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The comparative study of the ICT collaborative environments in master courses ITC Euromaster and A/E/C University of Stanford

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Key words: *engineering education, computer supported collaborative learning, distance learning, problem based learning, ITC Euromaster*

Abstract:

ICT collaborative environments surpasses old practices with drawing learning closer to a real life with interactivity and authenticity of real world problems in learning and consequently reducing de-contextualization in the learning process. Contemporary educational ICT usage in learning processes is student-centred. In 1993 University of Stanford (USA) started an ICT supported distance learning course named Architecture/Engineering/Construction Computer Integrated Global Teamwork Course (AEC Global Teamwork). The mission of the program is to educate the professionals to be able to work in multi discipline collaborative environments and to take advantage of information technologies to produce high quality products in faster and more economic way. In autumn 2001, nine European universities started the project in order to develop an inter university postgraduate programme in information technology in construction (ITC Euromaster). The paper presents a comparative study of both distance learning master courses with the focus on the ICT collaborative environments.

1. Introduction

Even though advances in information and communication technologies (ICT) significantly changed the way professionals in building and construction (BC) industry work, the dominant training method is still the traditional classroom lecture with all its drawbacks. Rebolj and. Menzel (2004) argue that this is an important reason why IT is not used in construction projects more often, even though the demand coming from the industry is clear.

During the last years the advances in technology and changed organizational infrastructure of the industry magnified the importance of teamwork. Serce and Yildirim (2006) emphasized that employees (in every industry) have to be able to think creatively, solve problems and most important – they have to be able to take decisions as a team. Therefore Serce and Yildirim pointed out that institutions of higher education should focus on educating graduates who are not only flexible and have market related skills but also have enhanced collaborative skills especially in the interdisciplinary teams. Since the year 1999 in Europe major activities within the Bologna reform are the definition of the graduates' competences. One of major projects is Tuning with its focus on generic competences and subject specific competences. The survey conducted in the field of civil, building and structural engineering among European employers in 2005 showed that employers ranked the competence "ability to work in an interdisciplinary team" on the 4th rank from 17 generic competences. It was ranked after "capacity

for applying knowledge in practice", "basic knowledge of the profession", "capacity for analysis and synthesis" (Šubic Kovač, Istenič Starčič 2006).

In addition, Turk (2000) stated that major problem in the implementation of technology is the varying IT capability of team members.

In response to the demands of the AEC sector for improvement and broadening of the competence of engineering students in using new technologies while solving specific problems, in 1993 University of Stanford (USA) started an ICT supported distance learning course named Architecture/Engineering/Construction Computer Integrated Global Teamwork Course (AEC Global Teamwork), also known as PBL (Problem- Project- Product- Process- People- Based Learning). The mission of the programme has been to educate the next generation of professionals to be able to work in multi-discipline collaborative environments and to take advantage of information technologies to produce high quality products in a faster and more economic way. It is aimed at undergraduate, graduate and postgraduate students from all over the world.

Positive feedback from the AEC Global Teamwork encouraged other institutions to introduce their own BC oriented distance learning courses. One of them is ITC Euromaster. In autumn 2001, nine European universities started the project in order to develop an inter-university postgraduate programme in information technology in construction (ITC). The objective has been to provide students with the ability to extend their knowledge in the application of ICT in BC and related industries (Dado and Beheshti 2005). The project was realised in the academic year 2004/2005 when the first generation of students started the Socrates/Erasmus European Masters course in construction information technology, ITC Euromaster.

In this paper both programmes are briefly described and major observations and differences are presented. This is followed by the survey carried out among participants in order to compare both courses. Finally, results are presented, key findings are discussed, and conclusions summarized.

2. The comparative study the ICT collaborative environments

ICT collaborative environments surpasses old practices with drawing learning closer to a real life with interactivity and authenticity of real world problems in learning and consequently reducing de-contextualization in the learning process. Contemporary educational ICT usage in learning processes is student-centred. This demands readiness for active learning methods, self-directed learning, and reflection of one's own learning progress, learn to learn skills, collaboration skills and digital literacy. Deployment of ICT collaborative environments can foster quality of teaching and learning but in the process of the sustainable implementation in study programmes many obstacles are faced such as curriculum development, interoperability standards and staff development (Istenič Starčič et al. 2007). The conditions for computer supported collaborative learning according to Johnson & Johnson: positive interdependence, individual and group responsibility, face-to-face promotive interaction, interpersonal and small group skills, group processing (1996).

ICT collaborative environments support many students who would not be able to attend courses in other departments and programmes than those they are currently studying. Fruchter (1996) addressed two critical problems of the practices in the A/E/C industry and education: (1) fragmentation and (2) discipline-based education. Poor communication among the professionals together with the fact that every professional involved in the project (architect, structural engineer, contractor ...) sees the final

product in a different way can result in a missed deadline or exceeded budget. Some of the problems could be addressed by new technologies, but without an improved team effort even the technology can fail. That is why in 1993 the Architecture/Engineering/Construction Computer Integrated Global Teamwork Course (AEC Global Teamwork) at Stanford University has been launched. The course was carried out in response to the needs of the industry to improve and broaden the competence of students. They are expected to become familiar with project performance, collaboration technologies, to improve their ability to work as a team, and to understand management concepts (Fruchter 1996).

In the AEC Global Teamwork course a number of teams (usually 4-5) of students are facing the challenge to complete the assigned project from the start to the successful finish. Teams are working on different projects with some unique constraints. All teams have an architect, several structural engineers and construction managers. Each team also has at least one 'owner' or 'investor'.

The goal of the course is to educate participating students in (1) how different disciplines (architecture, engineering, construction) impact each other, (2) using up-to-date technologies for collaboration and daily work, (3) how to build a team and be able to take decisions as a team over the internet and (4) how to simulate concurrent engineering and collaboration technology from the organizational point of view (Fruchter 1996).

Project is being done almost exclusively over the internet, using available technological solutions. Team members are coming from different countries and are dispersed all over the world. They are forced to employ technology to overcome the limitations and problems caused by different geographical location and time zones. In that way knowledge and resource sharing among programmes and universities is guaranteed.

Cooperation instead of competition was the primary driver of the ITC Euromaster initiative too. Rebolj and Menzel (2004) stated that from the beginning of the course development the main idea was to share, jointly develop and organise knowledge in the field of information technology in construction. They identified current education practice as an important reason why IT is not effectively used in construction.

Consequently a consortium of nine universities started the project and developed European Master in construction IT in order to improve and speed up the transfer of latest findings in the field of IT into construction practice.

While it would be almost impossible for every university to have experts in all fields of ITC, partner institutions were among the leading ones in the ITC field (Rebolj and Menzel 2004), so the idea was for each of them to offer the best knowledge and experience it possesses. Instead of sharing that knowledge in small classes at multiple places, lectures are given in virtual classroom using appropriate technology solutions (Figure 1). Virtual classroom is used to give lectures and share knowledge on topics from various fields of ITC.

The curriculum is focused on graduate students with university degree in civil, building or structural engineering (Rebolj and Menzel 2004) and span the whole range of ITC: (1) technological aspects, (2) theoretical aspects, (3) models (including their functionality) and (4) processes (including their simulation) (Dado and Beheshti 2005).

Comparison was made using two approaches:

- close observation of both courses discussed,

- using the results of the questionnaire which was sent to the students in order to compare their view on the programme they participated and technology that was involved.

Considering the fact that in both cases learning is more or less student-oriented, it was concluded that evaluation should also be student-oriented and questionnaire was chosen as an appropriate option.

2.1 Observations

Even though both courses are using similar approach, they are quite different at the same time. While AEC global teamwork is project-oriented, ITC Euromaster is a postgraduate programme, covering more than one topic. The strongest link between both programmes is the use of modern IT tools in learning and working process. Some of them were introduced by course personnel while others were used on the initiative of the participating students.

As shown in Table 1 and Figure 1, although similar technologies were identified as important in both courses, different solutions were introduced.

	AEC Global Teamwork	***ITC Euromaster***
audio	phone, Skype	ClickToMeet
video	VSee	ClickToMeet
application sharing	MSN NetMeeting	ClickToMeet
instant messaging system	MSN Messenger, Skype	ClickToMeet, MSN Messenger
learning management system	Think Tank™	Moodle
whiteboard	MSN NetMeeting	ClickToMeet
asynchronous communication	e-mail, Think Tank™	e-mail, Moodle
asynchronous lectures/sessions	Recall™	-

Table 1: Technologies used in AEC Global Teamwork and ITC Euromaster

In AEC Global Teamwork, modular approach using easy accessible software was chosen. Some of the software (MSN NetMeeting, MSN Messenger, Skype) can be obtained for free from the internet, while other (Recall™, Think Tank™) has been developed at University of Stanford. In that way, each module (for chat, audio, video etc.) can be quickly replaced if there is a problem with the tool currently used or if a better solution becomes available. There are also some drawbacks:

- it is necessary to obtain, maintain and master many tools,
- with many different software solutions there is higher probability that something will go wrong,
- more opened ports in corporate firewalls,
- usage of 'unusual', patented (although excellent) non-free tools (Recall™, Think Tank™),
- confusion (MSN NetMeeting is used only for application sharing although it is capable of providing audio as well as video channel).

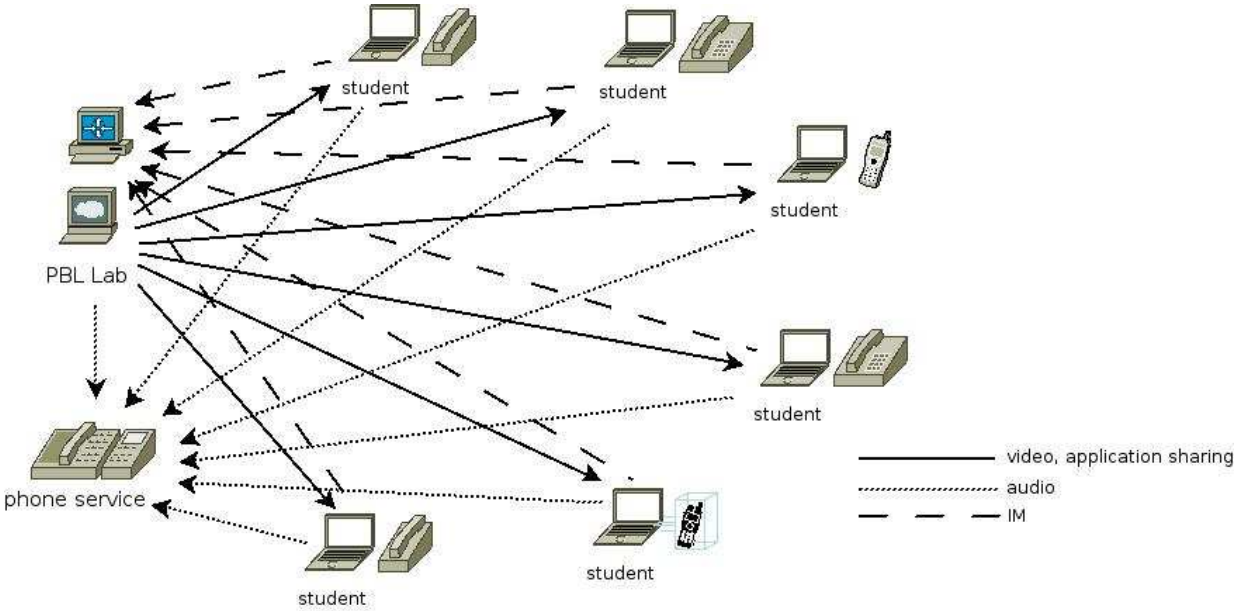


Figure 1: AEC Global Teamwork - decentralised approach to lectures

On the other hand, ITC Euromaster is using centralised solution (Figure 2) named ClickToMeet (CTM). CTM is a client/server solution for on-line meetings. It runs on a server and enables students and lecturers to use everything they need from their web browser (audio, video, chat, presentations, whiteboard, application sharing) so that there is no need to download, install and maintain other software tools. The only thing needed is a single ActiveX control for user's browser. The advantage of the solution is that it is very easy to use and that there is less effort needed to get things moving despite firewalls. The main advantages are at the same time major disadvantages of this system:

- CTM is not free (license fee per user),
- student is limited to Internet Explorer (and to Windows operating system),
- ActiveX controls are considered to be potentially dangerous and therefore prevented on some corporate systems,
- it is harder to identify and deal with possible problems.

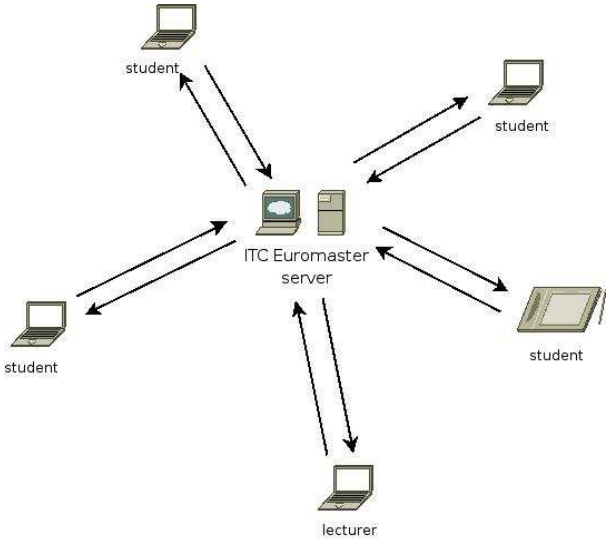


Figure 2: ITC Euromaster - centralised solution

The only major thing that ITC Euromaster lacks is a system module for recording lectures and sessions in order to listen to them asynchronously. This feature can be useful if student misses a lecture, mentor session or something similar and would like to see and listen to it anyway. For that reason in AEC Global Teamwork software package Recall™ is used.

In both cases there is a central portal with all information needed for the course together with the learning material. While with the AEC Global Teamwork Think Tank™ is used as the central system (in-house solution of the University of Stanford), ITC Euromaster uses a well known open-source system Moodle. In either case the public asynchronous communication between the persons involved (students, lecturers, mentors) is possible.

2.2 Survey

In the development of ICT assisted learning is the main aim to foster student-oriented learning and to support teachers' facilitative/transformative function. Communication is very important in a process of forming knowledge of concepts and theories. It helps individuals to better understand others knowledge and at the same time strengthen their own knowledge. As a consequence the use of ICT in teaching and learning has shifted from individual use to collaborative learning. The individual use can be limited in some ways when, for example, limitations in ICT assisted learning design originate from difficulties in (1) identification of individual's learning styles, motivation, needs, and (2) acknowledging their differences. Individual teaching limits the resources to the individual; the support of the groups of learners in developing shared mental models is lost (Johnson, Johnson 1996).

Primarily the survey was intended for getting some feedback on the courses from the students who participated in the course. It was intended to evaluate and compare both courses in two crucial respects:

- the communication technologies used,
- the experiences and impressions of the course.

The survey was conducted by Webswey, a tool for creating surveys on the Web (http://www.scix.net/). The survey population was selected among the students who participated in one of the courses in the year 2006. Due to a small number of students participating in ITC Euromaster, similar number of students participating in AEC Global Teamwork was randomly selected. The total number of survey respondents was 15 (8 from AEC Global Teamwork and 7 from ITC Euromaster).

Students were asked several questions of different types. First, some questions were asked in order to determine whether educational background had affected course experience and then questions regarding course experience and technologies used followed. Last, some questions regarding the whole experience were asked.

As mentioned before, 15 (83% of invited) students responded to the survey. The average age of respondents from the AEC Global Teamwork was 25 (Figure3) with 75% males and 25% females (Figure 4), while the average age of respondents from ITC Euromaster was 33 (Figure 3), with 63% percent of male students and 27% of female students (Figure 4).

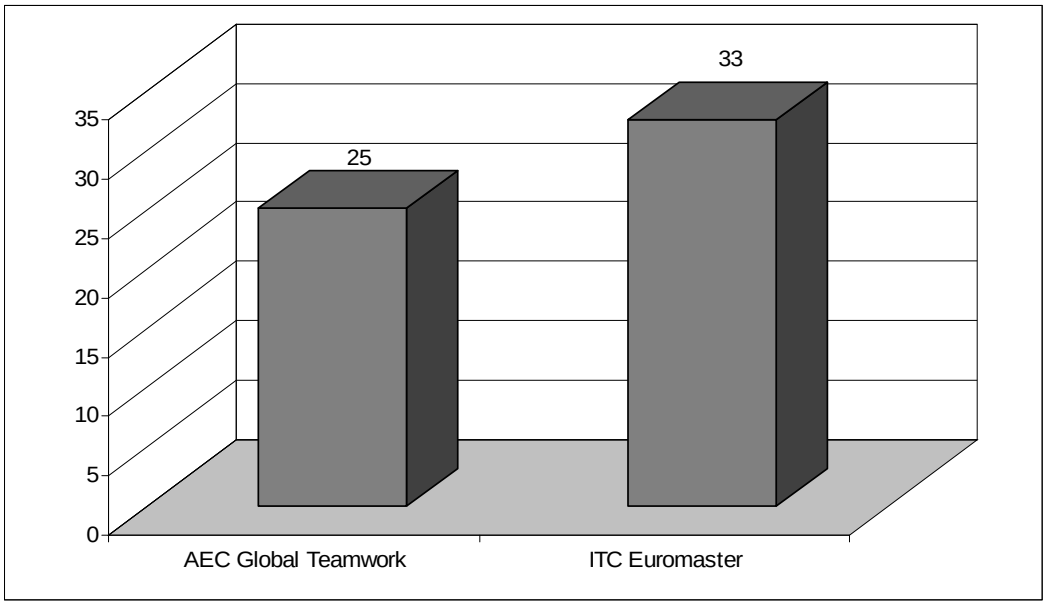


Figure 3: The average age of the participants answering the questionnaire.

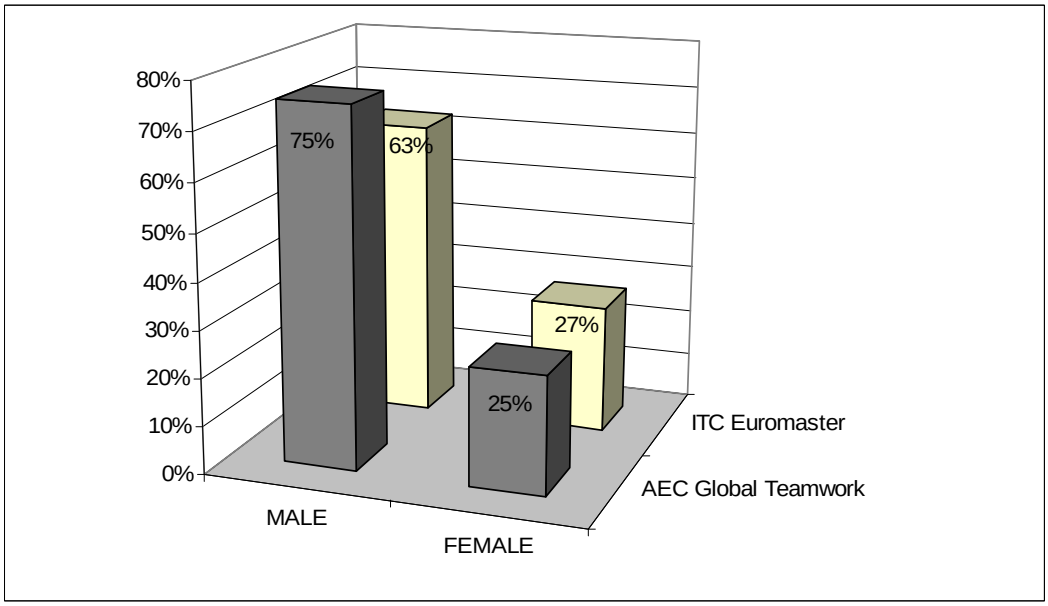


Figure 4: Gender of the respondents.

When students were asked to evaluate their knowledge of communication technologies (from 1 to 5), the average answer in both groups was the same (Figure 5).

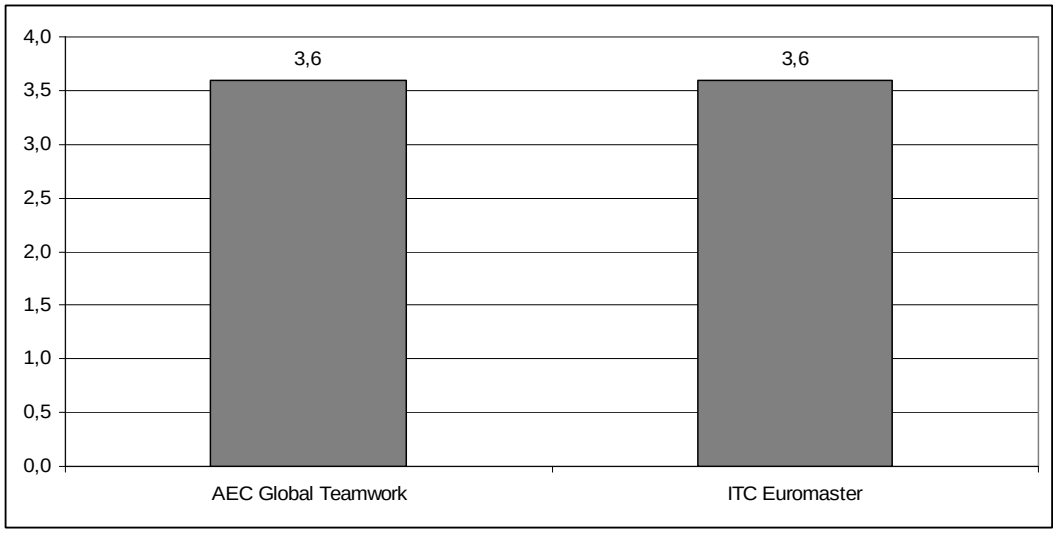
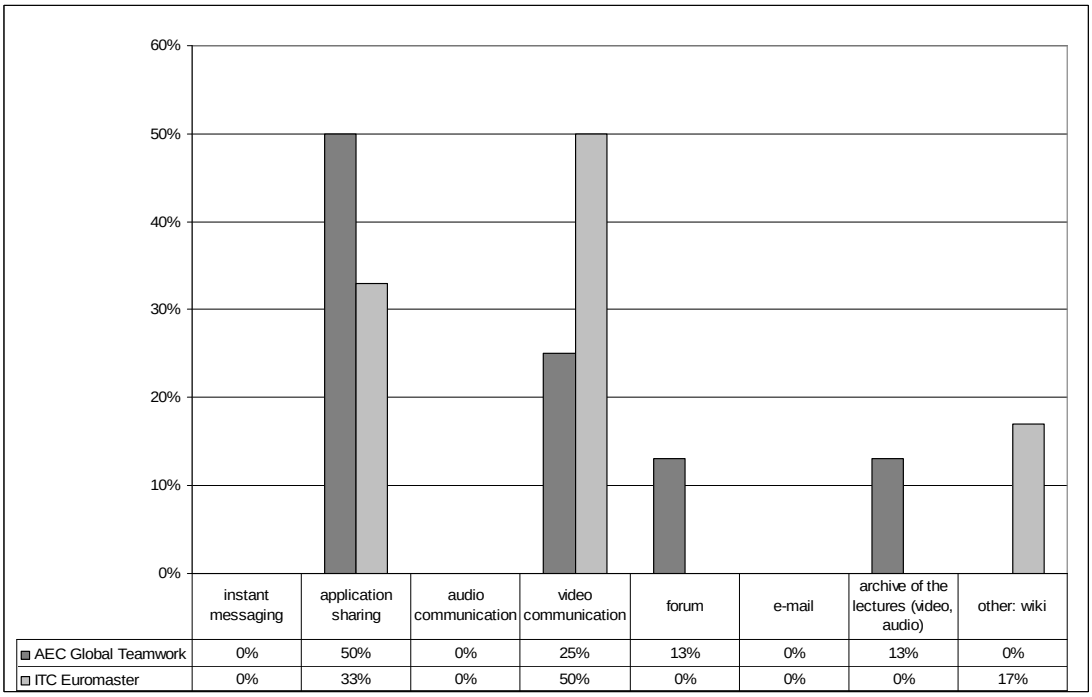


Figure 5: Answers to the question: "Please, evaluate from 1 (poor) to 5 (excellent) your knowledge of communication technologies prior to taking this course?"

It can be concluded that both groups were fairly comparable.

As seen in Figure 6, least known technologies prior to taking the course were application sharing and video communication.



	instant messaging	application sharing	audio communication	video communication	forum	e-mail	archive of the lectures (video, audio)	other: wiki
AEC Global Teamwork	0%	50%	0%	25%	13%	0%	13%	0%
ITC Euromaster	0%	33%	0%	50%	0%	0%	0%	17%

Figure 6: "Which tool was least known to you prior to taking the course?"

When asked for most useful tool during the course, 50% of students from AEC Global Teamwork answered that most useful was instant messaging, while on the other hand 43% of students of the ITC Euromaster thought that most useful was application sharing (Figure 7).

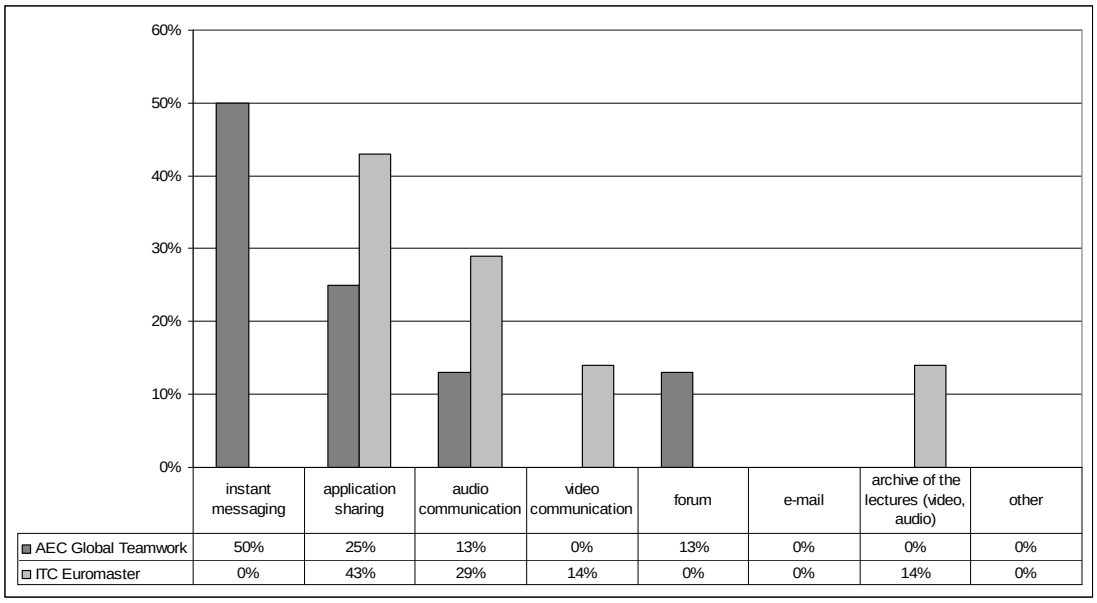


Figure 7: "Which tool was most useful to you during the course?"

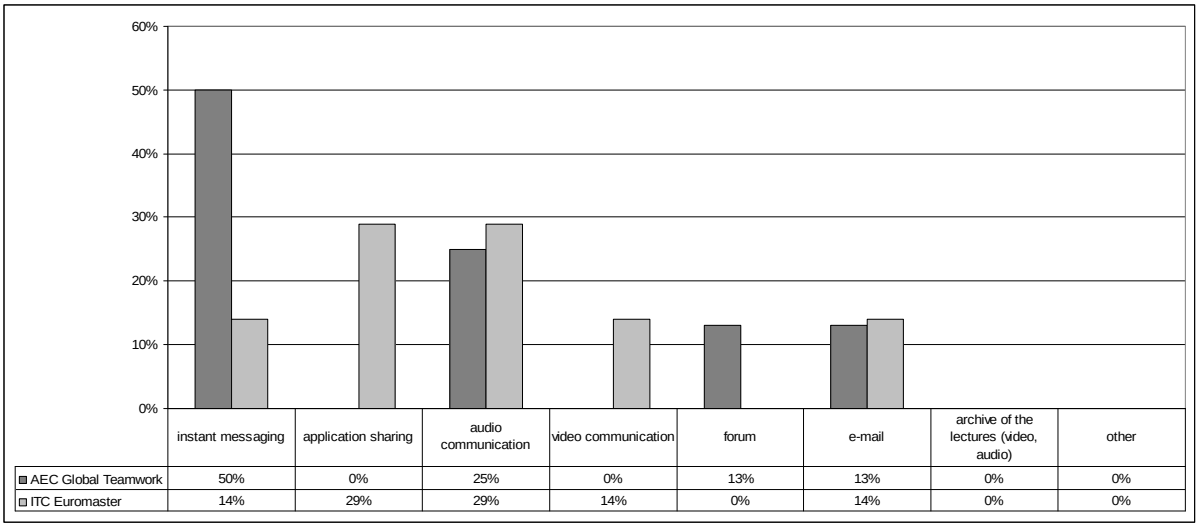
Considering the answers, most used technology in AEC Global Teamwork was instant messaging, while students of ITC Euromaster most often used audio and video communication and application sharing (Figure 8).

Respondents wrote:
"Because it was the most convenient method to communicate with others." (audio commucation)
ITC Euromaster student #6

"Helps in making quick decisions. Avoids lag time of e-mail." (instant messaging)
AEC Global Teamwork student #6

"It was the easiest and fastest way to convey a message. It also took the least amount of time to set up." (instant messaging)
AEC Gobal Teamwork student #7

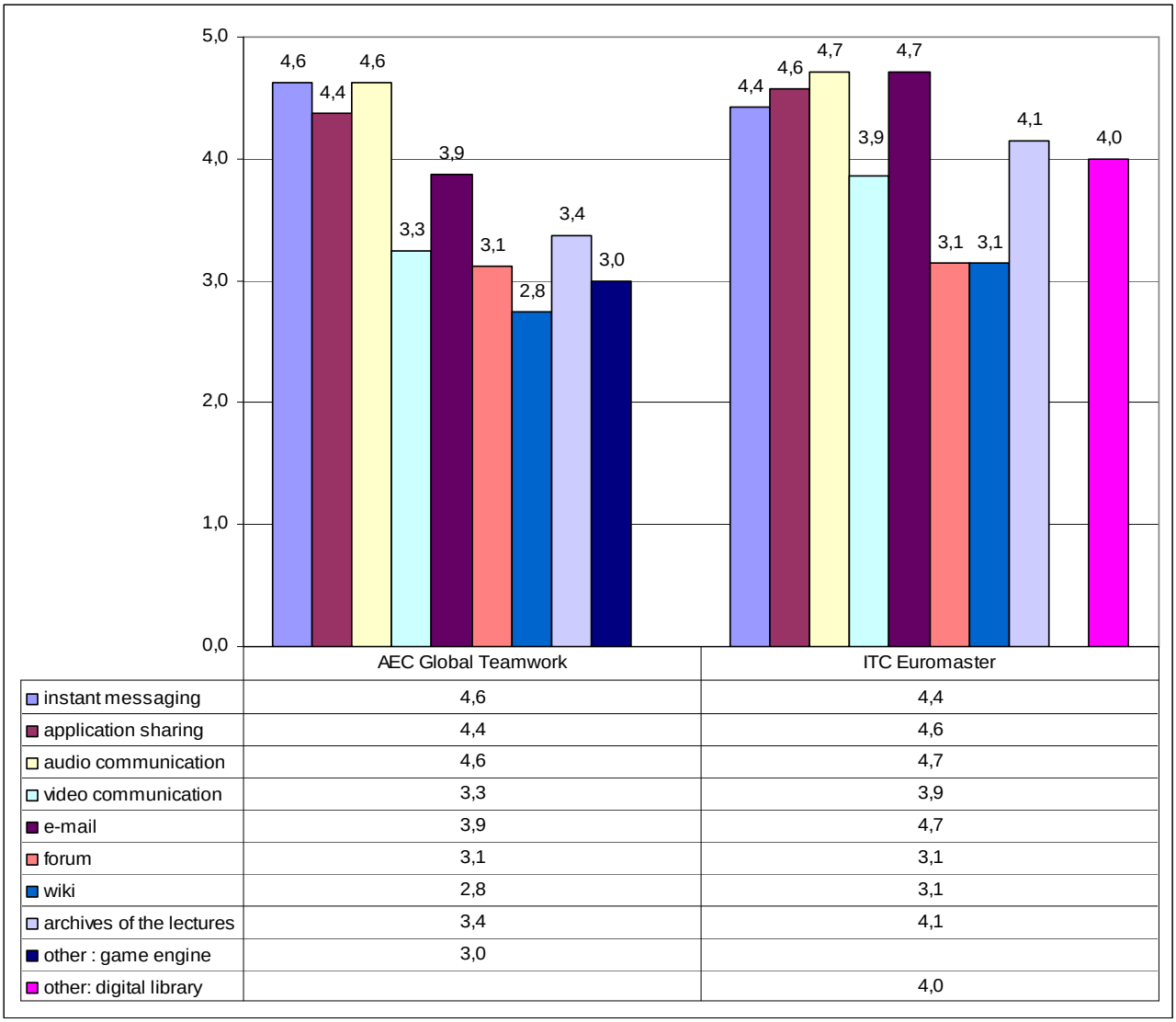
This is mostly related to the tools used during the lectures. While ITC Euromaster uses ClickToMeet which has audio\video capabilities and application sharing included and works out of the box, it is more convenient for AEC Global Teamwork students to use what they know best.



	instant messaging	application sharing	audio communication	video communication	forum	e-mail	archive of the lectures (video, audio)	other
AEC Global Teamwork	50%	0%	25%	0%	13%	13%	0%	0%
ITC Euromaster	14%	29%	29%	14%	0%	14%	0%	0%

Figure 8: “Which tool did you mostly use during the course?”

To sum up, as far as technology is concerned, the least important technologies for use during the two courses are wiki, game engine and forums (Figure 9). In order to be precise, it has to be mentioned that wiki and game engine were not introduced as a part of the courses but were used on recommendation of some students in the AEC Global Teamwork.



	AEC Global Teamwork	ITC Euromaster
instant messaging	4,6	4,4
application sharing	4,4	4,6
audio communication	4,6	4,7
video communication	3,3	3,9
e-mail	3,9	4,7
forum	3,1	3,1
wiki	2,8	3,1
archives of the lectures	3,4	4,1
other : game engine	3,0	
other: digital library		4,0

Figure 9: "In your opinion, how important is each of the following technologies for the course? (1 = not important at all, 5 = very)"

What is interesting is that the forum (discussion boards) was not highly rated although the advantages are clear. AEC Global Teamwork student #4 noted:

"It is most similar to email and instant messaging, but has the benefit of being recorded for everyone to see. Email does not necessarily let everyone see the conversation. Instant messaging may not keep a good record of conversations. Forums have both of these."

Students were also asked if they had any problems with technology and the related tools. Results show (Figure 10) that almost all participants had some problems.

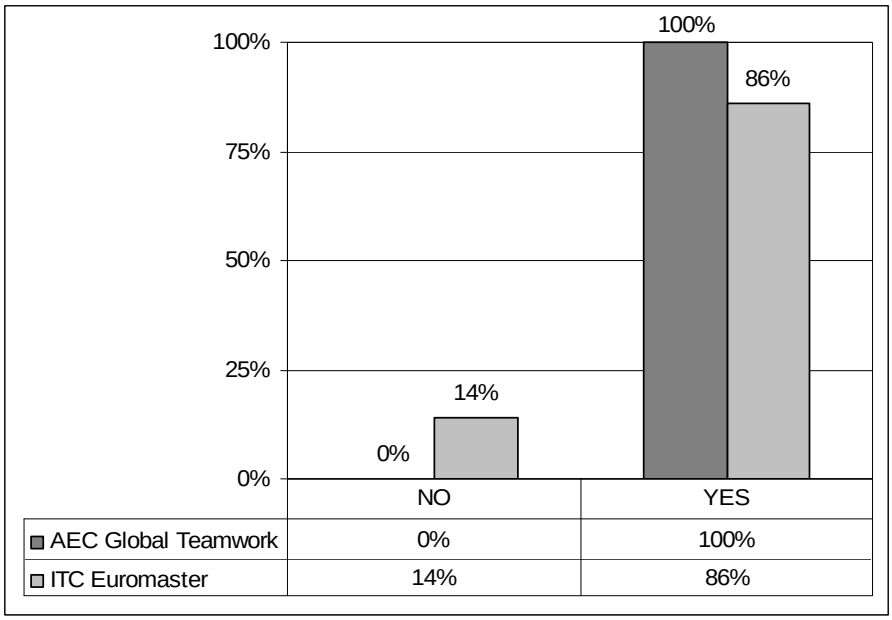


Figure 10: "Did you experience any problems during the course?"

Regarding question on specific problems that emerged during the lectures, similar answers were given. Among the AEC Global Teamwork students most answers were related to FTP and forum inaccessibility, usage of diverse software solutions and the lack of a central solution.

"FTP servers and the forum servers went down every once in a while, which caused problems for our team. Then we had to rely on other methods of communication and distribution."
AEC Global Teamwork student #4

On the other hand it seems that ITC Euromaster students had a lot of problems with ClickToMeet system. ITC Euromaster student #1 wrote:

"Sometimes it just didn't work."

Despite the problems, 93% of all students think that IT knowledge gained during the course is invaluable in their further work and 87% of students are convinced that IT can be one of the major factors in competitiveness of the BC industry.

3. Conclusions

In order to educate the next generation of professionals to be able to work in multi-discipline collaborative environments it is necessary to present the advantages of information technologies. This study showed two examples of such transfer of ICT related knowledge into practice and comparison of two approaches taken. Survey confirms that participants gained valuable experiences using technologies that were available and presented. It was also presented that despite the clear benefits of the use of some tools available, students use technology they know best if it is more convenient to them.

The paper once again shows the lack of modular integrated systems required to support distributed learning environments. Results show that students prefer ITC Euromasters' centralised virtual

classroom to more than decentralised solution and usage of diverse software tools in AEC Global Teamwork. To illustrate why, AEC Global Teamwork student #5 reported:
"Computers were not capable of handling multiple softwares."

On the other hand, ITC Euromaster students reported bandwidth and firewall problems using centralised system.

What is interesting is that when participants were asked about their reflection on the course and what they have gained from that experience, the majority of AEC Global Teamwork participants wrote about social aspects of the whole experience while IT Euromaster students focused more on IT issues although they arguably had fewer problems.

Despite some technological drawbacks both courses seems to be delivering what they have promised. AEC Global Teamwork student #6 wrote:
"I gained the ability to compete in a worldwide market and obtain skills that I will use to pursue a career that is challenging and insightful. I also gained many valuable resources in many specialties and in many places."

And that is why it is worth developing them further.

Acknowledgments

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