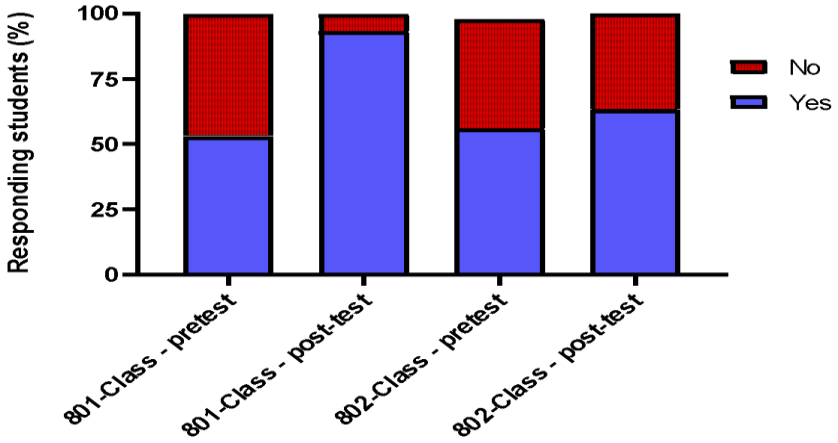
When asked if they like practical microbiology classes, the groups have similar results, with the 801-class and 802-class presenting, respectively, results of 53.12% and 56.06% of the students answering "yes" to the question. However, this value changes

when the post-test is analyzed. The 801-class rises to 93.33% and the 802 goes up to 63.3% (Figure 10). The students who carried out the practice in the laboratory presented a favorable index according to the analyzed results, in which home-made culture media were elaborated to observe bacterial growth and fungal proliferation. While the 802-class students who did not do the practice basically maintained the same concept about the practical classes. As in other authors' works in which the results are motivating after using the developed materials, simple access and applicability point to good perceptions. Students stated to know more about microbiology at the end of the class, in which the results presented are increased, resulting in improvements in teaching. The results found are reinforced by Souto et al., (2015) which demonstrated that the use of experimental activities carried out by the investigation method generates not only content learning, but also procedures and attitudes [08].

Figure 10

Response of elementary school students to the question “Do you like practical microbiology classes?



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Together these data suggest that the applicability of microbiology practices in basic education is of great importance, as it is a way to provide the student with the opportunity to understand the content taught in the classroom. As well as providing a new

scientific knowledge, arousing the students' interest, in addition to complementing the knowledge acquired during the activities performed [25]. For this reason, classes that are taught outside the common environment provide the student with situations that drive and favor the construction of learning. However, this requires previous planning and preparation, as just leaving the classroom does not result in learning more easily [26].

It is noteworthy that many educational institutions do not have the materials needed to carry out practical classes and the lack of laboratory structure negates the possibilities of providing more interactive practical classes. In this way, important concepts become abstract, so that there is a greater difficulty for students to approach and understand essential contents of Biological Sciences [14, 27].

Also, studies show that for the experimental activity to achieve its goals, it is essential that the teacher has skills and knowledge about the themes to be presented, mainly including the student in the execution and reflection of the data in an engaging way, as it is in this investigative environment that the student learns [22].

Regarding didactic games, authors state that they are of great importance in teaching and learning in an agile and fun way, both for the student who learns and also for the mediator who teaches. The game provides fun moments and also seeks to transcribe knowledge in a dynamic way [28].

Conclusion

The microbiology approached in secondary and elementary education can be performed as an additional instrument for meaningful knowledge of basic concepts through the applicability of alternative ways of teaching. Furthermore, educational games are pedagogical tools capable of providing students with fun and curious learning, providing professionals with current and efficient tools, promoting significant gains in the teaching-learning relationship with students. The data obtained in this study indicate that the use of pedagogical resources contributes positively to the teaching of microbiology, where students obtained results that were different from those who had only had theoretical classes. The use of pedagogical resources made the students show greater interest and curiosity, arousing greater attention, making the classes more interactive, which favored teaching-learning. As a relevant result, the need for differentiated methodological activities in the teaching-learning process is highlighted, as well as the dynamics of experience of the playfulness of this material, providing excellent pedagogical tools, making contemporary students more participative and interested, which is one of the greatest barriers in educational construction.

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