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Mobilizando o Conhecimento Especializado por meio de Recursos Didáticos no Ensino de Microbiologia: Um Relato de Experiência.

Mobilizing Specialized Knowledge through Didactic Resources in Microbiology Teaching: An Experience Report.

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Resumo:

Ensinar microbiologia no ensino médio continua sendo um desafio devido à natureza abstrata dos microrganismos e à escassez de infraestrutura laboratorial nas escolas públicas. Este estudo analisou quais domínios do Conhecimento Especializado do Professor de Biologia (BTSK, na sigla em inglês) foram mobilizados durante as práticas em sala de aula, por meio de relatos de experiência qualitativos de uma professora do ensino médio em Carangola, Minas Gerais, Brasil. Recursos didáticos de baixo custo — como modelos de argila de bactérias e células, meios de cultura caseiros, jogos interativos e atividades de microscopia — foram implementados com 101 estudantes do 2º e 3º anos. A análise de conteúdo dos relatos indicou que essas práticas integraram de forma eficaz os domínios do BTSK, especialmente a articulação entre conceitos biológicos, modelos e estratégias pedagógicas. As atividades despertaram curiosidade, promoveram o engajamento dos alunos e favoreceram uma aprendizagem significativa ao conectar os conceitos microbiológicos ao cotidiano. Apesar da limitação de basear-se em relatos de experiência, e não em observações diretas, os resultados demonstram que metodologias experimentais acessíveis são eficazes para mobilizar o conhecimento especializado e superar barreiras estruturais no ensino de microbiologia. Portanto, o uso de recursos didáticos alternativos representa uma estratégia valiosa para fortalecer o ensino de microbiologia, e pesquisas futuras devem explorar a implementação em tempo real em sala de aula e abordagens híbridas, a fim de ampliar o potencial do BTSK como ferramenta analítica.

***Palavras-chave**: Microbiologia, Recursos Didáticos, Conhecimento Especializado, BTSK, Ensino de Ciências*

Abstract:

Teaching microbiology in high school remains a challenge due to the abstract nature of microorganisms and the scarcity of laboratory infrastructure in public schools. This study analyzed which domains of Biology Teacher's Specialized Knowledge (BTSK) were mobilized during classroom practices through qualitative experience reports of a high school teacher in Carangola, Minas Gerais, Brazil. Low-cost didactic resources—such as clay models of bacteria and cells, homemade culture media, interactive games, and microscopy activities—were implemented with 101 students from the 2nd and 3rd grades. Content analysis of the reports indicated that these practices effectively integrated BTSK domains, especially the articulation between biological concepts, models, and pedagogical strategies. The activities stimulated curiosity, fostered student engagement, and promoted meaningful learning by connecting microbiological concepts to everyday life. Despite the limitation of relying on experience reports rather than direct observation, the findings demonstrate that accessible experimental methodologies are efficient in mobilizing specialized knowledge and overcoming structural barriers in microbiology teaching. Therefore, the use of alternative didactic resources represents a valuable strategy to strengthen microbiology education, and future research should explore real-time classroom implementation and hybrid approaches to expand the potential of BTSK as an analytical tool.

Keywords: Microbiology, Didactic Resources, Specialized Knowledge, BTSK, Science Education.

1. **Introduction**

The teaching of microbiology represents a recurring challenge, especially in high school, due to the abstract nature of microorganisms and the lack of laboratory infrastructure in public schools. This limitation often leads to pedagogical practices centered on traditional lectures, which hinder meaningful learning (LIMBERGER; SILVA; ROSITO, 2009).

To face this scenario, different strategies have been proposed. Research shows that low-cost investigative practical activities, such as games, didactic models, and homemade culture media, favor the understanding of abstract concepts and increase student engagement (BARBOSA; BARBOSA, 2010; PRADO; TEODORO; KHOURI, 2004; SILVA; LIMA, 2020).

In the international context, recent experiences show that alternative resources can also be mediated by technology, such as the use of gamified virtual laboratories that stimulate higher-order thinking (DUSTMAN; KING-KELLER; MÁRQUEZ, 2021) and hybrid practices that integrate face-to-face and online activities for teaching microbiology (SANCHO *et al*., 2006; WINTER; KETHEESAN, 2023). Similarly, simulations applied to the teaching of clinical microbiology have shown potential to fill formative gaps in health-related courses (XU *et al*., 2025).

In the context of teacher education, the Biology Teacher's Specialized Knowledge (BTSK) represents a relevant theoretical framework, as it articulates biological knowledge (BK) and pedagogical content knowledge (PCK), enabling analysis of how teachers mobilize specific knowledge when teaching biology (LUÍS; CARRILLO, 2020; MARQUES, 2020). Thus, understanding how teachers use accessible resources to bring teaching closer to students' reality contributes to strengthening pedagogical practice in microbiology and broadening the connections between content, strategies, and everyday life.

Although the teaching of microbiology is very important in the schools, in high school, because it is directly related to our daily lives, most of the time it is worked theoretically, limited to traditional methods with few experimentation classes, due to its degree difficulty because they are invisible organisms to the naked eye (LIMBERGER, *et al*., 2009; CASSANTI, *et al*., 2008). To transmit the content inappropriately makes it impossible for the relationship between students with the microbiological world, making it extremely abstract. Undoubtedly, this lack of proximity makes it difficult to learn about this topic, which is of great relevance (PESSOA *et al*., 2012).

Some diseases such as AIDS, mening, tuberculosis, pneumonia, chlamydia, among others are healthy by microorganisms, therefore, many people relate these organisms as exclusively dangerous to human health. (KIMURA *et al*., 2013). However, microorganisms are undoubtedly important for human life, namely, for the production of food, drinks and medicines, contributing to the cure of some diseases, and others are directly related to the planet's natural cycles, such as the decomposition of organic matter and the nitrogen cycle in the soil. There are also microorganisms that are used in basic sanitation, providing urban cleaning, in addition to establishing positive connections to the human body as part of the natural microbiota (CAVINATTO; PAGANINI 2007; BRAGA *et al*., 2016; SILVA *et al*., 2016; PELCZAR *et al*., 1997).

For this reason, observing the significant theme in the face of the dimensions of Microbiology, it is necessary to implement teaching-learning strategies in the area of Biology that make classes more attractive, effective and dynamic, awakening the participatory side of the student, in order to take it out of the conventional methodical classes of everyday life. These practices are extremely important for the expressive learning of students, bringing them closer to usual events with the content taught (SOUTO *et al*., 2015; BARBOSA; BARBOSA, 2010).

According to (INEP 2016), more than 70% of schools in Brazil are public schools and, a large number, they are scarce of laboratories and technological equipment to support experimental classes in microbiology. Affected by this scarcity of resources, the alternative of the teacher, reports experience present in this article, it was to use alternative low-cost resources to make different teaching materials that could be used by students to make the teaching-learning process more effective and interesting.

Considering the above, the objective was to characterize which specialized knowledge of Biology the teacher mobilized during her classes proposed for the theme with the use of alternative teaching resources and, thus, to discuss the effectiveness of using different strategies.

Biology teacher's specialized knowledge

The theoretical model of Biology Teacher's Specialized Knowledge (BTSK) (LUÍS, 2021) provides a framework of knowledge necessary for the teacher when teaching Biology, as shown in Table 1.

Table 1 – Biology Teacher's Specialized Knowledge

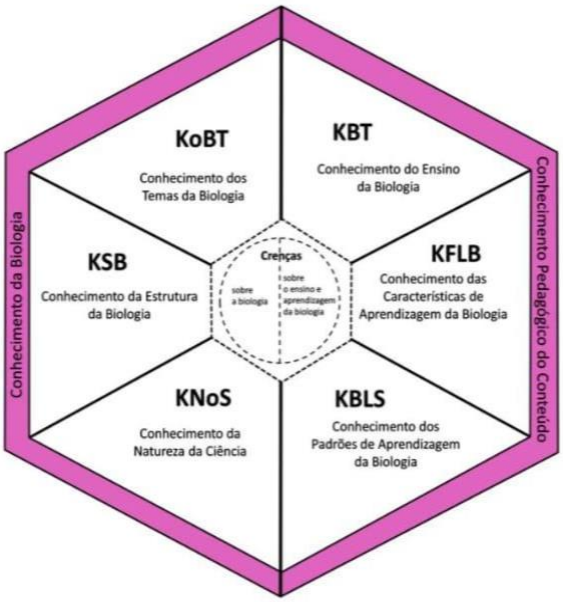
Domains	Subdomains	Categories
Biology Knowledge (BK)	Knowledge of the Biology Topics **(KoBT)**	Knowledge of Biology concepts and associated examples.
		Knowledge about laws, principles and theories of Biology.
		Knowledge of facts and biological phenomena.
		Knowledge of observation procedures and techniques in Biology.
		Knowledge of models associated with the content of Biology.
	Knowledge of Structure of Biology **(KSB)**	Knowledge of *Big Ideas*.
	Knowledge of the Nature of Science (KNoS)	Knowledge of scientific research methods.
		Knowledge of the status of science and scientific knowledge.
Pedagogical Content Knowledge (PCK)	Knowledge of Biology Teaching **(KBT)**	Knowledge of learning strategies, cycles and sequences, techniques and activities for teaching biology content.
		Knowledge of material, language or virtual teaching resources associated with Biology content.
	Knowledge of the Features of Learning Biology **(KFLB)**	Knowledge of strengths and difficulties associated with learning Biology content.
	Knowledge of Biology Learning Standards **(KBLS)**	Knowledge of learning expectations of Biology content at a specific level.
		Knowledge of sequencing with themes before and after a given school moment.
Beliefs	Subdomain of Beliefs about Biology **(Beliefs about Biology - BB)**	Beliefs about the nature of science.

	Subdomain of Beliefs about Teaching and Learning Biology **(Beliefs about Teaching and Learning Biology (BTLB)**	Beliefs about teaching.

Source: Luis e Carrillo (2020). Adapted by the Authors.

Such specialized knowledge is based on the domain of Knowledge of Biology (BK) which brings in the domain of Knowledge on Themes; of Structures; and the Nature of Sciences, and in the domain of Pedagogical Content Knowledge (PCK) in which we have the Knowledge of Teaching and Learning; and Learning Patterns. All of these are called Subdomains and have their Categories. In the center of the hexagonal figure (Figure 1), BTSK contemplates the Beliefs that portrayed a subjective and personal knowledge of Biology teachers: Knowledge about Biology and Knowledge about Teaching and Learning Biology.

Figure 1. BTSK model



Source: Luís (2021).

2. **Materials and Methods**

This study is characterized as qualitative, descriptive–interpretative research, based on teaching practice reports. The qualitative approach was chosen because it allows an in-depth description of pedagogical practices and the identification of specialized knowledge mobilized

by teachers during microbiology lessons, making it particularly suitable for understanding contextualized meanings within teaching narratives (AYDIN-GUNBATAR, 2020; BENEGAS; VILLEGAS, 2022).

The study was submitted for ethical review on Plataforma Brasil, under CAAE 40941920.0.0000.5105. Following the descriptive-inductive perspective proposed by Bogdan and Biklen (1994), the study emphasizes the investigative process within a natural educational environment. The data set comprised three experience reports authored by a high school biology teacher from Escola Estadual Emília Esteves Marques (Carangola, Minas Gerais, Brazil), involving a total of 101 students aged 15–18.

Reports were included if they presented low-cost didactic resources, contained a sequential description of teaching practice (pre-test, activity, post-test), and documented supporting evidence, such as photographs or questionnaires, whereas reports lacking sequential description or supporting material were excluded. Data collection was conducted through reflective and descriptive reports (FAIKHAMTA et.al., 2020) written by the teacher, with teaching activities designed to increase student engagement using modeling clay to represent bacteria and cells, homemade culture media, games, and pre/post questionnaires, integrating theoretical and practical approaches with low-cost, accessible materials. The corpus consisted of the teacher's written reports, photographs of activities, and student responses to questionnaires when available, collected without researcher interference to preserve the authenticity of teaching practices (ALMONACID-FIERRO *et al*., 2023).

Analyzed artifacts included lesson scripts, pre/post questionnaires, photographs of classroom activities, and student support materials, with a standardized protocol applied for reading and extracting evidence to ensure consistency. Reports were analyzed through inductive qualitative content analysis with iterative coding cycles (NORVILLE; PARK, 2021), involving initial reading for overall comprehension, segmentation into meaningful units (teaching episodes), open coding to identify manifestations of teacher knowledge, grouping codes according to the Biology Teacher's Specialized Knowledge (BTSK) framework, triangulation between empirical categories and theoretical constructs, and double coding by two independent researchers followed by consensus discussion. Teacher knowledge was further categorized into "evidence of knowledge," referring to episodes demonstrating mobilized knowledge, and "potential evidence of knowledge," referring to episodes suggesting that the subject could know more, which could become evidence if elaborated later or verified through interviews (MORIEL JUNIOR; CARRILLO, 2014; FLORES-MENDRANO, 2015; MARQUES, 2020).

Connections of knowledge were also identified, representing linking relationships between subdomains of specialized knowledge manifested during teaching episodes (MARQUES, 2020). A reflexive research diary was maintained to enhance auditability Sirwan 2024). Credibility was ensured through triangulation of reports, photographs, and questionnaires, independent double coding with inter-rater agreement (Cohen's Kappa), thick description, and researcher reflexivity, with representative excerpts provided for external verification, in line with contemporary qualitative research rigor recommendations (ZHAI, *et al*., 2021; SCHREIBER; CRAMER, 2022).

The study adhered to confidentiality principles by anonymizing teacher and student identities, obtained authorization from the school administration, and, when required, secured ethical approval from a Research Ethics Committee according to national regulations, with written informed consent or assent from participants. Limitations of the study include reliance on written reports, which restrict direct observation of classroom dynamics and generalization of findings. Future research should incorporate real-time classroom observation, teacher interviews, and longitudinal case studies to strengthen the evidence base. Despite these limitations, triangulation and double coding contributed to the methodological rigor of the study.

3. **Results and Discussion**

The results indicate that the pedagogical practices analyzed significantly engaged the domains of the BTSK model, particularly the articulation between knowledge of biological topics (concepts, models, phenomena) and pedagogical content knowledge (teaching strategies, didactic sequences, and the use of material resources). This integration was evident in the application of cell models, homemade culture media, and the use of the microscope, which sparked students' curiosity and promoted active participation in class.

These findings corroborate research highlighting the importance of investigative and accessible practices in microbiology teaching (BARBOSA; BARBOSA, 2010; PRADO; TEODORO; KHOURI, 2004; SILVA; LIMA, 2020). Moreover, they reinforce international evidence that alternative methodologies can be both physical and virtual, such as gamified laboratories developed during the pandemic (CUNHA *et al*., 2024) and online microbiology programs that expand access to scientific practice (WINTER; KETHEESAN, 2023).

Similarly, the use of simulations in the teaching of clinical microbiology has proven effective in addressing structural limitations and enhancing the development of professional competencies (WANG *et al*., 2025). The literature also shows that low-cost practical modules

can support interdisciplinary approaches, as in the case of characterizing antimicrobial compounds, combining biology and physics in accessible experimental strategies (KAUSHIK *et al*., 2015).

Despite the limitation of this study, which was based on experience reports rather than direct observations or interviews, the data suggest that alternative didactic resources are effective tools for mobilizing specialized knowledge and for the promotion of meaningful learning. Future studies should explore real-time monitoring of teaching practices and "Integration of hybrid methodologies in order to expand the formative potential identified in the use of the BTSK as an analytical tool."

The teacher's narrative here expressed by three reports of experiences and that make up our data configured in results will be presented separately as well as their discussions as shown below.

Report 1- Introduction to microbiology and morphological types of bacteria

“At first, a questionnaire containing 10 questions was passed to analyze the students' prior knowledge about microbiology. Soon after, a class script was distributed, with the theme "Introduction to Microbiology and Bacteria", containing a brief introductory text highlighting the definition and role of microbiology, and, then, the content on bacteria, showing their classification, morphological types, metabolism and its mode of reproduction. With the script in hand, we performed the shared reading where each topic contained in the script was explained in detail.

To illustrate the fundamental morphological types of existing bacteria, a modeling clay model was created demonstrating bacteria of the bacilli, cocci, staphylococci, streptococci, spirilla, vibrio, bacterial spores and flagellate bacteria type. For its manufacture, simple and easily accessible materials were used, such as modeling clay, a piece of PVC lining to be used as a support, E.V.A to cover, a toothpick and white glue.

At the end of the class, the class was divided into 4 groups to play a game, which is based on the traditional game of bingo, in which blank cards were distributed instead of containing numbers and then questions related to the topic were raffled. previously (microbiology and bacteria), so the group that completes the card first wins the game. This playful activity promotes student interaction with discipline, in addition to being a dynamic strategy to secure knowledge. Finally, questionnaire 2 was answered, the same as the initial one, to compare the level of knowledge before and after the class.”

Table 1 – Characterization of the Specialized Knowledge of the Report 1

MANIFESTATION	RESEARCHER ANALYSIS		EVIDENCE OR CLUE
	Subdomain	Category	
"In the first moment, a questionnaire containing 10 questions was passed, to analyze the students' previous knowledge about microbiology."	Knowledge of Teaching - **KBT**	Knowledge of learning strategies, cycles and sequences, techniques and activities for teaching biology content.	Clue
	Knowledge of the Features of Learning - **KFLB**	Knowledge of strengths and difficulties associated with learning Biology content.	Clue
"Shortly after, a class script was distributed, with the theme "Introduction to Microbiology and Bacteria", containing a brief introductory text highlighting the definition and role of microbiology, and then the content on bacteria, showing their classification, morphological types, metabolism and its mode of reproduction."	Knowledge of Teaching – **KBT**	Knowledge of material resources, language or virtual teaching tools associated with Biology content.	Evidence
		Knowledge of Biology	Evidence

<table>
<tr><td></td><td>Knowledge of Topics - KoBT</td><td>concepts and examples associates.</td><td></td></tr>
<tr><td rowspan="2">“To illustrate the fundamental morphological types of existing bacteria, a modeling clay model was constructed demonstrating bacteria such as bacilli, cocci, staphylococci, streptococci, spirillas, vibrios, bacterial spores, and flagellated bacteria-types.”


Figure 1 – Prototype of bacteria / Model of modeling clay</td><td>Knowledge of Topics - KoBT</td><td>Knowledge of models associated with the content of the Biology.</td><td>Evidence</td></tr>
<tr><td>Knowledge of Topics - KoBT</td><td>Knowledge of biology concepts and examples associates.</td><td>Evidence</td></tr>
<tr><td>“At the end of the class, the class was divided into 4 groups to play a game, which is based on the traditional game of bingo, in which blank cards were distributed instead of containing numbers and then questions related to the theme were drawn previously taught (microbiology and bacteria), so the group that completed the card first won the game.”</td><td>Knowledge of Teaching – KBT</td><td>Knowledge of material resources, language or virtual teaching tools associated with Biology content.</td><td>Evidence</td></tr>
</table>

<table>
<tr><td colspan="3">

Figure 2 – Bingo game cards</td><td></td></tr>
<tr><td rowspan="2">“This playful activity promotes student interaction with the discipline, in addition to being a dynamic strategy to pin knowledge.”</td><td>Knowledge of Teaching - KBT</td><td>Knowledge of learning strategies, cycles and sequences, techniques and activities for teaching a biology content.</td><td>Clue</td></tr>
<tr><td>Knowledge of the Features of Learning - KFLB</td><td>Knowledge of strengths and difficulties associated with learning biology content.</td><td>Evidence</td></tr>
<tr><td>“Finally, questionnaire 2 was answered, the same as the initial one to compare the degree of knowledge before and after the class.”</td><td>Knowledge of Teaching - KBT</td><td>Knowledge of learning strategies, cycles and sequences, techniques and activities for teaching a Biology content.</td><td>Evidence</td></tr>
</table>



Figure 3 – Students answering the questionnaire

Source: Authors.

In the first experience report about the introduction to microbiology and morphological types of bacteria, it was mobilized knowledge from both BTSK domains (BK and PCK), in which there was evidence only of the subdomain Knowledge of Themes relative to the categories Knowledge of concepts of biology and associated examples and Knowledge of models associated with the content of biology in the domain of Knowledge of Biology, and on the knowledge related to the PCK domain, showed two subdomains: Knowledge of Teaching, with the knowledge of the two categories mobilized, Knowledge of strategies, cycles and learning sequences, techniques and activities for teaching Biology content and knowledge of material, language or virtual teaching resources associated with Biology content; and Knowledge of Learning Characteristics.

As for the development of the playful activity in this first experience report, it was possible to verify the connection of knowledge from different subdomains, for instance, the connection of Teaching Knowledge with the Learning Characteristic, as well as Teaching Knowledge with that of Themes. The resource developed and applied in this Biology class for a specific topic was considered specialized knowledge since it would not meet applied knowledge as rules of activity in other sciences, for example, chemical elements bingo wouldn't meet Biology.

It's as well as possible to highlight that there was a moment when the Biology teacher presented evidence of knowledge, such as when applying a questionnaire to verify students' previous knowledge about microbiology, so it cannot be said that the teacher chose such activity with the purpose of knowing and work with students' difficulties using it as a teaching strategy, and that due to the lack of justification for the choice of activity and applicability, they were classified as evidence of teaching and learning knowledge due to the need to find clear proof that the teacher knows how to justify the choice of the material, choosing the type of activity.

Report 2 - Prokaryotic and eukaryotic organisms

"The diversity of existing microorganisms is great, with some being eukaryotic beings such as fungi, where the nucleus is surrounded by a membrane, prokaryotes that are simpler organisms, in addition to acellular microorganisms, such as viruses. Through this structural variety, it was proposed to develop a practice to demonstrate the difference between prokaryotic and eukaryotic cells, highlighting their composition, organelles and functions.

For the manufacture of these cells, more accessible materials were used, such as styrofoam, modeling clay, transparent silicone glue, plaster, paraffin (produced from candles), yellow gouache paint, pet bottle, glue, brush and scissors. The bottoms of the bottle and styrofoam were filled with plaster and then silicone glue was added on top that can be replaced by paraffin, and with the modeling clay models of the organelles were built to form the cells."

Table 2 – Characterization of the Specialized Knowledge of the Report 2

MANIFESTATION	RESEARCHER ANALYSIS		EVIDENCE OR CLUE
	Subdomain	**Category**	
"The diversity of existing microorganisms is great, with some being eukaryotic beings such as fungi, where the nucleus is surrounded by a membrane, prokaryotes that are simpler organisms, in addition to acellular microorganisms, such as viruses."	Knowledge of Topics - **KoBT**	Knowledge of Biology concepts and examples associates.	Evidence
"Through this structural variety, it was proposed to develop a practice to demonstrate the difference between prokaryotic and eukaryotic cells, highlighting their composition, organelles and functions."	Knowledge of Teaching - **KBT**	Knowledge of learning strategies, cycles and sequences, techniques and activities for teaching a Biology content	Evidence
	Knowledge of Topics - **KoBT**	Knowledge of biology concepts and examples associates.	Evidence

"Models of organelles were built to form cells."	Knowledge of Topics - **KoBT**	Knowledge of models associated with the content of the Biology	Evidence





Figure 4 – Cell models and their organelles

Source: Authors.

In this second experience report on the topic of prokaryotic and eukaryotic organisms, the teacher demonstrates Knowledge of Biology Themes by presenting concepts and examples of eukaryotic and prokaryotic beings and knowledge of teaching strategy on this topic of biology by developing a practice demonstrating the differences of these cells. This mobilized knowledge made it possible to identify the connection of knowledge related to the BK and PCK domains, of the Themes Knowledge and Teaching subdomains, respectively.

Report 3 - Where are the microorganisms?

"The practical approach consisted of analyzing where the microorganisms are, through the use of simple materials and homemade methods. The materials used were: colorless unflavored gelatin package; Seasoning for industrialized meat; 100 ml of water; Petri dishes; cotton swabs; and Spoon. Procedure: Dissolve the meat seasoning in a pan containing 100 ml of water, add the gelatin, bring it to a low heat and stir until it becomes a homogeneous mixture, without letting it boil. Cover the bottom of the Petri dishes with the culture medium.

Once the culture medium was made, the students were encouraged to pass the swab in places where they thought there were microorganisms. The places chosen were: the door handle, dirty hands, clean hands, gum and on the chairs in the room. Hereafter, the Petri dishes were left at room temperature for seven days for observations to be made and viewed under the microscope. Still within this same dynamic, it was suggested to carry out an observation of the

deterioration that occurs in food, using bread as an example, in which it occurs by the action of bacteria and fungi (yeasts and molds).

During the seven days of the growth of microorganisms in the Petri dishes, the students observed the changes that occurred. On the fourth day, the culture media already contained alterations with the formation of colonies adhered to its surface with light color, oval shape and some with a grainy appearance.

The accomplishment and the results of the execution of this practical activity were satisfactory. During this experience, the students were curious, saying they hadn't participated in classes involving the microscope, in addition, they reported that the culture media were, as they assumed, with numerous microorganisms, thus demonstrating that they had basic notions about the microorganisms existing in the school environment, in which it reveals that the culture medium examined was covered with fungi and bacteria, proving the hypotheses made by his students.

After seven days at room temperature, the culture medium had complete formation of powdery and cottony colonies, presenting a darker tone, with growth of structures above the surface of cultivation and in a much greater number. The places where the students placed the cotton swabs and that showed the highest proliferation of fungi and bacteria were the gum and dirty hands, subsequent to the door handle, washed hands and, finally, the classroom chairs.

With the intention of visualizing the microscope, an explanatory class was held presenting the constituent structures of the microscope, highlighting their respective functions. Then the students received a glass slide for microscopy to be positioned on the culture medium of their choice and visualized under the microscope. Due to the limited number of microscopes available, the classes were divided into smaller groups to better develop this activity, so all students were able to effectively participate in the proposed class.

The application of this experimental class resulted in enthusiasm on the part of the students with full participation and interest in handling the equipment, despite the insufficient number of them. During practice, many reported that they hadn't yet had the opportunity to handle the microscope and that this experience was relevant to the increase in knowledge about microbiology.

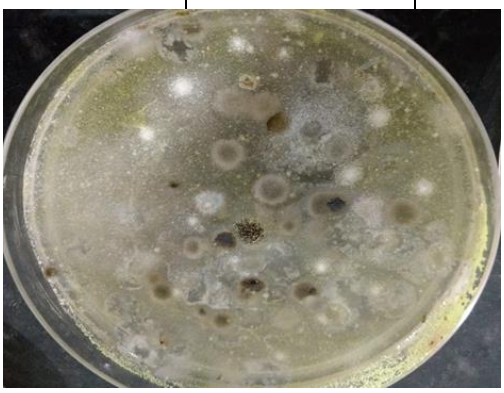
The second practice sought to highlight the importance of fungi as decomposers of nature, how to break down organic products, to recycle carbon, nitrogen and other soil and air compounds, in addition to being essential for industrial fermentation processes.

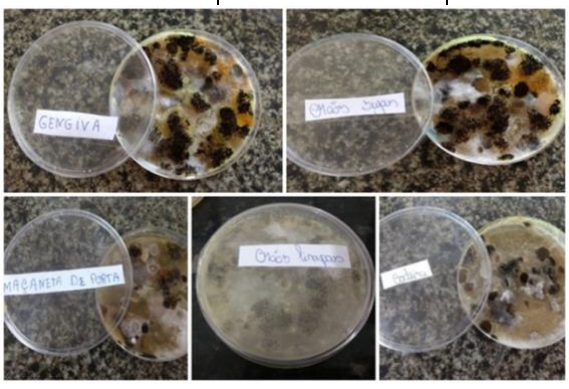
In addition, the students carried out observations of a bread kept in a pot at room temperature for a week, and they were able to verify the action of the fungi, pointing out changes such as gray and yellow spots with a cottony appearance and a strong smell."

While the third report, on the theme "where are the microorganisms?", presented a significant mobilization of knowledge in the field of Biology, more specifically in the subdomain of Biology themes - fungal function and observation, with notes in different categories, being those of knowledge relating to procedures and techniques of observation in biology and of biological facts and phenomena the most significant, and to categories on concepts of biology and associated examples was mobilized only once.

Table 3 – Characterization of the Specialized Knowledge of the Report 3

MANIFESTATION	RESEARCHER ANALYSIS		EVIDENCE OR CLUE
	Subdomain	**Category**	
"Once the culture medium was made, the students were encouraged to swab in places where they thought there were microorganisms. The places chosen were: the door handle, dirty hands, clean hands, the gum and on the chairs in the room."	Knowledge of Topics - **KoBT**	Knowledge of procedures and observation techniques in Biology.	Evidence
	Knowledge of Teaching - **KBT**	Knowledge of learning strategies, cycles and sequences, techniques and activities for teaching a biology content.	Evidence
"Then, the Petri dishes were left at room temperature for seven days to carry out observations and visualize them under the microscope. Still within this same dynamic, it was suggested to carry out an observation of the	Knowledge of Topics - **KoBT**	Knowledge of observation procedures and techniques in Biology.	Evidence

<table>
<tr><td>deterioration that occurs in food, using bread as an example, in which it occurs by the action of bacteria and fungi (yeasts and molds).”</td><td></td><td></td><td></td></tr>
<tr><td>“On the fourth day, the culture media already contained alterations with the formation of colonies adhered to its surface with light color, oval shape and some with a grainy appearance.”

Figure 5 – Colony Formation</td><td>Knowledge of Topics - KoBT</td><td>Knowledge of biological facts and phenomena.</td><td>Evidence</td></tr>
<tr><td>“The realization and the results of the execution of this practical activity were satisfactory. During this experience, the students were curious, saying they hadn’t participated in classes involving the microscope, furthermore, they reported that the culture media were, as they assumed, with numerous microorganisms, thus demonstrating that they had basic notions about the microorganisms existing in the school environment in the which</td><td>Knowledge of the Features of Learning - KFLB</td><td>Knowledge of strengths and difficulties associated with learning Biology content.</td><td>Evidence</td></tr>
</table>

reveals that the culture medium examined was covered with fungi and bacteria, proving the hypotheses made by his students.”			
“After seven days at ambient temperature, the culture medium had completely formed powdery and cotton-wool colonies, showing a darker tone, with growth of structures above the culture surface and in a much greater number. The places where the students put the swabs and that showed the highest number of fungal and bacterial proliferation were the gum and dirty hands, subsequent to the door handle, washed hands and finally the classroom chairs.”  Figure 6 – Culture Formation	Knowledge of Topics - **KoBT**	Knowledge of biological facts and phenomena.	Evidence
“In order to visualize the microscope, it was made an elucidate class, presenting the constituent structures of the microscope, highlighting their	Knowledge of Teaching – **KBT**	Knowledge of material resources, language or virtual teaching tools associated with biology content.	Evidence

respective functions. Thereafter the students received a glass microscope slide to be placed on the culture medium of their choice and viewed under the microscope."			
 Figure 7 – (A) Class about the microscope (B) Visualization of blades			
"The second practice sought to highlight the importance of fungi as decomposers of nature, how to break down organic products, to recycle carbon, nitrogen and other soil and air compounds, in addition to being essential for industrial fermentation processes. In view of this, the students carried out observations of a bread kept in a pot at room temperature for a week, and they were able to verify the action of the fungi, pointing out changes such as gray and yellow spots with a cottony appearance and a strong smell."	Knowledge of Topics – **KoBT**	Knowledge of Biology concepts and associated examples	Evidence
	Knowledge of Topics – **KoBT**	Knowledge of observation procedures and techniques	Evidence
	Knowledge of Teaching – **KBT**	Knowledge of learning strategies, cycles and sequences, techniques and activities for teaching biology content	Evidence



Figure 7 – Action of microorganisms on bread

Source: Authors.

It was also evidenced PCK knowledge regarding the subdomain of biology teaching, when there is the use of material resources, in this case the microscope, the glass slide for microscopy, used in the teaching of biology content, as well as the steps used described in the report show that the teacher knows how to sequentially develop the activities. About Knowledge of Learning Characteristics, an example is prior knowledge "thus demonstrating that they have basic notions about microorganisms existing in the school environment".

4. **Conclusion**

In the experience reports, the mobilization of teaching knowledge was verified, not only of evidence for the domain of Biology and Pedagogical Knowledge of the Biology Content, but as well as evidence of the Pedagogical Knowledge of the Biology Content. At the subdomain level, more specifically, there was a connection of knowledge from both BTSK domains, for example, when the teacher presents knowledge of biology topics connected to the Knowledge of Biology Teaching.

The didactic resources used proved to be efficient in the teaching of microbiology, not only allowing to verify the increased interest of students highlighted by effective participation, but also associating the contents worked in the classroom with the daily life of students in the scope of applicability. Therefore, the efficiency of experimental activities in the face of the teaching of microorganisms stands out, including corroborating the results presented in the literature on the fact that strategies are indispensable to improve the learning of microbiology (MORESCO *et al*., 2017).

The limiting factor of the research is due to the use of experience reports that don't allow the interview with the teacher who worked the content in the classroom, for instance, the non-deepening of the evidence in the perspective of evidencing the knowledge mobilized. However,

the quality of information in the experience report allowed for a promising result and as future research it is suggested to follow a class on the same topic for analysis and use of BTSK as an analytical tool.

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