

**PhD THESIS**

**ABSTRACT**

**"The exhibits of "Divertiesperimenti" as bridge between the informal learning and the formal one in the teaching of the Physics in the Secondary School."**

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The actual surveys highlight that teaching scientific disciplines it gives often-inadequate results, in Italy particularly, and it emerges that, in general, the educational aspects of the teaching of the Physics are not enough take in account. Usually, the students consider the physics a distant, incomprehensible and difficult discipline: I have verified with the present work as, on the other hand, the teaching of physics could be engaging and stimulating, and entertaining in discovery and fun activities.

The research study is therefore based on the need:

- To improve the knowledge and the skills related to the teaching and learning of scientific disciplines at school;
- to experiment educational methodologies and strategies for teaching Physics more effectively.

This topic is complex and it is not easy to transfer educational research in the real classroom, so this work cannot aspire to be complete and exhaustive. I tried to give a contribution to the physics educational research starting from the description of the main issue, as well as of the potentialities, taking account of the actual situation, also normative, in the Italian Secondary School. Then, I have experimented some psico-pedagogic methodologies and I have proposed some original models of good practices.

I tried to answer to the question:

*What contribution can I provide starting from the informal learning, through a didactic laboratory centred on a mini University Science Center, for the construction of new competences in Physics of the students and the teachers?*

My work:

- From the point of view of the methodological aspects was based on Laboratory teaching, and in particular using the Inquiry Based Science Education (**IBSE**) approach; the IBSE is a scientific inquiry that starts from exploration of phenomena, based on constructivism paradigm and experimental teaching. This methodology is among the most recommended for teaching science, for its applicability and for good educational outcomes.
- From the point of view of the laboratory equipment, I mainly used the interactive experiments of the collection "DivertiEsperimenti"; "DivertiEsperimenti" ("Fun-experiments") is the collection of interactive exhibits, I designed for the Department of Physics at the University of Salerno according to the model of the Exploratorium of San Francisco [1], [2]. This collection of experiments aims to enable the public, especially the school, to "manipulate" and familiarize themselves with many physical phenomena, through an informal and even entertaining approach.

New way of teaching and learning the formalization of knowledge, to be effective, have to activate the motivation and creativity of the learners, just as the scientist does during his research. Informal and non-formal learning are therefore gaining more and more a prominent role. An important question remains how to use informal learning in science to build formal knowledge.

The first chapter of my research work is an excursus on the main issues related to the teaching of physics and on psycho-pedagogical models for didactic practices, according to the current research. In the second chapter, the teaching of the Physics it is contextualised also with respect to the new Italian regulations for Secondary School. For a number of years, a legislative change has been taking place in the Italian school, introducing important innovations, also according to the European guidelines in educational, that recommend Competency-based Education, laboratory teaching, digital technologies, and trainings for teachers.

The core of my educational research study are the **project for the** Secondary School. They have been several and diversified, all aimed at building, from informal to formal, effective learning, by raising in students curiosity and motivation.

For the reasons described in Chapter 3, I privileged the experimental dimension of physics teaching, using the didactic laboratory, with a focus on IBSE and using the interactive experiments "DivertiEsperimenti", and its extensions. Chapters 4 and 5 describe how the exhibits of DivertiEsperimenti was born, and what projects (and what results) with the school we conducted with the exhibits and / or the IBSE methodology:

- The project “DivertiEsperimenti: we experience the Modern Physics”
  - A ‘tunnel’ between High-School teachers and High-School students;
  - A new exhibit for a mechanical analog of a quantum device (Josephson Junction);
- The experiments with the Inquiry Based Science Education
  - Teachers training
    - ✓ IBSE dissemination, by the European project TEMI experts
    - ✓ The National project “Laboratories for Scientific High-School”
  - The project with the “DivertiEsperimenti” for High-School students:
    - ✓ the project “Nequēunt sine luce esse colores” (“Without light there in not colour”)
    - ✓ activities for the National project “Liceo Matematico”
    - ✓ activities for the “Physics Summer School”.

Our exhibit collection is not a “Science Center”, because their limited dimensions but, despite of the difficulties, it has become a reference point for the scientific culture diffusion in our Country.

By my research activities, I highlighted the possibility to extend didactic approach from the informal to formal, making it possible the transition from “hands-on” to “minds-on”, from the handling of experiments to the concepts construction. Out of the University, it is very hard to reach this result. On the contrary, our experience confirm analogue experiences (like the collection GEI from the University of Udine, Italy [3]) that learn us that inside the University it is possible for school students and teachers using even the research instruments. With respect to a usual Science Center, people in fact can more easily extend the inquiry from empirical starting clues to some advanced research topics in modern physics (superconductivity, astrophysics and more in general quantum physics) [4], [5].

About the IBSE methodology, my work propose some good didactic practices to implement the constructivist research theories about Inquiry [6], [7].

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