Integrating Passenger and Modulo as ICT Tools in an International Collaboration Engineering Education Program

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Abstract *¾ The Gerhard Mercator University (GMU), the Universiti Kebangsaan Malaysia (UKM) and the Universitas Indonesia (UI) have agreed to cooperate as partners to establish joint degree programs for Bachelor Degree (3+1), Masters Degree (1+1) and Postgraduate Diploma, in Computer Science and Communications Engineering, under the Offshore Project. The main objectives of the Offshore Project are,*

i. to establish joint venture initiatives of German and Asian universities for engineering education programs, by combining phases of education at different partner institution(s), amalgamation of faculties, and aiming at offering of joint-award degrees, and

ii. to increase student mobility and cultural understandings through implementation of supporting non-technical courses and set-up of infrastructure for an international student exchange program.

This paper describes the introduction of the Offshore Project and the extending of ICT applications to the partner institutions in this international cooperation which would very much enhance the operations of the new initiative in engineering education, which could provide students in far distance with more flexible learning environment.

Index Terms ¾ Common Degree Course, Groupware in Education, CSCL, Multimedia Education Concept

INTRODUCTION

Engineering Education throughout the world is undergoing significant changes in light of the changing world. The general recommendation is that "institutions must educate their students to work as part of teams, communicate well, and understand the economic, social, environmental and international context of their professional activities". Strategies and approaches have been developed by institutions to adapt to the current demand, while at the same time maintaining quality for the professional accreditation of the programmes.

The international context of Engineering Education has gained tremendous momentum, especially, over the last decade of the 20th century. With the globalisation of world-wide economy, the enhancing internalisation of universities, and the spread of inter-university credit exchange systems, many universities are now tying student exchange agreements with universities abroad and operating short-term study programmes. Beside producing graduates 'spiced' with 'international ingredient', such international co-operation between institutions from different countries in Engineering Education also provide one of the very many means of attaining international recognition and credibility.

In Europe, student mobility programme has been in operation since the introduction of Socrates-Erasmus Programme in 1987 [1]. During the period 1987 – 2000, over 750,000 students have benefited from the programme, involving 1,800 institutions in 30 countries. The European Community promotes study abroad as a means of improving the quality of academic co-operation bringing benefits to students and higher education institutions. Studying abroad can be a particularly valuable experience. It is not only the best way to learn about other countries, ideas, languages and cultures; increasingly, it is an important part of professional and academic career development [2].

THE OFFSHORE PROJECT

The Faculty of Engineering at the Gerhard-Mercator-University, Duisburg (GMU) has acquired approval and funding from the German Academic Exchange Services (DAAD) for implementation of an Offshore Project, "Establishing Common Degree Courses in the field of Computer Engineering with Partners in the Southeast Asia". The Offshore Project proposes for the establishment of joint degree programmes between the three Partner Universities, namely; Gerhard-Mercator-University, Universiti Kebangsaan Malaysia and Universitas Indonesia, for Bachelor Degree (3+1), Masters Degree (1+1) and Postgraduate Diploma, in Computer Engineering. The Offshore Project will also be extended to Electrical and Electronics Engineering, Mechanical Engineering and

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Computer Science. The main objectives of the Offshore Project are,

i) to establish joint venture initiatives of German and Asian Universities for Engineering Education Programs, by:
   a) combining phases of education at different Partner Institution(s)
   b) amalgamation of Faculties, and
   c) aiming at offering of Joint-Award Degrees, and

ii) to increase student mobility and cultural understandings through implementation of supporting non-technical courses and set-up of infrastructure for an International Student Exchange Programme.

The main motivation of this international academic co-operation programme is centred on the initiatives for internationalisation of each individual partner institution.

THE SETTING-UP OF THE GMU-UKM-UI (GIM) PARTNERSHIP IN JOINT-DEGREE PROGRAMME

The main objectives of each of the Partner Institutions in GIM are to be internationally recognised and creditable institutions and to produce graduates well suited to the demand of international professional career. To achieve this it is necessary for students to spend a significant of their study period abroad. To facilitate this requirement in a way that their study programmes are not affected in term of duration, and effective and efficient way of utilising this time is for them to attend an academic institution and to follow a programme of technical studies integrated with that in their home institution. These studies can be recognised by giving credit towards the home qualification thus minimising the total period of study and making space for the inclusion of integrated language and cultural studies prior to the period abroad.

Setting up of joint academic programme, to facilitate international student exchange programme, require great scrutiny in many aspects. In identifying suitable partner institutions for this type of student exchange programme academic compatibility is the first and the greatest problem to be solved. With the differences in the academic systems, rules and regulations, traditions and approaches to education, it has to come to a realisation that a flexible and pragmatic approach would have to be used towards academic compatibility. Subjects may be taught in a different order and content may be distributed differently across modules but once identified this should be accommodated. The availability of a suitable credit transfer system, such as the European Credit Transfer System (ECTS) [1], [3], has greatly simplified this process and has been a great success with a range of collaborative activities throughout member states within the EU.

Apart from the purely academic factors, questions of student tutoring and welfare are also crucial to a successful exchange programme. Students selected for this programme will be facing new environment, system, culture and language, alien to their home institution. In order that their study programme is not very much affected, students should be prepared for their year abroad in a number of ways in addition to the language programmes during the pre-exchange study period in their home institution.

DEVELOPMENT OF THE GMU-UKM-UI PROGRAMME

The Offshore Project has a main objective of implementing a jointly developed Bachelor and Masters Degree Programmes for joint-awards by the three partner institutions. However, in view of the critical scrutiny required especially in meeting the requirements for accreditation of the programmes by authorities of each countries, the three partners decided to implement the international collaboration programme in two stages.

STAGE 1

This is an immediate implementation of international collaboration on engineering education between the three partners to facilitate immediate implementation of student exchange programme. This collaboration will be carried out on equivalent existing programmes being offered at the three partner institutions, for Bachelor degree (3 + 1) and Masters degree (1 + 1), namely

- GMU: Computer Science and Communications Engineering
- UKM: Communications and Computer Engineering
- UI: Communications Engineering

The three partner institutions have also decided that the international collaboration will be extended to the other engineering disciplines of Electrical and Electronics Engineering, Mechanical Engineering, Environmental Engineering, and also Computer Science and Information Technology. Discussions and exchanges of information on these are being implemented at the same time.

Evaluation on academic compatibility: The three partners recognised that there exist different systems, traditions and approaches in education between the institutions. However, it was agreed that the qualifications and quality of student intakes at the three partner institutions are compatible. For the given partners, this holds true although the differences in the educational systems are evident, partly due to equivalencies in school education and partly based on the effects of selection of freshman by national and additional university entrance examinations. In fact, the differences given in parts of the educational process disappear when looking at the sum of school education and Bachelor studies. This justifies the adoption of the simplification of philosophy, as adopted by Coventry

University and her partner institutions, that basically one year spent studying say in Mechanical Engineering in one country was much the same as in another provided the students had equivalent qualifications on entry to the programme [2], thus providing a flexible and pragmatic approach towards academic compatibility. The ECTS will be used as for credit recognition between the institutions. Subjects for the transfer year will be identified at each institution and will be submitted for approval by the highest academic authorities at each institution for credit transfer.

Model for the International Collaboration: The three partners proposed for the implementation of the international collaboration and student exchange programmes, based on three plus one (3 + 1) for Bachelor degree, and one plus one (1 + 1) for Masters degree. The exchange year for the programme will be in the final year for levels of study programmes.

Language of instruction: It is recognised that language of instruction will be one of the major issues to be debated at great length. However, it is also understood that, for the international collaboration and the student exchange programmes to be viable and attractive, any extension to the duration of study, if at all necessary, should be kept to the minimum. If the students are required to follow their studies fully in the national language of the host institution, the students may have to follow a very extensive language course, resulting in longer time duration and greater effort to acquire the language skill. This will not fully justify for just the one year of exchange year. Therefore, it was agreed that the subjects identified as credit transferable for the exchange year will be taught in English at all partner institutions, as English is accepted as the second important language by the three countries.

STAGE 2

In this stage, the partners aim at implementing a jointly developed new engineering programme for joint-award of the degree by the three partner institutions. Discussions on this programme are being taken in parallel with the collaboration in STAGE 1. The three partner institutions also have agreed to be involved in offering postgraduate diploma programme for continuing professional development for executives from the industry and the profession.

Apart from the academic evaluation, the three partner institutions did also agree on the needs to prepare for supporting requirements and programmes for this collaboration. These include;

- Series of seminars on culture, traditions and life expectation at the host institution, and language course to prepare students for the exchange year. Exploratory visit to the host institution will be organised to provide first impression of the expectation of the exchange programme, pending availability of financial grant.
- Support and facilities, such as accommodation, health facility, etc., for students at host institutions.
- Administrative procedures relating to Admission, Registration of Courses and Examinations, Record of Transcript, etc.
- Preparing strategy to acquire grants to support the collaborative programme to provide financial aid to students, and to support Academic Staff Exchange programme for maintaining liaison and following the progress of the students.

ICT TOOLS

Applications of *Passenger* and *Modulo*, developed by GMU, have provided more effective and efficient learning environment in engineering education. *Passenger* is a synchronous groupware developed at GMU to support virtual student teams during a software engineering laboratory exercise. The newly developed education concept, *Modulo*, aims at creating new possibilities for differentiation and decentralized learning by a multimedia teaching and learning system. The didactical new conception of the learning environment is supposed to take the students different learning prerequisites into account. Thus, procurement methods are striven for that enable individual preparation, consultation and practice dependent on the students' educational background.

Extending the applications of *Passenger* and *Modulo* to the partner institutions in this international cooperation would very much enhance the operations of the new initiative in engineering education, which could provide students in far distance with more flexible learning environment.

THE PASSENGER CONCEPT

Only in exceptional cases will an individual developer control the entire life cycle of a software system. Modern software engineering in any case signifies team work. The world-wide extension of the data networks and the continuing globalization add another component to software engineering: the development in worldwide distributed teams. Our experiences with software engineering projects showed, that the teams cooperate in different ways in the separate development phases. Different requirements on the computer support result from this. Earlier stages of the development require numerous group meetings with a high proportion of cooperative work. Videoconference systems and group editors can serve these computer supported face-to-face meetings. In addition to that, special software engineering CASE-tools are necessary to support the design phase. Coding during the implementation phase mainly employs individual work and does not require special support because of its strong individual work character. An exception from this can be found in big software companies with development departments all over the world and in

different time zones. In this case, the use of special tools can enable a 24-hour software production [4].

At the GMU Software Engineering is an one semester course that consists of two hours lecture and six hours of lab per week [5]. During the lab, the students work in teams on a close-to-reality task that is chosen in such a way that it can not be solved by an individual. Therefore, the students are forced to divide it into subtasks.

Tools to support the early design phases are required for asynchronous and synchronous sessions. Several investigations [6] deal with public available tools like Microsoft Netmeeting or SeeUSeeme but these tools drop out because of the different requirements for use in the educational field. The tools for synchronous work need to have more functions than publicly available tools like

- a better support for discussions,
- the setup of partners images and relationship aspects,
- mechanisms for preventing communication breakdowns and
- support for the students in their cooperative actions.

Looking at commercial systems shows that they drop out according to their high costs (license fees, connection costs in case of ISDN-based systems, asset costs). These results are gained from investigations published in [7]. Beyond that, the application of Software Engineering CASE-tools requires additional time of the students that depends on the tool complexity [8]. In case of Software Engineering CASE-tools it has to be taken into account that modern tools such as e.g. Prosa or Rational Rose perform consistency checks at model transitions from one level to another. But especially this work is supposed to be carried out by the students. From the design process view, this reduces the needed tool to a simple drawing tool with a special object library. Altogether, these arguments suggest the development of a individual Groupware that should contain:

- a synchronous communication tool,
- a floor control to support discussions and also to handle access to the commonly used resources and
- a Software Engineering CASE-tool for common modeling and document processing.

From a technical point of view a session management to control the network communication and a protocol stack to support the required network services are also needed.

SYSTEM ARCHITECTURE OF PASSENGER

The above described tools require also mechanisms for multimedia data exchange in order to make efficient working over a computer network possible. Our tool concept sees windows-based systems as its target platform and the global internet as its transport medium. This concept is realised as a client/server architecture and several methods of data transfer have been implemented: unicast connections for client/server-communications and multicast connections for interclient-communications. Client/Server connections require reliable services for the transmission of document data, login data and control data. On the other hand, interclient connections only require unreliable services, but a guaranteed bandwidth and delay for the transmission of video- and audio-data. For the realisation of the above described architecture, a suitable protocol stack has to be developed. In a first step only implementations of standardised protocols which are currently available, or which will become available in the near future are used (IPv6, RSVP, RTP, ICMP..).

The floor control is implemented on the server side and handles the access to the public window and the shared resources. Furthermore it coordinates the course of communication through an administration of different kinds of permissions, e.g. permissions to speak, permissions to alter the documents. Floor control approaches are usually mainly technically or social oriented. Our approach differs from those methods in that way, that it combines the advantages of technical and social floor passing methods. An essential part of our floor-control implementation is the permission list. This list can have three possible entries. The actual spokesperson is followed by the next two clients who requested to speak. Each demand of the permissions and each passing of the permissions results in updating this list. Important is that the list never shows two equal entries. Thus two members cannot exclude the third person from the discussion. Further more a tutor can be called by any user at any time. Therefore the model serves all of the above formulated requirements.

Working in a team, dividing up the given task into subtasks, discussing provisional results and integrating first results afterwards, already require discipline of the students without using groupware. The usage of videoconference techniques also requires that students work in a completely new scenario. Thus interface design obtains an outstanding meaning. Our client user interface contains video screens of each member and a CASE-tool in a public window for the common process on the outline documents. Figure 1 shows the user interface of the client software. Each member has the same view of the window according to the WYSIWIS-principle, but only one of them can alter the document at a certain time. A telepointer serves to elucidate and to present facts. Each member is also equipped with a private working window for trying out ideas. A chat window was implemented so the conference can be ended simultaneously in case of bad transfer circumstances.

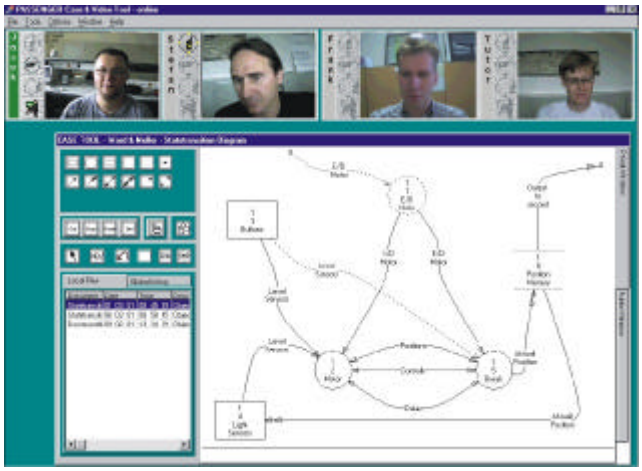

FIGURE 1
PASSENGER CLIENT USER INTERFACE

Other features of the user interface result from the above mentioned demands,

(a) of setting up and promoting partner images and relationship aspects and

(b) of supporting group awareness.

These requirements are taken into account by the following design and implementation steps:

- each member is represented in an individual video screen (a),
- the members are always shown in the same video screen (a),
- the video screens can not be changed in either size or position (a),
- none of the video screens can be covered up by another window (a),
- the video screen of the person who has access to the shared resources is always highlighted (b),
- the entries of the permission list can be fetched and visualized (b) and
- the CASE-tool contains a global and local history of changes (b).

THE MODULO CONCEPT

The project Modulo aims at forming new possibilities for differentiation and for a decentralized learning by using a multimedia teaching and learning concept. The didactical new conception of the course should take the different learning suppositions of the students into account. Thus, imparting methods should be aspired, which enable a varying dimension of preparation, consultation and practice effort for the students dependent on their educational background.

The hitherto course forms need to be supplemented on a computer basis by means of suitable concepts and realizing these by means of multimedia techniques in order to procure the contents and to translate the quoted objective targets into action. The interactive, multimedia teaching and learning software is set up so that the different learning methods of the students are taken into account. Thus, different possibilities of accessing the study material exist. One possibility of access is the subject structure. Here, students can choose his or her way of learning according to the content structure of the lecture. The previous course form used exercises as trial and application of the taught theories. These are also implemented into the interactive learning concept in a suitable way. By means of the second entry possibility, the interaction between the theories, that needs to be learned, and the later practical experience will be clarified on the basis of a concrete task of the technical development environment. Thus, a learning-goal oriented or res. problem oriented learning is enabled. The students act upon a given action structure. This so called Scenario is echangable, so that the individual educational background of the student can be brought into line.

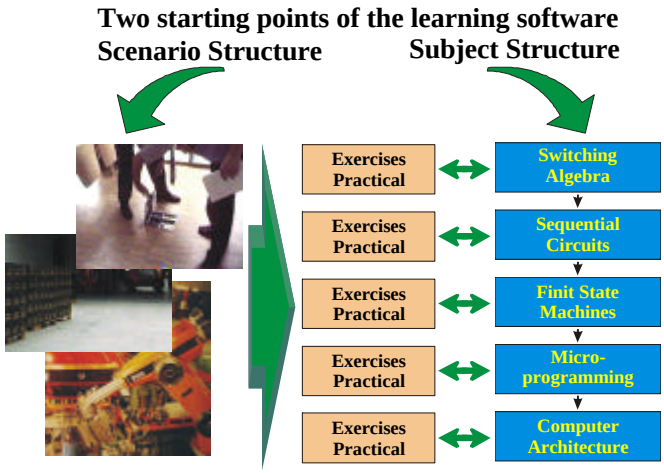

FIGURE 2
SYSTEM ARCHITECTURE OF MODULO

The emphasis of the technical implementation of Modulo lies on the platform-independent and support of standard Browsers for the user interface. Furthermore the software is accessible via the internet. This enables the learner to determine his or her workplace as well as his or her working time flexibly: be it home workplace, or public computer laboratories at the university which are frequently used particularly during intensive group-work phases. The software itself is design in a modular way to easily exchange and update the moduls.

PURPOSE AND EVALUATION OF MODULO

The Modulo software should be employed and evaluated within the scope of the lecture „Fundamentals of Computer Science“, which are to be attended 5 hours per week. The students need to spent the same amount of time preparing and revising the topics learned during the lectures. Hereto, the Modulo software can be used. The content of the lecture is particularly based on the fundamentals of Boolean algebra and switching algebra which lead to technical implementation of logical circuits and the construction of digital circuits and systems as well as the construction of simple digital computers.

Aim of the project Modulo is the permanent introduction of new media as a supporting step to the hitherto presence-teaching-concepts. Students should be enabled:

- to acquire the necessary professional information more efficiently for studying**;** as well as
- to experience teaching and learning corresponding to the current pedagogical concepts.

First observations of student groups during their work, which took place during the development accompanying testing of Modulo, showed that the comparative studying of textbooks and especially the regular attendance of lectures tends to lose importance through the introduction of web-based instruction, while the co-operative working in the student group as well as the personal contact with the teacher was rather of increasing importance to the students. The same effect was found in a survey of J. G. Schutte [9].

With the background of this perception the teacher have the aspiration of being able to control the specific modifications of the learning culture, so that solutions for a number of already long-term perceived problems of the engineering studies can be found:

- in comparison to the requirements for the professional life, too little training of the capacity of teamwork,
- strong orientation of the studies on a subject structure and
- lacking integration of superior and professional relations.

The evaluation of Modulo is divided into three core areas:

- **Group Interview**
  According to our surveillance, the essential part of the collegiate learning and working takes place in small groups outside of the lecture time. Collegiate employees should survey the functioning of these groups in respect of the use of media or res. the distribution of the group.
- **Record of the Utilization Statistic of the Web-Based Instructions**
  Person-based user profiles could be diagrammed by an automated evaluation of the protocols of the web-server. These profiles should adjusted to the results of the questionnaires and group interviews.
- **Questionnaires to Register the Entirety of the Learners**
  The questionnaire records the personal data of the participants, their learning strategy (among others the distribution of attention on diverse sources of information in various learning situations), their social behavior and their study satisfaction. Each of these questions situational scrutinizes the role of the newly introduced media.

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REFERENCES

[1] EU, The European Commission – Socrates Programme – Higher Education (ERASMUS), 2001, http://europa.eu.int/comm/education/erasmus.html

[2] DAAD, Success Stories IV – Das European Credit Transfer System (ECTS) in Deutschland, 2001

[3] Tubman, K.A., Lloyd, D. and Harvey, S.J., European Exchange Schemes within a Bachelor of Engineering Course at Coventry University, *Int. J. Engineering Education*, Vol. 14, No. 3, 1998, pp186-190.

[4] Gorton, I.; Motwani, S., Issues in co-operative software engineering using globally distributed teams, in Information And Software Technology, Elsevier 38 (106), 1996, 647-655.

[5] Hunger, A., The Concepts of the Internationally Orientated Degree Course ‚Computer Science and Communications Engineering‘, in *Proceedings of the International Conference on Engineering Education*, 1998

[6] Brereton; Lees; Gumbley; Boldyreff, Distributed group working in software engineering education, in Information and Software Technology, Elsevier 40 (4), 1998, 221-227.

[7] Sarjoughian, H.S.; Zeigler, B.P., Ham, M. Parris, J., Distributed Group Software Engineering Projects: *Challenges to State-of-the-Art Collaboration Technologies, in Proceedings of WMC 99*, 1999

[8] Boloix, G., Robillard, P.N., Case tool learnability in a software engineering course, in *IEEE Transactions on Education*, 41 (3), 1998, 185-193.

[9] Schutte, J. G., Virtual Teaching in Higher Education - The New Intellectual Superhighway or Just Another Traffic Jam?, 1997 See: http://www.csun.edu/sociology/virexp.htm