

INFORMING THE DESIGN OF A COURSE DATA VISUALISATOR: AN EMPIRICAL STUDY

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Instructors have less understanding of their students when teaching at distance than when teaching in classrooms. Course management systems facilitate the delivery of distance courses but provide very little help to instructors to gain understanding of cognitive and social processes in distance classes. This paper presents an empirical study that investigates the instructors' needs when teaching at distance using course management systems. The aim of the study is to identify what kind of student information instructors require in their activities and to inform the design of a system to support distance learning instructors.

INTRODUCTION

Web based distance education is rapidly becoming very popular. There is a growing interest in universities to adopt this form of teaching in order to provide flexible education solutions to many people. Until recently, the required technical abilities of teachers were limited to drawing clearly on a blackboard and, in some cases, preparing computer presentations. Nowadays, the role of the teacher is changing: the advent of the internet, the globalisation of economy, communication, and culture, as well as rapidly changing technologies with increasing mobility on workplace demand constantly new qualifications from any member of society, and this is valid for teachers as well (Flueckiger and Mazza 2001). Distance education led to changing the role of the teacher from “lecturer” into “facilitator” of learning. In this context, even the “teacher” term is changing to some more appropriate ones, such as “instructor” or “facilitator”. This change of roles requires new competencies and abilities in order to support distance students effectively. Activities that should be carried out by instructors include answering students’ questions, monitoring discussion, and promoting discussions (Gratto 1999; AFT 2000). Furthermore, a good tutoring practice requires monitoring the learners' progress with course material and testing the acquired knowledge and skills on a regular basis (Helic et al. 2000). Although technology is expected to aid instructors in accomplishing these tasks, it often provides complex, difficult to absorb and not very useful information about the processes that occur in distance classes. While research has been conducted to help students avoid problems affecting learning when using computer-based environments, e.g. tailoring the content and presentation to individual learners (Brusilovsky 1999), very little has been done to facilitate distance teachers, especially to help them understand what is happening at the students' side (e.g. the material a student has read, the level of mastery achieved by a student on a specific domain topic, the frequency and effectiveness of the participation in discussions, etc.). As argued in Mazza (2002), one of the biggest problems with the data provided by commercial learning environments, also called

Course Management Systems (CMS), is that it is in a numerical tabular format, often incomprehensible, with a poor logical organisation, and difficult to follow.

Our research aim is to investigate possible ways of helping distance teachers gain understanding of their students. Specifically, we consider the use of Information Visualisation techniques (Tufte 1990; Spence 2001) to aid teachers in understanding data from course management systems. Information Visualization exploits graphical representations to render a vast amount of abstract data to help people comprehend and interpret the data. By managing complex multi-dimensional data with appropriate visualization techniques instructors may be facilitated to form mental models of the data and obtain a better understanding of specific features of the data (Spence 2001). Techniques for graphically externalising student data have been applied in learning systems, e.g. VisMod (Zapata & Greer, 2001) uses concept maps to render a Bayesian student model. Reffay and Chanier (2002) analyse interactions between students by using Social Network Analysis (Scott 1991). However, these systems are implemented as prototypes and are difficult to utilise in commercial CMSs. We are implementing CourseVis: a tool for graphically representing students' information in on-line courses managed with commercial CMSs. A study was conducted to examine what kind of information the instructors require for their distance teaching activities and to identify possible ways to help teachers gain understanding of this information.

This paper presents a summary of the major findings from a survey that we submitted to distance learning instructors to identify their needs when running on-line course. Based on the results of the study, we will draw recommendations how to help teachers gain a better understanding of cognitive, social and behavioural aspects about individual students in on-line distance teaching. These requirements are used to inform the design of CourseVis.

THE EMPIRICAL STUDY

In order to investigate what information about students instructors need in distance learning courses, we conducted a questionnaire with people involved in distance learning.

Objectives

The aim of the survey was to elicit answers to the following themes:

- *Social aspects* that tutors can be interested in. These may be various kinds of interactions that occur in a web based course management system, namely, interactions between students, interactions between students and the teacher, interactions between students and the system, and vicarious interactions¹.
- *Cognitive aspects* that tutors can be interested in. These can be the students' overall course performance, their performance on a selected evaluation proof, such as quiz or assignment, the measured students' performance on a specific topic of the course, etc.
- *Behavioural aspects* that tutors can be interested in. These include identifying specific features of students' behaviour, for instance, the students' attendance in the course, students performing very well or very badly, students that are progressing too fast or too slowly with the course schedule, etc.

Participants and settings

The participants in this survey were instructors involved in distance learning courses. Particularly, we contacted people involved in the Swiss national research program "Swiss Virtual Campus", people from the ICLT² group at Leeds University, the IFETS mailing list³

¹ Vicarious interaction takes place when a student actively observes and processes the interaction between other students or between other students and the instructor, without taking an active part in interaction (Sutton, 2001).

² ICLT stands for "Interaction, Communication and Learning Technologies", for details see <http://cbl.leeds.ac.uk/~aisha/iclt/home.html>.

(well-known among distance teachers around the world), some people that participated in past seminars organised by the Global Educators' Network of the Canadian TeleLearning Network of Centres of Excellence (TL*NCE)⁴, and, finally, some people involved as instructors in on-line courses in the UK and in Switzerland and whom we knew personally.

Procedure

The questionnaire was prepared in a Web form and located at a Web server in Lugano⁵. An e-mail message was sent out to 188 individuals and to the mailing list. The e-mail explained the purpose of the study, encouraged recipients to respond to the survey on a voluntary basis, and provided the address of the web page with the questionnaire. The access to the questionnaire was straightforward and required only an internet browser.

The questionnaire comprised 17 questions. Almost all questions were in a multiple choice format and respondents answered by just clicking on the choice that corresponded to their response. Some of the questions also had a small open-text box where respondents were enabled to specify in details other items not covered by the set of choices provided in the question. Participants were allowed to write general comments about the study. They could also request a copy of the results and in this case they had to provide an e-mail address.

The survey was conducted for 2 weeks (Dec 2nd 2002 - Dec 15th 2002), during which 98 responses were received. After this time, the web page containing the questionnaire was replaced with a page indicating the end of the survey and providing the e-mail of the author.

The questionnaire was structured across four major categories:

- *User related questions*, asking the type of involvement in on-line courses, the length of this involvement, and the size and type of the classes.
- *Platform related questions*, asking some information about the technological platforms used and the facilities provided by these platforms.
- *Student and assessment related questions* that aimed to identify what assessment techniques were utilised by the instructors and how the assessment information was used in their teaching activity. In addition, some questions addressed information about the students the instructors demanded.
- *Feedback related questions* included a couple of open text boxes where participants could provide comments and feedback and another one to type their e-mail address in case interested in receiving a summary of the results.

In addition to the questionnaire, we conducted several structured discussions with distance teachers in Leeds to uncover aspects that had not been captured by the questionnaire.

RESULTS ANALYSIS AND RECOMMENDATIONS

The analysis here presents the key issues and findings extracted from the survey data. We had respondents from 11 different countries, and 78% of them were instructors involved in university courses. More than 83% of the respondents have experience of more than 1 year in on-line courses. We therefore consider that the survey involved a representative sample of potential users of our system. We ought to acknowledge though that the data from the survey may not be fully representative of the views of all instructors involved in on-line teaching, which is out of the scope of our work. The findings from this sample provide an interesting

³ International Forum of Educational Technology & Society (IFETS) is a subgroup of the IEEE Computer Society Learning Technology Task Force (LTF), see <http://lfff.ieee.org> and <http://ifets.ieee.org>

⁴ The Global Educators' Network (GEN) is an international community of on-line educators. The main activity of GEN is to promote monthly on-line seminars on topic related to learning and teaching on-line. The Global Educators' Network can be found at <http://vu.cs.sfu.ca/GEN/welcome/welcome.html>

⁵ A copy of the questionnaire is accessible in <http://telos.usilu.net/survey/questionnaire.html>

range of responses that can be used to extract some trends, rather than being a definitive picture of all distance learning instructors. In line with the objectives of the study, the analysis here will consider three themes - social, cognitive and behaviour aspects which tutors are interested in. We will identify requirements of distance teachers related to each of these themes and will give some recommendations for the implementation of a tool for externalising appropriate information to instructors.

	Access to the course	Quiz and assignment grade	Participation in discussions	Posting e-mail to colleagues	Frequency of re-visiting of the same page	Participation in chat	Participation in group exercises
Extremely interesting + Very interesting	54.35%	64.13%	66.30%	32.61%	25.00%	28.26%	67.39%
Interesting + Somewhat interesting	34.78%	26.09%	22.83%	44.57%	36.96%	41.30%	20.65%
Not at all interesting + I don't know	7.61%	8.70%	6.52%	18.48%	26.09%	27.17%	11.96%

Table 1: Summary of information about students the respondents found interesting.

Social aspects of the learners

The main tools in an on-line course that engage students and instructors in communicative activities are discussion forums, e-mail and chat. The former two are used by more than 80% of the respondents in the study, while chat is popular only with a half of them (Fig. 1). Group work is also an interesting opportunity for students to cooperate together and socialise. When the course is completely on-line, this facility is crucial for the creation of a successful on-line course. The group work is used by 62% of the respondents (Fig. 2).

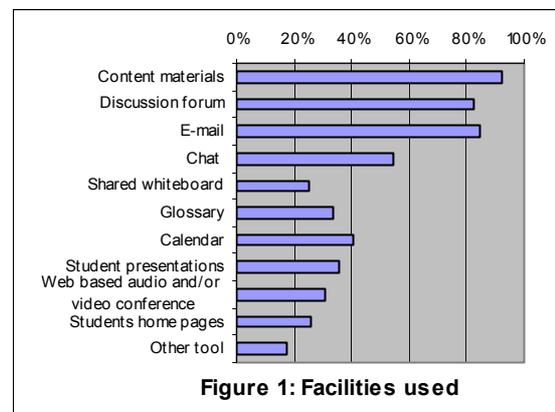


Figure 1: Facilities used

Recommendations: A tool that represents the students' social activities in the course should consider the data provided by the communication facilities included in that course. The participation in discussion is considered as the most interesting and valuable in the evaluation of both the course and the students' activities. Several respondents made interesting comments about the usefulness of the qualitative analysis of discussions, but dialogue analysis is laborious and, at the current state of research, is done mainly manually by humans. Our recommendation is that a quantitative visualization about discussions should be provided. The instructor can use this information as an indicative element to decide which parts of the

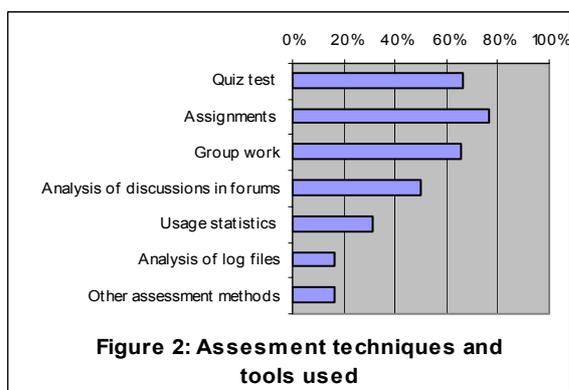


Figure 2: Assessment techniques and tools used

interaction have to be analysed qualitatively to further understand certain social aspects in distance classes. Data from other communication tools (e-mail and chat), although very common in on-line courses, is rated with a low interest for the teaching purposes (Tab. 1). We, therefore, believe that visualizing this data may not be that useful. The participation in group work is also crucial for the instructors and appropriate visualization of the data about this kind of activity should be considered.

Cognitive aspects of learners

Unarguably, the most interesting aspect for instructors is the cognitive one. This is probably valid both in distance and in face-to-face education. Students enrol a course because they want to learn the concepts of the course. A good teacher has to check that this is accomplished

in their course, and, if not, to remedy by adjusting the teaching or adapting the material to the target of the class.

Recommendations: It is highly recommended to give a suitable external representation of the students' performance in the course. The survey indicated that the assessment techniques typical for on-line courses (quiz, assignments and group work) were used by more than 62% of the respondents (Fig. 2). The participants in the

questionnaire expressed a high interest in having information about the overall performance in the course (82%), the level of knowledge achieved by each student for each domain concept of the course (63%). The importance of this information was also stressed by participants in the discussions we had. Almost all instructors wanted to use this information in order to identify and remedy learners' common misconceptions in their courses (Fig. 3). A visualization system should provide instructors with a clear and immediate external representation of students having difficulties with a concept. Moreover, this representation should carry out a comparison of a student with the whole class, as confirmed by 62% of the respondents (Fig. 4).

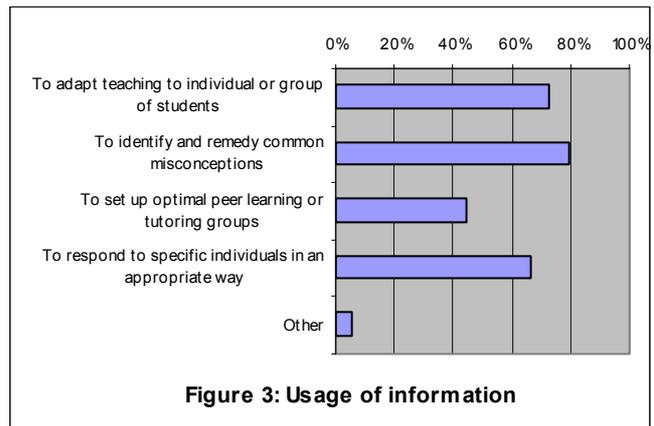


Figure 3: Usage of information

Behavioural aspects of learners

Who doesn't remember our primary school teacher with their concerns about "improper" behaviour? (e.g. "you are always late at school", or "you have to stop talking to your classmate and try to follow the lesson"). Teachers tend to look at behavioural indicators and use them to judge the factors like active learning, motivation, engagement, and in general to assess the success or the failure of a course. With computer mediated communication some of these indicators are difficult to analyse, others are not relevant. We asked the participants in the survey about the various behavioural indicators distance teachers require. Interestingly, the majority of the respondents found as vital the information about the students' access to the course, participation in discussions and group exercises (Tab. 1). In addition, many instructors were interested in discovering students progressing slowly with the course schedule (Fig. 4).

Recommendations: Highly needed information that should be represented externally in a course is the students' access to the course. Akin face-to-face teaching, poor course attendance is considered as a symptom of a possible problem with the learner. Other information that should be represented is the reading of course material (e.g. access and time spent), the performing of evaluation proofs and the participation in discussion. Some instructors use these activities as basis for judging the mandatory participation in the course⁶. Moreover, an indication about the students' progressing with the schedule of the course should be provided as well.

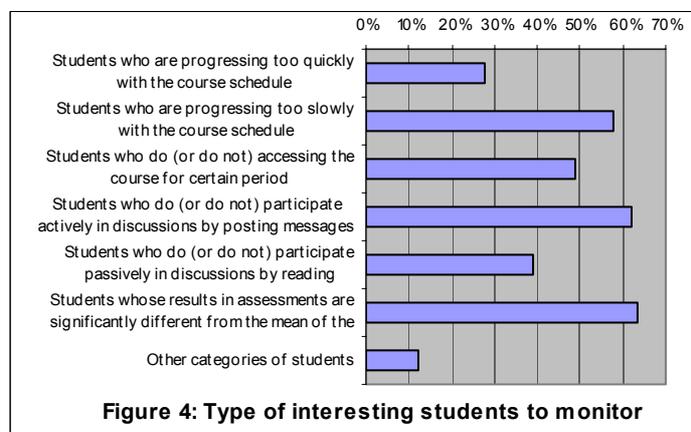


Figure 4: Type of interesting students to monitor

⁶ One of the respondent to the survey included the following comment: "20-30% of a student's grade is based on active, meaningful participation in asynchronous group discussion databases. If students do not earn 60% on this component, they fail the course".

NEXT STEPS

This survey gave some useful indications about what kind of information is required by distance teachers. Our next step is to exploit visualization techniques to present this information to instructors in an appropriate manner that facilitates the required understanding. A visualization tool - CourseVis - is being implemented to meet the recommendations drawn from the survey. The tool, which is out of the scope of this paper, extracts data from an on-line course maintained with WebCT (one of the most popular course management systems) transforms the data into xml format, and, at the present, visually represent some of the information needed by the teachers using 2D and 3D scatterplots and visualization techniques such as zooming, focusing, and panning. The advantages of CourseVis are: (a) tutors and students continue to use the CMS in the usual manner; (b) the information visualised complies with the instructors' requirement; and (c) the tool can be used independently from a CMS.

CONCLUSIONS

This study draws interesting indications of the type of information required by instructors teaching at distance by focusing on three themes: social, cognitive and behavioural aspects of the students. The results of the study elicited useful recommendations for the implementation of a graphic visualization tool, CourseVis, to support distance learning teachers. However, the findings of the survey can inform not only the design of this particular system, but also every application aimed at facilitating distance teachers. We are currently implementing CourseVis by utilising visualization techniques, and intend to conduct an empirical evaluation of the system in due course to examine its usefulness in distance learning.

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