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Gender Differences on Information Literacy of Science and Engineering Undergraduates

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***Abstract*—Information literacy (IL) forms the basis of lifelong learning and plays very important role for students majoring in science and engineering. As far as higher education concerned, gender differences to may influence students' academic achievements. In order to evaluate the gender differences on information literacy of undergraduates, we surveyed certain undergraduates using self-made questionnaire. The data of the survey was analyzed by SPSS. The findings of the study indicate that the gap of gender difference does exist in the sphere of information literacy. The result of t-test for two groups of male and female students shows significant difference in terms of mean scores obtained in information consciousness, information competency and information ethics tests.**

***Index Terms*—Gender differences, information literacy, undergraduates, t-test**

I. Introduction

A. Definition of Information Literacy (IL)

The term of "information literacy" (IL)was first defined by Paul Zurkowski, the president of the Information Industry Association, who used it in his proposal to the National Commission on Library and Information Science in 1974. In the proposal, Zurkowski described information literate individuals as those who are "trained in the application of information resources to their work" and campaigned for a national program to teach the necessary skills, which would eventually yield an information literate generation a decade later.[1]

In the information society, IL has become a necessity for everyone; it forms the basis for lifelong learning [2]. Everyone needs to use IL to make choices that arise every day. Over the past decade, IL has been an area of increasing interest to science teachers.

IL has been defined in a variety of ways. The concept of IL has been promoted by library and information professionals for several decades.

The Prague Declaration 2003 stated IL encompasses knowledge of one's information concerns and needs, and the ability to identify, locate, evaluate, organize and effectively create, use and communicate information to address issues or problems at hand; it is a prerequisite for participating effectively in the information society, and is part of the basic human right of life long learning.[3]

The Alexandria Proclamation on IL and Lifelong Learning defined IL as "comprising the competencies to recognize information needs and to locate, evaluate, apply and create information within cultural and social contexts. It empowers people in all walks of life to seek, evaluate, use and create information effectively to achieve their personal, social, occupational and educational goals".[4]

The Association of College and Research Libraries (ACRL), a division of the American Library Association (ALA), has been active in promoting IL. ACRL published IL competency standards and guidelines for best practice in instructional efforts [5], [6]. The IL Competency Standards for Higher Education articulated five standards which are divided into 22 performance indicators.

ALA defined IL is "a set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information".[7]

IL is now considered by several regional and discipline-based accreditation associations as a key outcome for college students [6]. IL is one basic existence skill, which forms the basis of lifelong learning and the key for students to become independent lifelong learner in information society [2]. IL skills must be incorporated throughout all areas of school's curriculum, not just in library orientation classes or isolated skills presentations [8].

IL is mainly shown as follow: ability to apply to information technology tools; ability to obtain information initiatively; ability to review, collect, use, deliver and exchange information; good coordinative awareness and cooperation ability; information immunity and information ethics cultivation; ability to use the information obtained to solve problems and carry out creative thinking activities. [9]

IL plays very important role for students majoring in science and engineering, as they may touch various information resources in the process of learning professional knowledge [2].

B. Suvey of IL

In the spring of2000, 3309 students of California State University were surveyed to acquire aggregate data to suggest a baseline of students' information competence skills. The survey included demographic questions, information scenarios and sets of questions scaled to areas related to information competence such as library use, research process skills, achievement, presence of

reference materials in the home, and computer and media literacy. [10]

Ian J. Cole and Amanda Kelsey completed a self-assessment questionnaire to examine a group of post-registered nurses' knowledge and competence of computer and IL. The results indicated that these students had deficits in both computer knowledge and IL. The study also outlined the structural and functional difficulties that need to be resolved in the area of using computers in education for nurses and midwifes. [11]

Ömür Sadiolu studied the IL skills of teacher candidates. The findings demonstrated that the teacher candidates did not have detailed or accurate knowledge of the subject and thus, they needed to be offered a course on IL in the beginning of their undergraduate studies. Analyzing in consideration of the genders, it was not found any significant differences in total between the teacher candidates' IL levels. However, a significant difference was found in favor of the male students regarding the skills of defining and evaluating information. [12]

Ma Feigcheng analyzed the current IL situation of university students in Wuhan Area based on big-scale statistical data. It reveals students' characteristics in six aspects respectively, such as information demands, information source selecting and searching, the abilities and skills of information accessing, information evaluating and utilizing, consciousness of information security and information ethics, and awareness of IL and situation of information education. [13]

With regard to IL-associated psychological adjustment problem of college students, Liang Canxing made a survey of4000 students. The results showed that around 15% of college students is healthy in mental. The information collation capacity of 60% of students need to be improved. [14]

Wong studied the gender differences in attitudes toward the usage of information technology (IT) related tools and applications. The results support the view that computer experience is gender-based as the increase in IT confidence over time assumed different patterns for females and males. [15]

Most of the studies surveyed the IL levels of students by different methods.

II. Research Background and Setting

A. Gender role theory

According to gender role theory, prevalent gender stereotypes are culturally shared expectations for gender appropriate behaviors. Females and males learn the appropriate behaviors and attitudes from the family and overall culture they grow up with, and so non-physical gender differences are a product of socialization [16]. There is evidence that boys tend to perform better than girls on timed, competitive, external tests and girls work better on cumulative, non-competitive, school-based assessment [17].

This study aims, firstly, to survey the levels of students' IL, secondly, to examine whether gender plays a role in IL, and thirdly, to help teachers improve students' IL.

B. Methodology

In order to understand gender differences on IL of undergraduates and establish the base for the practice strategy promoting undergraduates' IL purposely, the self-made "Questionnaire of Undergraduates' IL" was used in the study. The questionnaire is mainly designed from the definition of IL, and consists of 27 questions. Seven of the items reflect information knowledge, five reflect information consciousness, six reflect information ethics, while nine reflect information competency. The questionnaire has both positive and negative items.

The survey was implemented in Taishan University, and the questionnaire survey didn't note the names of investigated objects. For obtaining a high response rate, questionnaires were distributed and collected by lecturers in the course of teaching. The sample consists of freshman, sophomore, junior and senior undergraduates who major in physics, communication engineering, optics, materials chemistry, electrical science, biological science. All of the 360 questionnaires were returned, 344 (197 males and 147 females) of them are effective, the response rate is 95.5%.

In terms of the theory of Likert five-point scale (1 = very poor, 2 = poor, 3 = adequate, 4 = good and 5 = excellent), responses to the survey items were coded and graded. In order to obtain an accurate score reflecting IL in a single direction, we reversed the score of negative items so that all of the individual item scores lie on the same scale with regard to direction. In reverse scoring, the 5 becomes 1, 4 becomes 2, 3 stays the same, 2 becomes 4 and 1 becomes 5. The findings were analyzed using the Statistical Package for the Social Science (SPSS 13.0) for Windows computer software.

III. FINDINGS

The evaluation of questionnaire reliability internal consistency is possible by Cronbach's α, which is considered to be the most important reliability index and is based on the number of the items of the questionnaire, as well as on the correlations between the variables [7].

The Cronbach's reliability coefficient can be computed using SPSS by clicking the icons of "Analyze→Scale→Reliability Analysis". The Cronbach's reliability coefficient of this 27-item scale was 0.875. Good tests have reliability coefficients which range from a low of 0.65 to above 0.90.

TABLE I.
DESCRIPTIVE STATISTICS OF IL SCALE

Mean	Variance	Std. Deviation
69.50	163.466	12.785

The average of the responses the all undergraduate gave to the items is 69.50, see Table Ⅰ. Table Ⅱ gave the item means; it shows that the average score of the undergraduates is centered on the "adequate" option.

TABLE II.
SUMMARY ITEM STATISTICS OF IL SCALE

	Mean	Min	Max	Variance
Item Means	3.398	2.200	4.811	.634
Item Variances	.785	.369	1.321	.064
Inter-Item Correlations	.203	-.275	.794	.062

Information knowledge is the base of the IL. Information consciousness is the sensitivity of information. Information literate students have sensitive conscious of information in daily life. Information competency is the ability to recognize the need for information, acquire, evaluate, organize, interpret and communicate information. The information literate students know why information should be used in a responsible, culturally sensitive and ethical manner, and understand how to accesses and use information ethically and legally.

Table Ⅲ gives the descriptive statistics of the IL for the two groups of male and female undergraduates. The last column gives the standard error of the mean for each of the two groups. The findings indicate that the total average score of the male students is much higher than females. The total average of male students' is 72.69 which have a standard deviation 12.481. The total average of female students' is 66.31 which have a standard deviation 12.315.

In Table Ⅳ, the columns labeled "Levene's Test for Equality of Variances" tell us whether an assumption of the t-test has been met. If the Levene's Test is not significant (the value under "Sig." is greater than 0.05), the two groups are not significantly different, we can say the two groups have approximately equal variance on the dependent variable. If the Levene's Test is significant (Sig. is less than 0.05), the two groups are significantly different. The column labeled "t" gives the calculate t value. The column labeled "df" gives the degrees of freedom associated with the t-test. The column labeled "Sig. (2-tailed)" gives the two-tailed p value associated with the test.

The results of t-test for two groups of male and female students showed that they had significant difference in terms of mean scores obtained in total scores, information consciousness, information competency and information ethics tests with these p-values 0.000, 0.000, 0.000 and 0.004 respectively. This implies there are statistically reliable differences between male and female students at the 95% level. The results demonstrate that the levels of male students were more successful in IL than female students; could be explained that females are generally more hesitant about using new technologies.

The result of t-test for two groups showed that they hadn't significant difference in terms of mean scores obtained in information knowledge. The findings demonstrated that male and female students have mastered information knowledge equally.

Table Ⅴ gives the descriptive statistics of the items for the two groups of male and female undergraduates. The result of t-test for two groups showed that they had significant difference in terms of mean scores obtained in obtain information by 13 items, such as search engines, knowledge of literature retrieval, assembly computer, concern with information related to own subject, determine information appropriate to the chosen topic, access needed information effectively and efficiently, evaluate information, organize and store information, use information in critical thinking and problem solving, use search strategies efficiently, frequency on the internet, skim harmful network information and use pirated software with these p-values 0.000, 0.000, 0.000, 0.015, 0.000, 0.001, 0.049, 0.003, 0.034, 0.003, 0.019, 0.000, and 0.000 respectively.

IV. CONCLUSIONS

Acquiring IL skills at higher education is required given the fact that lifelong learning has become a must and the information widely used in teaching, learning, training and research activities is steadily growing in electronic environments [18].

As seen in the study, reliable and valid questionnaires will enable higher educator to determine gender differences of IL. The internal consistency reliability coefficient of the scale is at an acceptable level. We can say that the scale has good internal consistency reliability.

The findings of the study indicated that gender difference had existed in IL.

The findings indicate that the total average score of the male students are much higher than females. The two groups have significant difference in total average.

The results of t-test for two groups showed that they had significant difference in terms of mean scores obtained in information consciousness, information competency and information ethics tests with these p-values 0.000, 0.000 and 0.004 respectively.

The result of t-test for two groups showed that they hadn't significant difference in terms of mean scores obtained in information knowledge. The findings demonstrated that male and female students have mastered information knowledge equally.

Teachers should minimize gender difference of IL, using effectively teaching reform strategies to develop students' IL. To overcome this gap, teachers should create more training opportunities to increase female students' IL, pay more attention to female students on information consciousness, information competency and information ethics, and promote female students' IL quickly. Teachers can performance and make necessary opportunity for female students to perform as the same as males in classroom, curriculum and environment.

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TABLE III.
STATISTICS OF IL

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Total scores	male	197	72.69	12.481	1.012
	female	147	66.31	12.315	1.134
Information knowledge	male	197	20.04	5.785	.469
	female	147	18.99	4.688	.432
Information consciousness	male	197	15.63	2.872	.233
	female	147	14.42	2.681	.247
Information competency	male	197	26.33	4.757	.386
	female	147	23.62	4.565	.420
Information ethics	male	197	10.69	4.240	.344
	female	147	9.27	3.674	.338

TABLE IV.
INDEPENDENT SAMPLES TEST OF THE IL

		Levene's Test for Equality of Variances		t-test for Equality of Means					
								95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Total scores	Equal variances assumed	.607	.437	4.194	342	.000	6.386	3.388	9.383
	Equal variances not assumed			4.202	327.225	.000	6.386	3.393	9.379
Information knowledge	Equal variances assumed	5.747	.017	1.601	342	.110	1.048	-.241	2.336
	Equal variances not assumed			1.644	341.490	.101	1.048	-.207	2.303
Information consciousness	Equal variances assumed	.371	.543	3.528	342	.000	1.208	.534	1.882
	Equal variances not assumed			3.559	333.034	.000	1.208	.540	1.876
Information competency	Equal variances assumed	1.460	.228	4.726	342	.000	2.710	1.581	3.839
	Equal variances not assumed			4.751	330.303	.000	2.710	1.587	3.834
Information ethics	Equal variances assumed	2.594	.108	2.891	342	.004	1.420	.453	2.387
	Equal variances not assumed			2.943	338.731	.004	1.420	.470	2.369

TABLE V.
INDEPENDENT SAMPLES TEST OF ITEMS

		Levene's Test for Equality of Variances		t-test for Equality of Means				
							95% Confidence Interval of the Difference	
		F	Sig.	t	Sig. (2-tailed)	Mean Difference	Lower	Upper
Word processing	Equal variances assumed	1.507	.221	-.739	.461	-.080	-.295	.134
	Equal variances not assumed			-.754	.451	-.080	-.290	.129
Spreadsheet processing	Equal variances assumed	1.193	.276	-.453	.651	-.050	-.267	.167
	Equal variances not assumed			-.460	.646	-.050	-.264	.164
Microsoft PPT processing	Equal variances assumed	.005	.943	.712	.477	.084	-.149	.317
	Equal variances not assumed			.715	.475	.084	-.148	.316
Use Windows operating system	Equal variances assumed	14.255	.000	1.420	.157	.175	-.067	.417
	Equal variances not assumed			1.464	.144	.175	-.060	.410
Obtain information by search engines	Equal variances assumed	.041	.840	3.802	.000	.458	.221	.695
	Equal variances not assumed			3.816	.000	.458	.222	.694
Webpage making	Equal variances assumed	6.446	.012	1.706	.089	.205	-.032	.441
	Equal variances not assumed			1.739	.083	.205	-.027	.437
Use software or computer language related to own subject	Equal variances assumed	6.178	.014	1.444	.150	.183	-.066	.432
	Equal variances not assumed			1.476	.141	.183	-.061	.427
Knowledge of literature retrieval	Equal variances assumed	.158	.691	3.991	.000	.532	.270	.794
	Equal variances not assumed			4.087	.000	.532	.276	.788
Assembly computer	Equal variances assumed	8.116	.005	6.900	.000	.898	.642	1.154
	Equal variances not assumed			7.095	.000	.898	.649	1.147
Concern with information related to own subject	Equal variances assumed	8.351	.004	2.389	.018	.232	.041	.424
	Equal variances not assumed			2.449	.015	.232	.046	.419
Determine information appropriate to the chosen topic	Equal variances assumed	21.834	.000	4.318	.000	.378	.206	.550
	Equal variances not assumed			4.381	.000	.378	.208	.548

Access needed information effectively and efficiently	Equal variances assumed	16.728	.000	3.459	.001	.319	.138	.501
	Equal variances not assumed			3.516	.001	.319	.141	.498
Evaluate information	Equal variances assumed	1.951	.164	1.975	.049	.196	.001	.391
	Equal variances not assumed			1.979	.049	.196	.001	.391
Organize and store information	Equal variances assumed	2.163	.143	2.990	.003	.304	.104	.505
	Equal variances not assumed			2.977	.003	.304	.103	.506
Communicate and share information	Equal variances assumed	1.217	.271	.739	.460	.072	-.121	.265
	Equal variances not assumed			.746	.457	.072	-.119	.264
Use information in critical thinking and problem solving	Equal variances assumed	2.236	.136	2.135	.034	.211	.016	.406
	Equal variances not assumed			2.144	.033	.211	.017	.405
Use search strategies efficiently	Equal variances assumed	1.310	.253	3.016	.003	.331	.115	.547
	Equal variances not assumed			3.067	.002	.331	.119	.544
Frequency on the internet	Equal variances assumed	3.596	.059	2.351	.019	.257	.042	.473
	Equal variances not assumed			2.394	.017	.257	.046	.469
Read specialized books and periodicals	Equal variances assumed	.065	.799	1.292	.198	.126	-.066	.317
	Equal variances not assumed			1.293	.197	.126	-.066	.317
Use databases	Equal variances assumed	2.859	.092	1.195	.233	.135	-.087	.357
	Equal variances not assumed			1.212	.227	.135	-.084	.354
Attacked by hackers	Equal variances assumed	.833	.362	-.619	.536	-.058	-.244	.127
	Equal variances not assumed			-.624	.533	-.058	-.243	.126
Login others computer illegal	Equal variances assumed	6.231	.013	-1.391	.165	-.115	-.279	.048
	Equal variances not assumed			-1.419	.157	-.115	-.275	.045
Skim harmful network information	Equal variances assumed	45.288	.000	-4.450	.000	-.405	-.584	-.226
	Equal variances not assumed			-4.706	.000	-.405	-.574	-.235

Spread harmful information	Equal variances assumed	10.042	.002	-1.679	.094	-.125	-.271	.022
	Equal variances not assumed			-1.747	.082	-.125	-.265	.016
Divination by Internet	Equal variances assumed	.168	.682	-.128	.898	-.011	-.175	.154
	Equal variances not assumed			-.130	.897	-.011	-.173	.152
Use pirated software	Equal variances assumed	18.193	.000	-3.952	.000	-.538	-.806	-.270
	Equal variances not assumed			-4.120	.000	-.538	-.795	-.281
plagiarize others article or book	Equal variances assumed	3.507	.062	-1.591	.113	-.167	-.374	.040
	Equal variances not assumed			-1.618	.107	-.167	-.371	.036

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