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USE OF 3D TECHNOLOGY IN KNOWLEDGE SHARING AND THE INCLUSION OF VISUALLY IMPAIRED STUDENTS

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ABSTRACT

The interaction between people favor the exercise to create, share and manage knowledge. In education this is no different, because the school has as purpose the building and knowledge sharing. Arriving at the school, students bring their baggage of knowledge, skills, difficulties and shortcomings. In this context, the article presents a case study in order to understand how the use of 3D printing technology can support the sharing of knowledge among high school students of a state school in Paraná, for the reproduction of works of art media they can be understood by the blind. The research is of applied nature with a qualitative approach, where the product was the creation of a work of art in 3D format, which can be interpreted by the visually impaired. The procedure adopted was to conduct a case study in the said school students, and one of those visually impaired. This research thus contributes to the effective inclusion of the visually impaired, making them active subjects in the construction and sharing of knowledge.

INTRODUCTION

One of the educational challenges of the present time is in use in an efficient and meaningful way, the knowledge students have and can apply at school. Increasingly connected and linked to technological innovations, these students require a more current learning format, which has been in conflict with the traditional paradigms, long rooted in schools that mostly work with the traditional method of teaching based on exposition and memorizing lessons. In the immediacy context and innovative inherent in the technological revolution that we are living in the information society or the knowledge society, increasingly, the Information and Communication Digital Technologies (TDICs) have been used to support this new challenge, stimulating the teaching and learning processes and supporting the application of active learning methodologies (SILBEIRA *et al.,* 2019). According to Choo (2003), the school is no longer the primary source of knowledge for students and sometimes even the principal, since, in the knowledge society (or the information society), through TDICs in particular the Internet, the information is accessible to all and can be easily manipulated generating new knowledge. Currently, more and more, it is considered that the school needs to take advantage of available resources and to allow a greater bond between teacher and student (SILVEIRA *et al.,* 2019). It is understood that thereby be possible to build an environment full of stimuli to learning and allow knowledge sharing occurs naturally (ONO 2014). It notes that knowledge is not only built through experiences lived by or applied using information techniques.

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Knowledge can come from a problematic or a paradox. Therefore, there is no doubt aware. For Nonaka and Tackeuchi (1997), knowledge must be dual questioner and because this is formed by elements that can be considered opposites. Knowledge is as a set of information interpreted by a person with experience in the subject, in order to solve problems, formed by data that in some way, provide the problems raised solutions. The issues involving accessibility and digital inclusion are increasingly apparent and discussed in society. Accessibility has to be defended as a right of all social coexistence. According to Law No. 10,098, of December 19, 2000, points out that "[...] accessibility - possibility and condition range for use with security and autonomy, spaces, furniture, urban equipment, buildings, transport, information and communication including its systems and technologies [...] (BRAZIL, 2000). It is then clear the importance of ensuring equality for the disabled, including visual, so they can participate in the knowledge society. In addition, Garvin (2000, p. 68) have made explicit that "ideas have the most impact when they are widely shared, not when kept in a few minds." Every discovery conceived from the construction of knowledge and in a school environment, mediated by a teacher, should be shared. In this context, the teacher's role is to guide the educational activities no longer being the holder of knowledge (transmitting knowledge) and, yes, the mediator between students and information, helping them to become active subjects in the process of learning, building their knowledge. In step of high school, among the areas in which the National Curriculum Common Base (BNCC) is organized, it has the "Language and its technologies" whose components are: Portuguese Language, Art, Physical Education and English Language. When talking about the construction of knowledge Arts has, as a requirement, understand that only with the support and

work of a teacher with effective action, committed to the processes of teaching and discipline learning, you can foster cultural growth individual and a person as spectator citizen and knowledgeable of the artistic production of their own nation (BARBOSA, 2016). Please note that the art of teaching can be considered a knowledge-building tool because it enjoys the context of history, broadens the worldview and individual perception of students. It also stimulates the subjectivity and can be used as a language in the expression of ideas and values. Also in this sense, its visual appeal encourages the sharing of knowledge with others, and its aesthetic appreciation of a strategy to draw the attention of other (BRAZIL, 2018). In the case study reported in this article, one of the participating students is visually impaired. The teachers involved have offered support to the decisions of students on what and what kind of work of art would be designed for reading the visually impaired student. As these teachers have a curriculum to meet, set up boundaries for the subject of research, but not the use of the tools available at the school. It was intended that the interaction between the students, the creation and sharing of knowledge work as head gear. All involved benefit in the creation and sharing of knowledge, be it tacit or explicit. Therefore, the main objective of this case study was to understand how the use of 3D printing technology can support the sharing of knowledge among high school students of a state school in Paraná, through the reproduction of works of art that can be understood by who are visually impaired.

Knowledge Building in School Context: The creation (or construction) of knowledge as Nonaka and Takeuchi (1997, p.12) is understood as "[...] ability of a company has to create knowledge, disseminate it in the organization and incorporate it into products, services and systems." "Already about sharing, Davenport (1998) states that it occurs when there is a transfer of knowledge, whether formally or informally. In addition to these ideas, Angeloni (2002 p.113) contributes stating that "[...] knowledge sharing is the main activity in the knowledge organizations." To strengthen these ideas, (Earth, 2001, p. 78) argues that organizations "[...] creators of knowledge, would thus be those that create systematically new knowledge, spread across the organization and quickly incorporate new technologies and products." Another important concept refers to the occurrence of the socialization of knowledge which, according to Davenport and Prusak (1998), generates new knowledge, regardless of whether this was conceived in the tacit or explicit format. The conception of knowledge to Nonaka and Takeuchi (2008) stands out in the following types of occurrences in the shape of a spiral: socialization, externalization, combination and internalization. Socialization occurs in situations where knowledge occurred, ie tacit to tacit. Referring to outsourcing is when tacit knowledge is represented in explicit concepts. Already the combination is related to the sum of new knowledge to existing explicit to explicit. The Internalization, this is the incorporation of explicit knowledge to tacit. Explicit knowledge can be measured, coded, Knowledge is not a static quality and, yes, a dynamic relationship. The shape of an individual approach reality is always a constructive way and has to do with their disposal, with your prior knowledge and the characteristics of the object. A "thing" is only an object of knowledge when there is interaction between it and the cognitive organism that is as an object (PEREIRA *et al.,* 2017, SILVEIRA *et al.,* 2019). For Franco (2004, p. 56), in the school context, "[...] the teacher is there to organize the interactions of the student with the means and discuss the situations in order to make the student himself, build knowledge on the topic being addressed. " Already Brenelli (2005) Serving as a problem-solving makes the teacher has more work in preparing their lessons. In addition, students need to be motivated to work as active subjects in the learning process, not only as mere spectators of traditional lectures. There are several factors that can influence the sharing of knowledge, leading to different results in the same process. One such factor is the sharing of knowledge, it depends on who will present, as will be presented and also who will assimilate it (SZULANSKI, 2000). Another point to consider is the context in which knowledge is shared, which may be configured as a barrier or impediment (DAVENPORT AND PRUSAK, 1998; NONAKA and TAKEUCHI, 1997; SZULANSKI, 2000; EARTH, 2001). This search movement, sharing and creation (or construction) of knowledge, needs to be encouraged and favored by organizations, especially in the educational field, at different levels and areas involving the processes of teaching and learning.

3D Printing of use in Context for Poor School Visual: Social engagement in the educational context is guided in the opening spaces promoted by the school, so that it favors the interaction of collaborative knowledge to the contents contained in the curriculum and the experience of the students. According Peruzzo (2003), students to participate in a practice in your daily life, facing the common interests of a group, act representing an organization, a social movement or school projects. Somehow each, has entered into a process of informal education, contributing to the cultural transformation, popular and training for citizenship. It is one school mediator of different subjects experiences that will be protagonists of local knowledge and practices in the construction of collective intervention projects, the commitment to socializing with social commitment, protagonist in the construction of knowledge. The school stands out, too, because working diversity - cultural, racial, gender, among others - that must be recognized and respected by all, especially to those that have a disability. An inclusive school is one where all work together to overcome the obstacles that perhaps can restrict the advancement of someone present need or a physical disability, hearing, visual, mental or multiple so that the construction of knowledge is guided the quality of education, as envisaged in the legislation (BRAZIL, MEC / SEESP, 2001). An organized and equipped environment favorable to exploitation, which stimulates the perceptual framework of the visually impaired, target audience of this work is the need that differentiates those who see. In addition, students with a disability need to be included, living and participating in all the activities proposed by the school. Reinforcing this statement, Sa, Campos and Silva (2007, p.14) point out that the visually impaired "[..]. Regarding the visually impaired potential", and Costa Pereira (2009) emphasize that the visually impaired also have developed skills, representing their knowledge of the world, which can also be shared. The interaction of students in a project like this, and teacher performance with broad understanding without prejudice or stigma related to any disability they may have, show that the visually impaired can perform different activities using the touch, allowing their inclusion and participation effective in the project. The use of 3D printing technology, and its ability to generate objects in three-dimensional format, meets the needs of the visually impaired with respect to the tactile perception, which is sharper. In addition to the three-dimensional shape,

MATERIAL AND METHODS

The methodology adopted in this research is applied by nature "[...] generate knowledge for practical application and directed to the solution of specific problems involving truths and local interests" (SILVA; MENEZES, 2005, p. 20). The research is a qualitative approach, since this methodological perspective arises in opposition to those who simply seek to quantify. Concerning the goal, fits as exploratory research by providing greater familiarity with the problem in order to make it explicit or construct hypotheses; it is also an explanatory research by identifying the factors that determine or contribute to the occurrence of phenomena (GIL, 2008). As for the procedure it is a case study occurred in a State school of Parana. Held in afterschool hours and called Creative Lab Project was conceived and coordinated by a teacher of that school Arts. Part of this project, five students of the 2nd year of high school, and one of these students is visually impaired. The school of this case study received as a prize for participating in a project sponsored by the State Department of Education in 2017, a kit of audio and video equipment, and a 3D printer. The kit was chosen due to the fact that the school has developed work with audio and video in the Art classes, allowing them to be designed to support and continuity of the activities that were already underway. Already the 3D printer is a challenge to be explored by teachers and school students.

RESULTS

In the process of valuing the knowledge within organizations whether educational or not, Lover and Petri (2017) highlight the importance of structuring an environment that encourages the acquisition and sharing of knowledge created from interactions or acquired outside the organizational context. Thus the ability of the teacher of Arts to organize a space within the school grounds was necessary, and have strategies so that students feel motivated and, likewise, acted as protagonists in building and sharing of knowledge. The generation of new knowledge and the mobilization / involvement of people only happens if there is a pre-set engagement (DRAGO; SILVA and SATO, 2014). To involve a group of high school students and introduce them to the challenge of using technological tools, especially a 3D printer, the teacher Arts had the support of the management team of the school. Another point that is worth noting, was the desire of the participating students to invest efforts in the reproduction of works of art, so that the visually impaired could perform the interpretation. Although experimental, evidence of the big difference in attributing challenges to these students.

Picture 1. Steps necessary for the use of 3D printing technology

step I	
Challenge	Find a tool that allows the simulation of the part in 3D before processing it, preventing material waste and time
Strategy	Study Tinkercad and Blender software, online and free tools, used for drafting and 3D design simulation models
Solution	Internet search, the group discussion and study.
step II	
Challenge	Finding solutions to the finish with clear definitions for tactile reading
Strategy	Study MatterControl, free software for design visualization 2:03 dimensions before and during printing. The Healing and Ultimaker Autodesk responsible for the slicing of the piece.
Solution	Contact a technical SEED LAB via Whatsapp messaging app. Internet search, the group discussion and study
step III	
Challenge	Using cards that transmit two-dimensional images into three-dimensional printing of the Mona Lisa by Leonardo Da Vinci, in order to be recognized with the use of touch.
Strategy	Exploration 3DP.Rocks/Lithophane software, which allows the representation of a figure in the 3D format and its measure.
Solution	Contact a technical SEED LAB via Whatsapp messaging app. Internet search, the group discussion and study.

Source: Authors (2019).

They were provoked to search for solutions and to experience the value of sharing knowledge, so that this would not be limited to one or another participant. The proactive participants in enhancing their knowledge, both for collecting information when in times of change was evident in the group feature. In order to meet the challenge by Professor of Arts, created a sync between all participants of the group followed the movement of thought (Stewart, 2002, p. 59) where. "[...] learning is one of the provisions of the new labor contract that everyone sign with anxiety" In light of this lived moment, the teacher must act as a mediator and advisor, which leads students to seek useful information and answers to current problems, so that these are not lost in a constant barrage of new information (EMYDIO and ROCHA, 2012). By causing social engagement in the school context, it is expected that the school open space for interaction of collaborative knowledge, the contents contained in the curriculum and the experience of the students. Importantly, the printer usage in school, in the first months, was virtually nil because the software was complex and little known within the school reality. It was still need more research and also engagement of students. Early in the second half of 2018, the teacher of Arts, which had participated in the training for printer usage, set before the students of the 2nd year of high school, the class in which it operates, the use of 3D printer on a project where everyone could participate. It was placed on the agenda the idea of 3D printing fabricate parts for a visually impaired student of the 1st year of high school. So it created a group of ten students to start impressions and searching software to bring solutions for modeling, collecting information about the parts, as well as how to slice and print pieces. The group had some difficulty at first because there was no timetable or set design. Again the printer stood by the end of 2018. In early 2019, a new group was organized pointing as basic requirements to participate in the expression of interest in art and technology. Currently the group is composed of five students, one of which is the visually impaired who is now in 2nd year. Still under the coordination of Professor of Arts and to include the 3D printer as a tool in the students' every day, it was decided to organize a so-called Creative Lab pilot project. The project takes place in afterschool hours with students from 2nd year of high school. Committed to using different methodologies and tools for conducting their classes and with the support of the direction and coordination of the school, the meetings take place in the late afternoon and lasts two hours. The application of different methodologies, such as active learning methodologies, make students and teachers to interact more and that learning is meaningful (BERGMANN, 2018). With a more select group and from previous experience, it was possible to develop a plan that favored the construction and sharing of knowledge among those involved for the sake of solution for operation of the 3D printer. weekly challenges were launched to the students begin to operate the printer. On the initiative of the participants, they organized according to their skills and prior knowledge already acquired. They invested efforts in a series of actions that can be observed by means of Picture 1. The return of the answers to the question made to SEED LAB technicians did not arrive in time, and when the answers were received, they were superficial. Thus, students conducted research on video tutorials on the Internet. In these searches, they find explanations of how to improve in great detail a piece. The discovery of the students, based on the accumulated knowledge and constant studies favored the understanding that could have the impression of the picture in 3D format. Students found that it was sufficient that they used reverse lighting, so that the texture of the image to stay on the positive and thus it would be possible to recognize it with the fingertips during tactile reading. It was a great victory for the group, every attempt to piece produced, subjected to the recognition of the visually impaired student, so that it pointed what was flawed and satisfactory. In presenting their needs with respect to the necessary relief in the form of edges, so

that the tactile reading was effective and he could identify the Monalisa. This work was chosen by the members of the group because they are studying on the subject during the lessons of Arts. After the notes of the visually impaired student, the other participants had a reference to invest efforts in the search for solutions. The Monalisa is printed in the form of a PLA filament plate, approximately 20 cm high by 15 cm wide in the vertical and horizontal reverse. This measure has been previously configured through software 3DP.Rocks/Lithophane with the thickness of approximately 3mm. This data can be changed before printing. The final print result of the work of Leonardo Da Vinci can be seen by Figure 1. When scanning the image of the Mona Lisa, an encoded file was generated and stored in a memory card. To print the card was inserted into the 3D printer and then the basic settings have been made, according to the desired result and started printing. The printing process of a painting like the Mona Lisa in 3D format usually lasts for approximately 22 hours. Hence, it is justified, every group's commitment to studying solutions that could optimize the time of printing, and to allow a preview in trying to find possible errors before finalizing the project. To operate the 3D Printer, we used the following software: Blender and Tinker cad for 3D modeling and Ultimaker Healing and Autodesk, which operationalize the slicers. Important to note that these slicers allow to define the thickness and the print speed of the object to be printed in 3D. To convert the images of paintings into three-dimensional objects used the 3DP. Rocks/ Lithophane. During the interactions of the group, the sharing of knowledge, a barrier was exceeded. New knowledge is built and assimilated, and more motivated the group became. The visually impaired student, who was validated productions and had peculiar and relevant information for job advancement. As a rule, the Creative Lab project, printing may not be used at random, without a goal. The purpose is that all participants: 1) share the knowledge achieved; 2) store the information found on an online platform, so it becomes available to all at any time; 3) periodic meetings and record decisions; 4) respect the limitations of feedback and visually impaired student, in order to establish a trusted relationship and inclusion. It is understood that in this way, those involved will be able to recognize that the results belong to the collective. Printing large works is only a starting point, a technical basis for students to create intimacy with this very complex tool, which involves the use of a 3D printer. From the knowledge gained from the impressions, students who present interest in art, design and illustrations, will have the opportunity to create, collaboratively and with social engagement, producing parts for the visually impaired from their creative and copyright works. Although the group supervision of Professor of Arts, his performance was almost exclusively as a mediator and counselor of the teaching and learning processes, and notes about the routines and steps to follow. The autonomy granted to the group and the possibility to build something suggested by them, can explore freely, find solutions and test the result that every attempt resulted in a new challenge. This was one of the points of this satisfactory experience that will continue. This mediation function and guidance and autonomy of students is one of the bases of active learning methodologies (BERGMANN, 2018). Throughout the study, there was collaboration between the students and the challenges stimulated the autonomy and the desire to create. Know the reality beyond the school, it is also important in building and sharing of knowledge. Students will make contact with other visually impaired to learn about different perceptions of the world, curiosities and which can be attractive for future tactile views. One of the results observed through the case study, was to determine what happened empathy in sharing the knowledge acquired and also found to be social engagement among the students involved. In addition to the appreciation of the individual potential of each participant, they invested in research and development of solutions.

Source: Authors (2019).

Figure 1. Monalisa printed with 3D technology use

Reinforces the speech that research is one of the important pillars in the teaching and learning, as highlighted Demo (2004).

DISCUSSION

It is believed that from this experience with the Creative Lab project, the participating students were able to experience effectively the value of building and sharing of knowledge. Seek answers using different channels and not become hostage of them, demonstrates autonomy to conduct a process, as well as make use of pre-established knowledge to create new knowledge. Involve students in organized projects and educational and social purpose is a methodological work experience that put them in challenging situations of reflection for the construction of knowledge together in new ways. The fact that, from the group of students, the desire to find solutions through the 3D printing technology, so that the visually impaired could make the recognition of art works presented during Art classes reiterates the importance of development and activities collaborative in school. Already collaboration while teaching methodology and learning involves group work mediated by a more experienced individual (in this case, the teacher). In this project the participants were well since it took place both cooperation, the collaboration. Among the students in the group there was no leadership or someone with less space. All had their place and commitment, both to share their personal experience, as well as absorb the rest. The result of the dynamic proposal - describe how the use of 3D printing technology can support the sharing of high school students of knowledge in a state school in Paraná, in the reproduction of works of art for the blind - was very satisfying because it was possible to combine three situations: (1) the working class content in the case of discipline Arts, using the technological support; (2) mobilizing students to work in teams, exercising conditions of cooperation and collaboration, in order to build their knowledge; and (3) effective inclusion of a student with a visual impairment, To school, is the result of that count on the support of the leadership and coordinating education, is one of the first steps so that other teachers are mobilized to devote themselves to promoting different practices, exploiting the resources available at school and cause students to broaden their knowledge, relying on what they have already accumulated through his experiences. There is still a lot to move and explore using 3D printing technology. However, it is considered very satisfactory what has been achieved so far. It is intended to give continuity to this project with 3D pieces of printing, from the copyright productions of the participating students. Note also that this project is open for participation of different areas teachers as well as students from other school years, understand the collaborative work as an essential skill for the 21st century, as it is teaching you learn and is sharing what we know.

Thanks

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