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Teachers multidimensional role towards meaningful learning: the potential value of interdisciplinary environments

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Abstract

The definition of “interdisciplinary learning environment” gives rise to different interpretations. This article presents and discusses interdisciplinarity in pedagogical practice for the construction of meaningful learning, strengthening the construction of knowledge in personal, scientific and social spheres. Case studies respectively show: the contribution of interdisciplinary work to self-identity and subjective constitution in early childhood; interdisciplinary work in an informal learning environment as a facilitating element towards scientific knowledge consolidation; and the university’s interdisciplinary work in social projects for building a fairer society. In the light of neuroscience, the article discusses aspects of cognitive and social-emotional developments, as well as the approximations and estrangements between the object of study and the epistemic subject. In the so-called Society of Information, the multidimensional character of the teacher’s work becomes a necessity and a challenge, since it is the school’s role to form citizen-students, developing competences to increase students’ academic knowledge and extend it to their personal, professional and social lives.

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1. Introduction

The definition of “interdisciplinary learning environment” gives rise to different interpretations. Learning is a continuous and lifelong process, concerning different people, different ages and into the most different contexts: familiar, academic, institutional, business and social. This article discusses interdisciplinarity in pedagogical practice, which along with well-defined educational objectives, tends to favour learning situations and promote student protagonism, systematic curiosity, encouragement to research and reconstructive questioning.

Museums are examples of interdisciplinary learning environments, which allow teachers integrative pedagogical approaches and allow students to make connections across disciplines. The National Archeology Museum, in France, is a well-known example of how an archeological collection of more than 30.000 exhibits can be presented in a contextualized and relevant way. Says the museum about its Neolithic objects collection: “*The Neolithic (dating from 5800 to 2100 B.C.) is prehistory’s second period. Back then,*

populations became sedentary due to the emergence of agriculture and livestock. The first villages are built and the first megalithic structures are erected. This period is characterized by technical innovations, such as stone polishing, the emergence of ceramic and weaving.” It is noticeable that, beyond the given collection, the visitor is led to ponder on the archeological collection under the perspective of different disciplines, such as: history, geography, biology, chemistry and physics.

In fact, school content is divided into disciplines to enable systematized and effective teaching. Beyond school's walls, museums, libraries, parks and expositions are opportunities to rescue, reinforce and articulate contents in an interdisciplinary fashion, making them relevant and interesting, maximizing the student's engagement in the knowledge construction process. In the 21st century, teacher training covers complex and multidimensional aspects: beyond the mandatory curricular content, protagonism is expected from the teacher, along with authorship that fosters, above all, meaningful learning.

2. Meaningful learning: continuous connections with previously known knowledge

The concept of Meaningful Learning started with David Ausubel's classic theory, specially his work “The acquisition and retention of knowledge: a cognitive view” [1]. Although dated and, according to some, surpassed, his theory lingers on and does require teacher's attention.

Meaningful Learning has as a main characteristic the interaction between previous knowledges and new knowledges. In a nutshell, meaningful learning is a process whereby symbolic expressed ideas interact in a meaningful fashion with student's previous experiences, allowing them to redefine and enlarge their knowledge. Previous experience is an anchoring idea or subsumer (specific knowledge already existent in student's cognitive structure). People learn from what they already know: meanings expand and get transformed, providing significance to new understandings. Evidently, there are conditions for this learning to occur: learning material must be potentially meaningful (logical, relevant) and the student must be willing to learn.

The teacher has the task of knowing not only what and how to teach, but mainly, to whom he is teaching and how that person learns. It is common within school's context, to require proofs whether the student “knows or does not know”, that they are “right or wrong”, that the answer is “yes or no”. So, student is expected to provide “right answers”, even though the subject in discussion is not yet understood. When teaching or grading, one must consider comprehension, meaning uptake, and, mainly, the capacity to transpose those knowledges to new situations, applying them into different contexts. It is important to allow the student to redo their learning activities, if wished or needed, minding that they explain, justify the given answers, showing true meaningful learning and not just a copy or simulation of a knowledge which they do not have.

The meaningful learning depends on new postures, new looks to different types of learning and, mostly, distinct ways to evaluate. From three case studies, this article presents and discusses interdisciplinarity in teaching practice to the construction of a meaningful learning, favoring the construction of knowledge in personal, scientific and social spheres.

2. Case studies: strategies for effective teaching and meaningful learning

2.1 The protagonist teacher and his contributions to the construction of subjectivity in early childhood

Early childhood is an important phase on the development of the child and the teacher is a fundamental part of it. Teachers must reevaluate themselves, understand others, notice the interdependence and interactions necessary for the job, the conviviality. Teachers have powers that emerge from their place and from themselves; the teacher's role is not simply to teach school content, as mentioned by Alicia Fernandez [2]. The teacher needs, before the technique, "to look" upon the student, "to listen", through any sense, or better yet, through all of them. The teacher needs to learn from the student before teaching him or her. The teacher in early childhood, expert or not, must be prepared to provide a creative process of learning, not a corrective one. Learning must be meaningful, captivating, planned and loving. Teamwork is important, and the complicity must occur between educational colleagues as well as among students, always aiming the education and overall development of this new person. The following case describes straightforwardly the importance of respect and the child's "beliefs", providing trust and the power to overcome difficulties.

Magali, struggling to express herself and filled with aggressiveness, started school when she was two years old, without talking, just making isolated sounds. The school staff got involved on the observation work to assess if her "problem" was cognitive or emotional, trying to overcome the unsettling speak blockage. The staff, composed of educational psychologists, psycomotricians, psychoanalysts, music teachers, dance teachers, art teachers, yoga teachers, capoeira teachers, foreign languages teachers, pushed themselves to motivate her towards communication, starting by forming good emotional bond. The goal was to develop her speech, without harming her self-esteem, so no damage would be inflicted on the construction of her self-concept. She was treated with confidence during classes and with equality among her friends. Her silence was not considered. Magali starts to do well in her foreign language classes. She realizes that her friends did not know how to speak this new language either; there they were also silent. This finding made her inhibition cease. She feels very comfortable and starts talking, feeling socially equal, well accepted and accepting others. Using her interest, the teacher starts to address contents from other areas. The foreign language was the trigger to unlock a possible "learning difficulty" and ends up achieving a better use for the group, and mainly to Magali because one language enriches the other and Magali finds in this encounter an opening to express herself, understanding the pleasure of putting herself out there and starting to speak, also in her native language. Her aggressiveness diminishes and her satisfaction towards her achievements is clear.

As children see themselves through adult's eyes, the teacher must go beyond formal fashion or find meaning in it, so the student can search and they can find solutions together. In this partnership, the way out, of what was before, a possible "learning difficulty", was the social acceptance, which although not real or clear, made sense to Magali. The "Meaningful" in Magali's case was her sensation of failure possibly triggered by some already overcome motor difficulty which could have been resignified through her success in foreign language; a new beginning.

2.2 Teaching through research and its contributions for scientific knowledge construction

Museums, parks and libraries are learning environments which allow an interdisciplinary experience of the

school's content. This case study reports the initiative of the Nuclear Sciences Museum to offer its teachers and students a deeper understanding on nuclear energy and its pacific applications. According to the Brazilian Guidelines and Bases to National Education Law [3] and the National Curriculum Guidelines to Basic Education [4], it is school's responsibility to provide the students a minimum curriculum, enabling the development of abilities and skills that lead to a fair comprehension on nuclear reactions and its applications. The teacher is expected to develop students' critical thinking, instigating deeper researches and discussion of real questions about nuclear technology [5]. However, nuclear science is still a controversial theme among a significant portion of the Brazilian population. Most often, even teachers are aware of the issue and the subject is explored in a superficial level, so that the minimum curriculum is attended. Considering nuclear technology's correlation to important aspects of everyday life (food safety, agriculture, nuclear medicine and industrial applications), how to help teachers to reach more accurately the National Curriculum Guidelines' goals?

The main goal of the Nuclear Sciences Museum is to communicate the peaceful applications of nuclear technology, demystifying paradigms, questioning unjustified prejudices and fostering the elaboration of critical thinking on daily issues related to nuclear sciences. The museum's collection includes objects, interactive panels, videos, photographs and models. The space offers guided visit, practical experiences and multimedia activities, which allows the visitors to deepen their knowledge and resignify the offered information. On occasion of the National Museum's Week, in 2016, tens of museums from all around the country fostered a variety of activities on the theme "Cultural Landscapes". During the week, the museum offered the academic public an opportunity to unravel "The radiation's secrets behind the most beautiful cultural landscapes". Doing this, through lectures and interactive activities, teachers and students from elementary and high school were led to know: France and nuclear power production; England and nuclear techniques for unraveling the secrets of mummies and sarcophagi; Egypt and the use of carbon-14 for archeological findings dating; United States of America and natural radioactivity; Bolivia and cosmic radiation; Italy and x-ray techniques for authentication and recognition of artworks. Yet, since it was a Brazilian audience, beautiful national tourist destinations that raise interesting reflections about nuclear energy were selected, such as: Guarapari, with its monazitic sands; Poços de Caldas, with its radioactive anomalies and Rio de Janeiro, the only Brazilian state to produce nuclear energy. This is one of many actions promoted by the Museum of Nuclear Sciences.

Every year, the museum participates on different thematic cultural weeks, presenting nuclear sciences through several points of view, articulating science with visitors' past experiences, promoting contextualized knowledge, making science meaningful and relevant. In a playful and apparently informal manner, a visit to the Museum of Nuclear Sciences offers a deeper learning of nuclear physics with an interdisciplinary approach; articulating Physics, Chemistry, Geography, History, Biology and Math. Each educational solution is developed to combine scientific knowledge with meaningful experiences which young people are dealing with, problematizing questions that instigate their curiosity. It is expected from this action that educators may know new dimensions of nuclear physics, enlarging the discussions in the classroom. In order to improve the communication actions, the museum invites visitors to rate their experience at the Nuclear Science Museum on a 10-point scale, where 10 means a very good experience.

In year 2016, among 1.442 responders, 88,6% of the visitors, rated 9 to 10, proving the high quality experience in learning nuclear science at the museum.

This experience reports the contribution of a non-formal space of learning to the improvement and modernization of science teaching, giving the teachers tools to complement schools content, favouring scientific literacy. According to UNESCO (2013), scientific literacy assumes the development of specific abilities and skills, such as the student's capacity of searching for information, his or her critical consciousness to analyze them, his or her questioning disposition and knowledge (re)construction [6]. It is the school's role to form citizen-students, able to extend their knowledge beyond academic sphere, able to actively participate on our society's decision making processes [6]. Scientific literacy is possible and needed since early childhood and it is the educator's role to foster learning situations that favors the transposition of merely didactic contents into everyday life applicable knowledge [7 – 8].

2.3 The teacher as a cultural mediator and his contributions to the construction of a fairer society

We understand that one of the teacher's role in modern society is to stimulate meaningful learning situations among young people. The sense of duty and justice must be the educator's ongoing commitment for the construction of a better society. The purpose of teaching work must favor the dimension of "*preparing young people to elevate themselves into the level of present time's civilization – its richness and its problems – so they can act*", including scientific, technical and, also, social preparation to do such [9].

Education in formal environments, throughout historical process, reinforces the traditional culture of teaching and learning. Non-formal environments, however, attest the relevance of assuming the pedagogical practice in different learning spaces, as a way to effectively understand the problems of current society [7]. In this context, meaningful mediations from teachers, in centers beyond school walls, become relevant, as they provide tools moving students towards a more equal society. The Federative Republic of Brazil's 1988 constitution postulates in its 5th Article that "everyone is equal before the law, with no distinction of any kind, granting Brazilian people and foreigners living in the country the inviolability of the right to live, to freedom, to equality, to security and to property, in the following terms" [10]. Therefore, children, young people and adults, in a social vulnerability situation, must benefit from social actions, implemented by adults committed to the construction and development of a fairer society.

We will describe some of the projects developed by young college pedagogy students from a private university in the city of São Paulo, Brazil. The projects were designed by students from the third semester, in a discipline called "Projects Elaboration and Analysis". Based on the discipline's demands, these college students, searched for non-formal spaces to apply their ideas. The teacher conducted learning situations, involving, motivating, and questioning the students in order to stimulate investigative possibilities. In this relationship, teacher and students co-construct knowledge together, distancing themselves from the traditional model, in which the teacher owns the knowledge, transmitting it through methodologies and contents, in many cases disconnected from student's reality.

The projects "Beethoven", developed through classical music, and "A mouth like a ten"¹, based on the importance of hygiene and oral health, were developed in children's and teenagers' foster home before or

¹ Original name in Portuguese : Projeto Boca Nota 10

after school's regular time. The "Brilliant talents"² project, managed through artistic activities, was conducted in a support home for children with cancer, in the central region of São Paulo (Southern Brazil), where they receive and accommodate children and teenagers from many other Brazilian states.

The "Beethoven" project arose from the premise that music activates brain areas, enabling the development of attention, concentration, memory and expression. Shortly, the project conductors sought to broaden these abilities through classical music among children from seven to ten years old. The activities took place in three distinct moments: a) awareness about the importance of music in life; b) practical activities with classical music and feeling externalization through drawings; c) conversation sessions on the activities developed as a form of verbal expression. The study verified that children, when exposed to classical music with defined purposes, became more serene, alert, concentrated on the activities being developed and easily expressing their feelings, through drawings or during the conversation sessions.

The "Brilliant talents" project used art during the activities conduction through the manipulation of play dough. Children, between four and five years old, initially manipulated the material as a way to recognize what they had in their hands. After the initial handling of the material and with the student researcher's support, they started to model different elements as: houses, parents, brothers, indicating, through an informal conversation with the student researchers, that they missed what was left behind because of the distance. Children, in a second moment, through intervention of the project developers, began to express other feelings, modeling the play dough and experimenting with dough mixtures transformed into new colors. This moment enabled the children to relive a "spontaneous way of playing" through a symbolic game. In addition to it, they were able to work up their touch, smell and vision, develop fine motor skills and concentration, and also socializing their productions with other children. The work, in its two moments, allowed them to externalize their feelings through the modeled elements. The advisor teacher's mediation was precise so the students, the project developers, could understand: (a) the work format to be developed with the sick children; and, (b) the channeling of necessary interventions.

Another project developed by the students of the same discipline was channeled with the premise that the situation of oral health in Brazilian society, although its progress over the last decades, still has a challenging configuration, especially when it comes to the underprivileged population. Brazilian social and economic scenario clarifies the following question: we suffer from a bad distribution of wealth, illiteracy, mostly in the northeast region of the country, poor levels of education, homelessness and, in many cases, precarious housing conditions. These conditions have an impact in our population's health. The "A Mouth Like a 10" project sought to raise awareness in children, from six to nine years old, about the importance of oral hygiene and health. The developers sought to consolidate the project by the following instruments: (a) an initial conversation session approaching the importance of oral hygiene; and (b) conduction of the steps for a good brushing. Both instruments, counted with playful elements as a way to approach the subject. The students, when asked to present the discussion of the project's results, concluded that they had not resolved the problem, but started a process of awareness in the target population, accomplishing, in this manner, the founding purposes of the project.

The above-described projects confirm that, during the process of teaching formation, it is fundamental to

² Original name in Portuguese : Projeto Talentos brilhantes

focus on the understanding of people's lives under real perspectives. In addition, these experiences proved that when well guided, they boost knowledge and amplify student's eyes around the object of study.

3. Results and discussion: cognitive and socioemotional development aspects

Playing is the beginning of "doing" for human beings. Playfulness is the pleasure in "doing". These experiences of "doing" are learning. Learning is a vivid process every time new information generates change in central nervous system (CNS). Receiving all kinds of information from the organism's exterior and interior, the brain constructs the man. We learn what is necessary to survive and what gives us pleasure. The brain has a rewards' circuit in its limbic system, which has other structures that trigger emotions and a variety of reactions throughout the body in it. When attention fuses itself with emotion a memory is created, learning is this acquisition. The quality of the experience is what defines the registered intensity. Stimuli and experiences are stored in different parts of the CNS and, when evoked, they fuse recreating input in a responsive way (output). New meanings construct themselves through the interaction with previous knowledge. The Brain is plastic, the experiences are important and they construct, by different ways, the learning process of every one of us. The different forms to interact and to experience lead us to learning and make us unique.

Emotions motivate us, make us more vigilant and have a strong influence on the consolidation of memories, favouring the learning process, but may have an opposite effect if they generate too much anxiety or stress. Stressful situations may destroy hippocampus neurons when secreting glucocorticoid hormones from the suprarenal gland. Hippocrates would say that we feel sadness or happiness through the brain. Therefore, by favouring meaningful and pleasant stimuli, humorous, enthusiastic and curious, we end up generating an easier and lasting learning. Activating emotion, attention and memory.

"Learning" usually makes us think of "teacher", but it could happen, and it happens, through many ways or agents, it goes beyond the "formal teaching situation" or even the virtual environments of distance teaching. "Teacher" makes us think of a "formal content, didactic" but there is a lot more to learn and teach. May a teacher lead his or her student to pleasure by seeking self-knowledge, self-sufficiency personal skills and relational abilities, beyond cognitive and productive ones? Yes, first they would have to be so that later they would have, or obtain information.

To involve more than one sense in the experience, reading out loud, declaiming or singing, for instance, is efficient, but the mediator must assess the individual or group in the search for the adequate type of reality they are inserted to signify and anchor the necessary information for a satisfactory acquisition. Allowing him or her to construct and insert him or herself in the world, producing and using the acquired resources with autonomy, seeing the value of the learning process, signifying it in his or her own reality. The "meaning" is in each one. To feel, to see, to hear, to touch, to use all senses, to take control of sensations, reflections and perceptions to understand the students universe makes the teacher a partner, seeking for alternatives together, academically speaking or not. The interaction shows itself as a fundamental part in the search of a solidary and much more meaningful education. The bigger the number of strategies and stimuli used, the bigger the possibility that the content will reach long-term memory; that it will find relational material, previous knowledge.

During the learning process' development and its difficulties, action areas as psychomotricity and neurolearning abide and use cerebral development stages, favouring the dialog between student and teacher, also using resources as Capoeira, Yoga, dancing, Circus, swimming, horseback riding and many more to provide content absorption, ability expansion, adoption of meaningful behaviors. Cognitive training programs as PEI (Ruven Fuerstein's Instrumental Enrichment Program) which seeks to develop the student's adaptation capacity through cognitive strategies and skills with mediated systematic training or the Mathew Lipman's philosophy program for children that focuses on the processes of self-reflection with autonomous and critical thinking also demonstrates that there are other ways the teacher and student can get involved in the learning process using cerebral resources. The IMBE "International Mind, brain and education Society" links scientists, physicians, educators and other education professionals. One of the main objectives of the Society is to foment the trade of information, researches, theories or interdisciplinary and intercultural dynamic practices, among neuroscience, genetics, cognitive science, development and education screening and bringing reliable and relevant results to the trade between mind, brain and education.

The museum, the cinema, the beach, the computer, parents, friends, are all sources of interaction and learning. But, should we thicken the homeschooling adepts' ranks? Or should we value socialization and the professional who prepares him or herself in a multidimensional manner to insert the subject into the world? For educating is this, is it not? Living is a great learning process. From the first cry to the last breath our brain is willing to learn. Although the rhythm diminishes over the years, the learning process never ends; it is our job to make it meaningful.

5. Final considerations: promoting learning process in different contexts

Teaching, over the years, has become more complex since the Traditional Teaching Approach's principles are renounced, and in their place it is adopted the horizontality of the teacher-student relationship for knowledge composition. The multidimensional character of the teacher's work has become indispensable for a global society, considering the necessity of orientations regarding social sustainability. The cases addressed in this article showed their relevance to the understanding of an individual identity construction, in science appropriation and social dimension, enabling the approximation between educational and social dimensions. In other words, they favour the comprehension of the social world from each subject's singularity.

We have highlighted, throughout the presented case studies, the importance of adopting active methodologies for subject's emancipation in many contexts. These methodologies glimpse a universe of challenges to be overcome, from topic researching, evaluation, to decision making related to risks taken according to the choices that are made. Furthermore, these methodologies stimulate proactivity, autonomy and self-management, which are necessary skills in our lives.

We have also emphasized the importance of the teacher's mediation, from the early childhood to college education: the students, their hypothesis and perceptions should be inside the teacher's attribution range, to question them and their possible conjectures, help them think under yet not contemplated perspectives in such a way that intellectual, emotional and personal skills are awakened. Soon, the works will, when

well guided by experienced and committed teacher, boost knowledge in multiple dimensions. This allow us to affirm that providing and mediating meaningful learning situations from early childhood to adult stage, as the ones described in this study, has become imperative to subjects' emancipation, when considering them in their own particular singularities.

We consider that in a "society for everyone" there is no more space for actions conducted in a traditional way, suppressing the voice of the students and neglecting the needs of its citizens. The "school", as an institution, and the education professionals must open themselves to new methodological appropriations. This article demonstrate the importance of these new methodological appropriations, as a tangible possibility that gives opportunity to effective meaningful learning experiences.

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