

Digital Didactics and Science Centres: An Innovative Proposal

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DIDATTICA DIGITALE E CENTRI SCIENTIFICI:
UNA PROPOSTA INNOVATIVA

ABSTRACT

This article presents the Pedagogical Itineraries, an innovative educational proposal to teachers and students of basic education and high school students (elementary and secondary education), and to the customers of science centres (museums, zoos and other informal education places). Besides offering elements to digital didactics and educational opportunities using a virtual support that allows interaction and appropriation of knowledge in topics of the natural sciences field, our goal is to offer subsidies for the use of these learning objects in a logical and flexible manner. Furthermore, new creations made by teachers, students and science centre visitors can be integrated with the pre-existing itineraries. Therefore, what is proposed is not a mass production of media fragments, but a professional structure that supports production and an interactive and educational use of these resources. So, it will be possible to contribute to increasing the scientific knowledge. In this context we have developed a didactic proposal which involves the production of learning objects with an emphasis on creativity, interactivity and interdisciplinary of content.

Keywords: Didactics, Digital Resources, Education, Learning object, Science centres.

1. INTRODUCTION

School is often considered as an uninteresting, far from reality and unable to attract and motivate its students. Moreover, in Brazil, as in other countries, basic education is deficient in several areas, among which we highlight the Sciences of Nature.

In fact, it is not a surprise the low performance of Brazilian students in the international PISA – *Programme for International Student Assessment* – is not surprising. This failure that has been explained by factors related to family background, school delay, school context, teacher training, repetition, dropout and repetition rates, and limitations resulting from a loss-making and low investments in education (UNESCO, 2005).

In this context we have developed a didactic proposal which involves the production of learning objects with an emphasis on creativity, interactivity and interdisciplinarity of content, aimed at producing multiple *Pedagogical Itineraries* from the composition of a set of videos, photos, podcasts and softwares.

The instructional design of this proposal lies in contextualization as a generating tool of links between scientific content and the daily lives of students, teachers and visitors. It also proposes expanding the possibilities to dialogue *Pedagogical Itineraries* from the hypertextuality approach and content aimed at creating educational programs in science centres to enable:

- the popularization of science among the general public and students of elementary and secondary education, from the use of digital resources;
- continued training of teachers away from learning objects and resources that explore the interrelationship between theory and practice, ongoing reflection and exchange of experiences on pedagogical practice.

This pedagogical conception follows a paradigmatic change in the teaching of science subjects that considers UNESCO an assertion about the need to modify the teaching of science revitalizing schools, involving students and educational professionals, based on the values of citizenship, solidarity, participation, social inclusion and wellbeing, making them the centre of dissemination of scientific and technological knowledge (Moran, 1995).

2. SCIENCE CENTRES AS EDUCATIONAL SPACES

Museums, science centres and other public spaces can provide excellent informal, non-formal and formal teaching-learning situations that encourage the curiosity of the visitors and provide opportunities to supply, at least in

part, some of the known needs of the schools in regarding the teaching of science.

In Brazil, teachers from public and private schools are struggling against the lack of physical infrastructure – such as labs, science rooms, etc. – and also against the lack of media resources and learning objects that could stimulate and contribute to the teaching-learning process. In this sense, the science centre has an important role to make good, at least in part, the deficiencies identified by the teachers.

Note that any science centre not only will promote education spontaneously by the possibilities and potentialities of the features offered. In order to reach this purpose, it is necessary that this space has a didactic and pedagogic interface. Thus, the pedagogical proposal described here reflects on the consolidation of science centres as educational spaces capable of amplifying their potential in seizing and disseminating knowledge of the biological, chemical, physical, geographical, historical and cultural kind, among others.

This proposal considers it important to meet three strategic objectives outlined in Brazil (UNESCO, 2006):

- promoting water resources management;
- promoting the protection, conservation and sustainable use of biological diversity;
- support the construction skills in science and technology for sustainable development.

And specifically in relation to the third objective:

- supporting the improvement of science education;
- reinforce the dissemination of scientific and technological knowledge, not only in universities and other research institutes, but also to the general public.

3. THE DESIGN OF TEACHING SCIENCE

Scientific concepts are complex by their own nature. Therefore, we accept that the transdisciplinary approach to the subjects implies a way to allow the appropriation and expansion of scientific knowledge. This approach, while minimizing the borders between disciplines, favors the didactical transposition of subject contents, to establish a reciprocal relationship between the object of knowledge, previous knowledge of the student and the different situations or dimensions of their personal, social and cultural life.

First of all we consider it desirable that the design of learning objects, to be used in *Pedagogical Itineraries* are designed in a cross-didactics approach

that explores the multiple intersections of biological, physical and chemical knowledge with culture, cuisine, history, geography, etc.

Considering this perspective, in Brazil, the *National Curricular Parameters* (PCN), in 1998, were already warning that an encyclopaedic and fragmented perspective does not reflect the dynamic and historical nature of science and pointed to the lack of a perspective established in different interests and values (Brasil, 1998).

However, the didactics «tradition» is still characterized by the fragmentation of knowledge into «artificial» modules that do not establish dialogue and do not connect with others knowledges, educational or informal as may be.

We understand that unrelated school contents, which are typical of common sense and still present in the teaching of science subjects, constitute an epistemological obstacle to the construction of meaningful learning in the appropriation of «scientific objects» (Bachelard, 1996). It is necessary to overcome outdated, reductionist, fragmented, linear ideas. The establishment of a dialogue to ensure that pluralism and diversity of opinions and points of view, may contribute to the understanding of a complex and dynamic reality (Almeida, Petraglia, Dal Mas, Queiroz, & Lorieri, 2006):

- level I: for the public visitor to layman and students of the first stage of basic education (1st to 5th grade);
- level II: targeted to the visiting public with specific topics addressed by students and for the second stage of basic education (6th to 9th) interests;
- level III: proposed for visitors interested in seeking further knowledge and high school students.

The different levels will be represented in the *Conceptual Framework* for digital learning objects of short duration. The objects are directed for level I and will heavily investing in the contextualization of knowledge and should be able to enhance the everyday classroom, arousing curiosity and the investigation, and also provide the articulation of knowledge. Level II should consider that it is possible to expand the world view of visitors, students and teachers, from the historical and social relationship between scientific knowledge, technology production and living conditions, in order to understand that human needs cause impacts on a changing environment. Objects for level III should allow the construction of a dialogical approach and articulate of the knowledge, focusing on «the structuring concepts» or connectors and overcoming the buildup of isolated and fragmented knowledge.

4. PEDAGOGICAL ITINERARIES

To establish and strengthen cognitive bonds in the pursuit of significant learnings - according to the conception of Ausubel (1968) – we propose the concept of *Pedagogical Itineraries* that can be translated by the metaphor of a sequence of «links» that may constitute a «chain». The gaps created by the lack of direct and immediate learning objects interconnectivity of short duration are not «empty», but represent the space of the mediation. It is precisely in this universe that the teacher, the educator or the students themselves or visitors in science centres may propose provocations based on previous knowledge and/or generate searches that contribute to the construction of new knowledges.

Predefined *Pedagogical Itineraries* are designed and proposed such that the intertwining of the learning content can generate contextualization in a less isolated and restricted way, as well as the understanding of scientific content. The nucleation of the themes will be explicitly or implicitly around issues that are efficient in allowing interdisciplinarity, providing paths so that teachers and students (formal education), in addition to the frequenters of science centres (informal education) may have opportunities to develop their knowledge. They can thus cherish learning contents related to the area of Science Nature, eliminating the arbitrary limits of the disciplinary separation.

A *Pedagogical Itinerary* does not seem to be an active tracing. However unfinished, always subject to change and be linked to local and social matters. In this sense, each itinerary features intentions, realities and meanings. The effect produced by the chaining of small learning objects, in turn, will only be able to produce knowledge as from the contextualization of information.

The information in these learning objects should not be seen as fragmented because they are part of an itinerary, in a pedagogical context. Thus a *Pedagogical Itinerary* itself can be perceived as a «macro» learning object.

New *Pedagogical Itineraries* with new learning objects, may be proposed by teachers, students and visitors of the science centres. These new creations can be integrated with the pre-existing itineraries and thus be able to generate a wide variety of *Pedagogical Itineraries*. The participation of these teachers, students and science centres visitors is another form of learning that can be supported by the team itself of the science centres.

These new *Pedagogical Itineraries* and the new learning objects will be interrelated and linked to the previous ones. In this way, it will be possible create endless *Pedagogical Itineraries*.

Hence, what is proposed is not a mass production of media fragments, but a professional structure that supports production and an interactive and educational use of these resources.

5. SELECTION AND ORGANIZATION OF DIGITAL RESOURCES

One should remember that learning objects are self-consistent entities of small extent and entail an easy manipulation of educational content, which may be combined with other learning objects or any other digital media in ways that can be reused in different processes of teaching and learning.

Flexibility, ease of upgrade, customization, interoperability, portability, reusability and combination are some of the characteristics of digital educational resources. Importantly, they must ideally be self-contained so they can be selected according to the itinerary designed for approach to content.

Regarding the designing of *Pedagogical Itineraries*, learning objects, as a fundamental characteristic, should be short-lived. This option is suitable for both the proposed use of these resources for informal education for visitors of science centres, and with the prospect of reuse and recombination of *Pedagogical Itineraries*.

Each digital resource must be accompanied by an educational orientation that points to a field of possibilities for its use to support teachers in their choices.

6. «CONCEPTUAL FRAMEWORK»: AN EXAMPLE

As a way to illustrate the concepts of pedagogical proposals we shall present a diagram illustrating the concept of pedagogical routes and «grain».

The approach to content through a focus on the central theme for the proposition is an exercise that must be performed with the support for teachers from specific areas, so that each *Conceptual Framework* can reflect widely about the context in order to enable interdisciplinarity.

The design of *Pedagogical Itineraries* requires the definition of the goals of teaching and learning for each level of information presentation (I, II or III) so that it is possible, in the content to be presented, to define those points (digital resources) to be selected for each itinerarie. For each objective, it is possible to raise one or more motivational questions facing the audience, whether for formal or informal education.

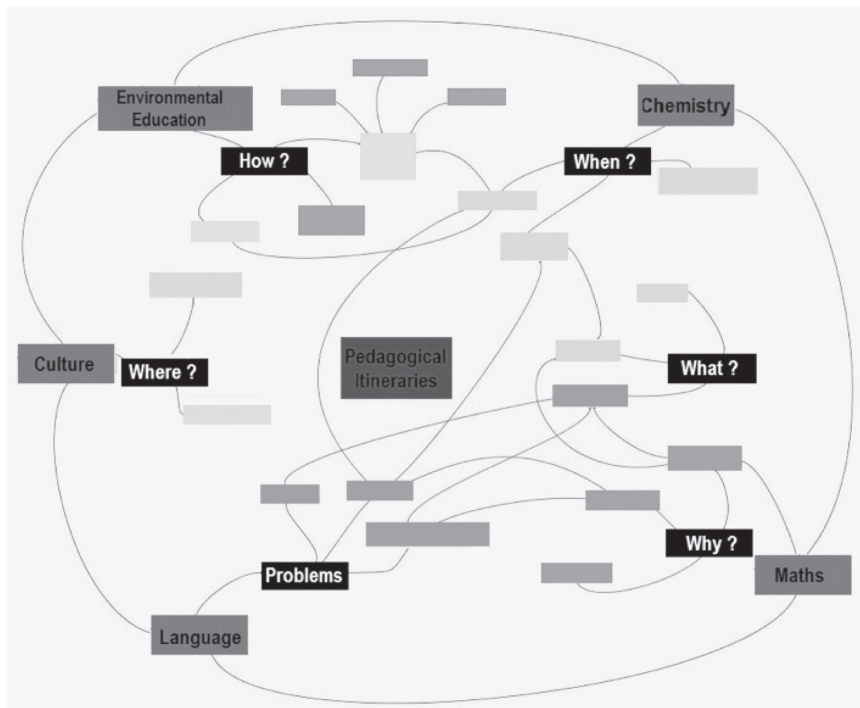


Figure 1. – Example of a Conceptual Framework.

The *Conceptual Frameworks* are basic for the selection, organization and presentation of *Pedagogical Itinerary* schemes. They represent the interrelationships of the themes of the different disciplines or areas around a subject. The conception of *Conceptual Frameworks* for a given subject, allows the visualization of different possible itineraries for each level of information to be presented to students, teachers and visitors (Figure 1).

The *Conceptual Frameworks* allow for a wide perception of the possibilities of interactions between digital resources contributing to:

- location of the desired itinerary in relation to others possibilities;
- identification of digital resources;
- navigation to material available;
- creation of new itineraries.

By providing learning objects, in general, there is a concern about the adequacy of using of the available materials.

In the context of this project, the evaluation of digital resources and the possibility of copies are crucial for the improvement of pre-established routes. The evaluation of the frameworks, *Pedagogical Itineraries* and digital resources must be continuous through the suggestions, criticisms and proposals from users, thereby enabling the complementarity of resources.

7. POSSIBILITY OF PRODUCTION OF NEW PEDAGOGICAL ITINERARIES

The proposal of *Pedagogical Itineraries* ensures that the teacher - as the author of your textbook route - can decide and select - the most appropriate learning objects to meet the objectives of your lesson. This prerogative is important to give the teacher different ways of organizing the *curriculum*, starting from the identification of the needs, interests and previous knowledge of the students.

Therefore, the available material can be «modelled» and reconstructed in several ways, allowing great flexibility in its use by the teacher, given the precept of recursiveness, typical of learning objects. This possibility as well as enhancing the options for use in planning your lesson, will allow the contents to be presented from a different *focus* of connection and context from a selection and organization of digital resources. Note that this material may not only be used by science teachers of elementary or high schools, but can also be integrated into contents from other disciplines.

8. IMPORTANCE OF EDUCATIONAL MEDIA AND ROUTES

We firmly believe that the appropriation of knowledge contained in each learning object - as a symbolic instrument in a Vygotskian perspective - does not always occur spontaneously and directly. The teacher's mediation is critical and necessary for signs to have meaning for the individual (student or visitor to a science centre) with whom we share knowledge. Therefore, all media must be linked to intentions, to concepts and didactic orientations that assist the teacher in the mediation process geared towards negotiation of knowledge. Furthermore, it is important to remember that people express and need different learning styles. For some people, the ability to learn is essentially linked to the act of viewing, while others are kinesthetic and need to be manipulating something. However, we endorse that educational resources aimed at meaningful learning of concepts must consider this difference and seek to facilitate different learning styles.

8.1. *Videos*

Videos can combine the languages of cinema, theatre, radio and computer graphics (Gomes, 2008). By using a synthetic language, associating images and sounds, a video allows you to expose complex ideas and abstract situations (Arroio & Giordan, 2006). difficult to be presented and understood only in textual form. Also, the videos are very important as triggers of emotions and sensations.

By exploring scenarios and colours (near-far, up-down, right-left, big-small, balance-unbalance), the video which is directly recorded or created on computer allows visual rhythms, static images or dynamic spatial possibilities, etc. (Moran, 1995). These possibilities are very useful in order to explain subjects.

Videos can be used at different educational levels since the quality of teaching is not left out (Gomes, 2008) and to be attentive to the themes and sub-themes, they are presented in accordance with the target audience.

8.2. *Softwares*

Educational software is a generic designation for learning objects with different proposals. These include animations and simulations, applications with an invaluable educational value, that enable the integration of a variety of media and which may have different levels of interactivity.

Software can enable a link between a variable, a theoretical element, and its representation, image, whose main didactic value is to mobilize the students' actions in the object manipulation and the elaboration of its meaning (Giordan, 2008). These are resources capable of guiding the look toward a more meaningful and motivator dimension of learning, because of the didactic game-like nature of the object that allows us to reinvent reality and, in some cases, to play with scenarios.

8.3. *Podcasts*

Cohesion and fluency are typical characteristics of podcasts. Thus they have an important communicative function in our proposal. This cohesion occurs through descriptive expressions which generate representations and make a message binds to a concept that connects to another, contributing to the fluidity of understanding.

The exercise performed by those who hear and imagine, is highly relevant to the process of teaching and learning. Some scientific concepts, because

of their complex and dynamic nature can be more easily transposed didactically by using the reports, the storytelling or testimonials.

Moreover, we must remember the important dimension of inclusive audio for the visually impaired.

Audio media offers the following advantages:

- extends personal experience, stimulating interest in issues, facts and previously unknown people;
- contributes to the Self;
- acts as a multiplier, accelerating the process of informing and supporting the grasping of new knowledge;
- facilitates the use of their sound references to establish dialogue between individuals and groups, promoting the notion of community.

9. SEEKING SOLUTIONS

We believe that there is a lack of scientific literacy in the population and that solutions should be sought to change this situation. In our proposal, we seek to show that digital resources can contribute to a rapprochement with the natural sciences of the population, regardless of the social-economic context in which it is inserted. Moreover, the implementation of our proposal will enable us to significantly contribute to the digital inclusion of teachers and to their continuing education. We know that especially in the elementary and secondary education levels, an adequate scientific education is necessary for children and young people to enable them to understand their surroundings and to expand their opportunities in the labor market. We hope that our proposal will contribute to the reflection and debate on the issue discussed and receive effective support enabling its implementation.

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RIASSUNTO

Questo articolo presenta gli Itinerari Pedagogici, ovvero una proposta educativa innovativa per gli insegnanti e gli studenti della scuola elementare e delle superiori e per i visitatori dei centri scientifici (musei, zoo e altri luoghi di educazione informale). Oltre ad offrire elementi di didattica digitale, e a mostrare le opportunità educative sviluppate utilizzando un supporto virtuale che permette l'interazione e l'acquisizione di conoscenza nel campo delle scienze naturali, l'obiettivo di questo lavoro è quello di offrire un supporto per l'uso di «learning object» in modo logico e flessibile. Inoltre si intende mostrare come gli studenti, i docenti e i visitatori dei centri scientifici possono contribuire alla realizzazione di nuovi «learning object» da integrare agli itinerari didattici pre-esistenti. Pertanto, ciò che viene proposto non è la produzione di un insieme di elementi di conoscenza frammentati, ma una struttura professionale che supporti la produzione e l'uso interattivo ed educativo di queste risorse: così sarà possibile contribuire ad aumentare la conoscenza scientifica. Nel contesto descritto è possibile sviluppare una proposta didattica che prevede la produzione di oggetti di apprendimento ponendo l'accento sulla creatività, l'interattività e l'interdisciplinarietà dei contenuti.

Parole chiave: Centri scientifici, Didattica, Educazione, Learning object, Risorse digitali.