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Work package 20 – Technology Enhanced Learning in Mathematics (TELMA)

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<http://telma.noe-kaleidoscope.org/>

What is Technology Enhanced Learning in Mathematics?

The central role of science and technology in the “knowledge society” conflicts with the well known weakness of our educational systems in this domain. As recent OECD data show, European educational systems are performing unevenly in the area of math education, and are exhibiting serious weaknesses. Mathematical learning difficulties are often a major obstacle in students education. ICT can offer new opportunities in this area by providing:

- new ways to give meaning to mathematics concepts;
- new learning situations that embed technological tools;
- new kinds of social interactions among the different actors involved in the teaching/learning processes
- new kinds of learning strategies (such as inquiry, collaborative construction of meaning, etc);

TELMA involves six European teams with a strong research background in the field of Technology Enhanced Learning in Mathematics. Its aim is to foster integration among the participating teams supporting a variety of joint research actions whose output can also be of value for the scientific community inside and outside Kaleidoscope and for the preparation of young researchers in the field (e.g. PhD students).

TELMA presently focuses on four areas:

- (i) *representation systems* (mathematical knowledge can be approached through the exploration and manipulation of various representation forms: visual, motor, perceptive, etc);
- (ii) *learning contexts* (it is not just the use of technological tools that matters, but rather the learning situations and contexts in which those tools are used);
- (iii) *Learning theories* (exploring the connections and complementarities that teams share, and exploiting this potential to improve the quality of research).
- (iiii) *Development of integrated approaches* to the study, design and analysis of innovative learning environments for math education.

What has your Kaleidoscope research/activity achieved so far?

We have jointly carried out a number of different research and integration activities such as:

The major achievements so far accomplished can be ascribed to three main categories: content, methods, supporting activities (how partnership is concretely promoted).

Content

Analysis of how different theoretical frameworks can affect the use of technology in educational contexts for mathematics.

Analysis of the nature of the representations and contexts that the research teams refers to in design and development of ICT-based learning environment and in learning research.

Analysis of ICT-based tools for mathematics education

Methods

A methodological construct to perform a comparative analysis of team approaches

At the beginning of TELMA work, integration among the different teams has been addressed collaboratively through the analysis of the work carried out by each team making reference to a number of different issues: theoretical frameworks of reference, ICT tools designed and/or employed, research methodologies, projects carried out, etc. Since from this work it was clear that to find similarities and to clarify differences it was necessary to find some common perspectives under which to look at the different approaches adopted by each team, it was decided to concentrate the analysis on three interrelated topics: the theoretical frameworks within which the different research teams face learning research in mathematics with technology, the role assigned to representations provided by technological tools and the way in which each team plan and analyze the context in which the technology is employed.

As a step toward this analysis a common conceptual construct has been elaborated: the notion of “didactical functionalities” of an ICT-based tool. This notion has been developed as a means to link theoretical reflections to the concrete pedagogical plans that one has to face when designing or analyzing effective uses of digital technologies in given contexts. The notion of didactical functionalities individuates three main dimensions to be analysed when considering technology mediated learning environments: a set of features/characteristics of the tool employed, an educational goal towards which the teaching and learning activity mediated by the tool is oriented, the specific modalities of employment of the tool in the teaching and learning process carried out to reach the outlined educational goal.

The project of cross-experimentations of ICT-tools for mathematics education developed by TELMA teams

Even if the notion of didactical functionality revealed itself quite useful to improve communication among groups and led to an interesting conceptualization of the use and meaning of technological tools in educational settings, to understand, beyond a pure declarative level, the role (both implicit and explicit) played by theoretical frameworks, representations and contexts in the research work carried out, it was then decided to prepare a joint short-term project based on a cross-experimentation approach.

That is, it was decided that each TELMA team would experiment, in real class settings, an ICT-based tool it had not produced but that was developed by one of the other teams. It was also agreed that the cross-experimentations would be carried out according to jointly developed guidelines and that their results would be discussed through an on-line collaborative activity. The idea of cross-experimentations is a new methodological approach to collaboration, seeking to facilitate common understanding across research teams with diverse practices and cultures and to progress towards integrated views of technology use in education.

A methodological tool for the analysis of educational ICT systems for mathematics

A methodological tool for the analysis of educational ICT-based systems for mathematics education (in particular, for algebra and arithmetic education) has been jointly elaborated by the TELMA teams; the teams used this tool to perform an analysis of a selected number of systems . An open workshop has been organized to present the analysis so far performed (Grenoble 14 November 2006).

Supporting activities

1. Joint elaborated proposals:

- a. Elaboration and submission of a **successful proposal** to the European Community of a STREP (IST call 4) involving all TELMA teams: RE-MATH “REpresenting

MATHEmatics with Digital Media” (IST-4-26751-STP).

2. Contributions to conferences and workshops:
 - a. TELMA session on “Inquiry Learning in mathematics” at the KAL SIG Inquiry Learning workshop (Genova, 2005);
 - b. TELMA Joint contributions to: ICMI (Int. Commission on Maths Instruction) Study 17 on Technology Revisited (Hanoi, 2006); French-Italian meeting on mathematics (Torino, 2006); CERME 5 (Conference of the European Society for Maths Education) (Cipro, 1007).
 - c. TELMA presentation at: French National Seminar in Didactics of Mathematics (Paris, 2005); IFIP WCCE 25 - World Computer in Education Conference of the International Federation for Information Processing (South Africa, 2005).
3. Exchange of a phd student (between the University of Siena and the MeTAH team - Grenoble) with a co-supervised thesis. Another one between ITD-CNR and DIDIREM is in due course.
4. Development and maintenace of TELMA web-site with resources including a discussion forum and a document and papers repository (<http://telma.noe-kaleidoscope.org/>)

What do you expect this research/activity will contribute to the field by the end of the project?

We are building a methodological tool that systematically explores the theoretical frameworks used in technology-enhanced learning in mathematics, and which also explores the role of representations provided by technological tools and the contexts in which they are used. We believe this tool will be widely useful in the study of TELMA, serving to highlight the similarities, differences and synergies between the six research teams involved. This tool, that has been designed within the TELMA work, will be used and tested also in the REMATH EC project in which all TELMA teams are currently involved.

We are also engaged in a comparative study of Interactive Learning Environments. Our hopes for this study are to continue to tune the analysis methodology developed and to maintain a list of analysed systems in the web-site (and of the analysis tools).

Further, we are planning to provide a service in the VDS to students and young researchers interested in TEL for mathematics education.

The activity of jointly developing research activities, papers and contributions to scientific events will continue to go on thus providing concrete outcomes and visibilities to the work performend within the TEL research community.

How has Kaleidoscope benefited your activities?

Kaleidoscope has first of all given us the opportunity and the structure to integrate our research teams and to begin to perform common research activities. Moreover, it has provided access to a wide range of researchers on all levels and from different cultures across Europe. This has enabled us to pair senior researchers with young researchers and PhD students and to directly involving students and young researchers in all phases of the activity, also providing opportunities for visits among research teams, supervision of phd thesis, joint development of scientific papers. Last but not least, Kaleidoscope has offered teams from different disciplines and competencies the possibility to meet together, compare approaches and open new research perspectives. The final important objective is to have a joint effort to establish TEL as a proper and independent research field.

What issues should your research field/activities address in the future and why?

TELMA priorities for the future are essentially the following:

- To consolidate the work performed and the integration among TELMA teams jointly carrying out **scientific and dissemination activities** (including the enhancement of the TELMA web-site);
- To provide the Kaleidoscope community with information, resources and interaction opportunities with TELMA teams by means of the TELMA website (integrated in the KAL platform);
- To develop shared resources for research, including a shared bibliography and an inventory of ICT-based systems for mathematics learning;
- To contribute the Kaleidoscope “state of the art initiative”.

What short message do you have for European policy makers, if any?

At present there is the necessity in Europe to have a less fragmented work in the ICT-supported learning field and some nexus for the wide variety of researches, initiatives and organizations active. In this context it appears particularly important to promote a synergy among different groups and research approaches and to develop some new constructs to compare and to integrate the different theories and methodologies adopted and/or developed. The work of the TELMA group has been presented as a step in this direction. This work tries to overcome the difficulties generated by the existing diversity of theoretical frames and the lack of communication between these, through a better understanding of the role played by theories, the development of methodological tools and cross-experiments. This is an on-going work and we hope to be able to offer a more sound contribution on these difficult, but crucial, issues proceeding with the TELMA activity.

What short message do you have for the man in the street about the work you are trying to achieve through your KJA?

The TELMA project, whose final goal is to work towards the integration of different European research teams, working in the field of technology for enhancing mathematics learning, addresses the problem of how to build bridges between different approaches, and tries to provide a some methodological constructs and a common language to connect the work of groups that have different traditions, frameworks and research approaches.