

Inquiry Based Teaching: An Experience with THE TEMI E.U. Project

Immacolata D'Acunto¹, Roberto Capone^{1*}, Marco Giliberti², Sara Barbieri², Marina Carpineti²

¹ Physics Department "E. R. Caianiello", University of Salerno, ITALY

² Physics Department, University of Milano, ITALY

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ABSTRACT

With the aim of giving new skills to engage their students with exciting new resources and of supporting teachers in their work to implement IBSE (Inquiry Based Science Education) in their classrooms, at the universities of Milan and Salerno various didactical activities for high school teachers have been planned and implemented in the last years. In particular, the Physics Education Research Group of Milan, one of the 13 partners of the European project TEMI (Teaching Enquiry with Mysteries Incorporated), has planned and organized a training session with a group of 34 high school teachers that have been held in Salerno. Teachers have been involved in directly making them experience the 5E inquiry methodology to be tested in their classes. Teachers have been engaged by a suitably chosen physics mystery and fostered to explore, to discover and find explanations of the mystery in order to practice scientific investigation. All the IBSE activities proposed had the main purpose of reducing the gap between standard high school practice and well-known education techniques, by offering concrete strategies and specific tools for physics teaching. In this work, we will briefly describe our training experience and outline teachers' practice in their classrooms.

Keywords: science laboratory, inquiry-based science education, T.E.M.I, mystery

INTRODUCTION

With the aim of giving new skills to engage their students with exciting new resources and of supporting teachers in their work to implement IBSE (Inquiry Based Science Education) in their classrooms, at the universities of Milan and Salerno various didactical activities for high school teachers have been planned and implemented in the last years. In particular, the Physics Education Research Group (PERG) of Milan, one of the 13 partners of the European project TEMI (Teaching Enquiry with Mysteries Incorporated) (TEMI), in cooperation with the Physics Department of Salerno, has planned and organized a training sessions (called cohort) with a group of 34 high school teachers that has been held in Salerno. Following the TEMI approach to IBSE, teachers have been involved by directly making them experience the 5E inquiry methodology (Bybee, 2006) to be tested in their classes. Teachers have been engaged by a suitably chosen physics mystery and fostered to explore, to discover and find explanations of the mystery in order to practice scientific investigation. All the IBSE activities proposed had the main purpose of reducing the gap between standard high school practice and well known education techniques, by offering concrete strategies and specific tools for physics teaching. In this work, we will briefly describe our training experience and outline teachers' practice in their classrooms.

INQUIRY BASED TEACHING AND THE TEMI EU PROJECT

IBSE is a well-known methodology based on the constructivist educational paradigm that can rooted back even to the pioneering work of Dewey and Piaget. This methodology is an active process that allows students to construct their own knowledge by means of active work, discussion of questions and cooperation between classmates, teachers, scientists, and using resources from the educational environment. The just finished EU-FP7 (Science and Society) TEMI project gathered 13 partners from 11 countries across Europe, had a duration of 42 months and a

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✉ tdacunto@alice.it ✉ rcapone@unisa.it (*Correspondence) ✉ marco.giliberti@unimi.it

✉ sara.barbieri@unimi.it ✉ marina.carpineti@unimi.it

Contribution of this paper to the literature

- All the IBSE activities proposed can be applied in the classroom by teachers and can offer practical strategies and tools for teaching physics.
- We proposed various didactical activities for high school teachers, with the aim of giving teachers new skills to engage their students with exciting new resources, and of supporting them in their work of implementation IBSE (Inquiry Based Science Education) in their classrooms.
- The possibility to try these methodologies in a lot of classroom gave us a validation of our original ideas.

supposed long-term legacy. It was part of the EU actions towards the implementation and diffusion of the IBSE methodology across Europe. TEMI aims at embedding four innovations in teachers' practice: to create curiosity with mysteries, to teach skills with gradual release of responsibility, to maintain motivation with showmanship and to teach concepts with the 5E learning cycle. To this purpose, teachers have been trained following the same five phases of learning they are required to implement in teaching activities: Engagement, Exploration, Explanation, Elaboration and Evaluation. Engage gets students' attention using the Mystery and leads them towards formulating a preliminary inquiry question. Explore makes students plan experiments, collect observations and data. While, in the Explain phase, teachers can make sense of the data and, drawing upon previous scientific ideas, try to answer the inquiry question. In the Extend phase, they apply the conceptual understanding gained to solve another problem. Evaluate is the phase in which students, with the help of teachers, assess their understanding and skills. This methodology is applicable at all levels of formal education, from infant schools to universities, and takes place in informal as well as formal learning contexts. Thus far, about 60 TEMI cohorts have been delivered in nine countries, reflecting country-specific issues as regards curriculum and suitability of context. Conferences and events have also taken place to disseminate the results, a website with downloadable mystery-based materials, a TEMI Book of Mysteries, a booklet guide for teachers titled "Teaching the TEMI Way" and smartphone apps on mysteries have also been produced by the project partners (TEMI).

OUR INQUIRY LEARNING LABORATORIES EXPERIENCE

In order to overcome a teaching approach based only on theoretical aspects, and remedy to the general students' disaffection to the study of physics, we proposed, on the basis of the TEMI guidelines, a teachers' training devoted to promote physics understanding through the development of self-made inquiry activities (Windschitl, 2006; Sherborne, 2014; Barbieri et al, 2014 (1)) in ten different schools of the provinces of Avellino, Salerno and Naples (Italian towns with a high students' density). The TEMI trainers of the University of Milan activated inquiry attitudes in teachers by proposing experiments stimulating the 34 participants to the cohort in asking questions and proposing scientific hypothesis. Starting from the introduction of "Mysteries", interactive lessons and hands-on activities concerning various physical phenomena, based on IBSE were proposed (Collins et al, 1991). The teacher training was divided into two phases consisting each of a two-day workshop (brief lesson and inquiry based laboratory activities) plus a follow up activity in the classroom. In the first day, the IBSE workshop concerned oscillations and harmonic motion (Barbieri et al, 2015; Giliberti et al, 2014)); in the second day, teachers have been involved in laboratory activities about geometrical optics and the vision of colours. (Barbieri et al, 2016). After the first two days' workshop, teachers tried to implement IBSE in their classes at least with a brief sequence of a few hours.

The second two days of Inquiry learning experience concerned mainly the gas laws, electrical circuits and the electromagnetic induction (Barbieri S R et al, 2013). After the second workshop, the teachers made a second activity with their students. This activity was carried out in steps. Step 1), the training topics have been agreed with the trainers and some training materials have been collected. Step 2), teachers implemented in their own classes some of the activities proposed in the first step, using the TEMI methodology. Tutors (researchers and teachers from the Physics Department of Salerno) supported teachers' classroom activities, by giving hints for the planning of the activities or describing them how to use lab material with students. Step 3), a discussion among trainers and teachers about teachers' work in their classroom, took place. All the teachers that decided to work in this phase of the project (about 50% of the trainees), choose to present the activity "Guess the colour" (Barbieri et al, 2016). This activity permits to introduce relevant physics phenomena through high level of empathy, with fun for the students. Moreover, this activity can be modulated at different levels so to be suited to students of different kind of school. By presenting a "mystery" about light and colours, teachers led their students through a qualitative study of the additive synthesis of lights, of subtractive synthesis of the coloured pigments, of the vision of colours under coloured lights and fluorescence, making inquiry with easily available materials. Tutors supported teachers' classroom activities (the classroom involved were eight, in three different schools).

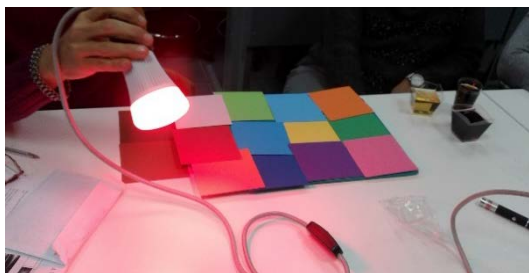


Figure 1. Inquire learning laboratory "Guess the colour"

Table 1. On a scale from 1 to 5, how confident do you feel to apply in your classroom the following topics that have been addressed during the training?

	1	2	3	4	5
Inquiry Based Teaching	13%	33%	41%	13%	0%
"Productive mysteries"	20%	47%	33%	0%	0%
The 5E enquiry cycle	0%	40%	40%	20%	0%
Apprenticeship (GRR - Gradual Release of Responsibility)	7%	31%	54%	8%	0%
Showmanship	31%	31%	22%	8%	8%

RESULTS AND CONCLUSIONS

In order to investigate how the teachers perceived their professional development during the workshop, the teachers answered a questionnaire at the end of each enquiry lab, and a final questionnaire. From comparison of questionnaires at the end of each of the two days' workshop, teachers appeared satisfied for what concerns the interest, the clarity, and the enjoyableness of the workshops. For what concerns the applicability of the IBSE methodology proposed, they were significantly more comfortable after the second series of workshop. In the third, final questionnaire, 60% of the trainees affirmed of having never used IBSE before, despite 83% of them had more than 15 years' experience. 100% of the teachers said that the workshops met their expectations (50% completely, 50% to certain degree), that the "productive mysteries" presented in the training were appropriate for their context, and the activities proposed were varied enough to fit all the levels of teacher experience and helped them tackle various aspects of the curriculum. 50% of the teachers declared to have gained new tools for teaching and 40% also a motivation to renew their own teaching from the training. Moreover, 70% of the participating teachers declared that they got a chance to implement the TEMI approach and techniques in their classroom, in the way presented during the training course or adapted/combined with other approaches. In our opinion, it is important to notice that teachers declared to want to introduce or improve inquiry in their classrooms in the future. In **Table 1** a synthesis of the answers, on a 5-point scale (5 = strongly disagree, 1 = strongly agree) is reported.

The attention paid by PER group of Milan and Salerno to teacher's professional development in order to build bridges between high school and university seems to have been really appreciated by teachers and will probably have future dissemination.

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REFERENCES

- Barbieri S. R., Carpineti, M., & Giliberti, M. (2016). "Guess the colour!" a mystery to approach the vision of the colour, *Chemistry in action!*, 107, 42.
- Barbieri, S. R., Carpineti, M., Giliberti, M., Rigon, E., Stellato, M., & Tamborini, M. (2015). "Good vibrations" a workshop on oscillations and normal modes. *Il Nuovo Cimento C*, 38(8).
- Barbieri, S., & Giliberti, M. (2014) (2). Magnetic vector potential at high school. A teachers' path. In *ICPE-EPEC 2013- The International Conference on Physics Education: Active learning in a changing world of new technologies*, 417-423, PRAGA: MATFYZPRESS, Praha, Czech.

- Barbieri, S., Carpineti, M., & Giliberti, M. (2014) (1), The European TEMI project involves Italian teachers: first outcomes. In *Proceeding GIREP-MPTL (2014) International Conference: Teaching/Learning Physics: Integrating research into practice*, 759, Università degli Studi di Palermo.
- Barbieri, S., Cavinato, M., & Giliberti, M. (2013). An educational path for the magnetic vector potential and its physical implications. *Eur. J. Phys.*, 34, 1209–1219.
- Bybee, R., Taylor, J. A., Gardner, A., Van Scotter, P., Carlson, J., Westbrook, A., & Landes, N. (2006). The BSCS 5E Instructional Model: Origins and Effectiveness. *Colorado Springs, CO: BSCS*.
- Collins, A., Brown, J. S., & Holum, A. (1991). Cognitive apprenticeship: making thinking visible. *American Educator*. Retrieved from <http://www.learnpbl.com/wp-content/uploads/2011/03/Cognitive.pdf>
- Giliberti, M., Stellato, M., Barbieri, S., Cavinato, M., & Tamborini, M. (2014). Detecting an harmonicity at a glance. *Eur. J. Phys.*, 35(6) 065012. doi:10.1088/0143-0807/35/6/065012
- Sherborne, T. (2014). *Enquiry & TEMI CPD: Enquiry based science education & continuing professional development (CPD)*. Retrieved from www.teachingmysteries.eu/wp-content/uploads/2013/12/Enquiry-CPD.pdf
- TEMI (Teaching Enquiry with Mysteries Incorporated). European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 321403 - 2012-1. Retrieved from <http://teachingmysteries.eu>
- Windschitl, M., Thompson, J., & Braaten, M. (2008). Beyond the Scientific Method: Model-Based Inquiry as a New Paradigm of Preference for School Science Investigation. *Science Education*, 92(5), 941-967.

<http://www.ejmste.com>