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Gender differences between theoretical and practical achievements of CS students

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Abstract

Computer Science (CS) education is more theoretical in earlier classes. After the first year of this theoretical education, the assignments and exams become more practical and applicable. The same situation keeps going in business life for CS and Information Technology (IT) areas. This will result the male outnumbering to the females in education and business life for CS relative areas. In this study, we try to discuss some inferences about this underrepresentation of females in such areas. The more practical nature of CS is held as a basis of statistical hypothesis and some statistical tests are performed on theoretical and practical overall grades of female and male students in Bahcesehir University. The results and findings are delivered with the final discussions.

Keywords: gender differences; computer science; male-female comparison; stereotyping.

1. Introduction

Women are underrepresented in the field of Computer Science (CS) and in the Information Technology (IT) industry. For instance, in the US, although women were 46% of the total workforce in 2000, they constituted only 30% of the IT workforce, and in 2003 this percentage had even decreased (Ahuja, 1995; Papastergiou, 2008).

Many studies (Cohoon, 2001; Kerner & Vargas, 1994; Frenkel, 2000) are performed to ascertain the real motivation behind this situation; females are outnumbered by males in CS and IT education (Beyer, Rynes & Perrault, 2003) and industry. These studies decide two main aspects as a possible cause of this situation:

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i. By the nature of CS and IT, the algorithmic and computation based actions are more male dominated areas. Male mind and male way of thinking is more appropriate than female mind for computation based areas, occupations (Ogzalek, 1989).
ii. Working styles of CS may be another cause of this situation such as: CS is not for women, CS is only programming, CS is very difficult and careers in CS require long hours on the computer and consist of little human interaction. It has been argued that the stereotypical image of the IT profession (a job which involves coding, suitable for male 'nerds' with poor social skills) may not be attractive to women who traditionally prefer professions with social interaction (Papastergiou, 2008; Kerner & Vargas, 1994).

This study considers the nature of CS as a more practical area beside theoretical areas like chemistry, biology, mathematics etc. According to the first aspect discussed above, the more practical nature of CS may be more appropriate for the male students. The later topics will discuss this issue with a statistical consideration. Finally a discussion about the statistical tests applied will be delivered.

2. Methods

2.1. The aim of the comparisons

The aim of this study is to determine the correlations between the grades of male and female students' theoretical and practical assignments. We intend to search four different aspects of these correlations:

1. The comparison of male and female students' theoretical grades
2. The comparison of male and female students' practical grades
3. The comparison of theoretical and practical grades of male students
4. The comparison of theoretical and practical grades of female students

Based on these aspects we will generate and test some hypothesis if they are accurate or not.

2.2. Method

This study aims to state the different behavioral aspects of male and female computer science students in view of the diverse nature of CS assignments. In general computer science assignments are grouped in two main types: Theoretical assignments and practical assignments.

For both theoretical and practical assignments, the grades of SE2101 Database Management Systems course students are grouped into these two assignment types:

- Theoretical assignments: Midterm and final exams, quizzes, homework etc.
- Practical assignments: Coding assignments, experiments etc.

Each group has its own weighting scheme to take the average for each student and for each group. Finally we obtain two columned lists indicating the theoretical and practical overalls of male and female students for the SE2101 course.

After the pre-determination of the theoretical and practical overalls of the students some statistical operations are implemented on these data sets. Z-test statistics and some descriptive statistics are applied on the data set and pre-defined hypothesis are tested according to these statistics.

2.3. Students' profiles and used metrics

The grades evaluated in this study are the theoretical and practical overalls of the students who have taken SE2101 course as mentioned before. The students which are exceedingly dissimilar to the student profile generalized for this lesson are eliminated from the overall list. Because we believe that these dissimilar samples may influence our study in an unfavorable manner.

The resultant list contains the theoretical and practical overalls of 52 female and 112 male students. The evaluation metric used in our study is the simple z-test statistics (Sprinthall, 2003). Because of the number of sample set which is exceeding the t-test level 30, we used z-test statistics to define truth value of the hypothesis according to the confidence level 0.95.

3. Results and Findings

Before giving our hypothesis and z-test results we will briefly explain our sample set. The dataset involves 52 female and 112 male students. For both female and male student sets theoretical and practical overall grades are included. Some explanatory information for these four aspects is as follows:

Table 1. Descriptive statistics for the student dataset

Variable	Mean	Std Deviation	Std Error	Lower 95% CL	Upper 95% CL	Count
Theoretical grades of females	66,956	13,565	1,881	63,179	70,732	52
Practical grades of females	72,380	20,318	2,818	66,723	78,036	52
Theoretical grades of males	59,071	17,124	1,618	55,865	62,277	112
Practical grades of males	67,060	25,450	2,405	62,295	71,826	112

Having these descriptive statistical values, the hypotheses which are inferred from mean values can be suggested as follows:

3.1. Hypothesis I: Female students are better than male students in theoretical assignments

As shown in Table 2 the mean for the theoretical overalls of female students is nearly 67, whilst 59 for the male students. By definition we can affirm the hypothesis "Female students are better than male students in theoretical assignments" is true. We apply z-test statistics to decide if this hypothesis is true or false for a confidence level of 95%.

Table 2. Z-test results for hypothesis I

Variable	Mean	Std Dev.	Std Err	Lower 95% CL	Upper 95% CL	Count
Theoretical grades of females	66,956	13,565	1,881	63,179	70,732	52
Theoretical grades of males	59,071	17,124	1,618	55,865	62,277	112
2-tailed z-Test						
Ho. Diff	**Mean Diff.**	**SE Diff.**	**T**	**DF**	**P**	
0,000	7,885	2,481	3,178	123,355	**0,002**	

The obtained p value for the z-test is 0.002 which is a very small number in comparison to 0.05 confidence level. So we accept our hypothesis **"Female students are better than male students in theoretical assignments"**.

3.2. Hypothesis II: Female students are better than male students in practical assignments

One can also infer that female students are better than male students in practical assignments. The mean difference between female and male students is 5.320, which is similar to the previous hypothesis' mean difference (7.885). We apply z-test statistics to decide if this hypothesis is true or false for a confidence level of 95%.

Table 3. Z-test results for hypothesis II

Variable	Mean	Std Dev.	Std Err	Lower 95% CL	Upper 95% CL	Count
Practical grades of females	72,380	20,318	2,818	66,723	78,036	52
Practical grades of males	67,060	25,450	2,405	62,295	71,826	112

2-tailed z-Test

Ho. Diff	Mean Diff.	SE Diff.	T	DF	P
0,000	5,320	3,704	1,436	122,498	**0,154**

By using z-test statistics we have to **reject** our second hypothesis. Because the probabilistic p value for this hypothesis is 0.154 which is greater than 0.05 confidence level.

3.3. Hypothesis III: Female students are better in practical assignments than in theoretical assignments

By using the mean difference between the theoretical and practical overalls of female students we can introduce a new hypothesis: "Female students are better in practical assignments than in theoretical assignments". We calculate the other statistical values and we apply z-test statistics to decide if the hypothesis is true or false with a confidence level of 0.05.

Table 4. Z-test results for hypothesis III

Variable	Mean	Std Dev.	Std Err	Lower 95% CL	Upper 95% CL	Count
Theoretical grades of females	66,956	13,565	1,881	63,179	70,732	52
Practical grades of females	72,380	20,318	2,818	66,723	78,036	52

2-tailed z-Test

Ho. Diff	Mean Diff.	SE Diff.	T	DF	P
0,000	-5,424	3,388	-1,106	88,930	**0,113**

The 3rd hypothesis is also rejected because of the respected p value 0.113 which is greater than 0.02.

3.4. Hypothesis IV: Male students are better in practical assignments than in theoretical assignments

The same state as in 3rd hypothesis is applicable for the male students. The mean difference between the practical and theoretical grades of male students is almost 8. This is a very considerable value. One can affirm that the male students succeed in practical assignments more than theoretical assignments. Then we can apply a z-test to cover this hypothesis with a confidence level of 0.05.

Table 5. Z-test results for hypothesis IV

Variable	Mean	Std Dev.	Std Err	Lower 95% CL	Upper 95% CL	Count
Theoretical grades of males	59,071	17,124	1,618	55,865	62,277	112
Practical grades of males	67,060	25,450	2,405	62,295	71,826	112

2-tailed z-Test

Ho. Diff	Mean Diff.	SE Diff.	T	DF	P
0,000	-7,989	2,898	-2,756	194,408	**0,006**

As shown above in Table 5 the probabilistic P value of z-test is 0.006 which is very small considering our confidence level 0.05. So we can thoroughly accept the hypothesis: **"Male students are better in practical assignments than in theoretical assignments".**

4. Conclusion

In this study, we have investigated the effects of gender differences on theoretical and practical success of computer science students. Some statistical inferences and findings are presented above. Considering these results we can infer that:

- Female students are better than male students in theoretical assignments but on the other hand we cannot affirm the same situation for the practical assignments.
- Male students are better in practical assignments than in theoretical assignments but on the other hand we cannot affirm the same situation for the female students.

IT industry demands very practical and applicable abilities from its employees. CS education is more theoretical in earlier classes but especially in the last 2 years of CS education, the students encounter more practical and applicable assignments and courses. Looking at both inferences discussed above, the practical nature of CS education and especially IT business after this education makes the area more appropriate for male students. But on the other hand the stereotyping such as "CS is not for women, the business conditions of CS is very inconvenient for women" may affect the courage of female students to cover a distance in this area (Kerner & Vargas, 1994)(Frenkel, 2000). We believe that more research and development based CS occupations which are consequently theoretical, may encourage the women interest to the CS education.

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