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A discussion on disciplinary knots concerning electromagnetism and superconductivity using a Web environment in the context of an EU Project (MOSEM) for research-based in service teacher training

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Summary. — Research literature highlights the importance of a revisiting of disciplinary content in a didactic perspective starting from students reasoning and learning processes. A research-based on these aims, concerning in-service teacher formation, was done treating electromagnetism and superconductivity in the framework of the national project PLS and the European MOSEM Project to realize a research-based in-service teacher training based on PCK.

PACS 01.50.-i – Educational aids.
PACS 01.50.F- – Audio and visual aids.

1. – Introduction

The important role of peer discussion in building knowledge is highlighted in literature by several research works (Smith *et al.*, 2009; Rubin *et al.* 1998). Today, the developing of Web 2.0 platforms, forums and online group discussions provide the ideal environments in which implement didactic proposal based on peer discussion (Harris & Sandor, 2007). ELearning environments give to the participants the opportunity to discuss whit many people spread around the world without the requirement of a face-to-face encounter (Garrison, 1997; Kear & Heap, 2007) allowing them to study, discuss and cooperate while they are almost anywhere at anytime (Dixson *et al.*, 2006; Leh, 2002). Dialogue and discussion are essential elements in eLearning content creation by peer production (Auvinen, 2009), that are useful instruments aimed to provide a framework in which collect participant's tacit knowledge and convert it to explicit knowledge through discussion and peer cooperation (Nonaka & Takeuchi, 1995).

2. – Master IDIFO2

In the framework of the national project "Progetto Lauree Scientifiche" (PLS), in which the Research Unit in Physics Education of University of Udine leads 15 Italian

Fig. 1. – Universities involved in PLS.

research groups (fig. 1), was activated the teacher training institutional course IDIFO2 (Innovation in Physics Education and Orientation 2) on modern physics teaching.

In PLS project, Master IDIFO2 was responsible for the training of in-service teachers on issues of modern physics. To do so a blended at-distance course was activated at the University of Udine for two year. The goals of the Master were: training teachers on issues of modern physics, increase the depth of teachers' skills concerning the mastering of subjects and pedagogical aspects, promote innovation in teaching strategies in secondary school, preparation and testing of teaching materials with blended strategy and development of proposals for orientation training. Project was structured into four formative areas (general, characterizing, design and located) and was divided into seven modules: 1) quantum physic, 2) relativity, 3) superconductivity, 4) time, 5) energy, 6) physic and art, 7) orientation and problem solving. All modules were organized into activity sections. The activities of the Master include: training in communication network, experimental activities in laboratory, intensive workshops, design activities and experimental teaching activities (fig. 2).

Into this Master several activities are designed and structured to promote online discussion and online cooperation between participants with the aim to create a dynamical framework in which cooperative learning is stimulated.

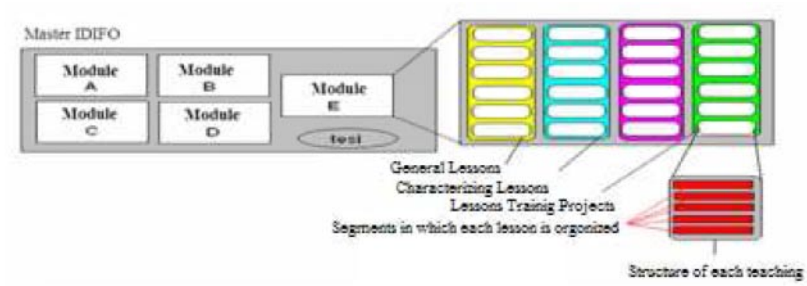

Fig. 2. – Structure of Master IDIFO2.

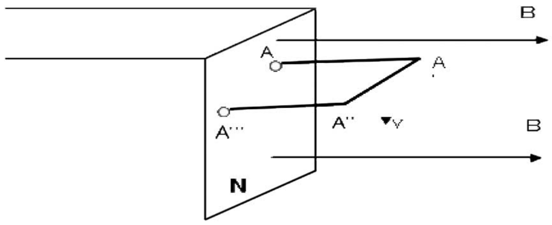

Fig. 3. – Example of proposed situation for PCK activity.

3. – The case of electromagnetism

More specifically, for what concern electromagnetism, each activity was correlated to a forum in which participants can discuss on selected topics and particular situation strictly related to the main conceptual knots highlighted by literature This last type of discussion is truly important because, how literature shown teachers had to acquire competence as in subjects mastering as in pedagogical skills through a PCK analysis of particular situation (Shulman, 1986). Doing so, teachers are in the condition to face directly the conceptual knots, studying which are the best ways to face them in classroom and implement strategies aimed to avoid the born of misconceptions.

Into the superconductivity teaching module, developed at the same time in the both frameworks (PLS national project and MOSEM European project), particular attention was given on the study of particular conceptual knots related to electromagnetism trough the development of a PCK analysis. The conceptual knots that were stressed during the discussions were token from the main knots highlighted by the international research literature. In particular were token into account students' difficulties related to static and dynamic electromagnetic fields as: the concepts of field as a superposition (Rainson & Viennot, 1992), the field representation (Guisasola *et al.*, 1999) and the relation of the field lines with trajectory followed by bodies placed inside the magnetic field (Tornkwist *et al.*, 1993) correlation between magnetic field and electric currents, the nature of the field itself—*i.e.* is it a state of space or a material entity?—(Thong & Gunstone, 2008), the sources of field and the role of relative motion (Maloney *et al.*, 2001). In particular, related to the interpretation of Lorenz law of induction, there are two main knots: students do not distinguish electrical and magnetic effect without recognizing Lorentz force and don't recognize that there are moving charges inside the conductor (Maloney *et al.*, 2001) and, for what concern the application of Lentz law, students have difficulties in the determination of the *versus* of the induced magnetic field (Bagno & Eylon, 1997).

Starting from this theoretical background and in the framework of a collaboration between the University of Udine and the University of Basque Country (Guisasola, private communication), a set of problematic situations is identified and some of these (Galili & Kaplan, 1997) are take into account to be proposed to teachers analysis in the context of the Master IDIFO2 (fig. 3).

4. – PCK activity on conceptual knots of electromagnetism

The PCK analysis performed was structured in three phases: in the first one teacher had to analyze the situation, master it and answer to a particular question in the second phase teachers had to analyze a set of typical students' wrong answer (each one is related to a particular conceptual knot) identifying the errors and in the third phase they had to plan how to face each one of these knot in classroom.

Teachers so have to analyze: 1) The situation itself; 2) Which are the situations that may be submitted to discuss the thesis incurred by each student; 3) Which are the models of interpretation and the types of reasoning that students show in the cases listed; 4) Which are the knots behind each answers; 5) How to deal these situations in classroom.

In this way, starting from the analysis of specific physics situations, teachers can investigate their knowledge and the pedagogical aspect facing directly the conceptual knots Furthermore, the comparison between teachers' answers is a source of interesting discussions on the conceptual knots present in the teachers knowledge establishing a peer-cooperative environment in which teacher help one each other to reach the formulation of a formal complete answer for this challenging situationsFor instance, analyzing the situation proposed in fig. 3, one teacher provide an application of the Lorentz force to describe the situation, another uses the idea of magnetic line cut by the circuit to explain electromagnetic induction.

After that, in the second phase, analyzing fake students' answers, teacher can recognize the presence of the various conceptual knots that sometimes are also present in the answer that they wrote in the first phase and, facing them, they can recognize roundly the knots During the third phase, to face this particular conceptual knots, teachers proposed methods that are focused on theoretical or experimental activity aimed to face these knots. Same example of them are the use of cooperative learning as a possible way to address the knots making comparisons between the students' ideas, project of focused experimental activity and use of everyday life object in withc is possible to investigate the phenomena. Between the experimental procedures proposed by the teachers, particularly interesting is the one which suggest to use a solenoid connected to the oscilloscope with a galvanometer in series with it (*i.e.* open circuit) to see if you have the formation of a potential difference across solenoid even when the circuit is open without the generation electric of currents.

5. – Conclusions

During the PCK activity teachers directly address the conceptual knots that characterize particular topics. In this way teachers can propose and discuss among themselves which are the best methods to face in a specific way the occurrence of specific conceptual knots. Particularly in our activity teachers address the knots related to the role of relative motion in electromagnetic induction, the role of the magnetic lines and the ways in which is possible to recognize the electromagnetic induction. The use of a web based platform allows teachers to compare their ideas and, arrive a well structured proposal of invention to face some of the most important conceptual knots.

* * *

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