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PROMOTING ACTIVE LEARNING IN BIOLOGY: VIRTUAL LAB AND *MAKER APPROACH*

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ABSTRACT
Practical activities in the discipline of Biology may require expensive and difficult to access equipment. The *maker* culture, an active methodology, emerges as a viable alternative for the creation of low-cost educational activities. Thus, we planned and carried out activities with a virtual histology laboratory in the second and third years of high school, in a private school on the outskirts of São Paulo with few laboratory resources. This work has as its methodological approach the qualitative research, of the experience report type. After the activity, the students were invited to answer a questionnaire to express their opinions on the effectiveness of the approach and its impact on interest in the topics worked. The results showed an increase in students' interest in histology, the use of *maker* culture and the virtual laboratory, enabling significant learning.

Keywords: Continuing education, Technology, Science teaching.

INTRODUCTION

The main objective of the Science curriculum is personal development and the implications of the sciences in society and the environment, and not only in the teaching of concepts and methods (Sasseron; Carvalho, 2011). For Miller (1983), there are three dimensions to scientific literacy: understanding the nature of science; the understanding of key terms and concepts of the sciences and; the understanding of the impacts of science and its technologies.

Science, in addition to being an important producer of knowledge, is an excellent tool to develop critical, investigative and logical reasoning skills in elementary school students. The skills worked on in Science classes, therefore, go beyond the content itself, as they also have an impact on society and the individual.

Exclusive attention to the transmission of content in Science disciplines, without contextualization, application or logical and critical exercise, is a waste of resources for schools, students and teachers. To this end, the curriculum based on Science, Technology and Society (STS) is important for technology to be present in the student's daily life.

According to Filho et al. (2013, p. 316), "one of the objectives of a STS curriculum is to facilitate students' understanding of experiences related to the phenomena that surround them in their daily lives". For the authors, school science should bring technological knowledge closer to our daily lives. Thus, the STS-based curriculum provides a filling in of the gaps left by the traditional teaching of Science, as it can assist in critical thinking and, thus, link students to Science, Technology and their relations with society, in the full exercise of citizenship at the local, national and global levels.

Reviewing the documents that govern education in Brazil, we find several topics that legislate on teaching, including Science, in a broader and less content-oriented way, and that are related to the current context of society. In the general competencies present in the BNCC (National Common Curricular Base), we find issues related to the pedagogical scope, learning and development rights (BRASIL, 2018). Among them, it is relevant to highlight those that are directly related to the proposal of the present study (Chart 1).

Chart 1 – Highlights of the General Competencies of the BNCC

General competence (BNCC)	Highlights
2	[1]<u>Exercise intellectual curiosity</u> and use the approach of the sciences, including <u>research, reflection, critical analysis, imagination and creativity, to investigate causes, elaborate and test hypotheses, formulate and solve problems and create solutions (including technological),</u> based on knowledge from different areas.

[1] Emphasis added.

5	Understand, use and create digital information and communication technologies in a critical, meaningful, reflective and ethical way in the various social practices (including school ones) to communicate, access and disseminate information, produce knowledge, solve problems and exercise protagonism and authorship in personal and collective life.
7	To argue, based on facts, data and reliable information, to formulate, negotiate and defend ideas, points of view and common decisions that respect and promote human rights, socio-environmental awareness and responsible consumption at the local, regional and global levels, with an ethical position in relation to the care of oneself, others and the planet.

Source: Mystery of Education (MEC)

Activities that use not only expository classes are fundamental to achieve the real purpose of science teaching. The adoption of active methodologies is a great way for students to be able to learn critically, consciously, and so that they can bring the knowledge obtained in the classroom closer to the issues of their daily lives.

In this way, these methodologies are a set of practices that remove the centralization of teaching from the role of the teacher and highlight the active role of the student in his or her own learning. Some examples are: flipped classroom (SAI); gaming; concept or mental map; problem-based learning (PBL); teaching by inquiry (Lima; Silva, 2022) and; the maker culture.

The potential of Science and Biology disciplines to stimulate scientific curiosity, the relationship between science and society, critical vision, autonomy and connection with content from other disciplines, is gigantic, and active methodologies are fundamental allies to achieve these skills.

Even so, there is a predominance of the use of traditional models, with expository classes, full of scientific and technical terms, which hinders real learning and leads to decontextualized memorization. Despite the low adoption of active methodologies in the teaching of Science and Biology, when they are used, they are predominantly those of teaching by investigation and problem solving, probably because they are methodologies similar to the structure of scientific practice (Ventura; Venturini, 2021).

In the present work, we seek different approaches to the teaching of Biology; we opted for the use of active methodologies, with a focus on the maker culture and the virtual laboratory (VL), with the use of Digital Information and Communication Technologies (TDIC). For Perrenoud (2000), in the planned use of teaching with new technologies, the teacher sharpens critical thinking, hypothetical thinking, deduction, observation, imagination, and involves the student in reading, analyzing texts and images.

However, due to the variety of technological resources found today, it is up to him to understand which one best applies to certain content. Thus, DICT are great allies in the construction of knowledge, scientific literacy, exploration and investigation, and insertion of the student in the digital culture. DICT are technologies (tools, programs, media) that allow students to simulate and connect to situations and environments, and that have a great attraction to digital natives, creating a scenario more conducive to meaningful learning (Oliveira; File; Arruda, 2021).

The Virtual Laboratory (VL), in the context of Biology classes, promotes the identification of concepts in an interactive way and "enables the organization and problematization of biological knowledge from an investigative perspective by leading students to analyze and compare data through the observation of simulations of common phenomena of our reality" (Oliveira; File; Arruda, 2021, p. 3).

The maker culture emerged from the "do it yourself (DIY)" movement, in Portuguese "do it yourself". This concept was brought to education in the context of self-directed learning, in which students have a direct action in solving problems. In this approach, it is possible to create items, stimulate creativity and develop critical analysis.

Some of the main characteristics of the maker culture are: the use of digital technologies, the work with interdisciplinary knowledge and the promotion of meaningful learning. In this scenario, the teacher plays the role of mediator, and his performance will be in accordance with the objective of the activity (Barbieri; Baccin, 2022, p. 19).

The choice of approaches was made both because of the limitation of equipment, slides and the availability of time to carry out face-to-face laboratory activity, as well as because of the encouragement and learning of the use of new digital technological tools and easy access to cell phones.

Technology is increasingly becoming part of our current context, and its didactic tools should not be left aside. We need to be aware that it is not possible for education to fight a battle with technology, since the future and the new professions that will emerge are intrinsically linked to it.

We can then join maker and LV activities in science teaching, also developing digital skills. It is important to emphasize that the use of digital resources does not replace the importance of practical laboratory activities, pedagogical outlets, among others.

Activities that use digital tools redirect, even if for a short period, the use of screens and give them an educational purpose. They also enable the learning of software and platforms relevant to the job market and academics. Although the impact of screens on cognitive development is already known, the use of screens is the resource that most families provide as a pastime to children and young people (Desmurget, 2021). We do not intend to encourage the use of screens in this work, but we reinforce that it is important to use them more assertively, so that they can enrich knowledge and materialize didactic content beyond theory.

Generations Z and A are known for being skilled in the use of technology, as they were born in this context. However, this ability, in reality, is extremely limited (Desmurget, 2021). The speed with which they move devices and can access information is, in fact, higher than those that do not belong to these generations.

However, the tools in which they are fluent are those of entertainment. Few are interested or find it easy to search for materials that can enrich their knowledge, or are able to filter information as true or false.

In order to be able to insert new tools in the classroom, it is necessary that there is continuous training of the faculty in the teaching degree courses, with the inclusion of disciplines that address the use of digital technologies and tools, in addition to inserting the use of active methodologies in Higher Education courses.

Thus, when rethinking their practice, the teacher modifies their methodologies, reviewing their strategies, thus breaking with the standard class focused purely on the transmission of information (Oliveira; Amaral, 2020b, p. 48). Teacher training is still far from what we find in the day-to-day life of classrooms (Feitosa; Milk; Freitas, 2011, p. 306), of the skills necessary for them to be able to adhere to the new didactic tools created by technology and for them to be able to adapt the way of teaching to the present generations.

In Filho et al., 2013, the speed with which society, technology and knowledge advance and how important it is for students and faculty to develop their learning capacities is highlighted. Therefore, the teacher is no longer framed as someone who only teaches, but also occupies the place of a student, and must constantly improve and update himself, including in technological matters. For Oliveira and Amaral (2020a), Oliveira and Amaral (2019), the school is the ideal locus for teachers to have access to continuing education, and the management team is responsible for identifying what their teachers need for the work to achieve the desired objectives.

The mastery of digital didactic tools by the faculty is essential for the teaching of relevant skills related to technology in the classroom. The speed with which new technologies emerge creates the need for teachers and students to be increasingly willing to learn and adapt to new circumstances, as the school is very distant from the students' reality (Moran, 2017).

However, technologies in the classroom face some resistance, due to the recreational way in which smartphones are used in the classroom by students. For

Perrenoud (2000), the use of smartphones by students can help the teacher in the long and tedious tasks that discourage them.

Thus, the teacher can focus on activities considered more productive and creative, such as answering questions, deepening basic information acquired to be contextualized. For Soares (2016, p. 2), "the educator can be a great precursor of the use of the smartphone as a pedagogical tool for teaching, using the newest applications for the enrichment and dynamization of content".

Romanello (2016, p. 9) argues that "by appropriating the practice of using technologies in classes, in particular smart phones, teacher and student become collaborative actors in the teaching and learning processes".

Therefore, the school needs to understand how technology can contribute to enrich student learning and be able to direct them so that they are able to enjoy, with awareness, ethics and wisdom, the resources provided by the digital age. However, "as a tool that provides interactivity among peers, it also requires continuous training from the teacher, providing a new way of planning their classes" (Oliveira; Amaral, 2018, p. 7).

This work arose from the interest of high school students from a private school in the peripheral region of São Paulo in deepening and getting closer to histology contents. The didactic laboratory does not have enough structure to enable practical activity efficiently.

Thus, we opted for the use of DICT to create a virtual histology laboratory. Using the qualitative approach, we analyzed the students' feedback, in response to a questionnaire and issued in person, to evaluate the efficiency of the activities and the increase or not of interest in the content.

METHODOLOGY

This work used qualitative research as a methodological approach, which, according to Creswell (2007), is the one that investigates narratives, phenomena or studies based on reality and analyzes the data from a constructivist or claiming/participatory perspective. It is fundamentally interpretive and uses complex, multifaceted, and simultaneous reasoning. We used the Google Classroom and Forms platform to create the activities. In this form, images of slides of epithelial, connective, muscular and nervous tissues were present for observation and a script with questions to be filled in. For each of the tissues, a different form was elaborated. The tissue microscopy images were obtained from the USP microscopy image bank.

In order to evaluate the effect of the activity and to know how we should proceed when creating the next ones, we developed a form so that students could leave their opinions. The questions were:

1) Did the maker activity help you understand the content?
2) What aspects do you consider important to comment on the maker activity?
3) What are the suggestions for the next complementary activities?

In person, we also talked about what they thought of the activity, difficulties in carrying it out and benefits of the format used. The activity was applied to 30 students from the second and third years of high school during histology classes.

RESULTS AND DISCUSSION

At first, we introduced the students, through a dialogued class, to the types of tissues that make up the human body. We consider it important to resume the topic, as many students had gaps in their learning, a reflection of the pandemic context, in addition to the difficulties in understanding and differentiating tissues, which is a specific content of histology.

This difficulty presented by the students corroborates Ventura and Venturini (2021), as traditional teaching models do not achieve the desired objectives, and they only memorize scientific terms without establishing connections. Thus, we agree with the authors that teaching by investigation and problem solving is a methodology that helps in the meaningful learning of students. This aspect is also suggested by Feitosa, Leite and Freitas (2011) about the speed of technological changes in our society, and that teachers and students must adapt to the new didactic tools.

Thus, we understand that, in addition to the use of technologies, the dialogued discussion about the shape and function of each tissue was important to resolve possible doubts. Only after this stage did we ask students to use their smartphones to access the virtual material on epithelial, connective, muscular and nervous tissues, which were made available in our Google Classroom classroom.

The students showed excitement about the activity, due to the use of smartphones, leaving the lecture. In the form of the respective tissue, they found images so that they could identify its main characteristics and relate them to its functions. At first, they had difficulty visualizing what was requested, however, throughout the activity, they were able to analyze the images more easily and describe the observations.

The activity also promoted socialization among all students in the class, because, despite being a VL, we carried out the activity in the classroom. They collaborated with each other, helped those who had difficulty accessing the platform or identifying a specific structure, debated the observations and results, and were able to see the activity in a playful and engaging way.

The students, especially those in the third year of high school, asked us to develop more interactive materials about muscle tissue, addressing issues related to physical exercise and the use of food supplements. In a strictly expository class that did not encourage the student to engage in his own learning, this request would probably not occur. In another situation, in which we did not have access to the necessary material to do a face-to-face laboratory practice, we proposed a new virtual laboratory, only this time with the theme of worms. The students were excited about the idea and saw in the LV a possibility to get closer to the handout content, especially that related to health issues and the human body.

The use of objects that are part of the students' daily lives as a didactic tool was well accepted in the activity and brought a new vision to the content. Despite the dense content, the students were able to deepen their knowledge in a practical way, and the theory was applied in situations involving observation, logic and creativity, thus developing more meaningful learning, and it was possible to give shape to extremely abstract concepts.

The practice managed to align the general competencies of the BNCC that discuss the use of technology in teaching and scientific method, and stimulated critical analysis, creativity, socialization and observation. Regarding the question 'Did the maker activity help you understand the content?' the students, in general, answered that the activity was important for understanding the types of fabrics and how to differentiate them. This result corroborates Perrenoud (2000), as thoughtful and planned activities help the teacher's work, who may have time for more reflective tasks related to student learning.

Thus, it is important to contextualize that, many times, schools do not have enough microscopes and slides of the tissues studied to do the activity in person. The VL format offered more dynamism and made it possible to visualize details and structures that students would hardly be able to analyze in person, with a lack of materials and time limitations. It was also possible, with the use of image editing tools, to circulate and highlight what we wanted the students to observe in the images and, thus, not fail to visualize exactly what was proposed in each item.

Some students found it difficult to use Google's platform, despite it being intuitive and simple. This fact reinforces Desmurget's (2021) statement that adolescents currently use cell phones and computers excessively, but do not know how to use the basic tools for writing texts, presentations, formal communication, file sharing, and search.

The use of screens is mostly directed to entertainment, and we, as educators, need to encourage the use of these devices in a moderate way and teach the use of tools that can be, in fact, useful in the academic and professional lives of these students.

One of the questions we asked the students was about which aspects they considered important to comment on the maker activity carried out. For the students, the activity was dynamic and helped them to think better about the use of technologies in an assertive way, always seeking to learn more. This aspect corroborates Barbieri and Baccin (2022) about maker culture, assisting in the use of digital technologies, working with interdisciplinary knowledge to promote meaningful learning.

However, in the last question about suggestions for the next complementary activities, the students indicated that they would like classes with the same dynamics and interesting, containing videos and slides. In this scenario, the teacher is a mediator of knowledge, but his performance must be in accordance with the planned objectives.

Some answers were surprising, the students thanked the time that the teacher dedicated to them, stating that the planning was very good and that it helped them in learning, especially the class on embryonic development.

Although it does not replace practical experiences, among the available tools, the LV and the maker approach were efficient for us to be able to approximate the theoretical concepts seen in class. In addition, the students reported that they liked to perform an activity different from the expository classes and that, compared to other practices carried out in the two months (VLE, workbook and seminars), this was the one they preferred.

FINAL CONSIDERATIONS

The maker culture is an excellent method to develop more meaningful and dynamic activities using easily accessible tools; all you need is a cell phone or a computer, internet and use of Google's free tools. In situations where there are not enough physical resources for practical activities, or even a computer lab, DICT offers a viable alternative for students to develop autonomy, apply their knowledge, reflect on the content and analyze the materials and activities created in a logical and critical way. In this way, they become the protagonists in the formation of their new knowledge and create more meaningful relationships with the topics studied.

There are several free and intuitive platforms and tools for creating virtual didactic activities. In addition to being attractive to students in Elementary School (final years) and

High School, as they are on a device that spends most of their time in the palm of their hands, they allow the reuse of the same material in other situations and, several times, allow changes, if necessary. The school itself can be responsible for creating and making these resources available to teachers and students and, thus, not overloading teachers even more.

The creation of the activity was only possible because we have facilities with digital tools, due to their use throughout our academic career. Despite being the first contact with the Google Classroom platform, it is extremely intuitive for those who are not afraid to venture into digital tools. It is essential that undergraduate courses encourage the use of currently available platforms, so that teachers get used to using enriching and facilitating pedagogical tools.

The adhesion of the analyzed class was great, and the visual approach, with playful and fun elements, brought them closer to the accomplishment of the task. The care with the elaboration of the activity was recognized by the students, and this contributed to them feeling important and having an affective proximity to the discipline and to the learning of Biology.

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