Comparison of Engineering Students' ICT Skills Ability Based on Gender, Year of Study, and Specialization

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ABSTRACT

The purpose of this study was to investigate if significant differences existed in engineering students' ICT skills ability based on gender, year of study, and engineering specialization. This study used quantitative approach with stratified random sampling of 317 students out of a population of 837 students. A survey instrument adopted from a previous study was used to collect data. The instrument was pilot-tested on 75 students. Data were analyzed using PASW Statistics V18. This study found no significant difference in ICT skills ability with respect to gender and engineering specialization. However there was a significant difference in ICT skills ability with respect to the year of study. Even though the research was conducted at a Malaysian college involving three engineering majors, the methodology is replicable in other settings. The findings would be useful in planning ICT pedagogical strategies.

Keywords: *ICT skills, gender, year of study, engineering specialization*

INTRODUCTION

Higher educational institutions play an important role to ensure graduates possess high-quality ICT skills relevant to the industry. To know whether the curricula succeed in producing such graduates, assessment of students' skills should be performed regularly. Information regarding students' ICT skills ability would also provide the basis for an intervention program for more effective learning. This study examined the self-perceived ICT user-skills ability of engineering students at a Malaysian college based on gender, year of study, and specialization. According to Perez (2002), students' collective perceptions about their acquired ability affect to a large extent, the measurement of a program's success in meeting its learning outcomes. Significant increase in skills level with respect to the year of study would seem to indicate the effectiveness of the engineering curriculum as a whole.

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2008), ICT user-skills ability comprises: i) the ability to operate ICT devices which include digital equipment, communication tools, and/or networks; ii) the ability to use application software and Internet-based services; and iii) the ability to define, access, evaluate, and use information in an information search process. This study compared these ICT skills among diploma of engineering students and discussed the implications of the findings.

BACKGROUND to the TOPIC

Certain demographic characteristics of ICT learners have been the focus of many ICT studies. Findings of these studies have been used to design pedagogical approaches to improve learning. Some of the characteristics of ICT learners that have been researched are gender and the year of study. The researcher included engineering specialization as another variable to investigate the differences in skill levels among civil, electrical and mechanical students. The results from ICT studies conducted since 2004 with respect to gender and the year of study are shown in Table 1. No published study on the relationship between engineering specialization and ICT skills has been found.

Table 1: Findings in ICT studies with respect to gender and year of study

	Findings
Gender	
1. Teck and Lai (2011) - Malaysia	No significant gender differences with regard to computer usage and experience. Male and female students report moderate ICT skills. Male reported higher computer maintenance skill than female.
2. Moghaddam (2010) - World	Gender gap in access and use of ICT exists among all nations but is wider in developing nations. In developed nations, there is gender difference in internet usage.
3. Nosek *et al*. (2009) - World	Gender gap in the choice of majors within science and engineering.
4. ECAR (2008) – the United States	A study on technology adoption practice shows that males do more audio and video creation than females.

	No significant gender differences in usage of social network services such as facebook.
5. Freehill, Javurek-Humig and Jeser-Cannavale (2006) – the United States	Gender gap still exists in traditional fields of engineering such as Mechanical and Electrical engineering, but the gap is smaller in relatively new engineering fields such as biomedical engineering.
6. Kvavik and Caruso (2005) - the United States	Gender differences in perceived ICT skills levels are small and declining. Both gender are more comfortable using general-purpose software such as email than specialized software.
7. Ono and Zavodny (2004) – Japan and the United States	Gender gap in computer and internet usage which existed in Japan and the United States during the mid-1990s has disappeared among American users but has persisted among the Japanese.
Year of Study	
1. Jung (2006) - China	First year students rated their ICT skills levels significantly lower in most computer applications compared to the other groups.
2. Kvavik and Caruso (2005) – the United States	Skill levels for using general-purpose software are more or less similar across study years, but seniors reported higher skill levels for specialized software.

Gender

Gender gap in the choice of majors within the field of science and engineering has not lessened since the past few decades (Nosek *et al*., 2009). Many ICT studies found gender differences regarding ICT use, internet use, access, adoption, experience, and learning opportunities (Moghaddam, 2010). The ECAR (2009) study found gender difference in technology adoption practices and preferences. The study discovered that females do less audio and video creation than males.

Some studies found no gender differences in core technology use among students (Kvavik and Caruso, 2005; Freehill, Javurek-Humig and Jeser-Cannavale, 2006). The size of gender gap might change in some countries and might remain more or less the same in others. For example, Ono and Zavodny (2004) found significant gender differences in computer and internet usage in Japan and the United States during the mid-1990s but noticed the gap has disappeared among American users while it has persisted among the Japanese.

These different findings motivated the researcher to investigate if significant gender differences existed in ICT skill levels in Malaysian context. Gender differences in ICT skill levels may mean that different approaches should be taken to improve ICT skills levels of male and female students. The majority of the students in the study setting are male, and to reduce the imbalance, engineering should be made more appealing to female students. The small number of female students should also be encouraged to stay in the engineering discipline by giving them assistance in their studies. ICT may be one of the ways to do this.

Year of Study

Year of study represents the academic experience students have. This variable was chosen to investigate possible significant differences in the level of ICT skills between students in different years of study. Very few studies have been conducted for this purpose. A study by Jung (2006) found differences in the perceived levels of ICT skills among students in different years of study. Those in the first year rated their ICT skills levels significantly lower in most computer applications compared to the other groups. Kvavik and Caruso (2005) found that students in different years of study report the same skill levels for using general-purpose software but seniors reported higher skill levels for specialized software than students in lower years of study. This current study would provide more empirical data on the association between the year of study and ICT skill levels, specifically among engineering students.

Engineering Specialization

There is a lack of literature on the effect of engineering specialization on ICT skills level. In Malaysia, the first two years of an engineering diploma program consist of common engineering and general university subjects. During the third year, students take specialized and elective courses according to their majors. These courses integrate and require ICT skills to a varying degree. At the setting in this study, Civil engineering program offers an ICT subject during the first year. Previous research on the effect of an ICT course on ICT skills level by Karsten and Roth (1998) found that a stand-alone ICT course had no effect on ICT proficiency. However, a study by Wong *et al*. (2009) on the effect of a stand-alone ICT course for student teachers in a Malaysian university showed some evidence of the benefits on students' perceived ICT skill proficiency. Jung (2006) found that engineering students rated themselves to have the lowest skills in creating graphics, video/audio files and web authoring. No known study has investigated the relationship between engineering specializations and ICT skill levels. Thus, this study would enrich the literature on the possible effects of different engineering specializations on ICT skills level.

Problem Statement

Student ICT skills ability profile based on gender, year of study, and specialization describes the current ICT skills used to perform engineering-learning tasks and the respective skills levels. This profile would also indicate which skills need to be further developed, and hence would be a useful tool in developing learning improvement strategies. However, there is a lack of empirical studies on students' ICT skills, particularly in Malaysian engineering education environment.

Objectives of the Study

The objectives of this study are to determine if there are significant differences in students'ICT user-skills ability with respect to their demographic characteristics, namely gender, engineering specialization and year of study.

Research Questions

To meet the objectives of this study, answers to the following research questions (RQ) are sought:
RQ 1: Is there a significant difference in ICT user-skills ability between male and female students?
RQ 2: Is there a significant difference in ICT user-skills ability between students in different engineering specializations?
RQ 3: Is there a significant difference in ICT user-skills ability between students in different years of study?

Research Hypotheses

To answer the research questions related to significant differences in ICT user-skills ability based on gender, year of study, and engineering, the study sought to test the following research hypotheses against the null hypothesis H_0.

Hypotheses for RQ 1:
H_0: There is no significant gender difference in ICT user-skills ability.
H_1: There is a significant gender difference in ICT user-skills ability.

Hypotheses for RQ 2:
H_0: There is no significant difference in ICT user-skills ability among students in different engineering specializations.
H_2: There is a significant difference in ICT user-skills ability among students in different engineering specializations.

Hypotheses for RQ 3:
H_0: There is no significant difference in ICT user-skills ability among students in Year 1, 2, and 3.
H_3: There is a significant difference in ICT user-skills ability among students in Year 1, 2, and 3.

METHODOLOGY

Research Setting

The study was conducted at a college of science and technology in the capital city of Malaysia. The college is under the jurisdiction of the Ministry of Higher Education (MOHE) and conducts diploma-level courses in various disciplines of engineering, science, technology, and technology management. The college currently offers seven diploma-level engineering programs conducted by the departments of civil, electrical and mechanical engineering. The diploma program duration is between three to five years, comprising between six to ten semesters.

Participants

Participants of this study were full-time diploma-level students enrolled in engineering programs at the college described above. Full-time students of a diploma program are usually between 17 – 23 years old and possess the secondary school certificate, Sijil Pelajaran Malaysia, which is equivalent to the GCE O Level. Diploma students must complete between 97 – 99 credit hours of courses before graduation.

A total of 400 questionnaires were distributed, and 381 were returned, giving a response rate of 95%. However only 317 were selected based on the completeness of the responses and the predetermined number of respondents for each stratum.

Sampling Technique and Sample Size

A cross-sectional study was carried out over one semester to describe a population of students with respect to their ICT user-skills ability for engineering learning. The quantitative data required to compare students' ICT skills ability were data on demographics and self-reported ICT skill levels. The quantitative approach used in this study is based on traditional statistical analysis. Stratified random sampling was used to select the participants in this study to ensure a highly representative sample of students based on gender, year of study and engineering disciplines.

In this study, the sample size used to conduct t-tests and non-parametric tests was 317, exceeding the minimum size suggested by GPower3 (Prajapati *et al*., 2010; Faul *et al.*, 2009), Bartlett's and Krejcie and Morgan's formulae (Bartlett *et al*., 2001; Krejcie and Morgan, 1970). The number of students in each stratum is shown in Table 2.

Data Sources

This study uses cross-sectional quantitative data collection strategy because the main emphasis is on the differences between groups based on gender, engineering specialization, and year of study.

Table 2: Distribution of student sample according to year of study, gender and engineering specialization

Course			Gender		Total = 317
			male	female	
Civil	Year of Study	First	9	7	16
		Second	4	6	10
		Third	17	3	20
	Total		30	16	46
Electrical	Year of Study	First	33	12	45
		Second	29	16	45
		Third	51	32	83
	Total		113	60	173
Mechanical	Year of Study	First	25	7	32
		Second	17	9	26
		Third	37	3	40
	Total		79	19	98

Quantitative Data Collection and Analysis

Quantitative data were gathered using the survey instrument developed by Ali (2012). Statistical analysis was performed using the PASW Statistics Version 18. To answer the research questions, statistical tests listed in Table 3 were conducted. A pilot study was conducted on a convenience sample of 75 students enrolled in engineering courses. Seventy forms were returned for a response rate of 93%. The internal consistency was high with Cronbach's alpha value of 0.93.

Table 3: Statistical tests

Research Question	Test
1. Is there a significant difference of ICT user-skills ability between male and female students?	t-test and Kolmogorov-Smirnov
2. Is there a significant difference of ICT user-skills ability between students in different engineering specializations?	Kruskal Wallis/ANOVA
3. Is there a significant difference of ICT user-skills ability between students in different years of study?	Kruskal Wallis/ANOVA

FINDINGS AND DISCUSSION

This section discusses the results of the inferential statistical analyses performed to answer the research questions.

RQ 1: Is there a significant difference in ICT user-skills ability between male and female students?

The result of 2-sample K-S test is shown in Table 4.

Table 4: Result of K-S test for gender difference in ability

		Estimated STUDENT Measure: UIMEAN=.00 USCALE=1.00
Most Extreme Differences	Absolute	.135
	Positive	.135
	Negative	-.085
Kolmogorov-Smirnov Z		1.099
Asymp. Sig. (2-tailed)		.178

Grouping Variable: Gender

Hypothesis for RQ 1:
H_0: There is no significant gender difference in ICT user-skills ability.
H_1: There is significant gender difference in ICT user-skills ability.

Since p= 0.178 > 0.05, H_0 is accepted. It can be concluded that there is no significant gender difference in ICT user-skills ability. This may mean that female and male students are given equal opportunity to use ICT skills in their study and have comparable access, and exposure to ICT.

RQ 2: Is there a significant difference in ICT user-skills ability between students in different engineering specializations?

Hypothesis for RQ 2:
H_0: There is no significant difference in ICT user-skills ability between students in different engineering specializations.
H_2: There is significant difference in ICT user-skills ability between students in different engineering specializations.

The result of Kruskal Wallis test is shown in Table 5 and Table 6.

Table 5: Mean ranks of measures for different engineering specializations

	Course	N	Mean Rank
Estimated STUDENT	Civil	46	164.54

Measure: UIMEAN=.00 USCALE=1.00	Electrical	173	159.99
	Mechanical	98	154.65
	Total	317	

Table 6: Result of test for student ability differences between engineering specializations

	Estimated STUDENT Measure: UIMEAN=.00 USCALE=1.00
Chi-square	.410
df	2
Asymp. Sig.	.815
Kruskal Wallis Test	

Grouping Variable: Course

Since $p = 0.815 > 0.05$, H_0 is accepted. It can be concluded that there is no significant difference in ICT user-skills ability between engineering specializations.
This may mean that the courses taken by these students or the extent of ICT integration in the courses do not make significant differences in the students' ICT skills levels, or that the courses do not require significantly different level of ICT user-skills ability.

RQ 3: Is there significant difference in ICT user-skills ability between students in different years of study?

Hypothesis for RQ 3:
H_0: There is no significant difference in ICT user-skills ability between students in Year 1, 2, and 3.
H_3: There is a significant difference in ICT user-skills ability between students in Year 1, 2, and 3.

The result of Kruskal Wallis test is shown in Table 7 and Table 8.

Table 7: Mean ranks of measures for year 1, 2 and 3

	Year of Study		N	Mean Rank
Estimated STUDENT Measure: UIMEAN=.00 USCALE=1.00		First	93	129.40
		Second	81	131.73
		Third	143	193.69
		Total	317	

Table 8: Result of test for student ability differences between year 1, 2 and 3

	Estimated STUDENT Measure: UIMEAN=.00 USCALE=1.00
Chi-square	37.394
df	2
Asymp. Sig.	.000
Kruskal Wallis Test	
Grouping Variable: Year of Study	

Since $p = 0.00 < 0.05$, H_0 is not accepted. It can be concluded that there is significant difference in ICT user-skills ability between students in Year 1, 2 and 3.

Since there is a significant difference between student ability measures in different years, the next step is to perform tests between those in:
Year 1 and 2
Year 1 and 3
Year 2 and 3.

Year 1 and 2:

H_0: There is no significant difference in ICT user-skills ability between students in Year 1 and 2.
H_2: There is a significant difference in ICT user-skills ability between students in Year 1 and 2.
The result of 2-sample K-S test is shown in Table 9.

Table 9: Result of test for student ability differences between year 1 and 2

		Estimated STUDENT Measure: UIMEAN=.00 USCALE=1.00
Most Extreme Differences	Absolute	.110
	Positive	.110
	Negative	-.080
Kolmogorov-Smirnov Z		.723
Asymp. Sig. (2-tailed)		.672
a. Grouping Variable: Year of Study		

Since $p = 0.672 > 0.05$, H_0 is accepted. It can be concluded that there is no significant difference in ICT user-skills ability between students in Year 1 and 2.

Year 1 and 3:

H_0: There is no significant difference in ICT user-skills ability between students in Year 1 and 3.
H_3: There is a significant difference in ICT user-skills ability between students in Year 1 and 3.

The result of 2-sample K-S test is shown in Table 10.

Table 10: Result of test for student ability differences between year 1 and 3

		Estimated STUDENT Measure: UIMEAN=.00 USCALE=1.00
Most Extreme Differences	Absolute	.355
	Positive	.000
	Negative	-.355
Kolmogorov-Smirnov Z		2.663
Asymp. Sig. (2-tailed)		.000

a. Grouping Variable: Year of Study

Since $p= 0.00 < 0.05$, H_0 is not accepted. It can be concluded that there is a significant difference in ICT user-skills ability between students in Year 1 and 3.

Year 2 and 3:

H_0: There is no significant difference in ICT user-skills ability between students in Year 2 and 3.
H_3: There is a significant difference in ICT user-skills ability between students in Year 2 and 3.

The result of 2-sample K-S test is shown in Table 11.

Table 11: Result of test for student ability differences between year 2 and 3

		Estimated STUDENT Measure: UIMEAN=.00 USCALE=1.00
Most Extreme Differences	Absolute	.291
	Positive	.000
	Negative	-.291
Kolmogorov-Smirnov Z		2.091
Asymp. Sig. (2-tailed)		.000
Grouping Variable: Year of Study		

Since $p= 0.00 < 0.05$, H_0 is not accepted. It can be concluded that there is a significant difference in ICT user-skills ability between students in Year 2 and 3.

Year of study represents the extent of knowledge, skills and experience that students acquire during their study. The first year in the diploma of engineering programs consists of general education courses, foundational studies in mathematics and science, and some introductory engineering courses such as Engineering Drawing, Statics, and Dynamics. During the second and third years, students would take more engineering courses, which normally demand more study time and use of ICT skills. Based on the statistical result that there is no significant difference in the ICT user-skills levels between students in Year 1 and 2, perhaps the engineering curriculum should be reviewed to incorporate more ICT components.

CONCLUSION

The study has shown that there is no significant difference in ICT user-skills ability across gender and engineering specialization. However, it shows a significant difference in ICT user-skills ability between students in Year 1 and 3, and between students in Year 2 and 3.

The findings of this study have several pedagogical implications on the teaching, learning and assessment of diploma engineering students, particularly for the study population. Firstly, since it has been shown that since gender and engineering specialization have no statistically significant impact on students' ICT skills ability, it seems that the approach of teaching, learning or assessment should not be gender or specialization-based. Rather, the focus should be on improving the integration of ICT into the second year curriculum so that there is a significant increase on students' ICT skills.

Secondly, this study also implies a need for regular assessment of students' skills to ensure the achievement of course and program learning outcomes. Even though ICT may not be taught as a course which has its specific learning outcomes, to inculcate the ICT skills which are particularly relevant to engineering learning, the curriculum must be designed to incorporate these skills among Malaysian engineering students.

Comparison of student ICT user-skills ability as produced in this study can provide empirical evidence of the effects of the associated factors. Knowing the relationship between demographic variables such as the year of study and skill levels can indicate the need to revise certain aspects of the curriculum such as the course content and learning objectives to ensure the skills levels increase along with study progression.

Further work on student ICT skills ability may include other student socio-demographics variables such as geographical areas, student physical disabilities, family economic and educational background.

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