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ONLINE TEACHING OF LARGE GROUPS IN INFORMATION TECHNOLOGY: A SURVEY OF STRATEGIES

Agnieszka Zmijewska, Elaine Lawrence, Gordana Culjak and Julia Prior

*Faculty of Information Technology
University of Technology, Sydney
PO Box 123, Broadway 2007 NSW, Australia*

ABSTRACT

This study addresses the problem of increased class sizes in Information Technology courses at universities. Our project aims to examine various strategies for improving effectiveness of teaching IT to large student numbers, focusing on the online teaching method. The paper discusses case studies of online teaching implementations at our university, and universities around the world. The cases are taken both from literature and personal interviews. The use of case studies is aligned with the approach taken in our project that is based on the belief that we should not 'reinvent the wheel', but rather learn from past experience. Specific strategies and results of online teaching implementations at various universities are reported.

KEYWORDS

online teaching, large class sizes, information technology teaching

1. INTRODUCTION

Many universities around the world are faced with larger class sizes and more demanding students. When student numbers grow into the hundreds, lecturers face a variety of challenges that are inherent in this type of teaching environment. New techniques and teaching styles to handle this change may be necessary. With large numbers, the lecturer's work of marking and providing individual assistance increases. The effort of preparing lecture materials, assignments, and exams is greater in a larger course, with more advanced preparation required (Kay, 1998). Not only it is harder to manage and effectively teach larger number of students, but such classes are more likely to have a diverse student body, with different learning styles and various degrees of computer knowledge (Meiselwitz, 2002). In large classes, students can remain largely anonymous. Their inattention can produce apathy and disconnectedness (Kay, 1998). Most of the human interaction aspect of the small class is lost, and the instructors often lose information about how well their students are learning. The instructor also has to distribute marking criteria to multiple markers, which also raise the issue of consistency and reliability (Preston, 1998).

Teaching Information Technology (IT) to large audiences involves further challenges in addition to the ones faced by other disciplines. For example, the material may involve more practical training than in other fields. The specification of programming assignments can be notoriously difficult. Assignments, especially those requiring production of software, are voluminous and require painstaking evaluation (Kay, 1998). With large numbers of students, these challenges multiply.

Our project aims to examine various strategies for increasing effectiveness of teaching IT to large student numbers. How could the abovementioned problems caused by increased class sizes be alleviated? Is online teaching, one of the strategies identified in our research, the most viable option? Are we able to learn from the experiences of other IT faculties that have adopted online learning? In section 2 the authors provide a background to the study while section 3 explains the methodology. In section 4 case studies that illustrate various models of online teaching are canvassed while section 5 discusses the results of our interviews with

our study subjects from around the globe with appropriate references to literature. Our conclusion is presented in section 6 and points the way to further research.

2. BACKGROUND

Our research identified online teaching as one of strategies for dealing with large class sizes. Online teaching is adopted by many universities to satisfy the demand for a greater number of higher education places especially when there is no corresponding increase in funding. There is a perceived advantage in cost-saving in delivering courses online. In large classes, online teaching benefits a larger clientele of learners with diverse needs, from varied backgrounds, with different motivations, abilities, learning preferences, time availability and course content requirements. There is more demand for more client-responsive and open and flexible courses (Fox et al, 1999).

If online teaching is to be used to tackle the problem of increased class sizes, an important question is whether such online teaching does not decrease the level of education. D'Souza & Bunt (2000) conducted a comparison between the use of the Internet and conventional lectures in education. The aim of the above study was to compare the pedagogical value of using the Internet for teaching with the use of standard lecture courses. Second year university students were rotated through: a) a conventional didactic lecture with Microsoft PowerPoint slides b) PowerPoint slides on a website (passive website) and c) an interactive, graphics intensive web site (active website). Each student took one subject presentation in each of the above conditions. Students were tested on the knowledge they had retained immediately after each teaching condition. At the completion of the study, attitudes to, and perceptions of the three teaching methods were surveyed. The authors of that study conclude that, in this particular situation, teaching via the Internet appears as effective as teaching via a didactic lecture. There was no significant difference in post class quiz scores after the various teaching methods.

3. METHODOLOGY

This paper investigates whether online teaching can indeed lead to more successful large-scale IT education, and if so, how it can be achieved. These questions are answered by the use of case studies of online teaching implementations at our university, the University of Technology Sydney, and universities around the world. The cases are taken both from literature and personal interviews. The use of case studies is aligned with the approach taken in our project that is based on the belief that we should not 'reinvent the wheel', but rather learn from past experience. The case studies, both from literature and from our own qualitative research, reveal specific models of online Information Technology teaching used at various universities. They also make it possible to see what the results of such implementations are, and how successful such teaching modes proved to be.

The Large Subject Teaching Committee of the Faculty of IT, University of Technology, Sydney, was successful in obtaining a grant to conduct a qualitative study in 2005 investigating the effectiveness of various teaching methodologies in similar Faculties teaching IT around the world. Interviewees were selected through web-based research to identify the most comparable teaching departments from various institutes locally, nationally and internationally. This is a continuing study and so far representatives from 8 different institutes have been interviewed by telephone. Questions were asked about their departmental profile, teaching load, issues, tools and strategies for large group IT teaching and also their evaluation of tested solutions. Preliminary results are discussed below.

4. CASE STUDIES OF ONLINE TEACHING IN LARGE SCALE INFORMATION TECHNOLOGY COURSES

While performing both our empirical research and literature review, the criteria used to select the particular case studies were that they had to a) describe online teaching methods, b) refer to teaching IT, and c) involve

teaching of large classes. Furthermore, we looked for those studies which described the results of such implementations and illustrated advantages of using them.

4.1 Case Study: University of Technology Sydney

The Department of Computer Systems at the University of Technology Sydney offers Cisco Academy Connection based courses into the Faculty's undergraduate and postgraduate programs. These courses are designed around a model of a minimum of 70 contact hours. In practice the hours needed to achieve quality outcomes are dependent on students, equipment ratios and teachers. An added benefit is that students are prepared for an industry based certification exam, for example, the Cisco Certified Network Associate (CCNA) or the Cisco Certified Network Professional (CCNP) which they can pursue privately at the end of the courses. The first case study concerns the teaching of one Cisco embedded subject called LANs and Routing – a first year postgraduate subject for the Internetworking courses at our university. This subject runs each semester and typically has over 100 students – Spring 2005 had 109. Normal contact hours in the class are comprised of a four hour session each week, which is a combination of:

- Mini Lecture - up to 30 minutes out of a 4 hour session
- On-line Chapter Exams - up to 30 minutes maximum out of a 4 hour session
- Lab Activity Session – up to 3 hours out of a 4 hour session

Students are expected to do some self directed learning. Mini lectures introduce the topics and appropriate references are cited. Emphasis is placed on hands-on learning, both through on-line course materials and practical exercises during the four hour laboratory session. On-line course material is provided by Cisco Network Academy Program via a mirror site (<http://iwork.uts.edu.au/enrolled/cisco>) which is used for online study. The Cisco Academy examination website is at <http://cisco.netacad.net> and this is only used for online exams which are conducted each week. Students are also encouraged to participate in a discussion forum created to actively discuss subject matters using Caucus software. This software allows instructors to upload lectures and lessons, and enables online conversations for learners and instructors. It enables a keeping of history about lessons. Practical lab sessions provide the opportunity to design and construct LANs, and connect, configure and test networking equipment. Students must maintain lab journals individually to record their findings, task configuration procedures, and new configuration commands. They are advised to submit their journals at appropriate times during the semester.

The lecturer is designated a “Guide on the Side”. This phrase has come to be taken somewhat for granted in education research literature (and the authors had difficulty in finding its origin), but essentially this is a student-centred approach where the lecturer (teacher) acts as a facilitator assisting the students' own discovery of knowledge for themselves, rather than taking the “Sage on the Stage” approach where the lecturer is the expert transmitting their knowledge in a one-way direction to the students (Underhill, 2006). Felder & Brent (2004) state that considerable research has shown that when student-centred instruction methods are implemented appropriately, there is “increased motivation to learn, greater retention of knowledge, deeper understanding, and more positive attitudes to the subject being taught” (Felder & Brent, 2004).

The Cisco curriculum has not been designed as a standalone e-learning or completely distance-learning course (Cisco, 2006). Throughout the history of the Cisco Networking Academy Program, the teaching and learning model has been based on instructor facilitation. The diagram "Learner Model: Academy Student" (Figure 1) summarizes the emphasis put on the learner. Starting with the students' prior knowledge, the instructor orchestrates learning events, built from a variety of resources, to help the students achieve desired understandings of networking (Cisco, 2006).

Student and staff satisfaction surveys have returned high scores on this method of learning as reported in Felix-Navarro (2002) and Lawrence et al (2003). The architecture of the Cisco Learner Model is illustrated in Figure 1.

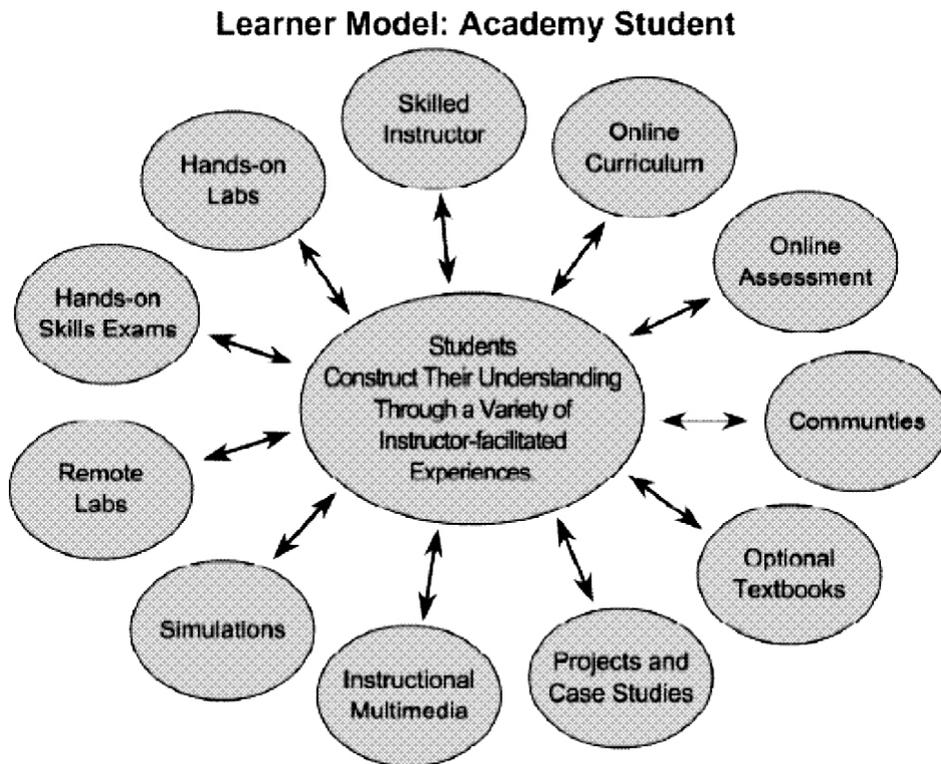


Figure 1. UTS Faculty of Information Technology is a Cisco Regional Academy which utilizes the Cisco Academy Learner Model (Cisco, 2006)

In Spring 2005, the subject scored the following results on the Student Feedback Survey. The ratings shown are either the average of a 5 point Likert scale or percentages of responses against points on a 5 point Likert scale. It should be pointed out that this subject has consistently scored high satisfaction rates with the students over the last four years.

Table 1. Results from the Student Feedback Survey for the discussed course

32524 - LANs and Routing	
The subject was delivered in a way which was consistent with its stated objectives	4.26
My learning experiences in this subject were interesting and thought provoking	4.21
I found the assessment fair and reasonable	4.08
There were appropriate resources available to support the subject	4.02
I received constructive feedback when needed	3.94
Overall I am satisfied with the quality of this subject	4.16
The laboratories assisted my understanding of this subject	4.02

4.2 Case Study: Curtin University of Technology, Western Australia

Another relevant case study is provided by Nagesweran et al. (2000), who describe the experience of online teaching to approximately 900 on-campus and approximately 400 off-campus students in a first-year Information Systems unit at the Curtin University of Technology. The Web has been used to supplement this unit from 1996. Materials concerning the unit program, assessment and administrative information (such as contact details of lecturers, tutors, and School office, book list, etc) were placed on the unit Web site. WebCT, a course management system, is the tool used to support the teaching of this unit. Placing these materials online in WebCT has enabled the instructors to manage and support this unit effectively and efficiently in terms of:

- flexibility to make changes to the information on the site
- availability to other links regarding the contents of the unit and unit information
- interactivity amongst students and tutors either synchronously or asynchronously
- portability of the unit which enables distance education students to gain access to the unit.

In that study, Nagesweran et al. (2000) used categorization of the tasks and roles of the online facilitator proposed by Collins and Berge (1996). These roles are divided into four areas: pedagogical, social, managerial, and technical. The pedagogical one focuses on educational facilitation. Social function is described as the promotion of friendly social environment which is needed in the process of online learning. The managerial aspects of online learning involve setting agenda, objectives, rules and decision making norms. The technical aspect focuses on the teachers' proficiency with the use of the technology. Collins and Berge (1996) believe that teachers in an online course must first become proficient and comfortable with the technology to ensure the comfort of the learners.

From the above description of the roles of the online facilitator, Nagesweran et al. (2000) conclude that the described unit has proven to fulfill the category of social, managerial, and technical areas. It is seen at this stage that since this unit is not offered as a fully developed online unit, the pedagogical area is not applicable in the online offering of this subject. The social context is promoted by allowing students to interact via email, bulletin board, and online chat. In terms of the managerial aspects, general unit information has been incorporated. Finally, staff members are competent and proficient, and able to support the teaching with the use of the technology. It was decided that it is not feasible to offer a first year first semester undergraduate unit in a fully developed online mode because, based on student feedback, many would still like to have classroom teaching and especially contact with other students and their tutors.

According to the authors of that study, for a large unit, the Web should be used to supplement classroom contact. Academics should be made aware that using the Web involves a shift in the role as a traditional teacher to an online facilitator.

4.3 Case Study: Towson University, Baltimore

Meiselwitz (2002) also reports on her experience with teaching computer science courses to classes of more than 100 students. At Towson University in Baltimore, their hybrid model of teaching includes a combination of in-class and Web-based instruction, including a hands-on laboratory session. The success of these courses, according to the author of the case study, depends to a great extent on logistical details, and the choice of online delivery tools. The hybrid model consists of one third Web based instruction, one third lecture, and one third laboratory time. The Web based component includes the complete course material. Powerpoint presentations cover the lecture material. Sample quiz questions for each topic enable students to assess their knowledge after each segment. The online material also contains detailed instructions for all laboratory exercises.

To support the online component, an online delivery tool CourseInfo by Blackboard is used. All student assignments are posted online. Grades for all assignments and quizzes are also posted electronically so that students have immediate feedback on their performance. The discussion board feature is used heavily. Assignments are posted to the discussion board, which serves as a showcase for the students' work. It encourages students' dialogue, as they get to ask questions about others' work. While the discussion board and online grade book are the core tools in this course, built-in email and internal homepages are also used for communication.

To evaluate the course model, data was collected about student performance in the new model, and compared to student performance when the course was taught in the traditional lecture/laboratory format. Performance was rated by the final grades students received. When comparing first and second year students, Meiselwitz (2002) found out that student performance was roughly the same. However, it was discovered that students in their third or four year definitely benefit from the new hybrid model. Performance for this group was clearly better using the new model of teaching than using the traditional lecture/lab model.

Additional comments were also solicited from students. The respondents liked the convenience and flexibility of the online elements. They liked the information being available all the time, and that assignments could be turned in regardless of time and location. Students especially welcomed the Web-based component.

Meiselwitz (2002) also found that the model works well for students with various knowledge levels and different learning styles. Students can customize the course to fit personal needs. The conclusion was that only this model makes it possible to teach a diverse student body of 200 students successfully with one instructor and two Teacher Assistants.

4.4 Case Study: Georgia Institute of Technology, Atlanta

Another online teaching system (used in Georgia Institute of Technology Computer Science courses) that supports large-scale class environment is described by Preston et al. (1998). The system is based on the use of newsgroups and anonymous surveys to improve the communication in the class, as well as the use of an on-line marking program. Newsgroups are used because in large-scale education, the student-teacher interactions are reduced, and so the interaction between students can be used to compensate for that. Anonymous surveys are used to capture feedback that is visible in small classes, but lost in large ones. Students and markers can submit, test, execute, confirm receipt of, and retrieve assignments electronically. This system not only improves the consistency of grades, but also the speed at which assignments can be processed by administrators and markers. The system allows for quality control of questions, criteria, and assignments.

4.5 Case Study: Drexel University, Philadelphia

Lass et al. (2003) describe the use of online Course Management Systems (CMS) in large introductory computer science classes at Drexel University. For large classes of 250-300 students, they typically employ 2 professors, and 10-12 teaching assistants. CMSs provide facilities for instructors to post assignments, for students to submit electronic copies of assignments or quizzes, and for instructors to post grades electronically. This is particularly convenient for large courses, in that all work is time-stamped and archived, students need not to hand in hard copies, and password protected grades are provided to students whenever and wherever they have access to a Web browser.

4.6 Case Study: University of Queensland, Brisbane

Brookes and Indulska (1997) describe the approach used in the School of Information Technology at the University of Queensland to teach Internet literacy to a very large and diverse audience. The class consisted of 312 students from a wide variety of faculties. The course was designed as very practical in nature, based on learning through interaction. The Internet was used in all facets of the course, including lecture presentation, self-paced student practical exercises, assignment submission and marking, and supporting student discussion. Learning materials could be accessed through both the Internet as well as in traditional paper-based format. Results of assignments were returned to students using electronic mail. An Internet discussion list and a newsgroup were created for the subject. Apart from one practical assessment and the final examination, students could fulfill the course requirements without needing to visit the university campus at all.

Feedback from students was very positive overall. Many students stressed that the best feature of the course was that all materials were available online. This supports the need for flexible delivery of coursework materials, and provides the greatest degree of access for the least cost. Most students liked carrying out the

assessments online. Online assessment increases the flexibility of the learning process as students can carry out the work at places and times convenient to them.

5. PRELIMINARY DISCUSSION OF RESULTS FROM THE LARGE SUBJECT INTERVIEWS

The previous section revealed a number of online teaching strategies used in large class IT courses around the world. In this section we supplement these findings with qualitative data from our interviews.

In one of our interviews, a Sydney university reports the benefits of using a Course Management System (WebCT). According to one of our lecturer interviewees, it is an adequate resource since it provides course content, a place to conduct quizzes and submission area, as well as mail lists and discussion boards. The lecturer points out that this online tool is especially useful for teaching large subjects, given the decreasing financial state of their Faculty. It allows for a greater flow of communication with students outside of the classroom.

A New York university lecturer reports similar observations. The university, according to the interviewee, is very much online oriented. Although students have classes, almost all the work is accessed and submitted online. This has proven to be an effective method for large classes as it allows quick and detailed responses to the individual student. By having online tutorials, the students are also in contact with one another, and can talk to their peers and thus develop greater flows of communication.

Other advantages of online teaching are discussed by Kay (1998) who focuses on strategies for an effective course management in large computer science classes. The author points out that having electronic submission of programs and automated testing of correctness may not only make the grading workload more manageable, but it can also provide a more thorough assessment and free the grader's time to consider issues such as design, style, interface, and documentation, that cannot be marked automatically.

One more strategy that has been suggested in our interviews is the use of web cameras to support teaching to large student numbers. This method however does not seem to have been widely adopted yet. One Australian university encourages lecturers to use webcams, and "one or two of which have started using this method". At another university they have tried to incorporate webcams, yet this has proven to be unsuccessful. Only at one German university webcams are often used to broadcast lectures to other universities. Our interviewee believes that the use of webcams is beneficial in terms of large subject teachings, however most communication should still take place in lectures.

One university in New Zealand has introduced yet another strategy. By the request of a student, lectures may be recorded to DVD and loaned out from the library. This method has been introduced because attendance numbers were very low. It was introduced last year (2005). Students benefit by being able to learn in their own time.

In one Australian university, there are also moves "to provide academics with VOIP and teleconferencing over IP facilities". At another institution, some lecturers record lectures in an MP3 format.

Another online teaching model is discussed by Landram (2002). This model is based on many educational procedures used in certification programs by corporations such as Microsoft or Novell. The model is based on the use of computer tutorial supplements, feedback in the form of short, timely quizzes, and uploading of major tests to learning centres to enforce testing security. Both quizzes and tests are computer graded. Students get to know the results minutes after completion. Online teaching here is used as a supplement to traditional textbooks. This fits in well with the Cisco certification model that is employed at the University of Technology Sydney and which was discussed in section 4.1.

6. CONCLUSIONS AND FUTURE RESEARCH

This paper has presented a number of case studies of using online teaching in large IT subjects, both from our interviews and from literature. A hybrid model where online teaching is used to supplement traditional lecture/laboratory based format seems to be most effective in terms of improving the quality of large-scale IT education. Feedback from students seems very positive overall when it comes to online components of their courses. They like flexibility and convenience of the online elements. The information is available all the

time, and assignments can be submitted regardless of time and location. Students can also interact with one another. An improved flow of communication between teachers and students was also stressed. The model seems to work well for students with various learning styles and personal needs.

In majority of the cases, online component was not used a standalone method, but rather to supplement traditional format. Students still seem to want contact with teachers and other students. Academics should be aware though that their role in such a student-centered hybrid model changes to a guide, or a facilitator, assisting the students' own discovery of knowledge for themselves.

Specific online teaching methods that can be used in the recommended hybrid model have been discussed throughout the paper, and are summarised in Figure 2.

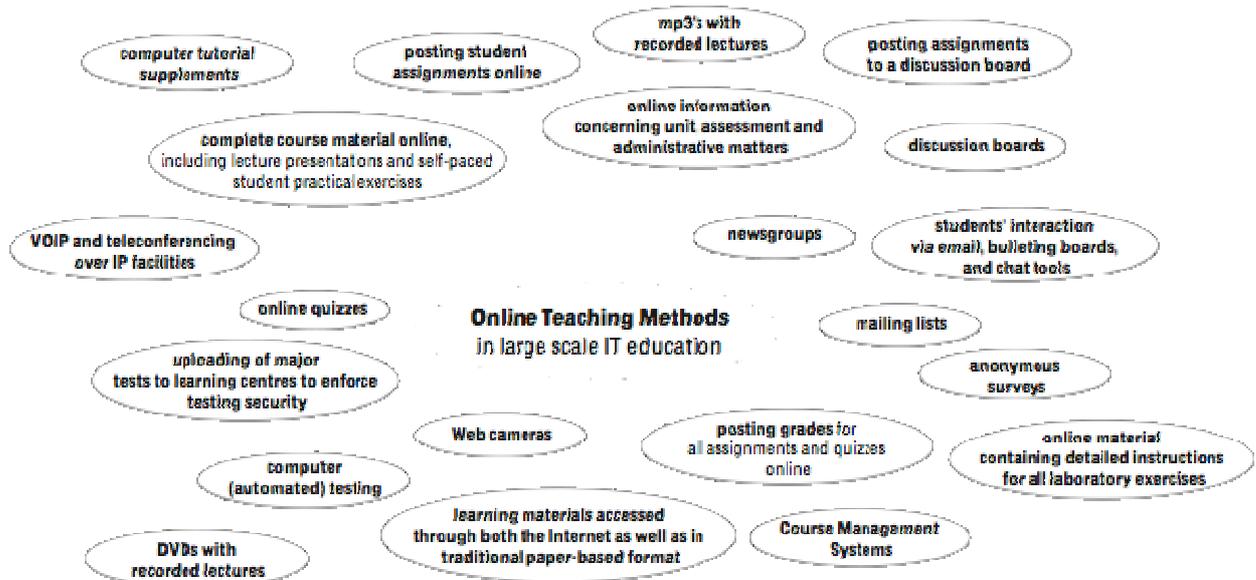


Figure 2. Online teaching methods identified in our case studies

Figure 2 outlines the multiplicity of online teaching techniques that have been identified in our research. As can be seen from this diagram, the methods can go from minimal online interaction such as posting grades on the web to full scale web and video presentation of material, lectures, discussion and chat rooms and class management. The case studies and interviews illustrated the various ways IT faculties are using these online teaching methods.

This paper has looked at online education as one strategy for increasing effectiveness of teaching IT to large student numbers. Both the case studies from the literature, and preliminary results from our interviews reveal a number of advantages of online teaching in large-scale IT education. Our next step will be to classify the various methods to provide an effectiveness measure of online teaching models for large scale teaching of IT subjects.

Further to the case studies and preliminary findings discussed above, the authors are continuing this research by gathering and further analysing of findings from interviews with lecturers in Faculties of IT or other similar faculties where IT is taught. These results will be published in due course.

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