HOW GENDER ISSUES CAN INFLUENCE STUDYING COMPUTER SCIENCE

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Abstract: This paper presents a gender related research conducted at Department of Mathematics and Informatics, Faculty of Science, University of Novi Sad; in order to explore the following points amongst female under-graduate students: (i) general success rate, (ii) professional confidence, interests and ambitions, (iii) level of satisfaction with the choice of studies, (iv) attitudes and beliefs towards the gender issue. The query resulted in indicative statistical data, providing basis for future work and discussion, as a contribution to narrowing of the gender gap within the field of Computer Science.

1 INTRODUCTION

Numerous researches shown a considerable lack of female students enrolled in Computer Science studies at universities worldwide. A lot of research analyzed different domains of ICT, involving different levels of education (Gunn, 2003), (Ilias, 2006), (Gharibyan, 2008), or related to new directions in education (Hughes, 2002), (Vekiri, 2008).

As stated in (Kilgore, 2006), in the USA, from 1995 to 2004, only 20% of BA degrees in CS were awarded to women, with the percentage continuously diminishing. Similar situation is in Australia (Miliszewska, 2006), or European countries: Germany (Vosseberg, 1999), Finland (Paloheimo, 2006), Holland (Prinsen, 2007), or Greece (Ilias, 2006). According to (Putnik, 2008), Serbia is also facing this global problem. The fact is that women who stay in the field discontinue their studies more often than their male colleagues – the phenomenon is known as "the shrinking pipeline": even though young girls are attracted by CS, the higher level of education, the smaller is the proportion of female students. Statistics show that only 22% of the employees in the science related fields are female, which does not match their share in the work force.

Some of the causes of this occurrence are following: (i) the intimidation with the male dominated nature of a field of CS, (ii) the absence of female role models (iii) the lack of respect towards female professionals, (iv) the lack of confidence in the abilities of female professionals, (v) social pressure not to study CS, (vi) fear of combination of work and family life in IT sector being problematic.

In addition, it has been reported that women are more attracted to applications that benefit society than in programming itself, and therefore, tend to lose interest when this aspiration is not satisfied, often because feeling restricted by somewhat abstract curriculum (Fisher, 2006).

On the other hand, historically observing, female researchers and programmers played a significant role in founding of CS. In the forties women formed a majority of the programmers. In the fifties and sixties female researchers contributed in the development of user interfaces (Ngambeki, 2006). A question poses: what have influenced a serious

Table 1: Number of female undergraduate students involved in the survey.

	1st year	2nd year	3rd year	4th year
Number of participants	36	38	24	18

Table 2: Average success rate.

June 2008 Year/Average mark	6.00-7.00	7.00-8.00	8.00-9.00	9.00-10.00	Unknown
1st year	11.11%	27.78%	33.33%	5.56%	22.22%
2nd year	-	-	68.42	31.58%	-
3rd year	-	64.29%	35.71%	-	-
4th year	-	33.33%	44.44%	22.22%	-

deepening of the gender gap over the past few decades?

Authors suggest that the key factor was the arrival of the home PCs: computers became a popular hobby for boys. This led to the situation where, the female students enter introductory CS classes with weaker programming skills and lack of computer related background. Also, according to (Paloheimo, 2006), social pressure is the obstructing factor: "The society does not actually prevent girls from accessing computers, but it has failed to introduce CS as a feasible option to them", and as a result, IT built a strong image as the men's playground.

What finally brings women to the table? The following was suggested: (i) the continuing presence of computers in a way that women can comprehend the versatility of computer use, (ii) support and encouragement by the female professionals in the field, (iii) help in understanding different career possibilities in IT, (iv) awakening of interest in math and science from the early age (Fisher, 2006).

The goal of this research was to explore gender influences on female undergraduate students at Department of Mathematics and Informatics, Faculty of Science, University of Novi Sad.

2 RELATED WORK

Beginning of the 21st century introduced a significant number of research and expert papers associated to gender politics. In (Paloheimo, 2006), authors state that "students perform far better if their comfort level is high". Students were divided into groups of female, male and mixed groups. The communication was observed, and surveyed. The study reveals that in CS classes "typical gender distribution (majority male) lowers the comfort level of all students in comparison to a case with even gender distribution", suggesting that both male and female students would benefit if more women studied CS.

In (Kilgore, 2006) no differences in abilities or ambitions between males and females are registered. Gender differences were shown in how students view the practical nature of engineering. "Men were more likely to discuss and be attracted to the hands-on possibilities: trying out ides in the real world", women were more likely to commit to "linking theory and practice: designing and creating".

In order to motivate and direct students in higher education, it is of great relevance to recognize life goals and attitudes towards profession (Ngambeki, 2006). Authors of the study analyzed personal and professional identity formation and attitudes towards learning amongst groups of female engineering and non-engineering students. Interviewers asked questions such as: "Where do you want to go in life and why? What have you learned in class that you feel really applies to your life? What impact does your field have on society? How and why did you choose your field?" They came to the conclusion that "students develop more sophisticated ideas about learning process and about their life goals as they progress through their undergraduate years, but that engineers have a clearer sense of professional identity than their non-engineering counterparts early and throughout their undergraduate careers".

Intriguing motives amongst female students for studying CS have been reported in (Gharibyan, 2008), providing completely different point of view. Author explored factors which attract women in Armenia to the field of CS. Namely, at some republics of former Soviet Union, female population is well represented in CS. Author explains that success with the following: "In Armenian culture there is no emphasis on having a job that one loves; there is a determination to have a profession that will guarantee a good living". Moreover: "Armenians consider themselves practical and reasonable, setting goals reachable within their talents, abilities and circumstances, and do not have glamorized expectations of life, therefore do not get disappointed easily and do not give up when things get difficult". As a result, CS is one of the most popular fields in Armenia.

Table 3: Expression of attitude towards curriculum.

Statement	Mean value	Standard Deviation
I am generally satisfied with my choice of studies.	4.27	0.86
I feel more comfortable with mathematical courses, rather than with CS courses.	2.87	1.59
Studies positively effected my intellectual development and interests.	4.29	0.95

Table 4: Interest in taken courses: the least preferred courses and the most preferred courses.

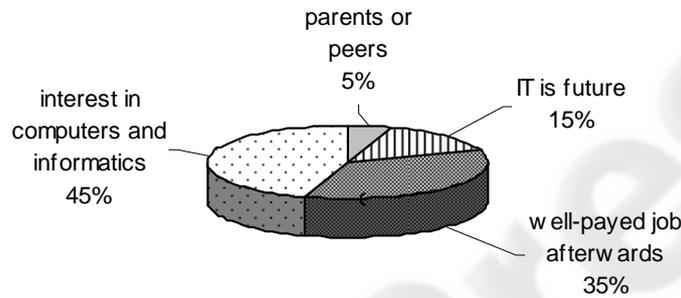|	1st year	2nd year	3rd year	4th year
The least preferred courses	Math. Logic and Algebra, Analysis, Financial Mathematics	Data Structures and Algorithms, Math. Logic, Analysis, Linear Algebra	Data Structures and Algorithms, Numerical Analysis	Differential Equations, Linear Algebra
The most preferred courses	Web design, Intro to E-business, Data Structures and Algorithms, Intro to Programming	Computer Organization, OO Programming, Data Structures and Algorithms, Web Design, Data Bases	Data Bases, Web Design, E-learning, Information systems	Data Bases, Information Systems, OO Programming

Figure 1: Results on question "What had the most influence on your choice of studies?".

Gender related study was made at our Department (Putnik, 2008), comparing success rates and enrolment data of male and female students. Its findings reveal a surprising fact: when it comes to technically-oriented courses, "there is no significant difference gender wise". When it comes to business-oriented courses, a difference in favour to women is noted. Yet, female students did show an inclination towards prejudices to some extent. Analysis of enrolment data in the same paper, reports that a constant number of females enrol into "Business Informatics" direction, while their number at "Theoretical Informatics" direction is steadily decreasing and there has not been a single female student enrolled into "Teacher of Informatics" direction in the past.

3 METHODOLOGY, SURVEY, COLLECTION OF DATA

The research presented here was conducted in June 2008, involving 116 female students of undergraduate studies of Computer Science at our Department (Table 1). The data was collected in the form of questionnaire, focusing on the following topics:

- General studies success rate
- Satisfaction with the choice of studies
- Professional confidence, interests, ambitions
- Attitudes and beliefs towards the gender issue

Survey was anonymous. Participants were asked to provide basic information: year of studies and average mark, and answer descriptive questions:

- How do you imagine your job position after the completion of your studies?
- On which job position do you see yourself in 10 years from now?

Participants were then asked to name the most liked and disliked courses they had. It was followed by three questions which required brief elaboration:

- What most influenced your choice of studies?
- Is IT a suitable field for women?
- Is it possible to have both successful career and family?

Finally, nine questions were given in the form of statements and participants responded on a Likert scale of 1 (Strongly Disagree) to 5 (Strongly Agree),

Table 5: Expression of personal ambitions regarding career.

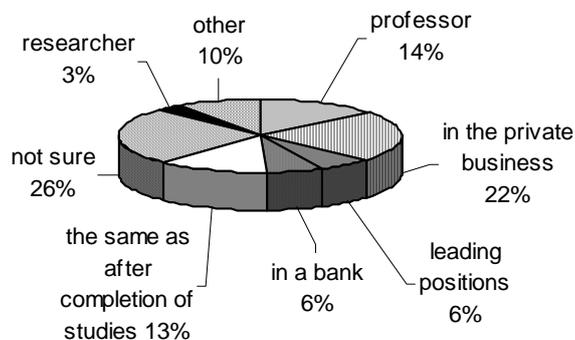| Statement	Mean value	Standard Deviation
Marks during studies are important to me.	3.66	1.05
I believe I am about to have a successful career.	4.31	0.78
I am worried about further course of my career after I complete my studies.	2.44	1.26

Figure 2: Results on question "On which job position do you see yourself 10 years from now?".

Table 6: Personal ambitions after completion of studies.

Typical answers	1st year	2nd year	3rd year	4th year
Working in education	4	12	-	-
Working in private business	2	4	2	2
Programmer, code writing	8	-	4	2
Working in a bank	4	2	10	4
Related to Data Bases	-	4	6	4
Related to Web programming	2	4	-	2
Manager	-	2	2	-
Researcher	-	2	-	2
Going abroad	-	4	-	-
Related to SE	-	-	-	2
Unknown	16	14	6	2

covering three key points of the research: expression of personal ambitions regarding career; attitude towards curriculum, and towards gender issue.

4 RESULTS AND DISCUSSION

This Section summarizes the results gathered by the survey:

4.1 General Success Rate

General success rate is given in Table 2. Grading system for higher education in Serbia is in a form of scale from 5 (failed) to 10 (outstanding excellence). Bologna education system, introduced in 2006, resulted in significantly higher passing rate and average success rate.

Notice that the 22.2% in the category Unknown for the 1st year students is due to the fact that research was conducted in June, before their first exam period. Those who provided data referred to the outcome of the winter semester.

4.2 Satisfaction with the Choice of Studies

Students responded on a Likert scale of 1 (Strongly Disagree) to 5 (Strongly Agree), to the statements presented in Table 3. We tried to determine the comfort level in studying and review effects of the studies on their intellectual development, and therefore our influence as an education institution. Results report it to be highly positive. Students have also shown satisfaction with the choice of studies. Answers on both of statements are with low standard deviation – even more encouraging.

Table 7: Expression of attitude towards the gender issue.

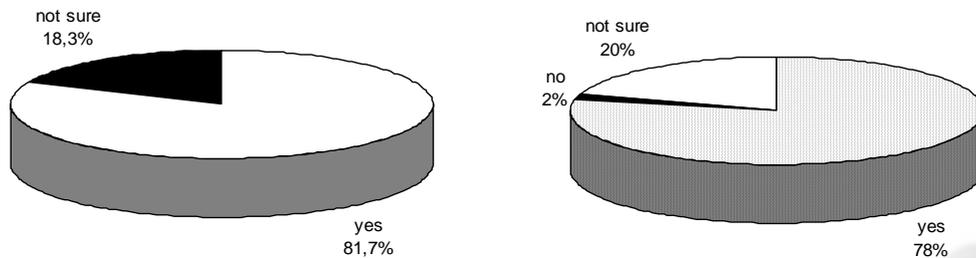| Statement	Mean value	Standard Deviation
Professionally, I feel completely equal to my male colleagues.	4.37	0.91
Concern regarding the lack of women in IT is justified.	2.62	1.33
Stereotypes regarding women in IT do not manifest in real life.	4.04	1.21

Figure 3: Results on question "Is it possible to combine IT career and family life?" and "Is IT a suitable field for women?".

Authors in (Fisher, 2006) suggested that girls are more inclined to mathematical than informatics related subjects. Obtained results indicate differently, but not strongly convincing – mean value is just about the middle (2.87), with high standard deviation (1.59). To support these claims, Table 4 illustrates expressed interest in taken courses, where mathematical courses often take place in the list of less popular. It can also be noticed that some of the courses go from category of "the most preferred" to the category "the least preferred" courses, as students advance through study years, as in case of "Data Structures and Algorithms".

Data about the motives for their choice of studies are given in Fig. 1. Compared to results of the study in Armenia, we can notice that well-paid job as a motive is as influential as in this former Soviet Union republic. We also detect lower significance paid to parents` or peers` influence.

In order to explore these ambitions in more detail, participants were asked to describe on which job position they see themselves after completion of studies (Table 6), and then, in comparison, where do they imagine themselves 10 years from now.

4.3 Professional Confidence, Interests and Ambitions

Insight into students` point of view regarding their professional future is given in Table 5. Marks seem to be lower priority than expected, consulting high general success rate. They also seem to be very confident in the realization of their career objectives and professional security and integrity.

Most popular options seem to be job in a bank and working with data bases. It seems that, as a consequence of rather conservative, male-oriented society in Serbia, only few participants in their answers mentioned terms such as "taking over leading positions", "multidisciplinary approach", "possibility of further education and professional growth". We also report very low interest in research. Reason for such attitudes could be a focus of some future work at our Department. Another interesting point is that surprising number of the participants in this research expressed a wish to work as a teacher, while none of them is enrolled in "Professor of Informatics" direction.

Teachers' positions, especially in elementary and secondary schools, are rather low-paid but on the other hand very secure and somehow protected in Serbia, as in most other countries. Also, it can be noticed that almost none of the girls in senior years used term "programmer" when describing their future goals. Also, term "software engineering" is only once mentioned. Group of answers classified in "Unknown" includes such as "it is too early to think that far". It is comforting that the share of such responses is decreasing with the year of studies.

How our students see themselves 10 years from now shows Fig. 2. Rather low number of students 12.7% gave answer "the same as after the completion of studies", supporting claim stated in (Gharibyan, 2008): by business owners, women are seen as more loyal, dedicated and less ambitious.

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4.4 Attitudes towards the Gender Issue

Figure 3 shows that 81,7% of the participants believe that it is possible to combine IT career and family life, not a single one responding negatively. This is a little bit in contrary to previously obtained answers and non-ambitious for further advancement in professional life and continuation of education. When asked "Is IT a suitable field for women?", almost none gave negative answer (Fig. 4).

More surprising data comes from Table 7, where girls tend to diminish the presence of the gender issue, although the statistics very argumentative indicate opposite (Putnik, 2008). These numbers reveal remarkably high level of confidence, comfort and gender self-awareness related to professional skills amongst the participants.

5 CONCLUSIONS

This paper presented results that reflect the gender climate at the Department of Mathematics and Informatics, at Faculty of Science, University of Novi Sad, with the focus on (i) the comfort level, (ii) the confidence level, (iii) the success level; amongst undergraduate female students of all CS directions.

The research revealed that female CS students show surprisingly high level of gender self-awareness and confidence. Participants expressed serious and ambitious attitudes regarding their career objectives, feeling professionally equal to their male colleagues, with their marks to prove those claims. The comfort level considering their studies and future professional growth is also on a satisfactory level, even though the number of female students is dropping each year, those who manage to complete their studies, prove to be as competitive and skilful as their male colleagues.

This could partially be explained by the fact that technical skills are gender-blind, and as a consequence, CS as such "bears more promises for equity between genders in opportunities, positions and finally salary, than the other fields" (Putnik, 2008).

To conclude, our findings show that it is necessary to make an effort to improve education politics and attract more female students both at undergraduate level, and postgraduate level.

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