Original Article

Medical Education and Information and Communication Technology

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ABSTRACT

Background: Information and communication technology (ICT) has brought many changes in medical education and practice in the last couple of decades. Teaching and learning medicine particularly has gone under profound changes due to computer technologies, and medical schools around the world have invested heavily either in new computer technologies or in the process of adapting to this technological revolution. In order to catch up with the rest of the world, developing countries need to research their options in adapting to new computer technologies. **Materials and Methods:** This descriptive survey study was designed to assess medical students' computer and Internet skills and their attitude toward ICT. **Results:** Research findings showed that the mean score of self-perceived computer knowledge for male students in general was greater than for female students. Also, students who had participated in various prior computer workshops, had access to computer, Internet, and e-mail, and frequently checked their e-mail had higher mean of self-perceived knowledge and skill score. Finally, students with positive attitude toward ICT scored their computer knowledge higher than those who had no opinion. **Conclusions:** The results have confirmed that the medical schools, particularly in developing countries, need to bring fundamental changes such as curriculum modification in order to integrate ICT into medical education, creating essential infrastructure for ICT use in medical education and practice, and structured computer training for faculty and students.

Key words: Basic biomedical sciences, clinical clerkship, computer knowledge and computer skills, information and communication technology, internship, medical education (MD program)

INTRODUCTION

Due to the rapid development of computer technology and access to personal computers, together with the Internet, e-mail, and various medical literature retrieval applications, study and practice environments in medicine have changed. Consequently, the use of information and communication technology (ICT) is rapidly increasing in medical-education.[1]

Medical schools – particularly in developed counties–have invested heavily in ICT, not only to deliver education, but also to improve the quality of services provided by health professionals.[2] This is in striking contrast to the plight of many medical professionals in developing countries who may suffer from inadequate computer knowledge and skills to use ICT effectively, or who are uninformed about the potential benefits of using ICT.[3]

International organizations such as the United Nations (UN)

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and the World Health Organization (WHO) have acknowledged ICT as a useful tool to address health care education in developing countries. The United Nations' Millennium Development Goals have articulated the significance of using ICT to address education and health issues.[2]

Besides its effective impact on medical education, ICT offers many opportunities for improving the quality of interventions and care provided to patients, and for better organizing the health care system, as well. Therefore, medical education institutions need to better prepare medical students for the future and information literacy should be considered a mandatory skill in the training of all physicians. Physicians of the future must be prepared for patients who are increasingly connected to the Internet and informed on their diseases and the latest discoveries in medicine.[4]

Because of the important role that computer technology plays in medical education in both industrialized and developing countries, medical students' computer skills have been researched for at least the past three decades.[5-7] These studies suggested that in both industrialized and developing countries, students realize the significant transforming impact of ICT on medical education and want to see the necessary changes being implemented to facilitate this revolutionary transformation.[4]

Many studies have assessed medical students' computer skills and their attitudes toward ICT worldwide. Findings from these studies demonstrate that industrialized countries have invested heavily in ICT and its integration with medical education. Medical students in countries aware of the importance of ICT and its impact on medical education have good access to the latest computer technology needed to successfully pass courses and do research. However, developing countries are behind in this necessary process of incorporating computer technology into medical education even though this integration is becoming increasingly important because of the move toward globalization and the ever changing medical knowledge.

In most of the studies reviewed, paper-and-pencil surveys were used to assess the students' computer skills, which may not be an accurate method due to the students' incorrect perceptions and understanding of the term computer literacy, the faculty and institution's inaccurate perception of computer literacy, lack of precise definition, and social desirability or possible bias in responding.[8]

Based on Lahore's research, when paper-and-pencil surveys are used to assess the students' computer skills, the results should be viewed with caution. Paper-and-pencil surveys should only be used to assess students' perceptions of computer skills rather than their actual skills.

This study was to assess medical students' perceptions of their computer skills and their attitudes toward the importance of ICT integration in medical education at Isfahan University of Medical Sciences and Health Services (IUMS), and to examine (a) the factors that encourage students to use computers and the Internet, (b) the main barriers in using computer technology, and (c) any possible implication for educational leaders at IUMS.

MATERIALS AND METHODS

In this descriptive survey study, medical students' perceptions of their computer skills, their attitude toward ICT, and their usage and access to computer and Internet were assessed through a quantitative inquiry in which the students were asked to participate in a survey.

Study context

IUMS, one of the largest academic institutions in Iran, is an integrated education–research–healthcare organization under the support of Iranian Ministry of Health and Medical Education.

Medical education in study context

The medical doctor (MD) program in Iran is a continuous study of 7 years, requiring 290 credit units in four steps to fulfill the requirements:

1. Step one (basic biomedical sciences): 2 years
2. Step two (introduction to clinical medicine): 12 months
3. Step three (clinical clerkship): 2 years
4. Step four (internship): 18 months

The graduates of General Medical Doctorate have the option to specialize in their profession which normally takes 3–5 years of extra studies leading to a specialized doctorate degree or apply for PhD in a discipline of their choice.[9]

ICT skills in study context

ICT skills and web searches for medical literature in Iranian medical schools are generally self-taught by the students; consequently, the students are mostly dependent on themselves to learn the necessary computer technology for the medical field and use it productively throughout their course of study. Medical students have asymmetric computer skills and use computer and Internet to different capacities and for a variety of purposes. Some researchers have observed the use of computers and the Internet for nonmedical purposes.[10]

Sampling

This study used stratified systematic random sampling for the quantitative inquiry. Seventy percent of the medical students from each of the first, second, third, fourth, fifth, and sixth year groups at IUMS were asked to participate.

The data were collected in the following manner: (a) Students from each year were electronically invited (via e-mail) to join an informational meeting with the researcher where she explained the details of the project; (b) the volunteers were asked to inform the researcher about their class schedules and help her to find and locate the next general course they attended as a group; (c) the researcher then coordinated with the faculty teaching those classes to schedule time to explain the research project to the entire class and distribute the consent forms and survey among the students; (d) the researcher collected the consent forms; (e) the students choosing to participate filled out the survey

form; and (f) the researcher asked the volunteers to collect the completed surveys, put them into the provided large envelope, seal the envelope, and return it to the researcher.

For each academic year of study, Table 1 shows the total number of the students, the total number of the questionnaires distributed, the percentage of surveys distributed, the number of surveys completed and returned, and the return rate. The goal of distributing surveys to 70% of the students in each academic year was met. The survey return rate varied by year; second year students had the highest return rate at 92% and fifth year students had the lowest return rate at 33%. A total of 1047 students were enrolled in academic years 1 through 6; 733 surveys were distributed, and 466 surveys were completed and returned. The total return rate over all the academic years was 61%. Twenty-one students did not include their year of study in the questionnaire.

Sample by gender and academic year

According to IUMS enrollment data, there were 1047 potential participants. After eliminating surveys with missing or incomplete data, an *N* of 466 surveys remained. The data were input into the SPSS statistical software package. The total student population in all academic years was 630 females (60%) and 417 males (40%). The gender percentages differed slightly in the study sample when compared with the student population: 68% of the study participants were females and 32% were males compared with 60% females and 40% males in the student population. Because students could choose whether or not to participate in the study by completing and returning the survey, it is found that there was a higher rate of return among the female students when compared with the male students.

Care was taken to distribute surveys proportionately among male and female students, so that 70% of the male students and 70% of the female students from each academic year received a survey and the opportunity to participate in the study. Overall rate of return among the first through third year students was considerably higher than the last three years because students in program years 4, 5, and 6 were assigned to different sections of the university hospitals for internship and practical training. Heavy workloads and different schedules made it harder to access and convince senior students to participate in the study. Table 2 shows the details for each academic year, the number of surveys distributed, and the percentage for each gender.

Table 1: Number of students, questionnaires distributed, and questionnaires returned by year

Academic year	Students in academic year	Surveys distributed	% of students receiving survey	Surveys completed and returned	% Return rate
1	199	139	70	114	82
2	176	123	70	113	92
3	161	113	70	92	82
4	154	108	70	29	27
5	169	118	70	39	33
6	188	132	70	58	44
Total	1047	733	70	445	61

Questionnaire

The quantitative inquiry was conducted through a questionnaire consisting of 45 questions regarding the medical students' knowledge, attitudes, and usage of computers for academic purposes. The survey instrument asked the students about their computer skills, the degree to which they use the Internet for academic purposes, the medical applications for which they use the Internet most often, their attitudes toward ICT, and their access to computers and the Internet.

Students' attitude toward ICT

Survey questions 1 through 10 explored the students' attitudes toward ICT and whether it should be offered to the students at IUMS. Questions 1, 3, 6, 8, and 10 asked the students about the importance of ICT in medical education (what did they think about ICT in medical education). Questions 2, 5, 7, and 9 asked them about campus facilities related to ICT, their preferences in attending computer workshops versus self-training books, CDs, and online sources for learning ICT skills such as taking online courses versus campus courses, and library sources versus electronic sources. The students were asked to express their opinion to these questions by marking the appropriate box on a Likert-type scale. The choices were: *Completely disagree* (2), *disagree* (1), *no opinion* (0), *agree* (1), and *completely agree* (2).

Students' ICT skills and knowledge

The second section of the survey (questions 11 through 24) explored the students' self-perceptions of their computer skills. Survey questions 12, 13, 14 asked about the students' self-perceptions about their abilities to do routine tasks on a computer such as fix routine hardware problems, load and install software, use Windows operating systems, and do file management tasks. Survey questions 11, 15, 16, and 17 asked about the students' self-perceptions about their abilities to use common computer applications such as Microsoft Word® and make a presentation using Microsoft PowerPoint®. Survey questions 18, 19, 20, 22, and 23 asked about the students' self-perceptions about their abilities to use computers and

Table 2: Questionnaires distributed and returned by year and gender

Academic year	Gender	Students in academic year	Surveys distributed	% of students receiving survey	Surveys completed and returned	% Return rate
1	Male	75	53	70	43	82
	Female	124	87	70	71	82
2	Male	67	47	70	35	75
	Female	109	76	70	74	97
3	Male	61	43	70	26	61
	Female	100	70	70	66	94
4	Male	77	54	70	7	13
	Female	77	54	70	22	41
5	Male	51	36	70	9	25
	Female	118	83	70	30	36
6	Male	86	60	70	21	35
	Female	102	71	70	37	52
Total		1047	733	70	445	61

the Internet for medical research and to aid their studies, i.e., finding research papers using Medline, using Internet websites for study aids, and using online databases such as OVID and ProQuest. Finally, survey questions 21 and 24 asked about the students' self-perceptions about their ability to use e-mail. Students were asked to respond with 1 being the lowest level of skills/knowledge and 20 as the highest level of skills/knowledge.

Students' access to computer and internet

Survey questions 25 through 39 asked about the students' access to computers and computer and Internet use. Question 25 asked if students had a personal computer at home, question 26 asked if the students living in a dormitory had access to computer, question 27 asked the students if they were able to use a computer at the university, and question 28 asked if a student had ever attended a computer course. Survey questions 32 and 37 asked students the amount of time spent on a computer and the Internet. Survey question 39 asked students about how often they checked their e-mail accounts. Lastly, survey question 45 asked about the students' use of the Medline database/search engine to find articles and other medical information.

Reliability and validity

The content validity of the survey used in this study was examined by a panel of experts in the fields of medicine and technology at IUMS in order to determine if the survey measured what it intended to measure: Did it represent the content? Was it appropriate for the sample/population? Was the survey comprehensive enough to collect all the information needed to address the purpose and goals of the study? Did the instrument look like a survey? The Vice Chancellor for Research and Technology and the Director of the Medical Education Research Center (MERC) at IUMS analyzed the questionnaire for content validity and approved it in March 2011.

The reliability of this survey was established through a test–retest process on a sample of 30 medical students from various years who did not participate in the actual study. In May 2011, a test–retest reliability study was conducted at IUMS with an interval of 1 week between the tests. The scores were correlated with one another and yielded a Cronbach's alpha reliability coefficient of 0.915, which is within the range of a reliable test according to Gliem and Gliem, 2003.

Data analysis

The data were processed and analyzed using SPSS 16. Frequency distribution of all questions was calculated, and *t*-tests, chi-square tests, regression, Kolmogorov–Smirnov, Mann–Whitney test and analysis of variance (ANOVA) were conducted with the level of statistical significance set at $P < 0.05$.

RESULTS AND DISCUSSION

Students' toward attitudes ICT in medical education

Students' attitudes toward ICT were scored from completely disagree as −2 to completely agree +2. Responses to these questions are detailed in Table 3. The mean of all attitude items was calculated as 0.78 ± 0.43. Relationship between attitude and gender was compared by Mann–Whitney test and the *P*-value equal to 0.594 showed that there was not any meaningful statistical relationship between attitude and gender. Attitude and knowledge did not show any regression by calculating *P*-value as 0.636.

Relationship between all attitude items and mean of knowledge was tested by Kruskal–Wallis test and the result is shown in Table 4. Meaningful relationship was found between mean of knowledge and attitude question numbers 1, 3, 5, 7, 8, 9, and 10. Students who had a higher knowledge score agreed with the important role of computer applications in the quality of medical education and students with lower scores had no opinion.

Students with lower knowledge score agreed with "It is necessary to include official computer courses in medical curricular." Students with higher knowledge score agreed to apply web-based and digital library and they prefer to attend online learning courses. The students with lower knowledge level had chosen no opinion item more.

Students' self-perceptions of skills and knowledge

The second section of the survey (questions 11 through 24) explored the students' self-perceptions of their computer skills.

Statistical analysis shows that in general, the mean of the students' self assessed score is 14.93 +_ 3.83 from 20. The mean and standard deviation for each question, analyzed by gender, is shown in Table 5.

The mean of the scores was tested with ANOVA for different years of study in order to explore the relationship between the mean of the scores and the different years of study. The *P*-value was 0.641 which shows no meaningful relationship between these two [Table 6].

The relationship between the mean of the scores and previous computer workshops was examined with *t*-test. Students who had participated in computer workshops had a mean score of 15.8 ± 3.26 compared with a mean score of 14.22 ± 4.04 for students who had not participated in prior computer workshops. The relationship between these two is a *P* value close to zero, showing that there is a meaningful relationship between previous workshop experiences and scores for self-perceived skills.

The relationship between the mean of scores and age was tested by regression and no meaningful relationship was found.

The relationship between the mean of scores and gender was tested by a *t*-test and the female students scored 14.64 ± 4.01 and the male students scored 15.56 ± 3.28. The *P*-value was 0.017 and shows that a meaningful relationship exists between the mean of scores and gender.

Based on the students' self-perception of their computer skills and the scores they gave themselves, it is found that the stu-

Table 3: Responses to survey questions 1 through 10

Attitude questions	Completely disagree		Disagree		No opinion		Agree		Completely agree		Mean of score	Median of score	Mean in men	Mean in women	Gender difference *P*-value
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%					
Computer applications have an important role to improve the quality of medical education	7	1.5	11	2.4	13	2.8	175	37.6	258	55.4	1.44	2	1.45	1.41	0.606
Computer facilities are not adequate in MUI	4	0.9	67	14.4	100	21.5	199	42.7	92	19.7	0.67	1	0.9	0.56	0.001
It is necessary to include official computer courses in medical curricular	32	6.9	70	15	77	16.5	176	37.8	109	23.4	0.56	1	0.45	0.63	0.135
Teaching ICT to medical students is not necessary	200	42.9	176	37.8	63	13.5	19	4.1	5	1.1	−1.18	−1	−1.02	−1.25	0.012
Self-training books, CDs, and online courses are better than computer workshops	53	11.4	165	35.4	115	24.7	86	18.5	40	8.7	−0.23	0	−0.08	−0.29	0.855
Application of web-based learning will improve the quality of education	17	3.6	54	11.6	111	23.8	210	45.1	70	15	0.57	1	0.58	0.56	0.279
I prefer to attend online courses versus face to face classes	44	9.4	155	33.3	122	26.2	102	21.9	39	8.4	−0.14	0	−0.05	−0.17	0.443
Internet provides rapid access to update scientific resources	5	1.1	9	1.9	15	3.2	167	35.8	266	57.1	1.47	2	1.44	1.5	0.799
I prefer to use library versus online journals and digital library	45	9.7	176	37.8	146	31.3	71	15.2	21	4.5	−0.33	0	−0.36	−0.33	0.53
E-mail provides easy and rapid connection	3	0.6	13	2.8	53	11.4	207	44.4	186	39.9	1.21	1	1.25	1.2	0.606

Table 4: Compare attitude and mean of knowledge

Attitude questions	Completely disagree	Disagree	No opinion	Agree	Completely agree	Gender difference *P*-value
Computer applications have an important role to improve the quality of medical education	16.423469	15.623377	13.195266	14.04708	15.511251	0.001
Computer facilities are not adequate in MUI	17.392857	14.11993	14.495016	15.097695	15.397192	0.105
It is necessary to include official computer courses in medical curricular	16.147622	15.162057	15.803971	14.538882	14.351804	0.018
Teaching ICT to medical students is not necessary	14.793172	14.71448	15.155897	15.87594	19.371429	0.063
Self-training books, CDs, and online courses is better than computer workshops	14.338916	14.282189	14.818955	15.774369	16.562134	0.001
Application of web-based learning will improve the quality of education	14.338916	14.282189	14.818955	15.774369	16.562134	0.647
I prefer to attend online courses versus face to face classes	14.241508	14.390467	15.092958	15.693396	15.528881	0.043
Internet provides rapid access to update scientific resources	14.241508	14.390467	15.092958	15.693396	15.528881	0.019
I prefer to use library versus online journals and digital library	16.128042	15.32645	13.896489	15.336179	14.579396	0.001
E-mail provides easy and rapid connection	18.142857	14.428571	12.679245	14.561575	15.941501	≈0

dents were mostly comfortable working with Word® software (72.2% scored themselves 16–20) and PowerPoint® (55.1% scored themselves 16–20). The students did not perceive their skills for other Microsoft applications such as Access® and

Table 5: Mean and standard deviation of self-perceived knowledge and skills for survey questions 11 through 24 by gender

	Gender	Mean	Standard deviation
I can use computers for the things I need and my routine applications	M	15.801	4.0786
	F	16.644	3.3233
Using the windows operating system, I can work with files and folders – create, delete, copy, cut, paste, etc.	M	18.128	3.6072
	F	18.804	2.9004
I can fix routine hardware and software problems in my computer	M	11.055	5.8566
	F	14.559	5.0079
I can upload various software on my computer	M	13.594	6.0859
	F	17.255	3.893
I can use word software to do my courses' writing assignments	M	16.286	4.8951
	F	17.178	4.0808
I can use microsoft office applications like access, excel, etc.	M	9.983	6.7701
	F	11.169	6.0020
I can make a presentation using Power Point software	M	14.942	5.6502
	F	14.095	6.2108
I can find books using online book search from libraries	M	14.331	5.9912
	F	14.707	5.3166
I can find research papers using online Medline database	M	14.174	5.6578
	F	12.899	6.3512
I can find and study Internet sites related to my major	M	16.116	4.5492
	F	15.874	4.4340
I can send and receive e-mails using electronic mailing	M	17.167	4.8859
	F	18.143	3.8642
I can download different software related to my major from the Internet	M	15.125	5.8545
	F	17.369	4.1731
I can use e-journals and databases of the university, such as ovid, Proquest, etc.	M	11.225	6.8468
	F	11.612	6.6676
I can open accounts, for instance, mail box in various search engines such as Yahoo	M	16.549	5.2260
	F	17.255	5.1020

Table 6: Knowledge scores by year of study

Year of study	n	Mean	Std. deviation	Std. error
1	114	14.7674	3.64927	0.34179
2	112	15.2695	3.44831	0.32583
3	92	15.2667	3.84209	0.40057
4	29	14.4693	4.60705	0.85551
5	38	14.3255	3.97600	0.64499
6	58	14.6862	4.37688	0.57471
Total	443	14.9300	3.83159	0.18204

Excel® as very high. Regarding using computers for medical studies, the students rated their skills for downloading studies-related software, finding and studying related Internet sites, finding books online, searching Medline databases, and using e-journals and databases provided by the university as high. The majority of students rated their ability to use e-mail and create e-mail accounts as high.

Male students rated their overall self-perceived computer skills/knowledge at 15.56 and female students rated their self-perceived computer skills/knowledge at 14.64.

First year students rated their overall self-perceived computer skills/knowledge at 14.76, second year students at 15.26, third year students at 15.26, fourth year students at 14.46, fifth year students at 14.32, and sixth year students at 14.68.

Students were mostly comfortable with using the Windows® operating system as their self-perceived general computer skills. They were least comfortable with fixing routine hardware and software computer problems in their computers according to their self-perceived abilities and the scores they gave themselves.

Students' computer use and access findings

Students who had participated in various prior computer workshops had a mean self-perceived knowledge and skill score of 15.84 on a scale of 1–20 compared with a mean of 14.22 for those who had never attended any prior computer workshops. Students with access to computers had a mean self-perceived knowledge and skills score of 15.1; students with no access had a mean of 10.06. Results were similar for students with and without Internet access: 15.69 for students with access compared with 12.83 for those without Internet access. Finally, the students with access to e-mail had a mean score of 15.59 compared with a mean of 12.04 for those without e-mail access.

The mean of the scores for the students with a computer at home was 15.1 ± 3.69; those without a computer at home scored 10.06 ± 3.67. Using *t*-test, the *P*-value was close to 0 and showed a relationship between access to computers and the mean of scores. The students who had Internet accounts at home had a mean score of 15.69 ± 3.25; those without an Internet account scored 12.83 ± 4.37. This was tested using *t*-test and showed a *P*-value close to 0, so there is a meaningful relationship between these two.

Time spent using a computer also resulted in higher mean scores for self-perceived skills and knowledge. Students who spent more than 10 hours per week on a computer had a mean score of 17.05, compared with 13.4 for students who spent less than 5 hours per week on a computer. Similar means were shown for Internet use: Students who used the Internet for 10 or more hours per week had a mean of 16.74 compared with a mean of 14.21 for students who spent less than 5 hours per week using the Internet.

The students who had e-mail accounts scored themselves on average 15.59 ± 3.16 compared with those without an e-mail account who scored themselves on average 12.04 ± 5.07. It was tested using *t*-test resulting in a *P*-value close to 0, so this relationship is meaningful. Furthermore, the frequency of checking and working with e-mail was checked against the students' mean of the scores with ANOVA test. With the *P* value of 0, it is concluded that there is a meaningful relationship between the students' mean score of computer knowledge and the frequency they check and work with their e-mail accounts.

Survey question 45 asked about the students' use of the Medline database/search engine to find articles and other medical information. Only 30% of the first year students used Medline for research. The percentage of use is similar for second and third year students, i.e. 33% and 30%, respectively. However, 55% of fourth year students used Medline and 56% of the fifth year students used it. The percentage for sixth year students was 50%.

Medline use increased for fourth, fifth, and sixth year students. The average number of students using Medline was approximately 30% for the first 3 years; the percentage jumped to 50% and over for the last 3 years of the study.

CONCLUSION

Research findings have shown meaningful relationship between medical students' self-perceived computer knowledge and their attitude toward ICT. The students with positive attitude toward ICT and the ones who knew the importance of computer technologies in medical education and practice had a higher mean of self-perceived computer knowledge score. Also, students' self-perceived computer knowledge was proved to be directly related to access to computer, Internet, and e-mail. Those students who had access to computer and Internet and frequently checked their e-mail had a higher mean of computer knowledge score compared with ones who did not.

In order to better facilitate the use of information and communication technology among the medical students at IUMS, educational leaders of that facility might consider a modification of the medical curriculum with regard to ICT and its implications in medical education and practice in the 21st century. IUMS educational leaders should also consider development of a cultural awareness toward ICT and its essential and critical role in medical education and practice, as well as a systematic approach to training and development of faculty in using ICT both as a teaching and evaluating tool. Finally, IUMS leaders should consider building an appropriate infrastructure to facilitate computer and Internet access for the medical students both during their course of study at the university and after their graduation and into their future practice. In order to enhance the efficacy of medical practice, and medical research and development in general, the reform should be initiated through medical schools particularly in developing countries like Iran.

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