

DOTTORATO DI RICERCA XXIX ciclo

Fisica, Matematica ed Applicazioni

.

**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."**

***Dottoranda Tutor***

***Immacolata D’Acunto Ch.mo Prof. Sandro Pace***

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’ beetween 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
* Theachers 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 “Nequĕunt 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].

[1] I. D’Acunto, S.Pace La mostra “DIVERTIesperiMENTI“ del Dipartimento di Fisica “E.R.Caianiello”. Quaderni di Fisica –AIF Associazione Insegnanti di Fisica, pag 80-82, settembre 2005

[2] P. Doherty, D. Rathjen “Gli esperimenti dell’Exploratorium” a cura di Piero Cerretta Zanichelli Ed. Bologna 1996.

[3] Bosatta G., Bosia M., Bosio S., Candussio G., Capocchiani V., Ceccolin D., De Zorzi P., Marcolini L., Mazzadi M.C., Michelini M., Michelutti G.L., Pugliese Jona S., Santi L., Sartori C., Scillia M.L., Stefanel A., 1998, GEI: una mostra per realizzare un ponte tra lo sperimentare quotidiano e l'attività scolastica, La Fisica nella Scuola XXXI, 1 Suppl

[4] I D’Acunto, S. Pace “Divertiesperimenti”: un mini science center universitario per collegare didattica informale e formale- Quaderni di Fisica -Associazione Insegnanti di Fisica, Atti del LV convegno 2016 ISSN 1120-6527

[5] I. D'Acunto, S. Pace “Divertiesperimenti: exhibits and activities to help teaching science” - ICERI2016 Proceedings ISBN: 978-84-617-5895-1 2016

[6] I. D’Acunto, R. Capone, M. Giliberti et al Inquiry Based Teaching: an experience with TEMI E.U. Project proceeding del WCPE 2016, S Paulo, Brasile

 [7] I. D'Acunto, R. Capone [R.Vegliante](https://www.researchgate.net/researcher/2119655876_Rosa_Vegliante), M. Giliberti [S.Barbieri](https://www.researchgate.net/profile/Sara_roberta_Barbieri), M. Carpineti “[L'Inquiry Based Science Education: il caso-studio salernitano”](https://www.researchgate.net/publication/311858044_L%27Inquiry_Based_Science_Education_il_caso-studio_salernitano)

Bibliography (paper or Conference proceedings) of the three years period 2013-2016

1. I. D’Acunto, R. De Luca, R. Capone “A teaching proposal: Mechanical analog of an over-damped Josephson junction” European Physical Society - GIREP 2015 Physics Education Division (EPS PED) University of Breslavia (PL) ISBN 978-83-913497-1-7 pag 25-29
2. R. Capone, I. D’Acunto, R. De Luca, O. Faella, O. Fiore, A. Saggese “The Role of Symmetry in Finding the Equivalent Resistance of Regular Networks” European Physical Society - Physics Education Division (EPS PED) University of Breslavia (PL) GIREP 2015 Conference proceedings
3. R De Luca,A Giordano, I D'Acunto “Mechanical analog of an over-damped Josephson junction” © 2015 IOP Publishing Ltd • [European Journal of Physics](http://iopscience.iop.org/0143-0807), [Volume 36](http://iopscience.iop.org/0143-0807/36), [Number 5](http://iopscience.iop.org/0143-0807/36/5)
4. I. D’Acunto, G. De Martini, E. De Masi, C. Guadagni, G. Molisso, M. Serra, P. Strolin “Insegnamento della fisica moderna: collaborazione tra università e scuole campane”. Quaderni di Fisica -Associazione Insegnanti di Fisica, Conference proceedings 2014 ISSN 1120-6527
5. I. D’Acunto, R. De Luca, R. Capone Analogo meccanico di una giunzione Josephson sovrasmorzata. SIF Conference proceedings 2015 ISBN 978-88-7438-095-4
6. R. Capone, I. D'Acunto, R. De Luca; A. De Santis; O. Faella, O. Fiore-“IYL: la scuola estiva del Dipartimento di Fisica di Salerno (SEF), le attività di laboratorio” Quaderni di Fisica -Associazione Insegnanti di Fisica, Atti del LIV convegno 2015 ISSN 1120-6527
7. I. D'Acunto F.Bobba, C. Noce P. Frallicciardi A. Saggese Un 'tunnel' fra PLS docenti e PLS studenti Quaderni di Fisica -Associazione Insegnanti di Fisica, pag 41-48 Atti del LIV convegno 2015 ISSN 1120-6527
8. Capone R., D'Acunto I., Dello Iacono U., Del Regno F. “Brownian motion: an interdisciplinary teaching proposal” “New Perspectives in Science Education, Conference Proceedings 2016” ISBN 8862927053 Libreria Universitaria Edizioni.
9. R Capone, F Saverio Tortoriello, F Del Regno, I D'Acunto, M R Del Sorbo, “Action Research: a New Perspective in Math and Science Education” Atti Convegno “New Perspectives in Science Education, Conference Proceedings 2016” ISBN 8862927053 Libreria Universitaria Edizioni
10. V. Bozza, R. Capone, I. D'Acunto, R. De Luca “Lezioni stellari: un percorso didattico per gli studenti della Scuola Secondaria di II grado” - in pubblicazione su Quaderni di Fisica -Associazione Insegnanti di Fisica, Conference proceedings 2016 ISSN 1120-6527
11. R Capone, I D'Acunto, M R Del Sorbo, O. Fiore The Light Prefers the Shortest Physics and Geometry about Shortest Path Problems from Heron to Fermat - History and Pedagogy of Mathematics, Jul 2016, Montpellier, France
12. I. D’Acunto, R. Capone, M. Giliberti et al Inquiry Based Teaching: an experience with TEMI E.U. Project proceeding del WCPE 2016, S Paulo, Brasile
13. I. D’Acunto, R. De Luca, R. Capone Didattica per competenze: gli effetti ottici nelle colonne dei templi di Paestum SIF Conference proceedings 2016 ISBN 978-88-7438-106-7
14. Capone R., D'Acunto I., Del Sorbo M.R., Tortoriello F.S [La fisica del Liceo Matematico.](http://congresso.sif.it/talk/435) SIF Conference proceedings 2016 ISBN 978-88-7438-106-7
15. I D’Acunto, S. Pace “Divertiesperimenti”: un mini science center universitario per collegare didattica informale e formale- in pubblicazione su Quaderni di Fisica -Associazione Insegnanti di Fisica, Conference proceedings 2016 ISSN 1120-6527
16. R. Capone, I. D'Acunto, R. De Luca; A. De Santis; O. Faella, O. Fiore “la scuola estiva del Dipartimento di Fisica di Salerno (SEF) 2016 Conference proceedings 2016 ISSN 1120-6527
17. I. D'Acunto, R. Capone A teacher training: physics Inquiry from university to high school –ICERI2016 Proceedings ISBN: 978-84-617-5895-1
18. I. D'Acunto, S. Pace “Divertiesperimenti: exhibits and activities to help teaching science” - ICERI2016 Proceedings ISBN: 978-84-617-5895-1
19. I. D'Acunto, R. Capone [R.Vegliante](https://www.researchgate.net/researcher/2119655876_Rosa_Vegliante), M. Giliberti [S.Barbieri](https://www.researchgate.net/profile/Sara_roberta_Barbieri), M. Carpineti “[L'Inquiry Based Science Education: il caso-studio salernitano”](https://www.researchgate.net/publication/311858044_L%27Inquiry_Based_Science_Education_il_caso-studio_salernitano)  Conference proceedings SIRD “Didattica e saperi disciplinari“, Milano Bicocca 2016 ·