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Promotion of knowledge in biology in high school through the use of different pedagogical tools

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ABSTRACT. Although the profile of students has changed, and the big diversity of the available didactic tools, the teaching methods remain the same. Therefore, the objective of this study was to evaluate the effectiveness of several didactic tools in the transmission of biology knowledge. The didactic tools used were: (1) Practical classes in the science laboratory, (2) Silent theater, and (3) Question game or Quiz. All the tools were applied after the expository classes, being evaluated through questionnaires assigned according to the Likert scale from 1 (strongly disagree) to 5 (strongly agree). Results revealed that all the used methodologies were considered very important for the learning of the participants. Thus, it can be seen that simple and financially accessible didactic tools are also adequate to help the teaching-learning process, such as biology contents.

Keywords: innovation; teaching; pedagogical tools; active methodologies.

Promoção dos saberes em biologia no ensino médio através do uso de diferentes ferramentas pedagógicas

RESUMO. Apesar do perfil dos alunos ter mudado e da grande diversidade de ferramentas didáticas disponíveis, os métodos de ensino permanecem os mesmos. Neste contexto, o objetivo deste estudo foi avaliar a eficácia de diversas ferramentas didáticas na transmissão dos saberes de biologia. As ferramentas didáticas utilizadas foram: (1) Aulas práticas no laboratório de biologia, (2) Teatro mudo, e (3) Jogo de perguntas ou Quiz. Todas as ferramentas foram aplicadas após as aulas expositivas, sendo avaliadas através de questionários para atribuição de notas segundo a escala de Likert de 1 (discordo totalmente) a 5 (concordo totalmente). Os resultados revelaram que todas as metodologias foram consideradas muito importantes para a aprendizagem dos participantes. Com isso, pode-se perceber que ferramentas didáticas simples e financeiramente acessíveis, e algumas vezes já disponíveis na escola, são adequadas para auxiliar o processo de ensino/aprendizagem de conteúdos abstratos, como é o caso dos conteúdos de biologia.

Palavras-chave: inovação; ensino; metodologias ativas; biologia celular.

Promoción del conocimiento en biología en el bachillerato mediante el uso de diferentes herramientas pedagógicas

RESUMEN. Aunque el perfil de los estudiantes ha cambiado y la gran diversidad de herramientas didácticas disponibles, los métodos de enseñanza siguen siendo los mismos. En este contexto, el objetivo de este estudio fue evaluar la efectividad de diferentes herramientas didácticas en la transmisión del conocimiento biológico. Las herramientas didácticas utilizadas fueron: (1) Clases prácticas en el laboratorio de biología, (2) Teatro mudo y (3) Juego de preguntas o Quiz. Todas las herramientas se aplicaron después de las clases magistrales, siendo evaluadas mediante cuestionarios para calificaciones según la escala Likert de 1 (totalmente en desacuerdo) a 5 (totalmente de acuerdo). Los resultados revelaron que todas las metodologías se consideraron muy importantes para el aprendizaje de los participantes. Por lo tanto, se puede ver que se eligen herramientas didácticas simples y económicamente buscadas, y en ocasiones ya disponibles en la escuela, para ayudar al proceso de enseñanza / aprendizaje de contenido abstracto, como es el caso de los contenidos de biología.

Palabras clave: innovación; enseñando; metodologías activas; biología celular.

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Introduction

The exercise of teaching in sciences and/or biology requires innovative pedagogical intervention since the teaching/learning process goes far beyond memorize contents (Segura & Kalhil, 2015). The traditional class format, in which the teacher is responsible for transmitting the content, does not stimulate the critical thinking of the student or the discernment to solve problems inherent in society. Traditionalism in the classroom is increasingly falling out of use, and this can be verified in several situations. With the advances of the Internet, e.g., the validity of a face-to-face class gains support only if there is something meaningful in it, something as much relevant and much more attractive than studying at home through your computer.

In biology classes, e.g., students encounter numerous terms, processes, and abstract structures that are most often verbal without any kind of demonstration, undermining the association between content and reality. According to Silva & Carvalho (2017), students who listen and memorize the names of animal and plant structures, but have no idea of their meanings, are referred to as 'nominal literates'. Only when the student overcome this deficit is that student moves to practice science de facto, because finally understands it, reaching the so-called 'multidimensional literacy' (Silva & Carvalho, 2017). For this level to be achieved, the curricular component of the discipline must include practical activities, field lessons, practical lessons in laboratories, and the use of teaching models, among others. From these activities, the teacher spects a better understanding of the content by the student, including group discussions, seminars, and studies in additional bibliographies.

The relevance of the topic 'active learning methodologies', in contemporary society and the lives of learners, has gained great space due to the great flow of information through technologies. This prerogative goes against the postmodern society that lacks general knowledge, such as globalization, sustainability, environment, economy, politics, etc. (Segura & Kalhil, 2015). According to Pozo and Crespo (2009), three characteristics of learning reflect the new culture of science teaching transmission: (1) information, (2) multiple knowledge, and (3) continuous learning. Considering such aspects, students need to know how to organize and interpret these informations, thinking and acting critically and reflectively.

Active learning methodologies have been studied since the 1990s and have as primary objectives to cause learners reflection and practice, as well as to investigate effective ways of engagement concerning active learning. The appropriate environment among the content addressed, various forms of interactions, and different teaching/learning strategies cause critical and reciprocal reflection in professors and students (Souza, 2013; Silva et al., 2018). Freire (1996) states that education is a process that is not carried out by a single person, but it requires interaction between historical subjects through their attitudes. With this perspective, it is possible to realize that while the traditional method prioritizes the transmission of information and has its centrality in the teacher, the active method prioritizes the student, making them the center of educational actions, with knowledge being built collaboratively. And contraring thus to the exclusivity of the intellectual action of the teacher and the representation of the textbook as an exclusive source of knowledge in the classroom (Pereira, 2012).

To strengthen this question, several definitions have been attributed to active learning methodologies. Pereira (2012), e.g., defines active learning methodologies as teaching strategies, centralized effectively in the student. Active methods are interactive processes of knowledge, analysis, studies, surveys, and individual or collective decisions, to find solutions to a problem (Moran, 2015). In this way, the active methodology stimulates the self learning and curiosity of the student to research, reflect and analyze situations for possible decision-making, the teacher being only the facilitator of this process (Berbel, 2011). Thus, it encourages the student to be an active and important part in their own learning process and transmitter of information to the teacher and the entire school community.

When their contributions are respected and analyzed, students feel valued and stimulated, and with a sense of commitment, competence, and belonging, toning themselves persistent in their studies (Berbel, 2011). Based on this understanding, the present study aimed to evaluate the efficiency of some didactic tools in the sharing of knowledge in Biology, during the execution of the extension project 'Dissemination and application of techniques of biological knowledge as a facilitating tool in the assimilation of the contents of Cellular and Molecular Biology, and Physiology in high school', of the undergraduate course of Biological Sciences of the State University of Ceará.

Methodology

The present study has been approved by the Research Ethics Committee in human of the State University of Ceará (UECE), under number CAAE 23105119.0.0000.5534. The active learning methodologies used were applied at the State School of Professional Education Paul VI in the Fortaleza, Ceará, between years 2018 and 2019, under supervision of the biology professors of the school. Students from 1st and 2nd years high school, into four classes, varying the number of students (from 29 to 32 participants) among the methodologies applied. Three didactic tools were selected: (1) Practices in the Biology Laboratory; (2) Silent Theater; and (3) Question game or Quiz. In general, the tools were applied under the same circumstances, i.e., students had a prior theoretical background, exhibited in the classroom by the teacher of the school and then, in the following class, the content was explained again through the learning tools chosen. The materials of these activities were made available by researchers without any charge to the school and/or students. In addition, the study was evaluated by through questionnaires using the Likert scale, through which are awarded grades on a scale from 1 (completely disagree) to 5 (totally agree).

Practices in the Biology Laboratory

For the implementation of the different laboratory practices described below, the procedures listed in the guide of each class were used.

a) Practice of microscopy

The first learning tool used during the practical class, in the biology laboratory, was the practice of microscopy with biological material of the oral mucosa and the leaf of the *Tradescantia spathacea* plant for the subjects on animal and plant cells, respectively. Initially, the main components of the microscope were pointed out and explained, as well as their functions and operation, beyond the different types of microscopies. Still were identified the magnification proportions that can be obtained through optical microscopy, such as the correct positioning of the blades and the best focus and light adjustment. This activity was held on two different days, during which the students (n = 32) were divided into teams of 3 members. The materials used were dark-end glass blades (n = 5), coverslips (n = 5), dagger (n = 1), dropper bottle (n = 5), bromotimol blue dye, beaker (n = 1), wooden spatula (n = 5), mortar and pestle (n = 5), paper towel and microscope (n = 1).

For animal cell analysis, students remained in teams, accompanied by a tutor. First, the materials were identified and demonstrated. Then the students were instructed to find the dark side of the blade, choose a name for the team, and write on it. In addition, each team selected a member to collect the sample made up of oral mucous cells. The sample was collected through a wooden spatula that the student passed onto the inside of the cheek. Then the material was deposited on a blade, and, with the help of a dropper, the cells were colored with bromotimol blue dye, which allows the visualization of the nucleus and cytoplasm. After the coloring, the students were instructed to mount coverslip on a blade.

For the evaluation of plant cells, leaves of *Tradescantia spathacea* of the *Commelinaceae* family were used, a discolored plant which, on the abaksial face of purple color, can be observed the morphology of the cells, as well as the presence of open and closed stomas without the use of dye. Students were instructed to perform, on the sheet, a pardermic cut with the help of a dagger. Then the sample was placed on the blade, a few drops of water were added to its surface, and the specimen was covered with coverslip. Once prepared, one student at a time led the samples for observation under optical microscopy.

b) Reaction of the catalase enzyme

In this practice, a potato was used, cut and separated into three portions, which were cooked, frozen or kept at room temperature. In addition, glass test-tubes (n = 5), oxygenated water or hydrogen peroxide 10 vol. (usually used in wound, n = 1) and Pasteur plastic pipettes (n = 4) were used. In the test-tubes were filled with water (tube 1) or potato pieces (tubes 2, 3 and 4) or hydrogen peroxide (tube 5). In tubes 1 to 4, students (n = 29) added a few drops of hydrogen peroxide and were asked to observe the result of the reaction. The observed result options were (1) negative or absent reactivity (tap water), or (2) weak reactivity (frozen potato pieces), (3) moderate (potatos pieces at room temperature) or (4) strong (boiled potato pieces). With this practice, students could see how the enzyme catalase reacts with hydrogen peroxide.

c) The activity of Vitamin C

To check the activity of vitamin C, 7 different solutions were used, which consisted of the addition of cornflour (Solution 1) or vitamin C (Solution 2) to water, or orange (Solutions 3 and 4) or lemons (Solutions 5 and 6) juices extracted the day before or on the same day of the practice class. An iodine solution at 2% in dropper bottle (n = 6), glass beakers (n = 6), and glass test-tubes (n = 6) were used. Briefly, each beaker received one of the six solutions, except for solution iodine. Then the students (n = 30) filled the test-tubes with each solution, identifying them and adding iodine solution. Students were instructed to focus on the color change and record the results.

d) Osmosis in the pepper

For this experiment, students (n = 31) were instructed to cut 9 filets (long and thin pieces) of chili pepper (n = 1) with the help of a blade (knife, n = 1 or dagger, n = 1) and place them on different petri dish (n = 3). Each of petri dish received 3 pieces of pepper and water. In the petri dish 1 only the pieces of pepper and water remained, and in the petri dish 2 and 3 one and two pinch of salt were added, respectively. The aim was to observe the morphological differences in pepper with the addition of salt and to analyze whether the aquatic medium was isotonic, hypotonic, or hypertonic concerning the pepper. This practice was used to exemplify the transport (osmosis) through the plasma membrane.

Silent theater

Concerning methodologies related to artistic production, the silent theater, although fleeing the traditional practices that are commonly used in basic education schools, has been used as a pedagogical tool. For the realization of this activity, the planning required a place that allowed the movement of students (n = 31), being chosen the sports court from the school, since it is considered an alternative and dynamic medium for practice. Students accepted the challenge of simulating the types of transport that occur in the body at the cellular level, i.e., transport through cell membranes. By moving their bodies, some students simulated being a cell, seeking to demonstrate the entry and exit of particles, while others tried to identify which process was being represented. In addition to mastering the subject, students must be creative, seeking the integration of other colleagues and, through play, help their understanding of the main types of cellular transport.

Question game or Quiz

Although it was carried out in the form of a game, the Quiz was the tool that came closest the traditional evaluations commonly used. The quiz consists of a game of questions and answers, drawn up in the easy, medium, and difficult levels. In groups of no more than 5, the students (n = 30) sorted the questions, discussed them with each other, and formulated the answer, which would be pronounced by one of the components of the group. Each group had up to 3 minutes to answer each question and if the answer was incorrect, the chance would pass to the next team. Whenever necessary, the questions were commented on to review the content and providing supplementary learning. The purpose of this methodology was to evaluate the level of knowledge of the students, as well as to review and clarify doubts about the subject previously discussed in the lecture.

Results and discussion

Just as important as applying active learning methodologies in the classroom is evaluating them, either through qualitative, and quantitative questionnaires, or both. Given the importance of using the two questionnaire models, to avoid the 'single element' (Silverman, 1997) that, in that case, would be to collect the results from just one perspective, quali-quantitative questionnaires were used to assess the impact of the methodologies used on the teaching/learning process. The analysis of the data obtained made it possible to outline four central themes, as described below.

Thematic 1. Importance of active learning methodologies applied to the learning of the contents of Cellular Biology

According to Rosa, Festozo, and Vera (2021), biology teaching should not be merely informative but should awaken scientific reasoning in the student. In this context, laboratory classes become excellent opportunities to produce more attractive and dynamic teaching, providing students to obtain and interpret

unexpected results, challenging their reasoning and imagination. Seeking to sharpen this scientific look, already in high school, the methodology of practices was applied in the biology laboratory, as well as other methodologies in the classroom to diversify the teaching methods.

As can be observed in Figure 1, the majority (91.7%, Figure 1C) of students agreed that the methodologies used were important and/or relevant to their learning, ranking the activities between grades 4 and 5. Individually, all the practices carried out in the Biology Laboratory (Figure 1A), as well as the other methodologies (Silent theatre and Quiz; Figure 1B) were evaluated positively by more than 80% of the class. Such results demonstrate that active methodologies stimulated the learning process, and guaranteed student participation and commitment to their learning (Nascimento & Coutinho, 2016). In addition, the educational conception presented by these methodologies breaks the traditional model of teaching, inserting the student in a problematic context. It stimulates the student to assume a developed and autonomous posture that ensures meaningful learning (Paiva, Parente, Brandão, & Queiroz, 2016) and quality.

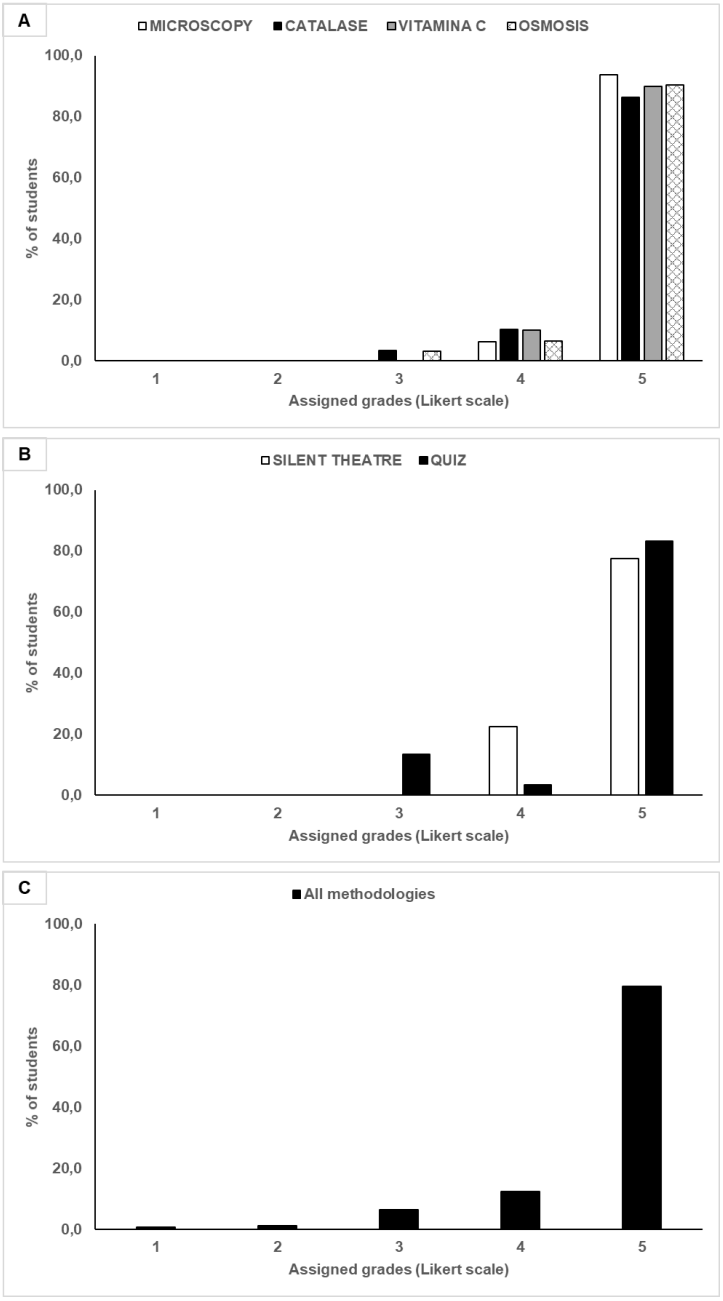

Figure 1. Importance and/or relevance of the methodologies applied to improve the quality of learning in Biology in a professionalizing high school in Fortaleza-CE. (A) Practices performed in the Laboratory of Biology (Microscopy, Catalase, Vitamin C, and Osmosis), (B) Other Methodologies (Silent Theatre and Quiz), or (C) All methodologies together, evaluated using the Likert Scale (1, Totally disagree, 2, Disagree; 3, Indifferent; 4, Agree; 5, Totally agree).
Source: Produced by the authors (Own Archive 2018-2019).

Classes in the laboratory environment can arouse curiosity and a consequent interest in the student, since, among other factors, it encourages the observation of some of the phenomena studied in theoretical classes (Morals & Santos, 2016), and can even be used as an indicator of learning (Pagel, Campos, & Batitucci, 2015). Furthermore, in disciplines with scientific backgrounds, such as biology, the use of laboratory practice offers the student the opportunity to explore a more interactive atmosphere, unlike the theoretical plan normally presented by the teacher (Franco, 2016). Considering such aspects, the practices conducted in the biology laboratory of the school have allowed students to visualize abstract scientific concepts and self-construct knowledge through the evaluation of their study object.

The silent theater, in turn, was brought as a theme both to promote interaction among students and to develop their creativity, features that were confirmed by the positive evaluation of 100% of the class. Several authors have verified that the insertion of theatre or its concepts in school contributes to a greater sense of belonging of the student to the school community. In addition, this activity allows to broaden the artistic and cultural universe of the student, enabling a reflective work, raising aesthetic appreciation, and, consequently, the formation of a citizen conscious of their several competencies and abilities (Costa, 2004; Koudela & Santana, 2005; Vidor, 2010). It is important to point out that the theatre also works on some aspects such as creativity, coordination, memorization, and vocabulary, thus being considered a multifunctional activity (Silva-Júnior, Silveira, & Ferreira, 2018). It is therefore understood that by using this practice as a tool of teaching and learning, an important cognitive development is promoted in the student, enabling them to act effectively and critically, opining, suggesting, and building their knowledge.

Among the methodologies applied, the Quiz is the most easily developed methodology in the school environment, since the materials needed for its application are easily accessible and do not require thorough planning. In this way, commonly, such methodology is well accepted by students, especially when it presents a competitive character, such as the one used in this study, a condition that increase the engagement of the class. In addition, to the support learning tool in the classroom (Lopes, Silva, & Souza, 2018), educational practices that have the teacher as a guide and the student as the creator of their knowledge (Alves, Glegio, Moita, Souza & Araújo, 2015), as is the case with the Quiz, contribute significantly to the learning of various disciplines, including Biology.

Thematic 2. Facilitation of learning and better understanding of the theoretical contents of Cell Biology by carrying out practical activities

Figure 2 demonstrates the degree of agreement in relation to the facilitation of learning and understanding of the theoretical contents of Cellular Biology through the performance of practical activities. Similar to what was previously observed, the majory of the students (98.9%; Figure 2C) stated that the practical classes in the Biology Laboratory (98.3%; Figure 2A), as well as the Silent Theater and the Quiz (100%; Fig. 2B) facilitated the assimilation of Cytology contents.

Results observed in this study can be confirmed by the students' speeches by stating that practical lessons are important for improving the understanding of the content studied, as well as arousing interest in scientific practice. In the case of the use of the microscope, for example, by facilitating the visualization of the cells, this equipment made the class more interactive and fun.

> To fix content it is important to have practical lessons (Student 12).
>
> I learn better when I see an example (Student 14).
>
> ... The explanation with practice becomes more fun and the class flows (Student 7).
>
> ... More dynamic lessons help a lot to fix the content (Student 8).
>
> It helped... I learned what I didn't know, and I went on to love biology more than I ever loved (Student 10).
>
> It opened my mind to new learning (Student 15).
>
> The practice helped in learning because, as it aroused my interest in the field of science (Student 18).

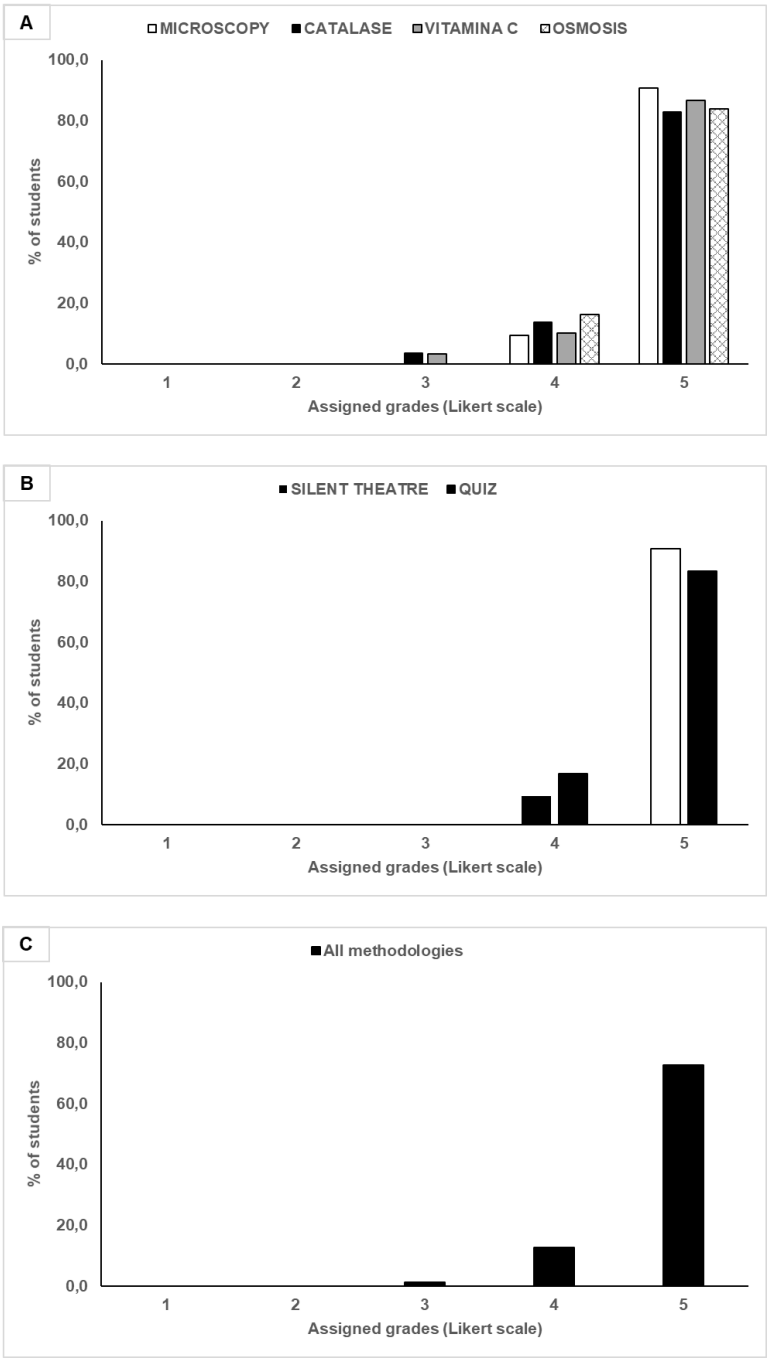

Figure 2: Degree of agreement of students as to facilitating learning and a better understanding of the theoretical contents of Cellular Biology through the methodologies applied in a professionalizing high school of Fortaleza-CE. (A) Practices performed in the Laboratory of Biology (Microscopy, Catalase, Vitamin C, and Osmosis), (B) Other Methodologies (Silent Theatre and Quiz), or (C) All methodologies together, evaluated using the Likert Scale (1, Totally disagree, 2, Disagree; 3, Indifferent; 4, Agree; 5, Totally agree). Source: Elaborated by the authors (Own Archive 2018-2019).

The fact that all students claim that the Silent theatre facilitated and contributed to the assimilation of the content addressed involves the multifunctional feature of this activity (Silva-Júnior, Silveira, & Ferreira, 2018). According to Glasser's Theory of Choice (2001), one should not only work with memorization in the classroom but rather stimulate students to actively build their knowledge. And the theatre, in turn, brings the playful and allows the interaction between participants, being students able to experience the content taught in the classroom through other senses, such as touch and vision, and thus potentiate learning, as they have stated in their speeches.

> He left clearer how some things happen in cytology (Student 7).
>
> It became less abstract (Students 24, 25, 27, 29, 30 and 31).

(It facilitated) enough to be able to carry this through my entire academic life (Student 10).

Generating new learning with a better focus and easier to understand (Student 11).

Yes, it has made it very easy. I had never seen it before. I was very happy that they chose our school (Student 12).

It becomes easier to learn (because it is by practicing, that one learns more; Student 13).

I was able to expand my knowledge even further because I had the pleasure of seeing a cell (Student 14).

In practice, everything is easier, because in school everything is always the same. When we have this type of practice it is easier to absorb the content (Student 16).

It helped a lot because the dynamics were very creative to the point of understanding each function of the content. Good professors, who can easily pass on the content to various people (Student 17).

An important aspect to highlight is the shortage of materials available in schools, especially those whose administration is public. This is something that can be amended with the use of methodologies such as the Quiz, for example. The Quiz is an inexpensive and easily accessible activity that allows teacher to make the class a play and, at the same time, test the knowledge of the students through gamification and competitions, in a light and relaxed way. In addition to facilitating understanding, the Quiz provides a review of the contents and, consequently, the perception of what needs to be studied or learned by the student.

(Help) Much, I clarified doubts, and learned by smiling (Student 2).

I could learn the content in a more fun way (Student 8).

It helps a lot because it involves a game (Student 15).

It was relaxed (Student 13).

We understand the content more and truly learn in an easier way (Student 27).

Competition always influences people to want to know to win (Student 19).

I was able to understand how the processes of the cell take place (Student 20).

It made it easier to remember the content (Student 28).

For being a review of all content (Student 25).

It could clarify doubts and helped for the test (Student 3).

(It helped) teaching me about cells, organelles, and many things (Student 7).

It makes it a lot easier because I listen to the opinions and perspectives of others (Student 10).

Because I paid a lot of attention and thought more to answer the questions (Student 29).

With questions, we learn faster (Student 14).

I had a lot of doubts, but I was able to develop today (Student 21).

It (The Quiz Methodology) helped me a lot to fix the theoretical part (Student 22).

I have a lot to learn from school (Student 4).

Thematic 3. Evaluation of the quality of participation, as well as of the lessons taught and the methodologies used by the project scholars

Figure 3 demonstrate the degree of agreement among students concerning the participation of the scholars in the activities developed throughout the project, as well as the classes taught, exhibitive or not. It is notorious that both the practices carried out in the laboratory (98.3%; Figure 3A) and those in the classroom (100.0%; Fig. 3B) were well executed by the scholars, according to the evaluation of the students themselves.

It is also possible to see that almost 100% of students (98.8%, Figure 3C) were satisfied with the way all the active learning methodologies were applied, as well as the participation and involvement of scholars during these activities were also pointed out as satisfactory. Through the speeches of the students, we can see how satisfactory the involvement of fellows.

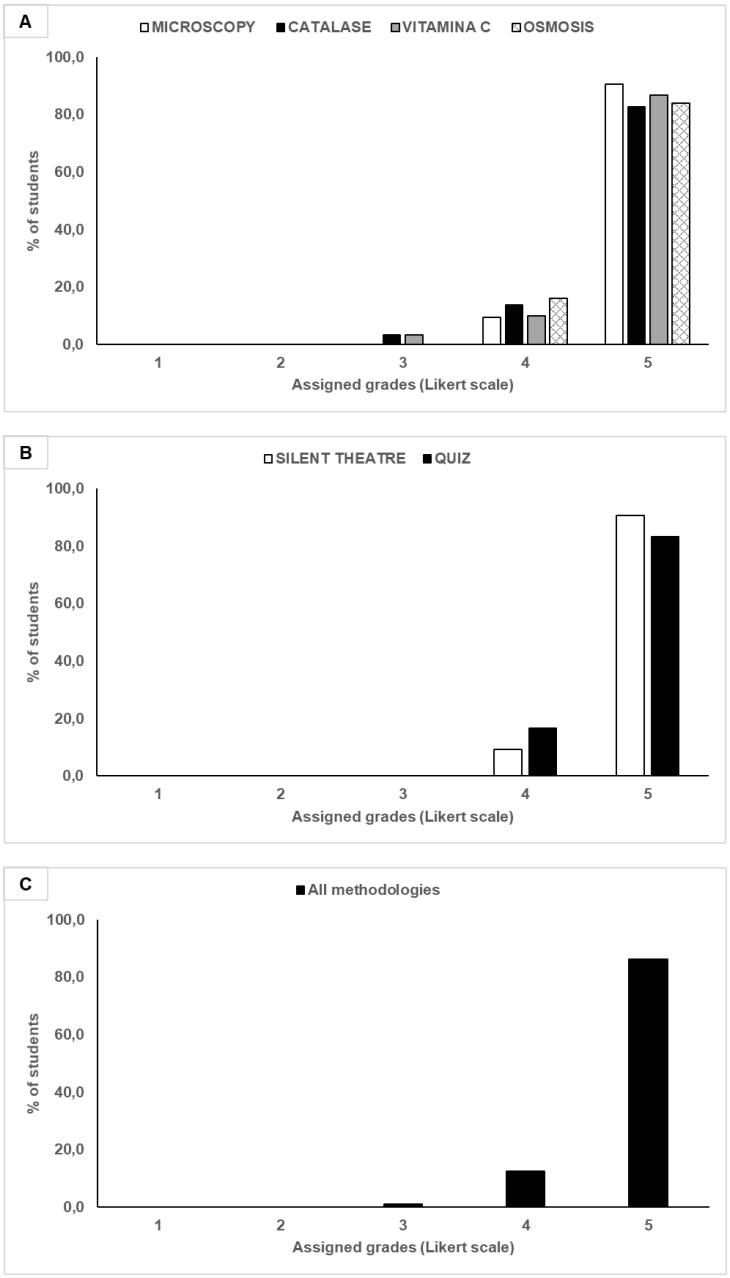

Figure 3: The degree of agreement of the students about the quality of participation, classes taught and methodologies used by the scholars during the application of the methodology in a professionalizing high school of Fortaleza-CE. (A) Practices carried out in the Laboratory of Biology (Microscopy, Catalase, Vitamin C, and Osmosis), (B) Other Methodologies (Silent Theatre and Quiz), or (C) All methodologies together. Students who participated in the project assessed the quality of the application of the methodologies using the Likert scale. (1, Totally disagree, 2, Disagree; 3, Indifferent; 4, Agree; 5, Totally agree).

Source: Elaborated by the authors (Own Archive 2018-2019).

All the professors (scholars and volunteers) were excellent, were participatory with the students, and interacted very well with us (Student 2).

Good mastery of the class and good content review (Student 5).

They were great!!! (Students of 6).

Everyone was great!! I learned a lot... (Students of 7).

The ease and importance that they (scholars and volunteers) give to the listeners of the content (students) were great (Student 11).

Overall, everyone did a good job, with a very interactive class, with exemplary (very good) behavior, and with great content (Student 15).

Everyone taught very well, and it was a pleasure to be a temporary student of them (Student 18).

These results, when combined with previous data, suggest that the organization made by the scholars and volunteers who applied the methodologies was crucial for the objectives of these practices to be achieved. As Morán (2017), education needs to be more dynamic and, for this, the plans of professors should follow a more flexible line that enables the sharing of experiences and knowledge among students, without compromising the quality of teaching employed in the classroom. For this, by including the active learning methodologies in the class plan, it is important to pay attention to basic points, such as necessary material, and class time, in addition to the professors knowing clearly how the methodology should be guided throughout the whole process, always appreciating the association between theory and practice (Brisolla, 2020).

Thematic 4. Learning line: The evolution of acquired knowledge for effective learning

From the observations carried out throughout the classes and from the students' reports, Figure 4 demonstrates what we call Learning Line. The line of learning represents the evolution of the knowledge acquired by students during the classes, whose methodologies, according to them, facilitated the understanding of the contents taught. In addition, the opportunity to experience something new, through playful and interactive activities, allows the student to turn the classroom into a real amusement park. The practical and playful activities carried out motivated students to 'learn more' (Student 27) about biology and to 'love' (School 10) this discipline. Execution of activities in the form of competitions, for example, assists learning through "play" (Student 15), making learning something "fun" (School 8) and "pleasant" (Student14).

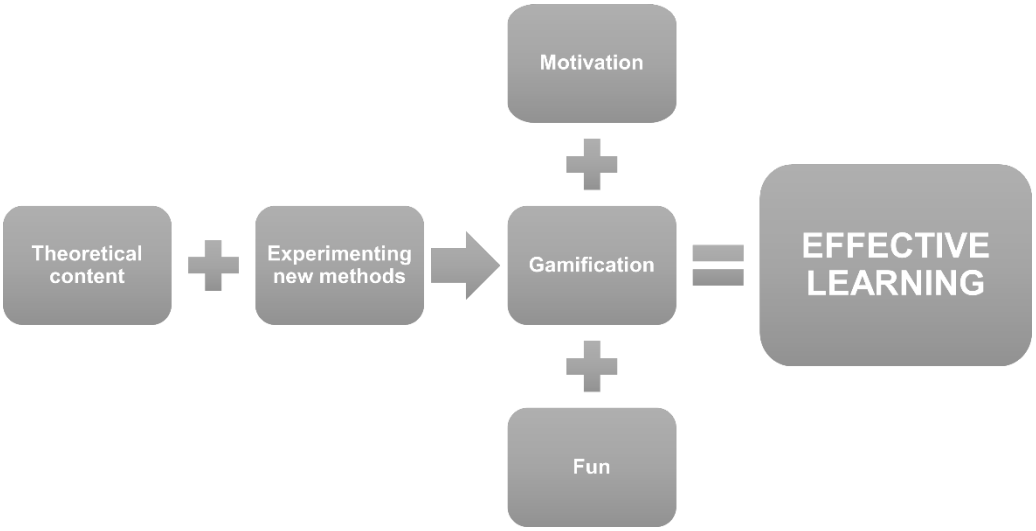

Figure 4: Representation of the Learning Line: The evolution of acquired knowledge for efficient learning.
Source: Produced by the authors (Own Archive, 2019).

Final considerations

As discussed earlier, active methodologies are relatively recent, and many professors and students are still learning the best way to use them in their favor. In addition, many factors need to be considered for the construction and implementation of these practices, something that involves everything from the availability of the workload of the teacher to the acceptance of the school for the presentation and implementation of new activities in the school environment. For this reason, the present project acts in the promotion of methodologies that can improve the transmission of theoretical knowledge, with an emphasis on the discipline of biology, especially in the context of the public school.

In general, Brazilian public schools do not have the resources or even the infrastructure to carry out alternative activities. On the other hand, it is necessary to recognize that the student needs to become the protagonist of their learning process. In this context, activities such as those used in this study, laboratory practices, silent theatre, and games, among others, must be increasingly present in the everyday life of the classroom.

Among the main benefits of active learning methodologies for the teaching/learning process are (1) facilitating the understanding and comprehension of the contents, (2) favoring group work and greater

interaction of the class, (3) stimulating the creativity and independence of the student, and (4) the acquisition of new skills, allowing the student a complete and motivated training. However, it is still necessary to develop and apply new and different methodologies with a focus on the reality of the student and their school context, evaluating their effectiveness and efficiency.

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