

Learning through technology, using the Internet at home for first year engineering students

L.G. Boussiakou[†] & E.C. Kalkani[‡]

King Saud University, Riyadh, Kingdom of Saudi Arabia[†]
National Technical University of Athens, Athens, Greece[‡]

ABSTRACT: In the present study, the findings are presented from research that was undertaken for a course for first year students of a technological curriculum. The students were asked about the availability of computers at home, Internet connections, the use of the Internet for education and playing games, the use for access for course materials, and for communication with the instructor. The findings indicate that students can use multiple sites on the Internet, devote different percentages of their study time to online learning, while the availability and the use of the Internet does not predict the grade of the final examination attained for the course. Students also indicated the most popular sites that they use on the Internet, the benefits to their learning from their present use of the Internet and the expected benefits from future use. Based on the above findings, not only do certain university Web sites need re-evaluation to improve their usefulness, but also there needs to be a modification in the teaching of the courses that are available online.

INTRODUCTION

The acquisition of knowledge through technology is extensively analysed in the bibliography in articles published in journals and conference proceedings. The research presented in this paper examines the attitudes of an engineering class about learning by using computers at home and via the Internet, and compares the results with the findings of other researchers.

The engineering education literature is replete with articles on the use of the Internet and distance learning from the perspective of students, academic staff and administrators. Although the material of each course is developed by the school teaching it, quality indicators in distance learning can be developed by students and instructors, while most of the research performed is concerned with the transition from class or laboratory learning to online learning [1]. Some researchers have considered a three-phase developmental study conducted in a graduate school, where the students were asked to brainstorm and develop a set of quality indicators, which were reviewed by faculty with the goal of obtaining the biggest impact on the future of educational pedagogy and the direction of online learning environments [1].

Online learning can be useful as a means of preparing individual students for assigned readings and study [2]. This will improve student preparatory reading by assessing lower level knowledge, educate the student as an integral rather than supplemental tool, ensure or assess students' preparation and guide the student to higher topics, and provide grading and reporting electronically to the instructor. Online education delivery and the improvement of online courses require the development of methods for the efficient organisation of the courses, with the goal of retaining more students in engineering programmes, and improving student learning and performance through the appropriate use of technology [3]. Methods used to develop the organisation of courses require the comparison of traditional instructor-led courses with Web-assisted courses, streaming media courses and interactive video courses. In carrying out this research, the researchers used a common syllabus, the same homework and tests, and a common grading system. The students displayed satisfaction, improved time spent on tasks and interest in the content [3].

With respect to programmes and modes of operation, engineering colleges and universities will be different in the future. The providers of engineering education will make extensive use of the Internet and powerful computer technologies to define the new methods of distance learning, the alternative methods of delivery of educational content, and the norms and standards for quantity and quality, as well as scale and breadth of online learning [4]. Worldwide communication networks and the existing computer technologies will redefine the concepts of distance learning and the delivery of engineering education content [4].

In this study, research was undertaken on the use of the Internet for online learning for the students of a regular class taught in a traditional way. A questionnaire was developed in order to establish the availability of computers at home,

connections to Internet sources, and the present and future benefits to the learning of the students of having home access to the Internet. The students participating in the research were first year students in an engineering class. The students' answers were processed, and conclusions derived on the outcomes of the research and the benefits in the future of students' online learning through the Internet.

RESEARCH UNDERTAKEN

In the present study, research on using the Internet at home for educational purposes was undertaken on a class of first year technological curriculum students. The research was based on questions put to the students regarding the availability of Internet access at home (dial up or ADSL), on the sources used for information and education on the Internet, on the benefits derived from using the Internet, and on the future benefits expected from the Internet.

The engineering class that participated in this research was a class of 300 students of the first year (second semester), registered at the School of Civil Engineering of the National Technical University of Athens, Greece. The course, *Introduction to Power Technology* included material on Conventional Fuels and Renewable Energy. The course materials (lectures, solved problems - tutorials, homework and past examination papers) were placed on the university Web site at www.MyCourses.ntua.gr and was accessible through the Internet. There was also Internet and telephone communication between the students and the instructor and other students, while lectures and tutorial sessions took place in the classroom.

The questionnaire developed was based on the work of other researchers and was given to the students after the course's final exam [5]. The questionnaire was organised as Questionnaires A, B, C, and D, the structures of which are shown in Table 1. The students had to provide written answers to the individual questions in each questionnaire. Responses were processed in Excel and tables and graphs were produced. The most important findings are presented in this paper.

Table 1: Questionnaire distributed to the students.

#	Description of Questionnaires A and B	#	Description of Questionnaires C and D
A	<p><i>Questionnaire regarding the availability of Internet access at home.</i></p> <ol style="list-style-type: none"> 1. Do you have a computer at home? 2. Do you have your own computer at home? 3. Do you have your own laptop? 4. Do you have a laptop with wireless connection to the Internet? 5. Do you have a dial-up access for Internet at home? 6. Do you have an ADSL broadband Internet access at home? 7. Do you play computer games online? 8. Do you play computer games at home? 9. At what percentage of your study time do you use the Internet? 	C	<p><i>Questionnaire regarding the available benefits from using the Internet.</i></p> <ol style="list-style-type: none"> 1. Material for courses, projects, solved problems, past exams 2. Announcements from the school (regulations, events, etc) 3. Schedules for classes, exams, events 4. Information on engineering projects, environment, current issues 5. Exchange of information, tips, suggestions 6. Supplementary knowledge on technical issues (theory, problems) 7. No answer
B	<p><i>Questionnaire regarding the available sources for Internet connection.</i></p> <ol style="list-style-type: none"> 1. E-mail to students, professors 2. Web site of the University (www.MyCourses.ntua.gr) 3. Web sites of foreign universities, search engines (Google, Yahoo, etc) 4. Web site of the School (www.civil.ntua.gr) 5. Web sites of students' associations (www.dap.nd.ntua.gr, www.pasp.ntua.gr) 6. Encyclopaedias (Wikipedia) 7. No answer 	D	<p><i>Questionnaire regarding the future benefits from using the Internet.</i></p> <ol style="list-style-type: none"> 1. Material for courses, lecture notes, solved problems, other secure information 2. Online courses, handing homework, taking exams, practicing problems 3. Communication between students, professors, chat rooms 4. Real time connection to classroom, video, audio-visual, teleconferencing, group projects 5. Registration to courses, progress of studies, test results, final grades 6. Online access to libraries, e-books, interactive problem solving 7. No answer

Statistics on the students registered in the course, those who took the final exam, those who answered the Questionnaires A, B, C, and D, and the presence of male and female students in the class, are shown in Table 2. Of the 300 registered students, 239 (80%) took the exam, and of those, 60% were male and 40% were female students. Some students did not respond to all the questions. Table 2 also provides a comparison of final exam results with responses to the questions in Questionnaire A.

Table 2: Participation of students in the research.

Students' status and answers	Male	Female	Total	Absent no answer
Registered	195	105	300	
Took the exam	144	95	239	61
Answered Questionnaire A	124	84	208	31
Answered Questionnaires B, C and D	110	75	185	23

The data collected from Questionnaire A were compared to the achievement of the students in the course, which mainly consists of the grades achieved in the final exam. The grades were sorted and plotted as exam grades versus the number of students, for which the numbers of actual male and female students was reduced to 100. The distribution of the grades and the relevant trend lines or fit lines with the respective equations are shown in Figure 1.

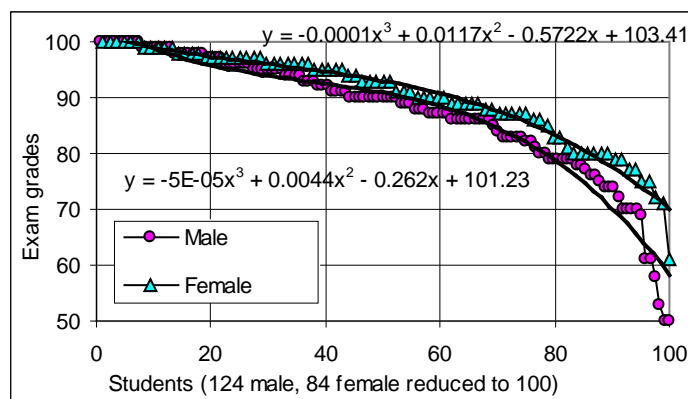


Figure 1: Examination grades in the final exam plotted separately for male and female students.

From those who answered Questionnaire A, the positive answers received for each one of the first eight questions separately from the male and female students are shown in Table 3. In addition, in the same table, the number of positive answers by students reduced to 100 male students and 100 female students are shown.

Table 3: Positive answers on the questions of the questionnaire.

Gender	Answers	Question Numbers 1 to 8							
		1	2	3	4	5	6	7	8
Male	124	119	110	62	37	35	86	51	94
Female	84	83	71	49	29	28	55	29	44
Male	%	96	89	50	30	28	69	41	76
Female	%	99	85	58	35	33	65	35	52

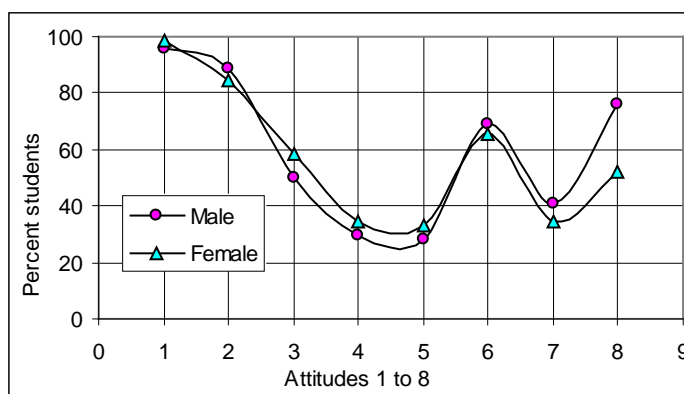


Figure 2: Availability of Internet access at home, Questionnaire A, {Attitudes: (1) computer at home, (2) your own computer at home, (3) your own laptop, (4) laptop with wireless connection to the Internet, (5) dial-up access, (6) ADSL broadband Internet access, (7) play computer games online, and (8) play computer games at home}.

The data presented in Table 3 are plotted in Figure 2. Question Numbers 1 to 8 that correspond to eight different attitudes with different content for each one, are displayed on the x-axis and refer to (1) computer at home, (2) your own

computer at home, (3) your own laptop, (4) laptop with wireless connection to the Internet, (5) dial-up access, (6) ADSL broadband Internet access, (7) play computer games online, and (8) play computer games at home.

From Figure 2, it is obvious that the proportion of students with laptops is less than that of students with motherboard computers, either the computers are at home or the students have their own computer at home. In addition, playing games online interested students less than playing games at home. The results may be skewed since there are more students with an ADSL connection than those having a dial up connection or wireless connection, and of those, about half play games on the Internet or use the Internet for entertainment. However, one may consider the cases of students answering positively to the questions about having all or some of wireless, dial up, or ADSL connections to the Internet, or playing computer games at one, available both at home and outside the home.

Question 9 of the questionnaire refers to the percentage of study time each student uses at the Internet at home. The study time as a proportion of the total for male and female students is shown in Figure 3. It is clear that female students spend a higher percentage of time studying than do male students, especially for larger populations of students. The trend line for female students is slightly higher than that of the male students, indicating the higher use of the Internet by female students. This may have happened for a range of reasons, including greater availability of computers and connections to the Internet or the overall greater time dedicated to studying.

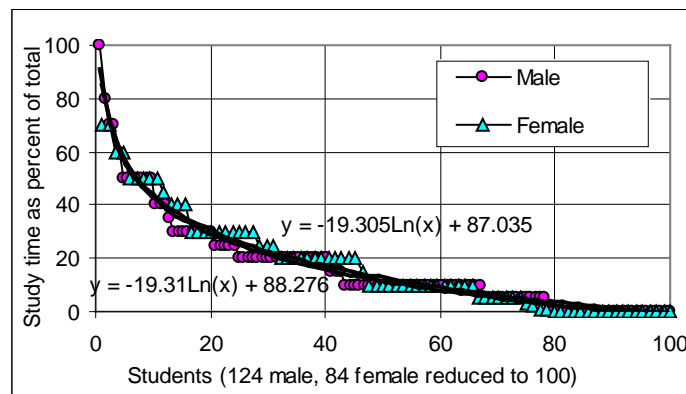


Figure 3: Availability of Internet accesses at home, Questionnaire A {Attitude (9) Percentage of study time using the Internet}.

The sources of Internet connections available to students are shown in Figure 4. The answers refer to Questionnaire B, and include attitudes on (1) E-mail to students and professors, (2) the University website, (3) Websites of foreign universities and search engines, (4) the School's website, (5) Websites of student associations, (6) Encyclopaedias, and (7) No answer.

In Figure 4, it can be seen that the university's Web site is the preferable site for both male and female students, as well as the Web sites of foreign universities, while the School Web site the student associations sites are used fewer times. The use of encyclopaedias represents a very low percentage of overall preference. These findings indicate that the Web sites of the School and that of the student associations need to be re-evaluated and restructured in order to become more popular with the students.

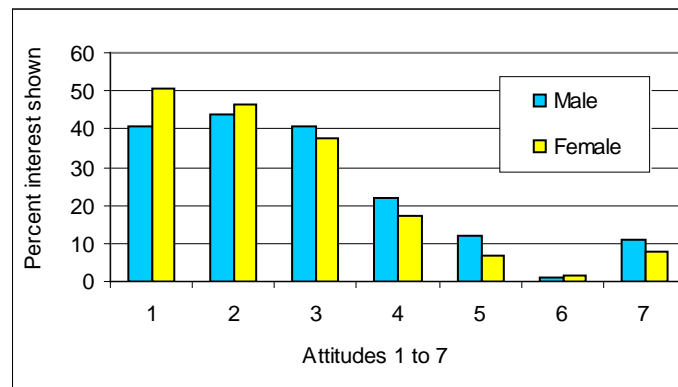


Figure 4: Available sources for Internet connections to students, Questionnaire B {Attitudes: (1) E-mail to students, professors, (2) Web site of the University, (3) Web sites of foreign universities, search engines, (4) Web site of the School, (5) Web sites of student associations, (6) Encyclopaedias, and (7) No answer}.

The benefits available to students from their present use of the Internet were sought in Questionnaire C, on attitudes to (1) Course materials, projects, solved problems and past exams, (2) Announcements from the School (regulations, events, etc), (3) Schedules for classes, exams, events, (4) Information on engineering projects, environment, current issues, (5) Exchange of information, tips, suggestions, (6) Supplementary knowledge on technical issues (theory, problems), and (7) No answer, are shown in Figure 5.

In Figure 5, one can see the increased interest of students in using course materials on the Internet, with almost equal interest for male and female students, while announcements from the School and the schedules for classes and exams come in lower but with almost equal percentages and other information from different sources in general follows in a decreasing order.

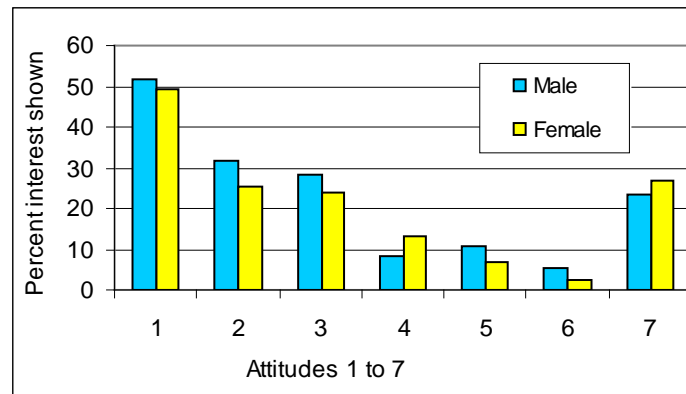


Figure 5: Benefits available to students from present use of Internet, Questionnaire C {Attitudes: (1) Material for courses, projects, solved problems, past exams, (2) Announcements from the school (regulations, events, etc), (3) Schedules for classes, exams, events, (4) Information on engineering projects, environment, current issues, (5) Exchange of information, tips, suggestions, (6) Supplementary knowledge on technical issues (theory, problems), and (7) No answer}.

The benefits available to students from future use of the Internet were sought via Questionnaire D. These benefits include (1) Material for courses, lecture notes, solved problems, other secure information, (2) Online courses, handing homework, taking exams, practicing problems, (3) Communication between students, professors, chat rooms, (4) Real time connection to classroom, video, audio-visual, teleconferencing, group projects, (5) Registration to courses, progress of studies, test results, final grades, (6) Online access to libraries, e-books, interactive problem solving, and (7) No answer, are shown in Figure 6.

Students reported that they were highly interested in having course materials streamed over the Internet in the future. The rest of the attitudes, such as online courses, communication and real time connection to classroom, course registration and online access to libraries are of lesser interest to the students and in decreasing order.

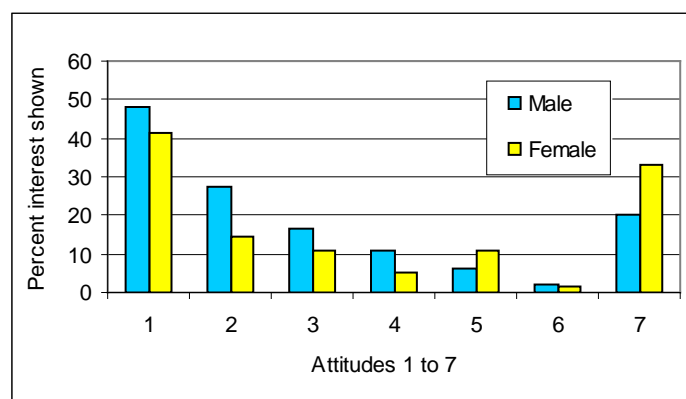


Figure 6: Benefits available to students from future use of Internet, Questionnaire D {Attitudes: (1) Material for courses, lecture notes, solved problems, other secure information, (2) Online courses, handing homework, taking exams, practicing problems, (3) Communication between students, professors, chat rooms, (4) Real time connection to classroom, video, audio-visual, teleconferencing, group projects, (5) Registration to courses, progress of studies, test results, final grades, (6) Online access to libraries, e-books, interactive problem solving, and (7) No answer}.

A comparison of the results of the research with the grades received by the students in their final course exam did not produce any significant findings. The students' grades were compared to an index for the answers 1 to 8 of

Questionnaire A. An index was developed by multiplying each of the positive answers for Questions 1 to 8 by ten, and considering the percent of the study time using the Internet multiplied by 100 points. By adding up the points, one is summing up 8 questions by 10 points (80 points), and 100% of the study time by 100. The total sum is 180 points, which can be reduced to 100 by dividing it by 1.8, to obtain a comparable index to the grading, which varies from zero to 100. By plotting the student grades versus the index, the graph in Figure 7 is obtained, for which the trend line was developed and plotted. The lower extremes of the grades and those of the values of the index were eliminated, and do not appear in Figure 7.

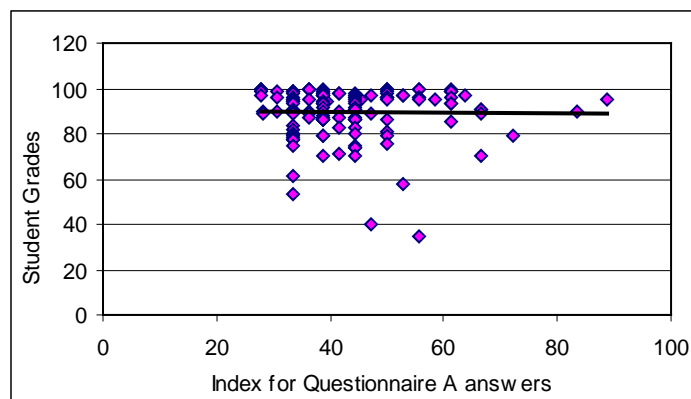


Figure 7: Variation of student grades versus the index for answers 1 to 8 of Questionnaire A.

One can see that by plotting the grades versus the index, the trend line is almost parallel to the x axis and is positioned at grade 90. Hence, for students with indices from 30 to 90, the average grade is 90. This means that there is no linear relationship between the grade with the index for answers obtained in Questionnaire A. Similar results of the grades of the students using the traditional form of learning and those using the Internet were found by other researchers [6], along with the realisation that course grades are not conclusive that learning has occurred.

DISCUSSION

The students in this research expressed their interest in using the Internet at home and their attitudes in expanding the use of the Internet at home for their education. From research by other researchers, similar findings are present and the application of the learning via the Internet is demonstrated as successful. Since the main techniques in delivering a course are (1) lectures, (2) homework, (3) laboratory experiments, and (4) team work, research was undertaken in four areas by replacing the traditional methods with those using information technologies. Research has been undertaken in all four areas by researchers, who reported the advantages and disadvantages in substituting each one of the techniques of traditional teaching into online teaching. Some examples from the literature are described hereafter.

Regarding lectures: In course reforms to employ Internet technologies, the usual class-based lectures can be replaced by videotaped lectures and materials viewed by students according to their own schedule. Actually, the researchers reversed the lectures and homework, which means that the lectures were taken at home, and homework was performed in class in small groups. More specifically, the lectures were videotaped, which made it easier for the students to take notes, and although they missed the opportunity to ask questions, they understood the lectures better by replaying the video and viewing the lectures according to their own schedule. The homework was transformed in live class periods for small teams with problem-solving sessions facilitated by the instructor and working together face-to-face [7].

Regarding homework: Researchers designed homework via the Internet and tried to keep the importance of homework in developing problem-solving skills, providing students with the practice they need and obtaining mastery in essential concepts and procedures [8]. Data that were created automatically by the computer server were collected on records of each student's use, students' patterns of software usage in the context of the course, and data on improving the student's performance [8].

Regarding laboratory work: Researchers developed a distance learning laboratory by using multi-media computer experiments, portable hands-on exercises and place-bound laboratory experiments. Class communication was realised by e-mail, online discussion groups and telephone conversations for hands on distance education [9].

Regarding Team work: Researchers consider that video and audio lectures are traditionally face-to-face lectures, while the lecture content sent via the Internet is not face-to-face teaching [10]. Since industry requires engineers to work in teams, students learn how to work and practice in face-to-face virtual teams. When working in teams, there are issues of time, culture, language and multiple perspectives to be resolved, and the need to function as team in order to satisfy the project performance, the processes and procedures for the project and the satisfaction of the team members. Researchers found that students were satisfied with face-to-face group experience, while computer mediated team communication is effective but not satisfying [11].

The advantages of using the Internet to deliver lecture material relate to students' learning. Researchers proved that online teaching increases student learning, the comprehension of the material, and the retention of the material [12]. In the same study, researchers found that well designed and pedagogically sound Internet-based supplementary modules result in a better understanding of the material and better student performance. At the same time, while there is no need to replace traditional instruction; the Internet creates the environment (broad and dynamic) for students with a variety of learning styles [12]. Elsewhere, researchers found that students with laptops, who had Internet connections, improved their learning, expressed more positive learning experiences and obtained slightly better grades [6].

The disadvantages of online learning relate to the impersonal nature of the Internet. Researchers found that although the Internet provides access for all types of students (younger and older, living close or far from the university), and provides flexibility in learning (time, pace, and sequence of learning material), there are serious disadvantages for the students such as missing regular face-to-face meetings, less disciplined students falling behind, experiencing a lack of motivation, missing support and encouragement from the instructor and other students, no mentoring or help, no questioning and answering, and emotions associated with an existing fear of decreased performance [13]. Traditional teaching allows for interaction with instant feedback from the professor and other students. However, researchers found that online teaching increases the amount of learning by the student time-wise, improves the efficiency of learning, increases the flexibility in time usage, enables catering to the individual and fostering responsibility for self discipline. Further, online teaching needs enhancements to increase the level of interaction with the user and providing assistance with discipline and time management [14].

Regarding the procedures followed, the researchers conducted the student surveys in the Internet-based lectures by creating two groups of students: those with and without Internet access. The learning styles of the students were recorded, and a course pre-exam and a final exam were graded and evaluated. When comparing the grades of the pre-exam and the final exam, the effectiveness and the satisfaction of students was assessed [15]. Researchers evaluating a larger body of students (undergraduates, graduates and on-off campus students) taking an online course realised that the students were satisfied with the course, the performance outcome was high, and the retention rate was high as well [16].

The application of online courses in the future will require the students' and the instructor's perspective on the advantages and disadvantages, important issues needed in Internet-based learning to be resolved, such as community, interaction, pedagogy, attention and feedback. Usually students' suggestions provide insight on the delivery method and the ongoing evolution of the course [17]. Researchers consider that establishing a community of practice in a specific course (and maybe in other courses) will help the mutual engagement of the instructors/researchers in joint enterprises and the shared knowledge, artefacts and practices. They intend to define the locus, members, management and content with the goal of improving education [18].

From the literature search, the interest of researchers would seem to be concentrated on the advantages of the delivery of lectures, homework, laboratory work, and team work online, and the advantages and disadvantages to student learning of the use of online teaching. Researchers evaluate their findings by looking at the grades of the students, the satisfaction of the students and, in general, the comments of the students from their experiences of online learning.

In the present research, by answering the questionnaires, the students displayed their interest in using the Internet at home, the availability of the Internet resources and the time used in online studying. The findings, although specific to the sample used, indicate that there are multiple sources of access to the Internet for students, who devote different percentages of their study time to online learning, but the use of the Internet at home cannot be taken as a predictor of the success of the students in their final exam.

Also in this research, the students declared the most popular sources of Internet they use, the benefits to their study from their present use of the Internet and their expected future uses of the Internet in their learning. According to the findings of this research, there is a range of interest in the various uses that can be made of the Internet. Those areas with lesser interest should be improved for the learning and satisfaction of the students. Also, the interest of students in certain Internet sites indicates that a re-evaluation and restructure of the rest of the sites maintained by the University could be beneficial to the students.

Based on these findings, modification of the teaching of the courses can be made by separating the parts of lectures, homework and teamwork that will be available online from the traditional teaching, and/or by delivering completely online versions of the courses.

CONCLUSIONS

There is a great interest in the literature in delivering lectures, homework, laboratory work and team work online, and the advantages or disadvantages to student learning from online teaching have been pointed out. The goal of the researchers is not only to display the success of the students regarding their grades, but also to increase the satisfaction of the students by taking the online courses instead of the traditionally taught courses.

In the present research, the first year students of a technological curriculum were questioned regarding whether they use personal computers at home, the type of connection to the Internet, the use of the Internet for education and playing, and the use for access to the course material and communication with the instructor. By answering the questionnaire prepared for the present research, the students displayed their interest in using the Internet at home, the availability of the Internet resources to them for their studies and the percent of their study time used in online studying. The findings indicate that there are multiple Internet sites that students can use, students devote different percentages of their study time to online learning, but the availability and the use of the Internet at home cannot predict the success of the students in their final exam.

Also in this research, the students indicated the most popular sites on the Internet they use, the benefits to their learning from the present use of the Internet and the expected benefits from future uses of the Internet. In the findings of this research, there is strong or less strong interest of the students in certain sites of the Internet, which indicates that a re-evaluation of the available sites could improve the services offered to students in the learning process.

Based on the above findings, a modification of the teaching of the courses can be made from the traditional teaching to online teaching of certain portions of lectures, homework, and teamwork, and/or developing the delivery of the courses completely online.

REFERENCES

1. Cohen, M.S. and Ellis, T.J., Developing criteria for an online learning environment: from the student and faculty perspectives. *J. of Engng. Educ.*, 93, 2, 161-167 (2004).
2. Marks, B.P., Web-based readiness assessment quizzes. *J. of Engng. Educ.*, 91, 1, 97-102 (2002).
3. Rutz, E., Eckart, R., Wade, J.E., Maltbie, C., Rafter, C. and Elkins, V., Student performance and acceptance of instructional technology: comparing technology-enhanced and traditional instruction for a course in statics. *J. of Engng. Educ.*, 92, 2, 133-140 (2003).
4. Bourne, J., Harris, D. and Mayadas, F., Online engineering education: learning anywhere, anytime. *J. of Engng. Educ.*, 94, 1, 131-146 (2005).
5. Machotka, J. and Nedic, Z., Is there better learning through technology? *Proc.11th Baltic Region Seminar on Engng. Educ.*, Tallinn, Estonia, 115-118 (2007).
6. Kolar, R.L., Sabatini, D.A. and Fink, L.D., Laptops in the classroom: do they make a difference? *J. of Engng. Educ.*, 91, 4, 397-401 (2002).
7. Foertsch, J., Moses, G., Strikwerda, J. and Litzkow, M., Reversing the lecture/homework paradigm using eTEACH® Web-based streaming video software. *J. of Engng. Educ.*, 91, 3, 267-274 (2002).
8. Taraban, R., Anderson, E.E., Hayes, M.W. and Sharma, M.P., Developing online homework for introductory thermodynamics. *J. of Engng. Educ.*, 94, 3, 339-342 (2005).
9. Alexander, D.G. and Smelser, R.E., Delivering an engineering laboratory course using the Internet, the post office, and a campus visit. *J. of Engng. Educ.*, 92, 1, 79-84 (2003).
10. Latchman, H.A. and Latchman, S.M., Bringing the classroom to students everywhere. *J. of Engng. Educ.*, 89, 4, 429-433 (2000).
11. Whitman, L.E., Malzahn, D.E., Chaparro, B.S., Russell, M., Langrall, R. and Mohler, B.A., A comparison of group processes, performance, and satisfaction in face-to-face versus computer-mediated engineering student design teams. *J. of Engng. Educ.*, 94, 3, 327-333 (2005).
12. Henson, A.B., Fridley, K.J., Pollock, D.G. and Brahler, C.J., Efficacy of interactive Internet-based education in structural timber design. *J. of Engng. Educ.*, 91, 4, 371-378 (2002).
13. Dutton, J., Dutton, M. and Perry, J., Do online students perform as well as lecture students? *J. of Engng. Educ.*, 90, 1, 131-136 (2001).
14. Nguyen, J. and Paschal, C.B., Development of Online ultrasound instructional module and comparison to traditional teaching methods. *J. of Engng. Educ.*, 91, 3, 275-283 (2002).
15. Evans, R.M., Murray, S.L., Daily, M. and Hall, R., Effectiveness of an Internet-based graduate engineering management course. *J. of Engng. Educ.*, 89, 1, 63-71 (2000).
16. Haag, S. and Palais, J.C., Engineering online: assessing innovative education. *J. of Engng. Educ.*, 91, 3, 285-290 (2002).
17. Williamson, C., Bernhard, J.T. and Chamberlin, K., Perspectives on an Internet-based synchronous distance learning experience. *J. of Engng. Educ.*, 89, 1, 53-61 (2000).
18. Fincher, S. and Tenenberg, J., Using theory to inform capacity-building: bootstrapping communities of practice in computer science education research. *J. of Engng. Educ.*, 95, 4, 265-277 (2006).