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Integrating educational technology tools and online learning environments into a course on Psychoacoustics and Music Cognition

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ABSTRACT

This study focuses on basic problems we faced and decisions that were taken in the design of a hybrid course – both online and campus based – on Psychoacoustics and Music Cognition. That project is supported by two collaborating Music Departments (University of Edinburgh – UK and Aristotle University of Thessaloniki – Greece).

Fundamental issues of online learning and the "Semantic Web" are discussed, such as: knowledge modeling and management, the role of interaction in online learning, communication tools that can support individualized and community centered learning activities and integrated course management. These issues are approached through the use of illustrative, domain-specific examples drawn both from our work and from other resources. Discussion will be mainly concentrated into two main topics: a) The use of "virtual lab" applications as a tool to visualize and gain a better understanding of psychoacoustical and music – related cognitive phenomena. b) The use of computer-based (software & hardware) environments to run online and/or offline psychoacoustical and psychological experiments, as a hands-on method to teach the fundamentals of experimental research practice.

The basic aim of focusing on these two specific topics is to use them as paradigms in order to discuss about alternative educational practices that may be proven to be useful in the development of educationally effective, both hybrid and online learning designs in the field of Psychoacoustics and Music Cognition.

Keywords

Cognitive Musicology, educational technology, online learning .

INTRODUCTION

Over the last two decades, we have seen an impressive flourishing of technological applications into educational practice and research. As a result, the traditional campus-based learning was greatly influenced by the enhanced communication, information retrieval and management capability provided by information technology and the Net. Net-based technological development within the area of educational technology also led to new methods and theories for designing effective online learning environments.

As a result, integration of Information and Communication Technology (ICT) into the school and classroom culture has led to endless discussions around three fundamental questions "what ICT is used, how ICT is used and why ICT is used" (Cavanagh et al., 2003). The challenge of theory

builders and practitioners in the domain has been to derive to new design principles and models that could function effectively in the new and complex environments. However, all these attempts have also had to be consistent with the underlying philosophical views of learning and theories of knowledge. Although recent models of online learning shift toward the constructivist approach on learning, both behaviorist and cognitivist theories have also contributed in various ways to the design of online and "hybrid" instruction strategies (see Ally, 2004 for an extended overview).

Before we focus our attention on more specific topics related to educational, methodological and technological considerations in planning our ongoing project of developing a hybrid course on Psychoacoustics and Music Cognition that will be shared by the two collaborating departments, it will be helpful to refer in brief to specific principles and contemporary models of e-learning and online learning which were taken as a theoretical basis to our work.

THEORIZING E-LEARNING AND ONLINE LEARNING

Anderson in his insightful works (2004, 2002), has stressed the value of interaction as a component of critical importance for any contemporary form of educational transaction that is supported by current technological options. The dominant role of interaction between the various elements that define a learning community and environment (e.g. students, teachers, content resources) is not a fact that comes as a consequence of the enhanced communication and knowledge management capabilities provided by the new media, as many recent theoretical approaches in the field may imply, but it has always been a principal concept in the work of many theorists since the times of John Dewey.

Several forms of interaction can be obtained in a Learner – Teacher – Content environment (see Figure 1). An analysis of the ways by which these relationships are shaped in contemporary psychological and communication "spaces", especially when learners and instructors are separated by time and/or distance, leads to significant insights for developing effective instructional processes and selecting the appropriate media to support them.

Besides the priority that was given by former pedagogical traditions in the relationship between learners and the teacher, contemporary practice and research revealed other forms of interaction as being equally important (e.g. student-student interaction, learner-content, content-content, e.t.c.). Although a detailed description of the pedagogical consequences that can result from all various forms of interaction in online learning environments is beyond the scope of this paper (for a extended review refer to Anderson, 2002), in subsequent sections we will selectively outline the specific forms that were enhanced through the use of technological tools in the development of our project.

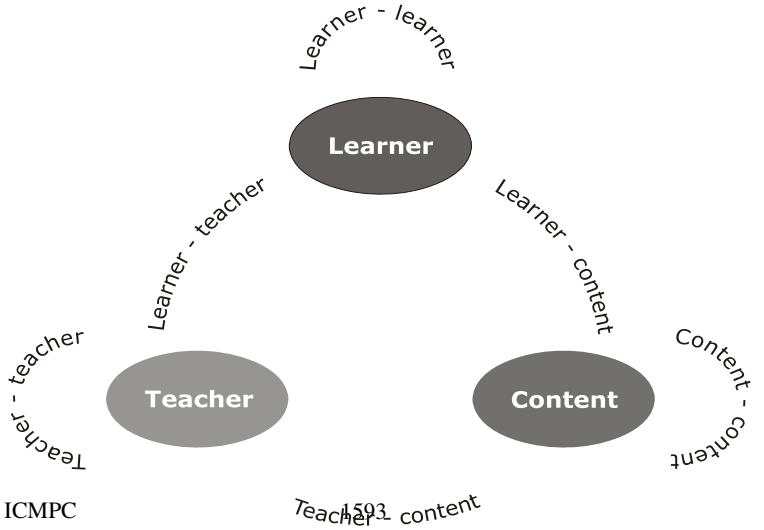

Figure 1. Constituent elements of a learning environment and main forms of interaction (from Anderson, 2002).

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TOWARD THE DEVELOPMENT OF A HYBRID COURSE ON PSYCHOACOUSTICS AND MUSIC COGNITION

As a result of contemporary trends in designing tomorrow's education within the European Community and the extended financial support of programs which are related to the "*e*Learning Action Plan", most universities are increasing the amount of teaching that partly or totally integrates new practices provided by network and web–based learning. Network learning refers to "learning processes in which information and communication technologies (ICTs) are used to promote connections: between one learner and other learners and tutors; between a learning community and its learning resources" (Jones, et al., 2001).

After a three year Erasmus project of teaching-staff mobility has been run between our departments (Music Department, University of Edinburgh, UK and Music Department, Aristotle University of Thessaloniki, Greece), the idea of setting up a joint project on curriculum development has emerged and led us to develop a learning module on Pschoacoustics and Music Cognition as a pilot. The main scope of this project was to integrate two existing "conventional" courses that focus on the target domain – one from each of the collaborating departments- into a new one, to which an extended use of networked learning facilities is going to be added. The scenario we adopted in the design of this course is influenced by "hybrid" models which involve both online and campus based activities for the participating and geographically distributed learner groups. The critical function of interaction among all participating groups (teachers, student) and the course content is enhanced by using a web based course management system (Blackboard Learning System ML^{TM}) that offers a robust set of tools and features for sharing distance learning resources and functions as an integrated learning environment.

Pedagogical framework and course design

It is a common sense among all academic staff who offer lectures or seminars on Music Cognition or Music Psychology embedded in music related curricula (e.g. studies in Music Performance or Musicology) that participating students face difficulties dealing with the content area of the course and frequently intended learning outcomes are not achieved in a sufficient degree. Consequently, a systematic instructional design is required which should be based on a thoughtful analysis of critical issues such as: learners' prior knowledge, general expected learning outcomes, specific learning outcomes or performance objectives, instructional strategies, assessment strategies and techniques, and evaluation procedures (Moallem, 2001).

In the beginning of our project, we mainly concerned ourselves with accomplishing a description of our target group of learners in terms of their prior knowledge on the main domain area as well as other areas which are rather peripheral but frequently of major importance for students dealing with domain specific problems and research questions. Thus, attention was paid to disciplines and/or practical skill domains such as: Music Theory, Music Performance, Cognitive Psychology, Experimental Design in Cognitive Science, Musical Acoustics, Mathematical and Statistical Analysis e.t.c. In agreement with empirical observations acquired in similar cases about students' knowledge profile, as well as in accordance with more systematic approaches (see Parncutt and Painsi, this volume), we decided to assign every student that enters the course, to the introductory learning phase within the continuum of Knowledge Acquisition Model proposed by Jonassen, McAleese and Duffy (1993). This phase occurs when learners have very little prior knowledge about the content area (Fig. 2). The general objective was to lead students to the next phase of domain specific knowledge building, where usually learners assume a considerable background on fundamental concepts of Psychoacoustics and Music Cognition, together with some experience to face and approach methodologically real-world problems and research questions (e.g., "How loudness changes with frequency?" or "Does tempo affect performance accuracy in isochronous tapping tasks?" e.t.c.).

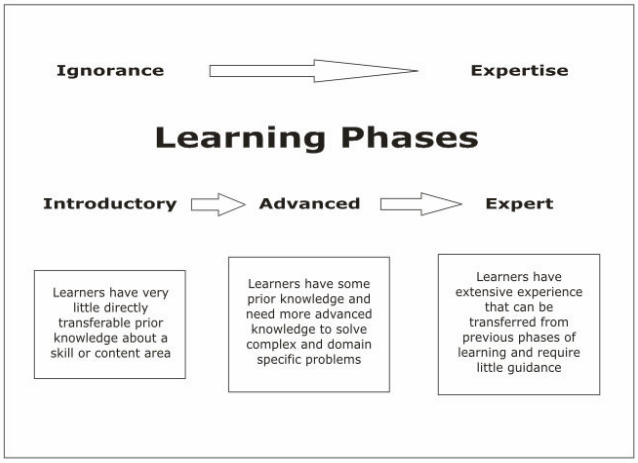

Figure 2. Learning phases within the continuum of Knowledge Acquisition Model (Jonassen, McAleese and Duffy, 1993).

In the light of constructivist views that real understanding is *performative,* the general framework we adopted in designing the course was project based and richly interdisciplinary. In addition, the course was divided into learning units which were ordered sequentially in a time line within a period of 12 weeks, so that to have students guided

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through a paced learning process in time, rather than an independent study format.

Due to time limitations implied by the total duration of the course, subject areas that are being covered are rather limited to a few introductory lessons on basic principles and concepts of Psychoacoustics and Music Cognition, preceded with a thorough introduction on the auditory function through extensive use of multimedia presentations and visualization software tools such as, for example "An auditory tour" [1] and "Auditory Image Model (AIM-MAT)" [2] (Patterson and Allerhand, 1995).

That introductory part of the course, which is based on traditional models of instructional design, is followed by a series of well-sequenced sessions that focus on a specific research problem. The main objective of this part is to guide students through a staged-project process during which they were expected to formulate research questions related to the problem under investigation, develop an experimental design to check the resulting hypotheses, run the experiment, analyze the results and finally write a research report. Priority was given to specific types of learning activities such as:

- observation through a series of virtual lab applications and visualization software which is under development in MAX/MSP.
- procedures through imitation and practice through the use of both self-developed and commercial software tools that can be adapted to support domain specific experimental work and statistical data analysis.

A crucial issue, which is related to the design of all implemented learning activities, was to make theoretically informed decisions about their form, as well as to choose appropriate tools and resources. This demanding task was accomplished using the "DialogPlus Toolkit",[3] a step-by-step guide, which embodies a preset taxonomy of learning activities in the form of concept maps that helps instruction designers to apply good practice and contemporary models to e-learning based activities (Conole and Fill, 2005).

In addition to more general issues of instructional design, a problem of major importance we had to face, was to deal with the organization of large amounts of learning material and lesson aids (e.g. lecture notes, electronic presentations, web resources e.t.c.). Although the main course management environment we have used provides preset utilities to organize learning materials in the form of folder structures or learning units, we have fascinated by the prospect of using more sophisticated and effective methods of knowledge modeling and representation. The recent emergence of concept mapping in a visual format of well-thought-out diagrams (fig. 3) has proven to be a valuable "complementary alternative to natural language as a means to communicate knowledge" (Chau, 1998). This kind of knowledge mapping has not yet been applied extensively to the domain of Psychoacoustics and Music Cognition, though a lot of worth noting approaches can be found in related areas of Physics.[4]

Environment Architecture

As discussed earlier, Blackboard Learning System ML™, was used as the main course management environment adopted by one of the collaborating departments. All major forms of interactions between instructors, students and the course content are supported by specific components and

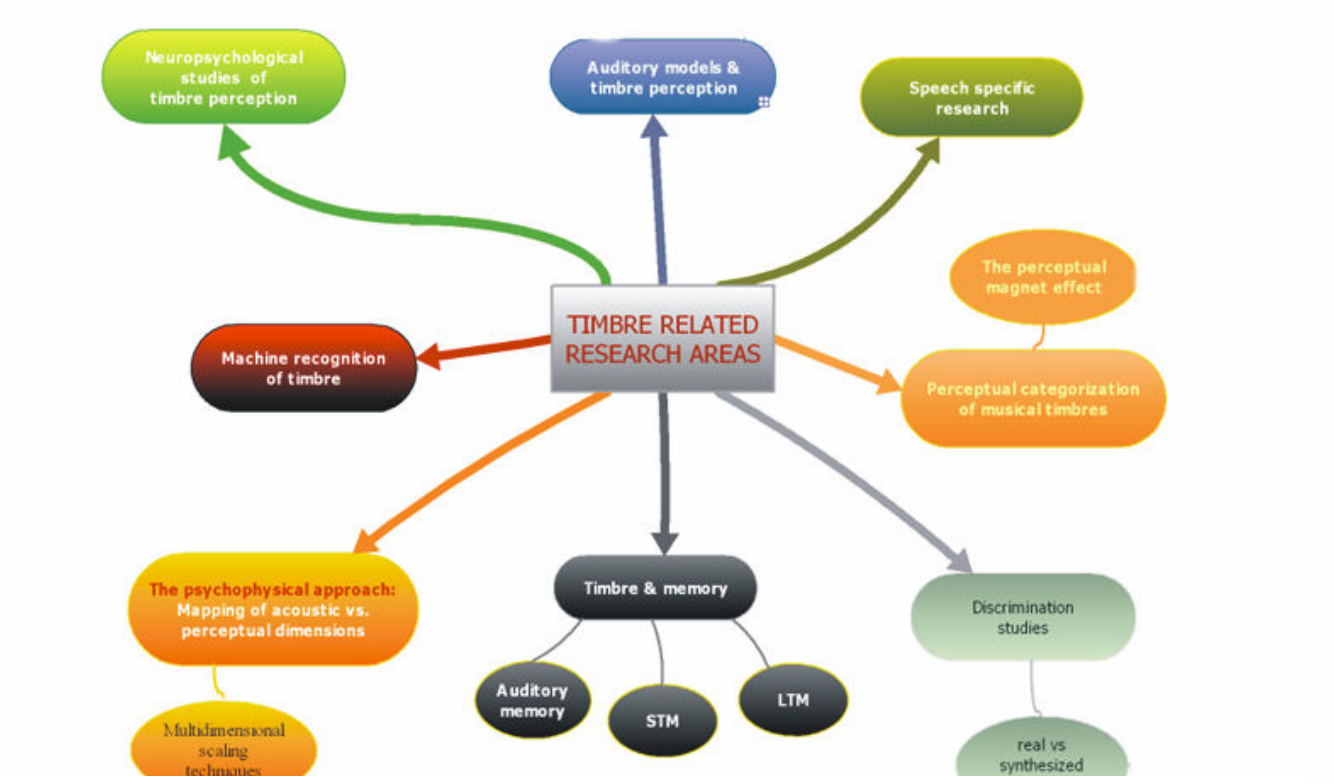

Figure 3. Visual mapping of contemporary research areas in the domain of timbre perception as a framework to present instructional material in a more meaningful way.

tools embedded in the course's web site, which are organized into discrete course areas. These areas are flexibly customizable by the instructor in a manner that a basic organizational structure of the course could be initially set up. In its fully functional format Blackboard's environment is comprised of five main function areas: content areas that contain tools necessary to add descriptive material about the course and learning material in various formats (text, hypertext, presentations, multimedia files e.t.c.); course tools that mainly contain communication tools for instructors (calendar, task organizer, send email) and group collaboration tools (discussion board, virtual classroom); course options, for management of course components; user management, that contain tools for the instructor to manage users and enroll new users to the course; assessment manager that provides tools for the instructor to create and organize quizzes, exams and surveys, as well as to record grades and post them to an online grade book.

The advantage of using web-based instructional and distant collaboration tools offers the opportunity to support learning groups which may involve students from both departments. However, the pedagogical framework for the management and guidance of student groups collaborating on a project through the net still remains a challenging issue we try to deal with, in our attempt to apply basic principles of *activity theory* (Redmiles, 2002) as a new thinking about online pedagogy.

We have already pointed out in previous section that the introduction of concept mapping in education has proven to be an effective instructional practice for a student to communicate knowledge, which contributes positively to increase interaction between a learner and the content (see fig.1). This form of interaction could be further enhanced in technologically enriched environments, through the use of more sophisticated applications such as: virtual labs, computer-assisted tutorials, and the development of interactive content that responds to student behavior and attributes (often referred to as "student models") - (Anderson, 2004). The educational value of providing students with interactive interfaces that have the capacity to map relations between physical and perceptual attributes of sound in a meaningful combination of auditory and visual feedback was a central issue in our efforts to develop visualization software and virtual lab applications. As we have already entered this project, an initial decision was to begin having as a reference "classical" collections of published auditory demonstrations,[5] and thus develop a series of interactive software applications that focus on fundamental phenomena of both lower-level and high-level perceptual processing of musical sound. Illustrative samples of this ongoing work together with teaching-support material can be obtained at an under development web-based platform that was given the name "Rhythmológos". [6]

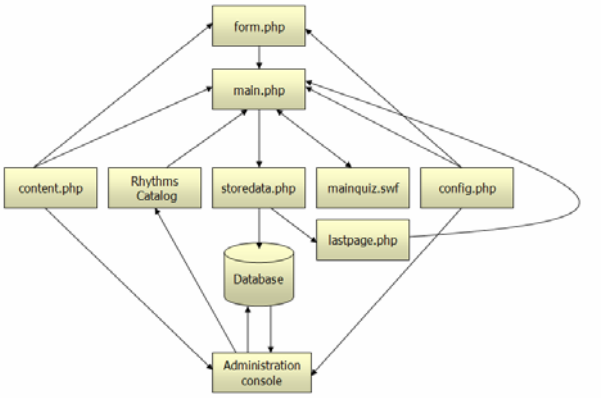

Figure 4. Main components of the "Rhythmológos" environment.

"Rhythmológos" was initially developed as a web based platform that will provide all necessary tools to a distributed research group, in order to run online experiments on specific areas of musical rhythm perception and related motor behavior (Fig. 4). "Rhythmológos" features all necessary functions that can support a number of predefined experimental procedures through the web (e.g. present audio data to remote participants, collect participants' responses, store all recorded data values to a database, perform data analysis, and output reports). Besides its functionality as a pure research environment, it has also been integrated into the instructional framework we adopted for the project-based part of our course, thus providing the opportunity to students to gain a better understanding of the basic principles of experimental research practice within the cognitive science, to experience separately all the parts of the process not normally seen, and finally to abstract a set of strategies to deal with similar problems in the future.

CONCLUSIONS

It is hoped that, after the rather fragmentary information about the vast area of learning technology and its impact on contemporary forms of learning environments presented in this paper, a clear picture emerges about certain pedagogical frameworks that could be proven as being most effective in teaching Psychoacoustics and Music Cognition to university students at Music or Musicology departments.

[5] For example: "Auditory demonstrations on CD-ROM" that was prepared at the Institute of Perception Research (Eindhoven, the Nederlands) by A. Houtsma, T. Rossing and W. Wagenaars, after a request of the Acoustical Society of America's committee on Education in Acoustics in 1984.

[6] http://orfeas.mus.auth.gr/rhqsnu/html/index.php

One of the main concerns throughout this discussion was first to highlight the rationale for integrating certain ICT tools and practices into the instructional design such as, concept maps, visualization software, virtual labs, web-based course support systems, and environments that support online experimental research, as an aid to enhance all forms of interaction within a learning community, secondly to support a rather constructivistic conception of learning, and finally, to make apparent that pedagogical frameworks that result from contemporary online learning models could be effectively applied to form collaborative knowledge construction environments among distant learning communities.

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