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LEARNER-CENTERED DIDACTICS: TOWARDS A NEW MODEL OF EXPERIENTIAL EDUCATION

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ABSTRACT. Scientific disciplines often result as difficult and not attractive subjects for the young generations. In recent years, the experiential didactic has shown to be a much more functional educative approach, both to encourage interest in science and to facilitate the learning of difficult concepts. In this paper a new highly effective method of education is proposed, in which the schooler becomes himself an active protagonist of the studied physics phenomenon, where the body and emotive sensations encouraged the spheres of learning. We will present an innovative project, the "Physics Adventure Lab", involving 10-14 years old students based on this new model of teaching.

1. Introduction

Physics subject is a poorly appreciated discipline among schoolers, so that in the last years physics faculties register an exiguous number of enrolled students.
The reasons are generally attributable to different factors: physics is considered too far from their everyday life, less easy and intuitive than humanities disciplines and social science.
In the last decades, new methods of teaching not relied heavily on textbooks have been elaborated in order to make these subjects more fascinating (Sassi 1995; Schauer *et al.* 2009; Dinescu *et al.* 2011). In particular, methods based on experiential education have proven useful in increasing the interest of the schoolers and encouraging their learning.
Physics phenomena are tangible in the world around us; so, the explanations of physics through common experiences of daily life has always been an excellent method to make it more fascinating: classic examples of the falling book, floating objects in water or the reproduction of the rainbow have proven extremely effective to explain concepts such as gravity, the law of Archimedes or the refraction of light.
In the last years, many schools introduced physics laboratories as mandatory and complementary to theoretical teaching and it determined an increased interest of students in this subject.
Recently, some families choose unusual alternatives, such as home-schooling or unschooling, which replace traditional methods of teaching by stimulating learning through active proposals concerning the main interests of the schoolers (Farenga 1998; Holt and Farenga

2003).
Furthermore, in children with disorders such as autism or attention deficit/hyperactivity disorder (ADHD), experiential teaching proves to be much more worthwhile in concepts learning. The protagonism and not boring contents, close to their context, make them at ease and more predisposed to learning (Salvitti 2007; Ford 2018).

2. The method of Learner-Centered Didactic

Some experiential methods have been revealed extremely effective in different fields of education, having results as excellent as to become a model for other forms of learning (Baden-Powell 1919; Dewey 1938).
The Learner-Centered Method wants to propose first-person experiences in order to teach Physics phenomena putting the attention on the learner and not in concepts as in traditional didactic methods; it results in contrast with the view of the teacher-centered method of learning. The schooler himself is not a passive spectator, but becomes an essential element of the experiment, with his total active participation.
In the first phase, thus the student makes direct experience of the phenomenon as an active protagonist. The direct involvement both of his body and his emotional sphere promotes openness and facilitates the ability to make connections and reasoning (Baden-Powell 1919; Davis and Leslie 2015). Then, the specific experience becomes an emblem of a series of analogue experiences based on the same Physics phenomenon. So, for example, a swing or an oscillating liana become both examples of the same phenomenon, *i.e.*, simple harmonic motion. The first understanding of complex phenomena is then stimulated and finally, a theoretical explanation lets students to fix the concepts better.
Therefore, we can consider this *learning by doing* method as made of three phases (Figure 1):

a. face the first-person experiment;
b. mentally process the felt emotions (focalizing the phenomenon and associating it to a prototype experience);
c. fix the general concepts.

Greater efficacy of the method is reached by taking care of the modality of the experiment: the chosen pedagogical tool is that is closest and most approachable to the young people, *i.e.*, the game (Baden-Powell 1922; Samuelsson and Fleer 2008). Indeed, the game is the preferred method of learning from mind (Ackerman 1999): it implies the development of thoughts, involving the person in his totality, both regarding emotions and intellect. The players, in fact, are not subject to formal evaluation such as in structured settings of school and are freer to develop spontaneously their personal evaluation (Ellis 1973): they have to choose the best solutions to face the challenges, need to activate the mind and regulate their acts in order to exceed the obstacles and reach the goal in the best possible way, then developing their capacity of problem-solving (Baden-Powell 1919; Rosoff 2007).
Furthermore, a context more congenial to the psycho-physical wellbeing of the schooler, outside of the classroom, can become extremely efficient and effective (Baden-Powell 1922; Miles and Priest 1999). An outdoor setting, totally involved in nature, is a more favourable ingredient of teaching, because it does not present any boundaries that limit the thoughts (Guerra *et al.* 2017). Totally involving the body dimension, a natural scenario is able to

teach through the use of all senses and stimulate the innate curiosity of young people in discovering the world through interaction with it (Rathunde 2009; Farné and Agostini 2014). Through nature, therefore, Physics becomes a complex reality closer to students and in line with real-life situations, then more fascinating to be learned (Guerra *et al.* 2017).

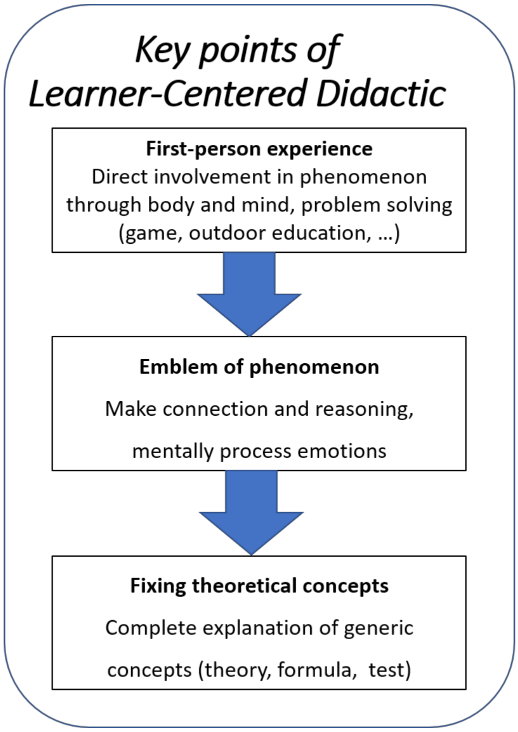

FIGURE 1. Scheme of the key points of Learner-Centered Didactic.

3. Physics Adventure Lab: a prototype of Learner-Centred Didactic

Following the fundamental principles of this new type of didactic, the project "Physics adventure lab" has been carried out. It is an experiential education project aimed to sensitize young people on Physics and stimulate their learning by using the game as an educational tool.

The "lesson" involved about 100 children aged between 10 and 14 years old. The location was an adventure park completely immersed in nature, where the visitors were involved in physics and physical challenges (Figure 2). The "adventurers" faced difficult paths traced among the trees (suspended walkway and swings, rotating trunks, lianas, Tibetan bridges, pulleys, levers...). They learnt interactively the physics laws that rule their movements, such as mechanical equilibrium, simple harmonic motion, the physical levers, the friction forces and the law of conservation of energy.

The activity made the children the absolute protagonists of the physical phenomenon, as they experience it directly becoming themselves the mass of the pendulum, the object on

the inclined plane, the body in balance, the weights on levers, etc.
The learning of physical laws was stimulated by their own experience and curiosity (such as finding the technique to stay in equilibrium on rotating trunks or understanding why you go down fast with the pulley). The children could apply the acquired concepts and discover some tricks to face more easily the obstacles along the hard paths.
After each route, the children were invited to reflect on the experimented sensations, on their movements and the strategies in facing the challenges.
The theoretical concepts that governed the movements were then reconstructed with them and, only at the end, a test was dispensed.
The project, which was awarded the second "European Physical Society prize 2017 - Best Activity of the Young Minds Project", turned out to be effective and stimulating in teaching concepts of Mechanics and Dynamics.

FIGURE 2. Picture of a player/schooler involved in the experiments of Physics Adventure Lab in the Adventure Park of Peloritani Mountain range (Messina).

4. An embodied cognitive science approach: Enactive Physics Education

This type of didactic approach finds theoretical feedback also in the Embodied Cognitive Science field, a theoretical paradigm which highlights the biological and physiological dimension of the mind. In particular, Embodied Cognition aims to overcome the approach of classical cognitivism which proposed a disembodied view of the mind, where cognition was seen as detached from the bodily dimension.
Indeed, the mental activity was conceived as an internal elaboration - brain-centred- of the external world and even the educational context was influenced by the dualist view separating mind and body. In this regard, traditional approaches focused mainly on activities of reading and memorization of abstract notions.
More recently, instead, the approach of Embodied Cognitive Science - inspired by the phenomenological tradition and the study of Varela, Thompson and Rosch (Varela *et al.*

1991) - highlights the role of the lived experience through the body in the constitution of the mind. In this theoretical framework, the enactivist research emphasized the sensorimotor system, postulating that the mind is constituted by the dynamic relationship brain-body-environment (Noë 2009; Capodici 2019; Di Paolo 2020).
Nowadays, the attention to this integrated system has also involved learning and educational research. In this regard, Skulmowski and Rey (2018) offered a detailed review of the application of Embodied Cognition theories. In particular, the authors proposed a taxonomy of embodied learning research which distinguishes between:

a) *lower levels of bodily engagement* (such as the observation of other people's gestures and movements, do homework sitting or other tasks implying minimal body involvement);
b) *higher levels of bodily engagement* (concerning the locomotion and a more extensive bodily activity).

This last full-body scenario was used by Gallagher and Lindgren in a project called "MEteor" (Metaphor-Based Learning of Physics Concepts Through Whole-Body Interaction in a Mixed Reality Science Center Program), which gives rise to an immersive simulation of a planetary system: dynamic imagery was projected on the wall and floor and the children had to properly move their body and rule the velocity of their movements in order to launch asteroids and predict their motion related to the presence of planets and their associated forces (Gallagher and Lindgren 2015; Gallagher 2018). This type of experiment is referred to as "strong enactive condition", in opposition to the "weak enactive condition", consisting of a lower bodily involvement, where the control of asteroids is obtained through minimal movements performed with the computer mouse (Lindgren *et al.* 2016).
In this study, Physics Adventure Lab and the Learner-Centered Didactic embrace the strong enactive condition: the participants experienced through their own bodies physics laws and the felt emotions drove their curiosity and commitment towards a proficuous learning. Therefore, it is necessary to conceive the mind in strict relation to the bodily dimension, considering that active exploration of the environment retroactively influences cognition (Capodici and Russo 2019).

5. Conclusions

In many contexts, experiential education exceeds the traditional formal learning method. In this paper, a new approach of teaching physics is proposed based on learning of concepts in a real-life context: the learner makes a direct experience of the phenomenon being totally involved with his own body and mind.
The mental re-elaboration of experienced emotions and actions (*i.e.*, the *re-enactment*) makes more accessible the complete understanding of phenomena. Then, the subject becomes more inclined in catching the real essence of physics experiment and storing the theoretical notions.
We can consider our approach of Learner-Centered Didactic consisting of three phases: direct involvement in a first-person experience, reflecting about the felt sensations letting to collocate the specific movements in a broader scientific context and finally fixing the theoretical concepts. Furthermore, the use of game and an outdoor experience, as in the project "Physics Adventure Lab", become an extraordinary educational occasion with a broad spectrum of opportunities: this method makes the learning more fascinating,

stimulates the mind developing the problem-solving capacity and increases receptivity and openness.

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