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EDUCATION AND CITIZENSHIP: CONTRIBUTIONS OF PSYCHOPEDAGOGICAL PRACTICES TO POPULARIZATION OF SCIENCE

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ABSTRACT

In the so-called Information Society, knowledge is a powerful tool for real social inclusion. Inclusion through knowledge is a citizen attitude, as it changes students' perceptions, allowing critical thinking, stimulating the ability to question the world and encouraging to change reality as active citizens. Popularization of science is a must and a challenge. In a globalized world where the Internet seems to be the largest vehicle for information, offering children and young people the illusion of unlimited knowledge, the traditional academic practices do not seem to correspond to the student's desire of learning. Under the light of psycho-pedagogical perspective, we can discuss different possibilities to communicate science in the academic context, at different ages, from pre-school to university. This article brings together the experience of six educational professionals who use the psycho-pedagogical know-how to promote a meaningful and interesting learning. Psycho-pedagogical practices consider the singularity of each group, students protagonists in learning process, stimulating reconstructive questions, re-signifying previous knowledge, making knowledge meaningful and relevant, thus articulating student´s desire to the scientific discourse.

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INTRODUCTION

The world has changed more in the last century than in the thousand preceding years. The twentieth century was marked by the reconstruction of traditional values that, shaking the foundations of our culture, guiding us towards the greatness of globalization, changing our technological, political, economic, social, cultural and family horizons (FERRY, 2010). Contemporary society is faced with new educational and social paradigms. In a globalized world where the Internet appears to be the greatest vehicle for information, propelling young people to the incessant quest for information and the illusion of unlimited knowledge, traditional academic practices, most often, do not correspond to the student's desire of learning. Whenever the student's "desire of learning" conflicts with the teacher's "desire of teaching" the student cannot be simply expected to learn, without any truly support to the student's desire (MANNONI, 2010). One of the most interesting ways to learn science, in order to reduce the gap between the "desired knowledge" and the "necessary knowledge", is to articulate science to everyday life, establishing parallels with the person's life experience. By promoting the articulation between the new information with relevant pre-existing aspects in the cognitive structure of the person, then – and only then - the new information can be converted into knowledge. This is what "meaningful learning" is all about: to offer

meaningful approaches of that "necessary learning", which most often is not included among students' preferences. The popularization of science is a citizen attitude, since it allows the individual to analyze, to question and to interpret situations, to build own opinions and to participate actively in society as a competent citizen.

MATERIALS AND METHODS

Sometimes, students themselves are unaware of their learning need. The following experience describes the identification of a specific learning need which do not figure in the school curriculum, even though the issue has a direct impact on the daily life of the population: the nuclear sciences. Nuclear Technology helps to improve the quality of our daily lives. Contributions to the medical field include accurate diagnoses and treatments for various types of cancer. In everyday life, nuclear sciences contribute to the safety of the population, for example in the case of smoke detectors, which contain americium, a radioactive material. These detectors are required to be installed in offices, homes and places with large concentrations of people. Smoke detectors, radioisotopes in medicine, x-ray machines, as well as other advances in nuclear science, save lives every day. However, there is still great misinformation and the issue divides public opinion in Brazil and worldwide. The media and social networks, strong opinion makers, often relate nuclear technology to nuclear weapons (Hiroshima or Nagasaki) or major accidents (Chernobyl or Fukushima). Sensitive to the need of new dialogues between science and society, the Nuclear and Energy Research Institute has promoted an initiative to communicate the beneficial uses of nuclear technology in medicine, industry, agriculture and electric power generation. The need for learning was identified through a survey, conducted in December 2016, where respondents were asked about one of the major Brazilian issues that directly impacts on the daily life of the population: food supply.

In fact, the theme is one of the great Brazilian issues and food irradiation is one of the research fields that emerges as an important contribution to respond to the emergence of this demand in Brazil and worldwide. Food irradiation is related to human health, agriculture, food safety, radiation protection, environmental issues, nutritional education, combating food waste, economic losses and international trade. The methodology to detect the issue (un)familiarity by the general public began with a survey, entitled "Science and Society". For the first phase of the research, there were invited 100 individuals from the public between 20 and 70 years old, living in São Paulo City. When asked about nuclear science research in Brazil, 90% of those respondents said they do favor the advances in research, recognizing their importance for the scientific and technological development of the country. However, when questioned about their first thoughts about nuclear technology, 55% of the respondents associated nuclear sciences with risk, danger, war, cancer, illness, accidents, weapons, Fukushima or Chernobyl. The vast majority of respondents were unaware of the Radura symbol, internationally used to identify irradiated food products: 67% of respondents claimed they had never seen the Radura symbol and 21% had already seen it, but they did not know its meaning. 20% of respondents said they would not eat irradiated food, making clear the lack of knowledge about the diference of "irradiated food" and "contaminated food." 28% of the respondents did not know how to answer, 9% associated the symbol with a quality criterion and only 3% demonstrated some knowledge about the food irradiation technique. After a brief explanation of the irradiation technique as a safe process for the consumer and its contributions to food safety, making it clear that irradiated foods are not radioactive or contaminated foods, respondents changed their opinions about their purchase intentions: 70% of respondents expressed confidence in the technique, stating that they would give preference to the consumption of these products and would inform in their communities about the new information they had acquired.
With these results, the working group undertook new actions for the dissemination of scientific knowledge for the most diverse sectors of society.

The purpose of this educational action is to bring together society and science, combating misinformation and omission of the media, demystifying unfounded fears, promoting reconstructive questioning and enabling citizen protagonism in issues that directly impact on society's everyday life (LEVY; VILLAVICENCIO, 2017). The notes above authorize the discussion of the need for different ways of teaching science as a possibility to strengthen the exercise of citizenship. Formal schooling, from basic education to higher education, should be based on practices linked to the social reality we live in, as a way of contemplating the effectiveness of social inclusion. However, this condition, although advocated in legal national documents, such as tthe Federal Constitution (1988), the Law of Directives and Bases of National Education (1996), as well as international documents, such as the Universal Declaration of Human Rights (1948), are many times neglected in its effective exercise. History guides us towards the rights of citizens. In this sense, most of the changes that occurred over time took place in the twentieth century. The Universal Declaration of Human Rights, adopted and proclaimed by United Nations General Assembly resolution 217 on December 10, 1948, establishes in its Article II that:

Everyone has the capacity to enjoy the rights and freedoms set forth in this Declaration, without distinction of any kind, such as race, color, sex, language, religion, political or other opinion, national or social origin, wealth, birth or any other condition (BRASIL, 1988 –CF Art. 205). The Law of Guidelines and Bases of National Education of 1996, based on this requirement, provides in its text:

Education, duty of the family and the State, inspired by the principles of freedom and the ideals of human solidarity, has as its purpose the full development of the student, his preparation for the exercise of citizenship and his qualification for work (BRASIL, 1996 –LDBEN Art. 2º). Given this panorama, how can we practice a differentiated teaching in the mold established by legislation? A teaching process where it is possible to promote the students´ empirical and personal knowledge? How to construct the individual as an integral being in the midst of this process? How can school practices be more attuned to the sociohistorical moment to which we are attached? Therefore, we emphasize the need of reviewing methodologies that contemplate more specific needs. Moreover, we turn to active learning methodologies which establish, as a founding assumption, the teacher as a mediator of a learning process based on real-life problems and situations. Students need in the first stages of training the "follow-up of more experienced professionals to help them to become aware of some processes, to establish unnoticed connections, to overcome steps faster, to confront them with

new possibilities" (Moran, 2015, p. 18). For this reason, there must be introduced challenges which, when well-planned by the teacher, allow to develop intellectual, emotional, personal and communicational skills (Morán, 2015). For the author (2015, p.18) the challenges "require research, assessing situations, different points of view, making choices, taking some risks, learning by discovery, moving from the simple to the complex." Thus, if we want proactive students we must search for methodologies that are as close to the real world as possible. This practical dimension makes it possible to break with traditions that distance themselves from reality, making it difficult to exercise the right of citizenship. By citizenship we consider 'the importance that the development of physical, psychic, cognitive, ideological, scientific and cultural conditions exerts in the achievement of a dignified and healthy life for all people' (ARAÚJO, 2007, p.11). In this sense, teaching tasks focusing social projects assume capital importance, as they seek to reduce the discrepancies existing in the world in which we live.

CASE STUDIES AND RESULTS

Systematic curiosity and investigative thinking from early childhood

It is well known that an environment that stimulates different stimuli and interactions helps the development and expansion of cerebral circuitry, particularly in the first years of life. The social influence on cognitive functioning was clearly demonstrated by Vygotsky. From Vianin´s researches (2013): parents and teachers are determinants in the learning of the cognitive processes and their further use by the child in future life. The question is: how to introduce science, curiosity and questioning in child development since early childhood?

This case study describes an experience in educational space where there were used search boxes. The children, between 1 and 3 years old, were divided into groups, each group composed by 5 children.

The first “search box” was called: “The Box of finding out myself”. The box was fulfilled with mirrors in various shapes and sizes varying the activity in different ways according to their developmental stages.

The children observe themselves and analyze the classroom friends around them. They look, smile, touch and kiss each other in the mirror and out of the mirror. After trying grimaces, laughter, and other facial movements, the child finally concludes that the mirror reflects his own image. In a second moment, the children construct the first hypotheses about “the other in the mirror” and soon begins to try new experiences, such as showing the tongue, making funny faces, finding out new possibilities. Images are fundamental in both socialization and individuation (LACAN, 1996).

The second “search box” was called: “The box of finding out the others”. This box brings children's figures in several different activities such as: jumping, dancing, playing with toys, reading books and other experiences that help children to develop social skills by imitating these actions, making use of costumes, hats and other accessories. During these playful and entertaining activities, teachers stimulate curiosity and creativity, as well as visual and spatial reasoning, so important in infancy to develop abilities for future scientific learning.

Mirror or Speculum, from Latin, originally means to speculate, in the sense of to observe, to see, to look at. Plato and Plotinus already proposed that self-image is expected to receive the influence of its models as a mirror (CHEVALIER,2008, p.395). Spinosa's thinking is also taken into account today: "The human mind perceives not only the modifications of the body but also the ideas of such modifications." What these authors really mean is that once the children form an idea of a certain object, they can form an idea of the idea, later on they can form an idea of the idea of the idea, and so forth. (DAMASIO,2004). Experiencing visual, sensory and social stimuli is part of growing up. The child is naturally a scientist. It is up to us, adults, to make these activities enjoyable.

The student protagonist in the construction of his knowledge: an experience in High School

This case study reports a pedagogical experiment carried out in high school classes at a private school in São Paulo. The objective of the experiment was to put high school students in contact with topics related to the production of electrical energy from radioactive sources, the famous nuclear power plants (SANTOS; LEVY, 2015). Teaching nuclear sciences in High School requires a multidisciplinary approach, articulating Physics, Chemistry, Geography, History and Mathematics. Nevertheless, there are difficulties to promote interdisciplinarity in the school routine, mainly due to the lack of communication between the professionals who teach different disciplines that are part of distinct fields of knowledge, as well as time to fulfill the workload established for the compulsory school content. The following experience was carried out in extracurricular hours for students of the several high school grades and on a voluntary basis. 12 students made their voluntary inscriptions. The work was developed in three distinct stages. The first step was to verify the students' previous knowledge about nuclear energy, identifying conceptual flaws and common prejudices that are part of the popular imaginary when it comes to nuclear sciences. The students were divided into groups, each tasked with researching different points about the production of electricity from nuclear sources. It was established previously, and in common agreement with the students, that each group would present their research results in the form of a seminar. Research education encourages the student's role in building his knowledge, promotes systematic curiosity, critical awareness and intellectual independence.

Looking for an interdisciplinary approach, for the second stage of the work, the groups were encouraged to research in library in the areas of Chemistry, Physics, Geography, Mathematics and History, according to the interest of the students. They were then asked to seek more specific information from reliable sources such as the National Nuclear Energy Commission (CNEN), the Institute of Radioprotection and Dosimetry (IRD) and the International Atomic Energy Agency (IAEA). The students were then instructed to carry out mini-courses in the Educational Portal Radioactivities (Portal Educacional Radioatividades), didactic and reliable material, freely available on the Internet for the teaching of nuclear sciences to schools, students and teachers (LEVY; SANTOS, 2015). The third stage of the project involved the preparation and presentation of seminars. The preparation of the seminars facilitated the dialogue among the participants, the re-signification of assimilated knowledge and the production of new knowledge. The activity proposed by the teacher provided

the student protagonism, involving students in building their knowledge, collaborative learning, sharing and acquiring new skills, and disseminating information, making students multipliers of knowledge before the Academic Community. As a result, the participating students demonstrated a significant improvement in their knowledge of physics and chemistry and the development of new skills such as the ability to speak in public, the transmission of knowledge and the willingness to work in a team. The work was praised by the pedagogical coordination of the school and aroused the interest of the academic community, bringing up current issues of society in an interesting and meaningful way (SANTOS; LEVY, 2015).

Teaching and learning through research in the University: planning social projects

It is a must to encourage young people to play their own role in schooling processes. Part of this study details a work done with young university students of the Pedagogy course of a private university in São Paulo City, Brazil. The discipline "Project Development and Analysis", is taught in the 3rd semester of the Pedagogy course. Students are encouraged to design and conduct social projects based on the demands of society, under the guidance of a teacher. This work is based on the need to instrumentalize future educators according to social reality, which is often discussed only theoretically and unrelated to practice. Based on the premise that the learner should reflect on issues arising from the social context, we consider it important that the student goes to field as a way of understanding the situation and seeks to play his real role as a constructor of the practice of citizenship. We emphasize, above all, the need to consider the specificities of youth identity and ensure that it should be applicable and relevant to their learning. In this way, "expanding the conditions of expression of youth as a way of engaging it in their own educational process is a goal that has been pursued in Brazil and abroad" (SOARES, 2011, page 15). It is imperative, therefore, to consider this irrefutable premise. These university students, when receiving the demand presented to them, sought places where they could act and consolidate actions, in order to minimize social and cultural discrepancies, using different learning tools. Among several projects, some of the highlight works were: "Chaplin in the Community", related to cinema; "Roots", related to culture; "A small dose of detachment", a project developed from social networks information.

The "Chaplin in the Community" project sought children between the ages of six and ten from a needy community in the eastern part of São Paulo, and they had contact with Chaplin's silent movies. The choice for silent films was due to the possibility of numerous imagery readings. The children did not habitually go to the movies and for many of them it was the first experience. There was a conversation wheel after the movie was shown, and then a drawing activity, as a way of externalizing interpretive variables. The drawings are meaningful and should not be neglected, especially in the bias of a psycho-pedagogical study (PERALTA, 2012). Although we have programs of popularization of culture in the city of São Paulo, it is observed that its access by the majority of the needy population is still very restricted. We emphasize the importance of the arts to open up new possibilities of expression. The "Roots" project sought to spread cultural democratization by offering workshops in arts, painting, handicrafts, cinema and theater to residents of a peripheral district in south São Paulo. The project, carried out at the residence of a beneficiary of the project, was supported by the other residents, who sought in the project a possibility of cultural expression. In the same sphere of previous projects, "A small dose of detachment", was also released on Facebook. This project aimed at the exchange of used children's clothes. Graduates sought to make people aware of "detachment" from weekly sharing. It is imperative to recognize the relevance of the media as the propagator of information in the modern world. The project was successful, given the fact that social networks constitute a huge way of propagating ideas and work. We reiterate the position that we must provide new conditions for the expression of young people, making them engage in their educational process (SOARES, 2011). Soares (2011, page 15), based on premises presented in the book endorsed by UNESCO (2009), observes:

[...] the new generations, when guided by adults who are significant to them (parents, teachers, managers of media projects and education), have chosen to assume their responsibilities in building a more intensely communicated world, contributing to make the forms of information at the service of building a more humane, peaceful and supportive society. Hence lies the discussion about the importance of meaningful mediations. They leverage student learning and make them autonomous beings in front of what they do. The psychopedagogical work, conducted by the tutor, occurred during four school months. The learning situations, mediated by the teacher, were conducted in the midst of provocations to the students, discussions on possible alternatives to moments of impasse and analysis of the activities developed.

DISCUSSION

Students intervention in social projects: inclusion through knowledge

The results pointed out that the students, when stimulated to carry out actions in real contexts, had characteristics in opposition to those of traditional learning and showed characteristics such as: autonomy, self-management and great awareness of the needs of a given population (PERALTA, 2016, P. 167). The practical conduction of the projects stimulated the teaching-learning process: (a) the undergraduates requested the teacher's mediation; (b) the questions raised for discussion in the classroom transcended the propositions contained in the lesson plan of the discipline; (c) the learning situations overlapped the bases of traditional teaching, highlighting characteristics such as: autonomy and awareness on the problems of the populations served. It was also evidenced that the students began to think about the importance of the role that they play as subjects that mobilize changes that touches our society. On the other hand, the practical experience presented relevant data regarding the real role of the teacher, seen in this context, as a mediator of learning. It is worth emphasizing that the school context, whether in basic or higher education, should be the place for new learning to take place. In this way, it is appropriate for the school to begin the debate about the relevance of the insertion of social projects in the school universe as a way to stimulate the idea of a society for all. School and teachers must assume this premise in the scope of their attributions and, in this dimension, the active methodologies are highly relevant. It is thus, in this spirit, that ordinary individuals are called to carry out projects of relevance to the conquest of citizenship.

Diversity and Inclusion: opportunities and possibilities for growth

The latest neuroscientific researches such as the "Human connectome Project Multi Modal Parcellation", new mapping of neural circuits that expanded in 97 new brain regions, brought a healthy revolution. These are regions that relate to movement, logical reasoning and even emotional regulation. The research included three different types of mapping, magnetic resonance imaging: functional task, functional at rest and relative myelin density map, besides the use of an artificial intelligence program (machine learning) to classify the information[1]. Such advances can help in the development, for example, of treatments for disorders such as autism, dementia, epilepsy, schizophrenia, Parkinson's and many others, as well as helping neurosurgeons avoid damaging important areas such as motor or language in their surgeries. It is a major leap forward into the future in both health and education. Disorders and learning difficulties have been illuminated with greater understanding of the brain. Mapping indicates new paths and neuroplasticity generates shortcuts.

Partners such as Psychomotricity and Neuro-learning that uses the CNS (Central Nervous System) as a basis, bringing diagnostic techniques and elaboration of plans for therapeutic intervention, enabling recovery in cases of dysfunction, as Fonseca (2014) explains in detail, has expanded the accuracy of its tools. The guarantee of the right to difference in inclusion relies on science for changes in both political-social and educational aspects. The scientific, technological contributions of communication and information have favored learning environments with instruments such as computers, internet and other digital languages such as distance education. Science has been generating challenging tools, flexibilizing resumes, making it possible to construct knowledge, to know and to expand metacognitive strategies as Vianin proposes (2013), allowing each one to take responsibility for one's own development. Thus, coexisting within diversity according to their needs, includes society, whether or not they have disabilities, difficulties or learning disorders. Science is present and reveals secrets and must also be revealed, included in the domains of the common citizen. Know thyself.

Final Considerations

In a globalized society in which "democratization of knowledge" and "social inclusion" are slogans, psycho-pedagogical know-how demonstrates that in the different phases of life it is possible to focus on the diversification of learning modalities, to invest in inclusive practices that privilege different cognitive styles and introduce the object of knowledge in an interdisciplinary way, which facilitates the articulation of knowledge and promotes meaningful learning. Psycho-pedagogical knowledge considers the singularity of each group, opening space for the interrogation and for the circulation of the word, re-signifying the object of knowledge, working from the non-complete ideas, thus allowing the subject to be re-launched into the field of scientific discourse and desire of learning. From pre-school to adulthood, every subject is a potential learner. And information is an important tool for real social inclusion. The twentieth century was marked by the deconstruction of traditional values which, shaken by their foundations, guided us towards the greatness of capitalist globalization, offering further possibilities and broadening our technological, political, economic, social, cultural and family horizons (FERRY, 2010). Scientific knowledge and new technologies are increasingly conditions for the individual to know how to position themselves in the face of processes and innovations that affect them.

The interactions between society and scientific discourse can occur from an early age and must continue in adulthood, for the journey of man is marked by continuous evolution and the incessant search for wisdom and knowledge. The example of the impact of the nuclear sciences on everyday life, a subject of which the general public generally knows nothing, makes us reflect on the contributions of scientific education beyond the school environment. In order to increase the dialogue between science and society, the professors involved in the "Science and Society" research carried out actions for the scientific education of the population. The choice was made through the development of interactive online activities, free available on the Internet. In this country of great territorial extension, Information and Communication Technologies (ICTs) contribute to the democratization of knowledge while simultaneously reaching many people geographically distant in a short time, with high quality information and low costs. With well-defined didactic goals and making use of the best didactic and pedagogical practices for distance learning, interactive activities act as resources that facilitate learning, requesting the active participation of the individual, enhancing the willingness to learn, implying the subject in the construction of his knowledge. In the Information Society, where the Internet seems to be the most popular source of knowledge, ICTs can contribute to the popularization of knowledge in an effective and inclusive way (LEVY; VILLAVICENCIO, 2017). The popularization of science is a must and a challenge. Being a citizen is having the right of access to information, the possibility of developing critical thinking and reconstructive questioning. To be a citizen is to have the capacity to analyze options and situations, to interpret the speeches of the media, to build self opinions, to participate in the decision-making processes of society, to modify the world through the application of knowledge, to intervene in the social, political and economic reality of the country as a competent and active subject.

[1] Article: A multi-modal parcellation of human cerebral cortex (Nature doi:10.1038/nature 18933 publish 20/07 - 178/nature/vo.536/11august 2016)

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