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MICROSCOPY AT SCHOOL: AWAKENING SCIENTIFIC KNOWLEDGE

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Abstract: Discussions related to practical classes in schools have increased considerably in recent decades. Despite so much modernity and technical-scientific advances, it is noted that the method of teaching Science and Biology is still archaic, because the conditions offered in public education are not adequate, leading to teacher discouragement. With this in mind, the aim of this project was to bring primary and secondary school students closer to the microscopic universe by expanding experimental practices, thereby increasing their level of knowledge about the activities being taught and awakening scientific thinking and greater interest in classes. Three schools were involved, with students from the 6th to the 9th grades of elementary school and from the 1st to the 3rd grades of secondary school, totaling 290 students served with microscopic practices. The students were interested and committed to the activities. There was an exchange of experiences between them, as the involvement and stimuli of the slides exposed to the microscope piqued their curiosity, allowing them to associate theory with practice.
Keywords: Interdisciplinarity. Practical teaching. Quality education

INTRODUCTION

Discussions related to practical classes in schools have increased considerably in recent decades, with researchers in the field of education looking for improvements that will facilitate the teaching-learning methodology. Experimental practices should be part of students' lives from an early age, as a way of encouraging them to research certain phenomena present in everyday life (ARAUJO et al. 2016).

According to De Roberts (1999), microscopy is defined as the part of the natural sciences that studies microscopes and their use in observing and visualizing structures that the human eye cannot see.

Robert Hooke's first visualization of the cell in the 17th century opened the door to the first concepts of cell theory. The high-resolution images provided by the microscope became associated with scientific knowledge. For these reasons, microscopy techniques, their applications and the enormous importance of the knowledge added by their use, have aroused great interest among researchers (GRAFITT, 2021).

Experimental classes are essential for students to have efficient and structured learning in various courses, especially in the area of Science and Biology, because in this type of class students handle microscopes, witness phenomena and organisms that cannot be observed with the naked eye. In addition, in practical classes, students evaluate results, test experiments and thus exercise their reasoning and are encouraged to challenge themselves (BEREZUK; INADA, 2010)

The use of practical-experimental lessons in science and biology content can make lessons different and attractive, favoring a more dynamic and enjoyable process. In addition, the use of experiments and direct observation of biological elements are indispensable for scientific training at all levels of education (SOUZA, 2013).

According to Interaminense (2019), for some educators, practical classes are more laborious and need to be very well planned, as well as requiring a greater workload than usual, which is why educators do not use practical classes.

Today, in the middle of the 21st century, despite so much modernity and technical--scientific advances, the method of teaching science and biology is increasingly archaic and this does not always result in satisfactory, quality learning. The conditions offered in public education are inadequate; there is still a lack of laboratories, microscopes, glassware, reagents and trained technical professionals to assist teachers in their practices, which discourages them from teaching. This is evident in Rondônia's public schools. A few schools even have laboratories, but there is a lack of microscopes, glassware, reagents, dyes and, above all, trained technicians in the area, which leads to students' lack of interest in theoretical classes.

According to Oliveira (2021), extension activities fulfill an important social role by bringing scientific knowledge or technical support to the community, in addition to participation in academic activities, bringing the population and the university closer together.

Extension is a prominent source of disseminating information produced at the university, as well as generating new knowledge in a democratic way, providing opportunities for citizen education, cooperating with the construction of a fairer and more equal society (SANTOS, 2012).

However, the aim of the project was to bring primary and secondary school students closer to the university by means of extension with experimental practice activities using the optical microscope, and thus broaden the level of knowledge about biological samples viewed under the microscope, thereby awakening scientific thinking in students and increasing their interest in classroom lessons.

MATERIAL AND METHODS

The university extension actions, through the project "Microscopy at school: awakening to scientific knowledge", were developed from October 2023 to December 2024, involving students from the Federal University of Rondônia - Presidente Médici Campus, and Science and Biology teachers from public schools, namely: Escola Estadual de Ensino Fundamental e Médio Dona Benta, Escola Estadual de Ensino Fundamental e Médio Emburana, both in the municipality of Presidente Médici, and Escola Estadual de Ensino Fundamental e Médio Carlos Gomes, in the city of Cacoal. The students were elementary school students, from 6th to 9th grade, and high school students, from 1st to 3rd grade. Visits took place every month, with an average class size of 20 students. The time spent at the school was four hours.

In the classroom or school laboratory, two microscopes were positioned, one on each table with two chairs, where the students sat to observe the biological material under the microscope. After viewing the slides, the pairs were exchanged so that all the students could see each slide with the biological sample. The methodology used to carry out the activities was based on Monteiro and Alves (2012) with modifications.

The biological samples chosen for observation under the microscope were collected beforehand and taken to the school in small labeled bottles, with the exception of the epithelium of the oral mucosa and the hair, which were collected by volunteer students. All the experimental practices worked on are part of basic Science and Biology content in schools.

The biological samples selected and worked on in the schools were hairs. This practice consists of removing a strand of hair, cutting it into small pieces, placing it on a slide with a drop of water and covering it with a coverslip, after observing under a microscope

Epithelium of the cataphyll of the onion (*Allium cepa*): in this preparation it is recommended to detach a piece of the cataphyll from the inside of the onion, place it on a slide containing a drop of methylene blue dye and cover it with a coverslip. The cell wall, cell shape, nucleus and nucleolus can be observed under the microscope (BALTAR, 2006).

A practical experiment was also carried out on the epithelium of the onion cataphyll to observe osmosis. A piece of the cataphyll was detached from the inside of the onion using curved tweezers. The sample was placed on a slide containing a drop of hypertonic solution and then covered with a coverslip. It was possible to observe osmosis in the plant cell (plasmolyzed cell).

Human buccal epithelium: the preparation of this practice consisted of removing superficial cells from the epithelium of the buccal mucosa using a cotton swab. The biological material was placed on the slide and spread out with a cotton swab, after which a drop of methylene blue dye was . The nucleus and shape of the cell were observed under the microscope. Student volunteers donated the buccal mucosa cells and made the slides.

Potato starch (*Solanum tuberosum*): the sample was prepared by cutting thin slices (transparent) using a razor or scalpel blade, and placing the cards in a watch glass with distilled water to make it easier to choose the most transparent cut; the tissue was removed with tweezers and placed on a slide and a drop of methylene blue dye was added. The morphology of the starch grain present in the potato, the cell wall and the polygonal shape of the cells can be observed (BALTAR, 2006).

Fish pond water: a plastic pipette was used to take a sample of the water and a drop was placed on a slide, covered with a coverslip. This slide showed rotifers, daphnia, insect larvae, cyanophycean algae (prokaryotes) and chlorophycean algae (eukaryotes).

On the leaf of *Tradescantia pallida purpurea*, a sample of the epidermis of the abaxial part was removed with tweezers and placed on the slide and a drop of distilled water was added, then covered with a coverslip. Stomata and chloroplasts could be seen.

The slides were mounted in front of the students so that they could get to know the procedure better. The basic slide mounting procedure was used, where the fresh biological sample was placed on the slide and a drop of water or dye was added to it. The sample was covered with a coverslip and observed under a microscope.

Two slides of each biological material were prepared and one was placed in each microscope. The students were organized into two groups so that everyone could see the structures under the microscope

RESULTS AND DISCUSSION

The project involved three public primary and secondary schools. The Dona Benta school served five elementary school classes, from 6th to 9th grade, and three secondary school classes, 1st, 2nd and 3rd grade. The Emburana school was attended by five elementary school classes, from 6th to 9th grade. At the Carlos Gomes school, five high school classes were attended, only the 3rd years. In total, 290 students were involved, divided into 18 classes, 10 of which were elementary school classes and eight secondary school classes.

On each visit, the extension students began by discussing the microscope with the students, explaining its optical and mechanical parts and how to handle it. They also discussed how the biological samples were collected and how they would be used.

the procedures for making the slides for observation under the microscope. The students were always invited to take part in making the slides, as a form of motivation and with the aim of involving them in the experimental practices (Figure 01).

Figure 01: Orientation on the optical microscope and how to make the slides. Sixth grade students at Emburana school. **Source:** authors' archive (2023).

According to Monteiro and Alves (2012), by handling the equipment, participating in the process of preparing slides for microscopy and observing micro-organisms and other structures under the microscope, students realize that what is shown in class and in the textbook has applicability and can be an interesting activity to carry out.

Slides were prepared from eight biological samples. In the hair practice, the students were invited to donate the hair, prepare the slide and look at it under the microscope (Figure 02 - A). There was a lot of interaction between the students and the UNIR staff. It was observed that the object analyzed aroused a lot of curiosity and questions, thus showing interest and involvement in the activity.

When practicing the epithelium of the onion cataphyll (*A. cepa),* the students carefully observed the preparation of the slides, and enthusiastically observed the plant cell under the microscope, where they looked at the shape of the cell, the cell wall, the nucleus and the nucleolus. After explaining how the cell wall is formed and its function for the plant, the students were asked what the function of the nucleus was. The answer was "to store the genetic material, the DNA" (Figure 02 - B).

A drop of hypertonic solution was added to the same slide and the students observed osmosis in the plant cell. The plasma membrane detached from the cell wall, showing plasmolysis, a shrinking of the cell volume, because the cell lost a lot of water to the external environment

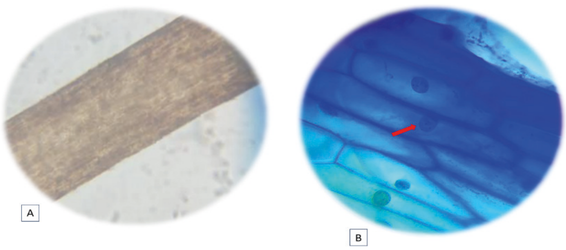

Figure 02: A) Strand of hair observed under the microscope; B) Onion cells showing the cell wall and the obvious nucleus (arrow). **Source:** authors' archive (2024)

To observe the cells of the oral mucosa, two students were invited to donate biological material. The buccal mucosa cells were collected with a cotton swab and slides were made with a drop of methylene blue to better visualize the structures. The students observed that the oral mucosa cell was smaller than the plant cell, that it had no cell wall and that it had an obvious nucleus. When asked about the difference between the plant cell and the animal cell, the students were unanimous that the difference between them was the "cell wall". (Figure 03 - A, B).

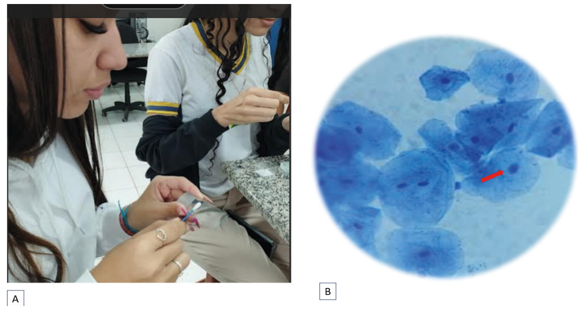

Figure 03: A) Third-year students preparing a slide of the oral mucosa epithelium. B) Oral mucosa cells with evident nuclei (arrow). **Source:** authors' archive (2024).

When practicing potato starch (*S. tuberosum),* the academics explained to the students that starch is a reserve substance produced by the plant during the process of photosynthesis that takes place in the leaves. Starch is the energy source for plants and animals alike. The slides were then prepared using a thin slice of potato tuber. A drop of methylene blue was added to the sample to better visualize the starch grains (Figure 04 - A).

The leaf of the purple ragweed (*T. pallida purpurea)* is often used in undergraduate cytology and cell biology classes to observe its tetracytic stomata. Under the microscope, the subsidiary cells, stomata and chloroplasts are evident (Figure 04 - B). The slides were made and the stomata and chloroplasts were observed under the microscope. When asked about the function of chloroplasts, the entry of CO_2 and the exit of O_2, in the plant's respiration process, it was noted that the students were involved in the subject, associating theory with practice.

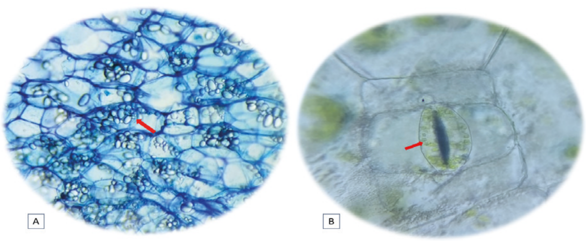

Figure 04: A) General view of potato cells containing starch grains (arrow); B) Stomata with chloroplasts evident inside the cells (arrow). Note the stomata surrounded by four subsidiary cells, characterizing a tetracytic stomata. **Source:** authors' archive (2024).

In the schools where the project was carried out, many students live in rural areas and many families have fish ponds for growing tambaqui, a source of protein in their diet. The water in the ponds attracts the students' attention because it has a greenish color. Based on this observation, a practical was set up for observing fish pond water. The sample was collected containing organic matter in order to identify a greater diversity of phytoplankton and zooplankton.

The students began this practice by explaining the importance of preserving water resources for the life of living beings. With regard to fish ponds, they emphasized microalgae and their importance as a primary producer in the aquatic ecosystem. With regard to zooplankton, he explained their importance in the nutrition of fish larvae and other organisms.

Looking at the slide under the microscope, the students were fascinated to see such a biodiversity of microalgae in different forms (Figure 05 - A, B).

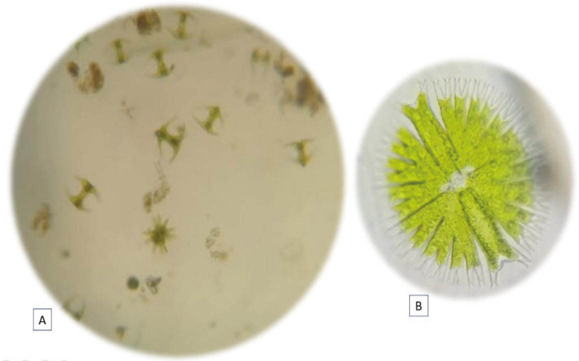

Figure 05: Microscopic observation of fish pond water. A) Diversity of microalgae with different shapes; B) Chlorophycean algae, *Micrasteria*. **Source:** authors' archive (2024).

As for the zooplankton, mainly observed Cladocera and Copepoda (*Daphnia*), popularly known as water fleas (Figure 06 - A, B), which are the main sources of protein for fish and shrimp larvae. Rotifers and water insect larvae were also identified. What caught the students' attention was seeing the little animals moving around in the water.

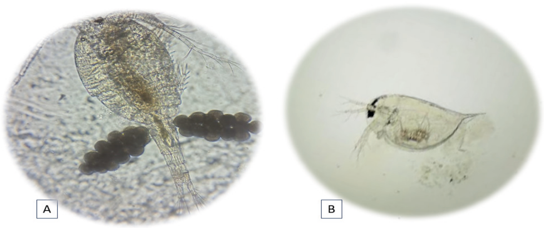

Figure 06: Microscopic observation of zooplankton in fish pond water. A) Copepoda with egg sacs on the back of the body; B) Cladocera, water flea. **Source:** authors' archive (2024).

In all the practical activities carried out in the schools, attention was always paid to contextualizing the observations made under the microscope with the topics covered in the classroom by the teacher. Some examples were the differences between animal and plant cells, the locomotion and nutrition of zooplankton, unicellular and pluricellular microalgae.

You learn best by practicing, when you put into practice what you learn in theory; science and biology provide teachers with various means of verifying the veracity of the content studied theoretically in the classroom, through practical experimental classes (INTERAMINENSE, 2019).

In all the classes attended at the schools, it was observed that the experimental practices worked on with students from 6th to 9th grade and from 1st to 3rd grade provided great benefits for teaching and learning in Science and Biology, both from the perspective of the teachers and that of the students, bringing theory into line with practice. It has aroused greater interest in classroom lessons, and has even stimulated some students' interest in going on to higher education (teacher testimonials).

Bringing together the theoretical knowledge acquired in the classroom with microscopic experimental practices makes the biological sciences more understandable, interesting and enchanting. With their curiosity piqued and the right equipment at school, today's students could become the innovative scientists of the near future.

Lima et al. (2022), in an extension project, Exploring invisible worlds: traveling exhibitions using microscopy, for elementary and high school students at a state public school in Camaragibe, PB, present an experience report describing an initiative to popularize science, using microscopy as a tool in the pedagogical process.

Cárias et al. (2018), in an extension project developed in three schools with Biological Sciences undergraduates from the Juiz de Fora Higher Education Center, observed that among the extension workshops presented, the microscopy workshop aroused the greatest interest, and that the use of a microscope in practical classes contributes to a better understanding and improvement in the students' learning process.

It's important to note that most of the students who took part in the experimental practices in the public schools involved in the project were receptive, participative and committed to all the experimental practices. When they came into contact with the microscope, they were extremely curious, handled the equipment enthusiastically and asked questions (Figure 07). However, some of the high school students showed a lack of interest in the microscope and the practices presented

Figure 07: General observation of the students' involvement in preparing the slides and making observations under the microscope. **Source:** authors' archive (2024).

The same enthusiasm was noted by Monteiro and Alves (2012), when working with three 7th grade classes in a municipal school in Seropédica (RJ). The authors observed that the opportunity to handle the microscope made the students very interested and motivated, mainly because of the possibility of visualizing their own cells (oral mucosa), and also when observing living beings moving in the "dirty water"

Souza et al. (2021), who worked with two 7th grade classes at the Mágylla Neto Municipal School, MA, report that at all stages, the microscopy workshop aroused enormous curiosity in the students and great interest in taking part in the practical activities. They point out that the students volunteered to handle the microscopes and prepare the slides, as well as asking many questions about how the microscopes worked and the characteristics of the samples they saw. In this practical, the authors only made slides of onion epithelium and oral mucosa epithelium.

As motivating activities, experimental practical classes play the role of reducing students' passivity in the teaching/learning process, since they are activities in which students must reflect on the relationship between the content presented during theoretical classes and the practice carried out through experimentation, making the construction of knowledge occur in an active way (SOUZA et al., 2021).

It is worth noting that the use of microscopes for practical lessons in schools is extremely important, and all schools should have this equipment to improve the quality of science and biology teaching, and only then will lessons be more enjoyable and easier to understand. Public schools still lack laboratories and microscopes, teacher training and other obstacles.

Barreto and Costa (2017), noting the importance of experimentation during science and biology lessons in public schools in Areia-PB, provided optical microscopy training to teachers from two schools, with the participation of four 7th grade classes in practical lessons. The practical activities included handling the microscope, practicing with newspaper and plant leaves to observe epidermal tissue and stomata.

When it comes to the subject of Biology, in high school, students are already finishing their grades, and many of them don't even know their way around a microscope. When they go to university, they are completely overwhelmed by the practical microscopy classes offered.

According to Krasilchik (2005), laboratory classes have an irreplaceable place in biology teaching, as they perform unique functions: they allow students to have direct contact with phenomena, manipulating materials and equipment and observing organisms. The Parâmetros Curriculares Nacionais do Ensino Médio (PCNEM - National Curriculum Parameters for Secondary Education) state that learning biology should allow the subject to understand the biological world and its particularities, that science is not immutable and can be analyzed, modified and discussed (BRASIL, 2000).

FINAL CONSIDERATIONS

Through the experimental practices carried out with primary and secondary school students, it was possible to observe that the methodology employed aroused greater interest in Science and Biology classes, as well as providing interaction between academics and public school students.

It was observed that the practical activities allowed the students to gain a more in-depth knowledge of the topics covered by the teacher in the theoretical classes, combining theory with practice, as well as stimulating scientific thinking and knowledge in the students, making Science and Biology classes more enjoyable and building more solid learning.

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