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Women in Computer Science: NO SHORTAGE HERE!

The dwindling number of women pursuing a degree in CS is a growing frustration for many countries around the globe, but in Malaysia female CS/IT students outnumber the males. What accounts for this dichotomy?

There are many studies tracing the declining number of women interested in pursuing a CS/IT degree, most of which were conducted in Europe and the U.S. Generally, these studies find that young women do not find CS an attractive career option, that women choose not to continue with computer subjects as often as men do, and that women in CS programs tend to terminate their training earlier than men [2, 4, 6]. In Australia, fewer women are employed as IT professionals; indeed, it is estimated the ratio of females to males in IT is 1:9 [10]. Young females in many parts of the world perceive CS as a masculine field—a perception we contend is not shared by their Malaysian counterparts.

Table 1a shows the number of Malaysian female and male students pursuing a bachelor's degree in CS (B. CS) and bachelor's in IT (B. IT) from the 1998/1999–2005/2006 academic sessions. The percentage of female students often exceeds the number of male students. In cases where the percentage of male students is higher, the difference is always less than 10%. Table 1b shows the number of students who withdrew from and who failed the bachelor programs. The numbers are small, but in both

cases the casualty rate for male students is higher. Table 1c notes there is little difference in the number of Malaysian female and male students pursuing a master's degree at the University of Malaya; in fact, the only noticeable distinction is in the Ph.D. program (Table 1d) where the number of male Ph.D. students often exceeds the females.

Our study attempts to determine if there is indeed a difference in the way Malaysian males and females perceive CS. Our hypothesis is that CS/IT is not viewed as a masculine field by young Malaysians; a key reason why this nation does not encounter the problem of too few young females interested in pursuing a degree in CS or IT.

Previous studies have identified the following as the reasons why CS is not attractive to young females:

- Traditional socialization and traditional roles of the sexes [4];
- Classification of CS as a science [3];
- Computer games and educational software are designed predominantly with boys in mind [3]; thus, boys become more familiar with computers and gain better computer

Session	B. CS				B. IT			
	Female		Male		Female		Male	
	Number	%	Number	%	Number	%	Number	%
2005/2006	61	45	74	55	41	71	17	29
2004/2005	96	48	105	52	82	71	34	29
2003/2004	86	59	60	41	82	56	65	44
2002/2003	169	62	104	38	100	55	82	45
2001/2002	167	52	156	48	130	67	64	33
2000/2001	246	55	201	45	197	69	89	31
1999/2000	127	46	147	54	88	59	60	41
1998/1999	144	51	137	49	107	61	67	39

(a) Intake for undergraduate programs

Session	Withdrawn			Failed		
	Female	Male	Total	Female	Male	Total
2003/2004	0	0	0	0	0	0
2002/2003	0	0	0	0	1	1
2001/2002	0	0	0	0	7	7
2000/2001	1	2	3	1	3	4
1999/2000	0	0	0	4	0	4
1998/1999	0	1	1	1	1	2
Total	1	3	4	6	12	18

(b) Number of students who withdrew or failed the program for both B. CS and B. IT

Session	Female		Male		Session	Female		Male	
	Number	%	Number	%		Number	%	Number	%
2005/2006	41	56	32	44	2004/2005	9	32	19	68
2004/2005	208	58	151	42	2003/2004	9	43	12	57
2003/2004	377	57	285	43	2002/2003	2	25	6	75
2002/2003	260	56	206	44	2001/2002	1	25	3	75
2001/2002	174	51	165	49	2000/2001	5	56	4	44
2000/2001	110	48	117	52					
1999/2000	65	42	91	58					
1998/1999	35	52	32	48					

(c) Intake for Master's programs

(d) Intake for Ph.D. program

skills than girls, which is an advantage when they attend college;

- Gender discrimination and low self-esteem [3]; and
- Lack of mentoring and role models [6].

We designed a questionnaire partly based on Sackrowitz and Parelius's work [7] to determine if Malaysian students have a different perception of CS. If so, does this lead to different attitudes toward CS among young Malaysian males and females. Our questionnaire was distributed to Malaysian undergraduate students studying for a degree in CS/IT at the University of Malaya (74%) and Universiti Kebangsaan Malaysia (26%). The results presented here are based on the response of 118 students (53% of which were female) within the age range of 20–30 (97%).

While a few of our findings are similar to those carried out by previous studies, others are significantly dif-

Table 1. The number of male and female students who choose and continue with—or fail/withdraw from—CS/IT programs at the University of Malaya.

ferent. Note that z-tests were carried out at the significance level of 0.05.

Computer and programming skills. We asked respondents to rate how competent they felt their computer skills were prior to starting their degree program. They were asked about their familiarity with programming constructs (Table 2a). In all cases, male students were more familiar with programming constructs and the z-test indicates significant differences. We also asked respondents to rate their familiarity with various operating systems, programming languages (we chose Pascal, C, and C++ because these are the programming languages often taught in schools) and applications (Table 2b). Once again, there was a significant difference in the level of competency between female and male students. Male students feel they are more competent in using computers prior to starting their degree program. This finding agrees with [7].

Skill acquisition. We asked respondents to specify how they acquired their computer skills (in high school, self-taught, private classes, books/magazines, friends, family, job, or by hacking) prior to beginning their degree programs. The only significant difference is that more male students acquire their skills by learning on their own. This finding is unlike [7], which establishes a significant difference in skill acquisition through self-taught, hacking, or job-based activities or from books and magazines.

Mathematics. Since the association of CS to mathematics and science was found to deter women from pursuing a CS program in [3, 4], we asked respondents their mathematic grades for SPM (the equivalent to O-levels) and STPM (equivalent to A-levels).

Our findings show there is no significant difference in mathematical competency between male and female students. Of the female respondents, 87% received a distinction for mathematics compared to 85% of the males in SPM, while 24% of the females received an A compared to 29% of the males for

STPM. In fact, when asked whether they “liked mathematics,” 51% of the females “strongly agreed” compared to 33% of the males. Indeed, the z-test indicates a significant difference in the attitude toward mathematics, with female students ranking a higher appreciation. While this finding does not disprove that females avoid majoring in CS/IT because of its association with mathematics and science, it does prove that young females in Malaysia have a markedly different attitude toward mathematics compared to their Western counterparts. Our experience, however, indicates that mathematics and science are not factors that influence whether a student chooses to major in CS/IT.

Perception toward CS/IT.

We asked the respondents to rate their agreements to a set of statements (Table 2c). In cases where there is a significant difference between the response of female and male students, female students are found to have a more positive attitude. For example, 37% of the females strongly agreed that CS/IT is suitable for women compared to 5% of the males; 56% of the females agreed that CS/IT is suitable for women compared to 40% males. When asked if they will work in the CS/IT industry upon graduation, 44% of the females strongly agreed compared to only 29% of the males. And 71% of the females strongly agreed that computer skills are important compared to 56% of the males. This finding indicates that female students do not experience demoralization while pursuing their study and are more certain they will pursue a career in the CS/IT industry upon graduation.

Table 3. Grade obtained for programming courses.

	Female	Male
*if-else	1.7	2.4
*while / for	1.7	2.4
*array	1.5	2.1
*procedure / function	1.5	2.1
*pointers	1.5	1.9

(a) Familiarity with programming constructs Scale: 1 (not familiar) to 4 (very familiar)

	Female	Male
*Windows	2.3	3.0
*Unix/Linux	1.2	1.7
Pascal	1.4	1.4
*C or C++	1.3	2.1
* Word processor	2.8	3.0
*Spreadsheet	2.1	2.8
*Database	1.6	2.0

(b) Competency with operating systems, programming languages and applications Scale: 1 (not competent) to 4 (very competent)

Statement	Female	Male
I enjoy a challenging environment	4.1	4.0
Computers are fun	4.2	4.3
*Computer science / IT is suitable for women	4.3	3.2
I was prepared for the program	4.0	4.0
Other people seem more prepared	3.5	3.5
*I like mathematics	4.4	3.9
I can program well	3.3	3.3
*I will work in the computer/IT industry after graduating	4.4	4.0
*Computer skill is important	4.7	4.5
Men are more skilled than women in using computers	3.4	3.6

(c) Degree of agreement with the statement Scale: 1 (no opinion), 2 (disagree), 3 (mildly disagree), 4 (agree), 5 (strongly agree)

Table 2. Mean of responses (* z-test indicates a significant difference).

RM5,001–RM10,000 (\$2,652) per month. Moreover, we found a small difference between computer ownership of male and female students (94% versus 88%, respectively).

We asked students their grades for programming courses taken (note that none of the male respondents had taken the assembly programming course) and found no significant difference in programming

To the statement “Men are more skilled than women in using computers,” 15% of the females and 35% of the males strongly agreed; 29% of the females and 19% of the males agreed; 42% of the females and 30% of the males mildly disagreed. The z-test shows no significant difference in the perceived computer skills of men and women, unlike the finding of [2] and [9] that both females and males believe males are better at computing.

Computer ownership and course outcome. We asked respondents their monthly household income and found little difference: 21% of the females and 20% of the males live in households with incomes less than RM1,000 (\$265) per month; 28% females and 26% males live with incomes between RM1,001–RM5,000 (\$1,326) per month, and 5% females and 1% males are from households with

	Grade A to A-		Grade B+ to B-		Grade C+ to C-		D+ to D-	
	Female (%)	Male %	Female (%)	Male %	Female (%)	Male %	Female (%)	Male %
C	28	26	38	43	32	32	2	0
C++	46	31	31	41	22	22	0	6
Java	38	0	41	50	21	25	0	25
Asembly	40	0	53	0	7	0	0	0
VB	38	0	38	100	25	0	0	0
Data structure	56	6	33	50	11	44	0	0
Others	50	25	50	50	0	25	0	0

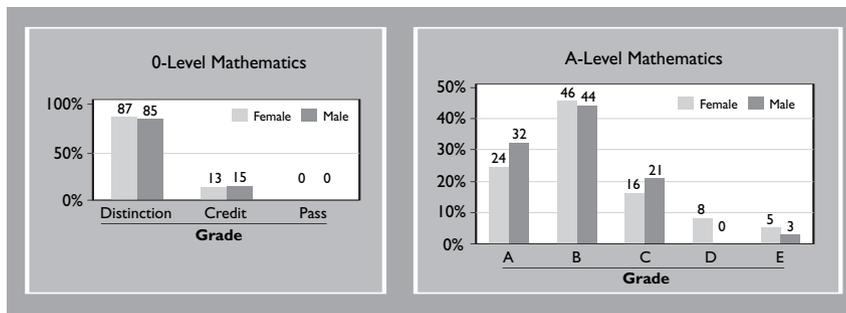


Figure 1. Mathematics results.

achievements with the exception of data structure. This finding contradicts [7] that found women underrepresented among the highest achievers.

Although male students acquired some programming skills prior to starting their degree program, this advantage does not translate to better performance compared to their female counterparts, another finding in opposition to [7], which claims prior familiarity with programming concepts is a success factor among male students. Our finding agrees with Margolis [5] who found no correlation between prior experience and success. Our findings also show that even though male students spend significantly more time playing computer games, programming, and hacking, these activities do not result in outpacing female students, which implies the amount of time spent at the computer is not a measure of how well one performs academically.

CONCLUSION

Our findings lead us to conclude there is no gender bias with regard to how CS/IT is perceived by young Malaysians. Even though male students often started their bachelor degree program with more computer skills, it does not result in male students outperforming female students. Neither are females underrepresented among the high achievers. Female students are also more certain they will pursue a career in computer/IT industry compared to male students.

While the lack of female role models or mentors in the field has been cited as a demotivating factor for female students in the U.S. and Europe, this is not a problem for Malaysian females. The dean of Faculty of CS & IT at the University of Malaya was a woman, and three out of four department heads are currently women. Of the faculty lecturers, 61% are female as are 73% of the Ph.D. holders. Nine out of 12 associate

professors are females. At Universiti Kebangsaan Malaysia, 66% of the lecturers at the Faculty of Technology and Information Science are female as are 40% of Ph.D. holders. Given this scenario, female students associated with these two faculties are clearly not lacking female mentors or role models, and are assured that pursuing a career in CS/IT is a normal, indeed, unremarkable option.

We conclude that young Malaysians have a different perception of CS/IT compared to the Western world. Young women perceive CS as a technical and difficult subject because that view has been ingrained in them since childhood.

If steps are taken to remedy this, it

is possible to overcome the shortage of women in CS and IT programs that ultimately lead to the shortage of women pursuing a career in this field. **C**

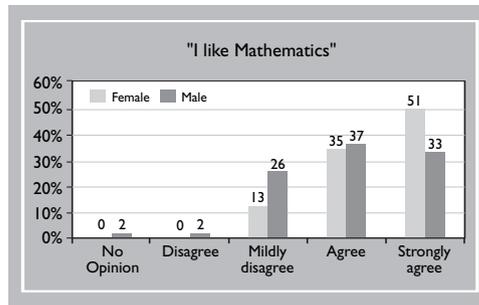


Figure 2. "I like mathematics."

REFERENCES

1. Camp, T. The incredible shrinking pipeline. *Commun. ACM* 40, 10 (Oct. 1997).
2. Clarke, V. Strategies for involving girls in computer science. In *Search of Gender-Free Paradigms for Computer Science Education*. C. Martin, Ed. ISTE, 1992, 71–86.
3. Craig, A. and Stein, A. Where are they at with IT? *Women, Work and Computerization: Charting a Course to the Future*. E. Balka and R. Richard, Eds. Kluwer (2000).
4. Kvande, E. and Rasmussen, B. Men, women and data systems. *European Journal of Engineering Education* 14, 4 (1989), 369–379.
5. Margolis, J., Fisher, A., and Miller, F. The anatomy of interest: Women in undergraduate computer science. *Women's Studies Quarterly*. Spring/Summer, 2000.
6. Pearl, A. et al. Becoming a computer scientist. *Commun. ACM* 33, 11 (Nov. 1990), 47–57.
7. Sackrowitz, M.S., Parelius, A.P. An unlevel playing field: Women in the introductory computer science courses. In *Proceedings of the 27th Technical Symposium on Computer Science Education*. (Philadelphia, PA, 1996), 37–41.
8. Sax, L.J. Predicting gender and major-field differences in mathematical self-concept during college. *Journal of Women and Minorities in Science and Engineering* 1, 4 (1995), 291–307.
9. Spertus, E. Why are there so few female computer scientists? *AIT Technical Report 1315*. MIT AI Lab, 1991.
10. Symonds, J. Why IT doesn't appeal to young women. *Women, Work and Computerization: Charting a Course to the Future*. E. Balka and R. Richard, Eds. Kluwer, 2000.

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