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2	Journal Name	Education and Information Technologies	
3	Corresponding Author	Family Name	**Kordaki**
4		Particle	
5		Given Name	**Maria**
6		Suffix	
7		Organization	University of Patras
8		Division	Department of Computer Engineering and Informatics
9		Address	Rion Patras 26500, Greece
10		e-mail	kordaki@cti.gr
11	Author	Family Name	**Tsagala**
12		Particle	
13		Given Name	**Evrikleia**
14		Suffix	
15		Organization	University of Patras
16		Division	Department of Computer Engineering and Informatics
17		Address	Rion Patras 26500, Greece
18		e-mail	
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Critical factors influencing secondary school pupil's decisions to study computing in tertiary education: Gender differences

Evrikleia Tsagala · Maria Kordaki

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Abstract This paper aims to determine the factors affecting the decisions of both male and female secondary school pupils whether or not to pursue undergraduate studies in Computing. It is based on research conducted in Greece, on a sample of 248 pupils, 135 of whom were female. All were aged 17 and about to decide on their future undergraduate studies. Questionnaires were used, addressing issues in the following four main categories: a) the reasons pupils chose/rejected Computing, b) how family and friends, the media and the school environment contribute to their decision, c) how pupils perceived their future after studying Computing and d) how pupils perceived the profile of a computer professional in terms of gender.

Keywords Computing · Gender differences · Secondary education · Undergraduate studies

1 Introduction

Computing is one of the most important and rapidly developing fields in Science. While the scale of the impact of Computer Technology on human activities, not to mention almost every other aspect of human life, is difficult to determine, it is undoubtedly constantly growing as more and more products are launched. Moreover, given the fact that modern living has made the use of computers an indispensable aspect of working and studying, it is now essential to examine whether computer technology is democratically shared by everyone who needs to use it.

Nowadays, not only are more men than women actively involved with computers but many believe that it is more natural for men than women to study Computing (Gürer & Camp, 2002; Klawe & Leveson, 1995). Indeed, women are underrepresented in all fields of Computing: undergraduate and graduate studies (Wardle & Burton, 2002), the Computing Industry (Duplantis, MacGregor, Klawe, & Ng, 2002) and the Computing Academic Sector (Camp, 1997; Moskal, 2002), a phenomenon that clearly needs to be addressed.

E. Tsagala · M. Kordaki (✉)
Department of Computer Engineering and Informatics, University of Patras, 26500 Rion Patras, Greece
e-mail: kordaki@cti.gr

In actual fact, active involvement by women in the world of computers dates from the early nineteenth century, where a greater number of women than men were involved with these machines because of their experience in typing and telephony (Lee, 2002). In addition, many remarkable women have made their mark in the history of Computing through their great achievements. Despite this, female Computer Scientists have been-and sometimes still are-treated as inferior scientists when they cooperate with their male counterparts, not to mention the fact that many people believe that men are more capable of using a computer than women (Gürer, 1995).

Although there are various factors, which are difficult to determine, contributing to the low participation of women in the Computing sector, many studies have been conducted with very illuminating results (Chen, 1986; Fisher & Margolis, 2002; Jepson & Perl, 2002; Woodfield, 2000). The main reason women are not actively involved with computers can be traced back to their early years: the male orientation of computer games (Duplantis et al., 2002; Goritz & Medina, 2000; Huff & Cooper, 1987; Kiesler, Sproull, & Eccles, 1985). Boys, more than girls, find computer games a very attractive source of fun, as the content is representative of their culture: guns, war, fights, aggressive scenes, male figures, vivid sounds and graphics (Pearl et al., 1990). Consequently, girls who do not enjoy this kind of entertainment fail to gain computer experience in their childhood and grow up in the belief that computers are "a boys' thing" (Balcita, Carver, & Soffa, 2002). On the whole, many researchers claim that the fact that, during their childhood and at school, females do not gain as much experience with computers as boys do is an important factor in discouraging them to decide on taking a Computing major (Pearl et al., 1990; Teague, 2000).

Diminished female self-confidence in using computers is another essential reason that causes low female participation in Computing (Gürer & Camp, 2002). The most harmful factors causing this low self-confidence are: a) discrimination, both within the classroom—Computing teachers rarely interact with female pupils (Lazowska, 2002)—and within the family, for example by placing the family P.C. in the boy's room (Balcita et al., 2002) as well as within the working environment (Pearl et al., 1990; Teague, 2000): b) lack of encouragement at school and at home in using computers or even studying Computing (Countryman, Feldman, Kekelis, & Spertus, 2002; Schofield, 1995): c) limited access to computers or computer games both in schools, as boys tend to dominate in computer laboratories, and video arcades (Kiesler et al., 1985; Jepson & Perl, 2002): d) the hostile and uncomfortable atmosphere created by boys when they participate in Computing activities (Gürer & Camp, 2002). Possessing self-confidence in the use of computers is essential when pupils are about to decide on whether or not to study on an undergraduate computer course (Gürer & Camp, 2002).

The media also contribute to the formation of a Computing stereotype: a greater number of men than women are presented using computers, usually appearing myopically focused on their P.C. and lacking in other social interests (Duplantis et al., 2002; Fisher & Margolis, 2002; Lazowska, 2002). More than this, a negative impression is promulgated through the media concerning the demands of a job in the Computing Industry, work isolation and the long and stressful working hours (Duplantis et al., 2002; Lazowska, 2002). These are characteristics that women do not appreciate when choosing studies or a career.

In addition, the lack of successful women as mentors and role models in the field of Computing, all levels of education, the Computing Industry and society in general, has a negative psychological effect on some women during the course of their studies, often leading them to drop out (Balcita et al., 2002; Lazowska, 2002; Pearl et al., 1990).

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As far as the Computing working environment is concerned, it has also been observed that women have different potential expectations of what a job in Computing entails (Clarke & Teague, 1996; Jepson & Perl, 2002). Additionally, their priorities are quite different from those of men, who are not so greatly concerned about creating a family as they are about their career and professional progress (Johnson & Miller, 2002; Pearl et al., 1990; Teague, 2000). Moreover, the male-dominated world of Academia (at least in terms of Computing Departments) appears to be blocking women from continuing their studies at a doctoral or even postgraduate level (Gürer & Camp, 2002).

Bearing the above in mind, it is clearly important to determine the factors and the arguments that influence the decisions of pupils of both genders whether or not to major in Computing. Despite the fact that many researchers have focused on the specific reasons that cause low female participation in Computing, surveys on the gender differences in career choices of secondary school pupils in terms of Computing have not yet been reported.

The aim of this article is to investigate: a) the factors and the main arguments affecting the decisions of both male and female pupils to take/reject Computing as an undergraduate study major: b) the dissimilar impact of crucial factors (e.g., family, school environment, friends and media) on these decisions: c) pupil perceptions of a Computing professional.

The article is organised as follows: Section 2 presents details about the manner in which the research was conducted, referring to the study sample and the methodology followed. Section 3 gives a full description of the research findings, illustrated with pertinent diagrams, and Section 4 categorizes the responses along with our interpretations. Finally, overall conclusions are summarized in Section 5.

2 The context of the study

The focus of the survey was to investigate through eight (8) suitably chosen questions both female and male conceptions of the following issues:

- Whether or not to chose Computing as a subject for undergraduate study and the reasons behind such a decision
- The role played by family, school, friends and media in the pupils' decisions
- Pupil perceptions of their future after studying Computing
- Pupil perceptions of the profile of a Computing Professional.

These issues became the focus of this study as they are considered essential in the literature. The study was conducted, during February 2005, in three typical provincial secondary schools located in Patras, Greece. A pilot study (Tsagala & Kordaki, 2005) was carried out previously to test the appropriateness of the questions used. Questionnaires were given to a sample consisting of 248 pupils—135 females, 113 males—all aged 17.[1] At this age, all Greek pupils have to make a crucial choice regarding their undergraduate studies; specifically, this involves selecting which Science is interesting for them to study. From a methodological point of view, this study was based on phenomenography (Marton, 1988), where the aim is to describe people's descriptions—in terms of their perceptions—of

[1] In Greece, all high school pupils take examinations in order to enter University. Depending on their grades, they enter one of the schools for which they have previously registered. In terms of entry requirements, computing departments are among the most competitive and demanding in Greece.

various aspects of reality. Consequently, both verbal and written descriptions of these aspects are investigated. Adopting this methodology, the pupil responses rather than their thinking become the focus of study. Pupil responses were carefully classified in order to depict their perceptions as accurately as possible. In fact, all responses to each question were classified according to the topics emerging from them. The results are presented in the form of a comparison between female and male opinions.

3 Results

Each of the questions included in the questionnaire is presented below, along with the results of the survey and our interpretations of them.

First question "*Do you intend to study Computing?*" This question aimed to determine the percentage of male and female pupils who wished to study Computing. Table 1 gives the number (column 3) and percentages of both males and females who answered in the affirmative (columns 4, 5, 6), together with the Total number of male and female pupils participating in this study (column 2).

These data show that about one-in-three pupils intend to study Computing (29.8%), of which. 16% denotes males and 13.8% females. Moreover, about one-in-three males (35%) will choose a Computing career compared with one-in-four females (25.19%).

Second question "*What are the reasons for your choice?*" This question attempts to reveal the motives behind males and females choosing whether or not to study Computing. Table 2 presents the reasons for not choosing to study Computing while Table 3 depicts the reasons for choosing to study Computing, together with a comparison of the answers according to gender. The number of females and males who expressed each reason and the respective percentages are also presented in both Tables.

From the above, it can be said that the most important factors discouraging both males and females from choosing Computing as a major are a lack of interest in the subject, Computing profession characteristics and difficulty in gaining a place in Computing Departments. A respectable percentage of the males claimed that their limited experience in operating computers as well as Computing profession characteristics such as unemployment, low financial benefits and low authority, were deterrent factors. As for females, only a small percentage stated the aforementioned reasons, adding that some characteristics of the Computing profession—such as long and demanding working hours, working before a computer screen and specialization—also affected their choice.

A large percentage of male and female pupils choose to study Computing because they find it an interesting subject and consider certain characteristics of the Computing profession attractive. Significant reasons for males are the financial gain and the prestige to

Table 1 Pupils willing/not willing to study computing

	Number (N)	Number of pupils who prefer studies in Computing (N1)	Percentage (N1/248) %	Percentage (N1/N) %	Percentage (N1/74) %
Pupils	248	74	29.8	–	–
Males	113	40	16	35.40	54.05
Females	135	34	13.8	25.19	45.95

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Table 2 Reasons why boys and females will not chose to study computing

REASONS NOT TO STUDY COMPUTING		MALES		FEMALES	
		ANSWERS			
		Number (N1)	Percentage (N1/73) %	Number (N2)	Percentage (N2/101) %
Interest in computing	Limited interest	56	55.44	92	91.0
Computing profession characteristics	Quantitative characteristics: Unemployment–Saturation–No financial benefits–Low authority	23	31.5	10	9.9
	Qualitative characteristics: Too many working hours, Work in isolation, Competitive work environment	4	5.5	15	14.85
Difficulty in entering a Computing School[2]	Low performance in Math, too many points needed to enter a computing school, hard work, money and time are needed for studies and career in computing	18	24.6	22	21.8
Previous experience	Limited access/experience in using computers	17	23.3	6	5.9

Q1

be had from working in a Computing profession. Females are far more interested in gaining job security, whereas a much higher percentage of males assume that their experience in using computers is an essential reason to study Computing. Females are persuaded to study Computing to a greater extent by the fact that computers are a significant technology than by their personal experience in using computers.

Third question "*Did your parents urge you to choose a Computer Science-based profession?*" This question aimed to expose the influence of the family on decisions to take Computing as a major, according to gender.

Table 3 Reasons why boys and females will chose to study computing

REASONS TO STUDY COMPUTING		MALES		FEMALES	
		ANSWERS			
		Number (N1)	Percentage (N1/40)%	Number (N2)	Percentage (N2/34)%
Interest in computing	Increased interest	28	70	20	58.8
Computing profession characteristics	Quantitative characteristics: employment opportunities, financial gain, profession with prospects, prestigious profession, job security	40	100	28	82.35
	Qualitative characteristics: importance of technology	0	0	12	35.3
Previous experience	Experience in using computers	19	47.5	3	8.8

Table 4 shows (through statements) the manner in which the family is considered to influence male pupils (B) and female pupils (G) who choose/decide not to study Computing and the number and percentage of pupils who expressed each statement. Table 4 also presents the total positive, negative and zero influences of family on both males and females who choose/do not choose to study Computing.

From the data above, it seems that the majority of pupils (higher than 47%) seemed not to be explicitly affected by their families in their higher education choices. These data also show that families explicitly affect the decisions of both females and males in equal measure. Families also seemed to use both positive and negative arguments on their children regarding the Computing profession; however, the percentage of explicit negative family influence on both pupils who choose and do not choose to study Computing is low (5–12.5%), making it difficult to generalize. The arguments used are: unemployment and saturation in the field, the unsuitability of females for computers and Computing not being interesting. Families also appear to be more worried about financial security for sons than for daughters.

However, a considerable percentage of pupils who choose to study Computing (about half the females and a third of the males) expressed a positive family influence. The ways that family positively affected those pupils' decisions were: a) communication within the family regarding the importance of technology as well as the positive characteristics of a Computer Science (CS)-based profession in terms of job security, prospects and financial gain, b) the infrastructure provided and c) living examples of family members. More specifically, the family gives the impression of exercising greater influence on sons than on

Table 4 Family influence on pupil choices regarding studies in computing

THE INFLUENCE OF THE FAMILY ON PUPIL DECISIONS TO STUDY COMPUTING								
INFLUENCING STATEMENTS	PUPILS WHO DO NOT CHOOSE				PUPILS WHO CHOOSE			
	Number		Percentage (%)		Number		Percentage (%)	
	M (N1)	F (N2)	M (N1/73)	F (N2/101)	M (C1)	F (C2)	M (C1/40)	F (C2/34)
Job security–Profession with prospects–Financial gain	11	12	15.07	11.88	4	6	10	17.65
Providing infrastructure (PC, courses etc)	2	1	2.74	0.99	4	2	10	5.88
Importance of technology	1	3	1.37	2.97	0	3	0	8.88
Members of family using computers	0	1	0	0.99	5	5	12.5	14.71
TOTAL POSITIVE INFLUENCE	14	17	19.2	16.8	13	16	32.5	47.2
Unemployment–Saturation	3	0	4.11	0	1	0	2.5	0
Females not suitable for Computing	0	2	0	1.98	0	1	0	2.9
Family dislike computers	0	2	0	1.98	3	0	7.5	0
Suggesting other studies	3	1	4.11	0.99	1	1	2.5	2.9
TOTAL NEGATIVE INFLUENCE	6	5	8.2	5	5	2	12.5	5.8
Feel free to decide	51	77	69.86	76.24	21	16	52.5	47
Family not well-informed about computing	2	2	2.74	1.98	1	0	2.5	0
NO INFLUENCE	53	79	72.6	78.2	22	16	55	47
TOTAL	73	101	100	100	40	34	100	100

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daughters to choose a CS-based profession, because of the employment opportunities the CS field presents for them. Moreover, parents appear to provide their sons, more than their daughters, with computers and related activities (courses). Females also appear to be more influenced than males by parental advice in terms of viewing computers as a technology of importance as well as by other family members using computers effectively or studying Computing. Finally, regarding the negative influence of family on pupils who choose/do not choose to study Computing, it seemed that females are less negatively influenced than boys.

Fourth question "*Did school give you motives to follow a CS-based profession?*" This question was put to investigate the way schools contributed to their pupils choosing or not choosing to study Computing. The following table (Table 5) presents the motives and anti-motives schools provided for their pupils. Table 5 shows the manner in which the school is considered by male and female pupils (through statements) to influence their choice of whether or not to take studies in Computing and the number and percentage of pupils who expressed each statement.

As is shown in Table 5, the majority of pupils (at least 61.7%) expressed the opinion that they were not explicitly affected by their schools in choosing or rejecting Computing as their higher education level major. Based on pupils' statements, it seems that there is a balance between the motives and anti-motives that school provides. It can be seen that essential motives/anti-motives provided by schools and affecting pupil choice regarding Computing studies are the adequate/inadequate infrastructure provided and the inspirational/non-inspirational role of secondary level education Computer Studies teachers. Of those pupils who chose to study Computing, the percentage of females (32.4%) who expressed a positive school influence is about 50% greater than the corresponding percentage of boys

Table 5 Motives and anti-motives school provides for male and female pupils to study computing

THE INFLUENCE OF SCHOOL ON PUPIL DECISIONS TO STUDY COMPUTING									
INFLUENCING STATEMENTS MOTIVES:	PUPILS WHO DO NOT CHOOSE				PUPILS WHO CHOOSE				
	Number		Percentage (%)		Number		Percentage (%)		
	M (N1)	F (N2)	M (N1/73)	F (N2/101)	M (C1)	F (C2)	M (C1/40)	F (C2/34)	
Infrastructure–Relative courses	11	14	15	13.86	7	9	17.5	26.47	
Teachers' recommendations–Inspiring teachers	1	1	1.4	0.99	2	2	5	5.88	
Providing information–discussion	2	1	2.7	0.99	0	0	0	0	
TOTAL POSITIVE INFLUENCE	14	17	19.1	15.8	9	11	22.5	32.4	
ANTI-MOTIVES:									
Insufficient information about computing	3	4	4.1	3.96	0	1	0	2.94	
Uninspiring teachers	2	0	2.7	0	1	0	2.5	0	
Boring experience in computing courses–Boring teachers	7	12	9.6	11.88	3	1	7.5	2.94	
Limited access and infrastructure	0	6	0	5.94	0	0	0	0	
TOTAL NEGATIVE INFLUENCE	12	22	16.4	21.8	4	2	10	5.9	
NO INFLUENCE	47	63	64.5	62.4	27	21	67.5	61.7	
TOTAL	73	101	100	100	40	34	100	100	

(22.5%). A low percentage of these pupils (under 10%) expressed a negative influence: boring teachers and inadequate infrastructure. This influence is greater (between 16 and 21.8%) for those pupils who do not wish to study Computing. Finally, it is worth mentioning that the positive influence of the school environment on decisions to study Computing is limited, falling between 15.8 and 32.4%.

Fifth question "*Did your friends influence you in choosing a CS-based profession*?" This question attempts to evaluate peer pressure as a factor in choosing whether or not to take studies in Computing. Table 6 presents the statements male and female pupils made and the number and percentage of pupils who made each statement.

From this table, it can be seen that pupils can be influenced by their friends' interest/non interest in Computing as well as by their opinions on CS-based job characteristics. More specifically, from these data one can assume that males are far more positively influenced by their friends than females are. The positive influence of friends is greater for both females and males who choose to study Computing than for those who do not choose such studies. The interest/non interest of friends in Computing seemed to affect males more than females. Pupils of both genders are positively affected by their friends through discussions about the job security that a CS-based profession provides as well as about the important role of technology in social, financial and everyday life. The negative influence of friends was expressed through their low interest in Computing and through discussions regarding CS-based job characteristics such as hard work, unemployment and saturation. Despite the above, the majority of pupils (at least 60%) seemed not to be explicitly affected by their friends on their choice of whether or not to follow a CS-based profession.

Sixth question "*In what ways did the Media affect your choice of a CS-based profession?*" The aim of this query was to examine the influence of the Media on male and female

Table 6 Influence of friends regarding computing studies

THE INFLUENCE OF FRIENDS ON PUPIL DECISIONS TO STUDY COMPUTING								
INFLUENCING STATEMENTS	PUPILS WHO DO NOT CHOOSE				PUPILS WHO CHOOSE			
	Number		Percentage (%)		Number		Percentage (%)	
	M (N1)	F (N2)	M (N1/73)	F (N2/101)	M (C1)	F (C2)	M (C1/40)	F (C2/34)
High interest of friends in computing	7	1	9.59	0.99	10	0	25.00	14.71
Job security	4	0	5.48	0	1	2	2.50	5.88
Importance of technology	1	0	1.37	0	4	0	10	0
TOTAL POSITIVE INFLUENCE	12	1	16.44	0.99	15	2	37.50	20.59
Low interest of friends in computing	2	4	2.74	3.96	1	0	2.50	0
Unemployment–Saturation	2	1	2.74	0.99	0	2	0	5.88
Hard work, money and time are needed for studies and career in computing	1	0	1.37	0	0	0	0	0
TOTAL NEGATIVE INFLUENCE	5	5	6.85	4.95	1	2	2.50	5.88
NO INFLUENCE	56	96	76.71	94.06	24	25	60.00	73.53
TOTAL	73	101	100	100	40	34	100	100

decisions to *choose a CS-based profession*. The Table below (Table 7) presents pupil responses (through statements) and the corresponding number and percentage of pupils who made each statement.

Table 7 indicates a positive Media influence, expressed through positive advertising promoting both the importance of computer technology in social, financial and everyday life and the potential jobs classified as a CS-based profession. However, insufficient information presented in the Media about Computing and job limitations such as demanding work, saturation and unemployment seemed to have a negative effect on pupils' choices. In the case of those pupils who choose to study Computing, we can presume that more females than males are positively influenced by the Media. In particular, more females than males are influenced by media advertising, and females also pay attention to the information about jobs the Computing Industry media provide. However, from the above data, one can see that the majority of pupils (at least 52.94%) seemed not to be aware of the role of the Media in their decisions whether or not to go for a CS-based career.

Seventh question "*How do you imagine your future after studying Computing?*" This question intended to identify how male and female pupils perceived their future, were they to study Computing. Table 8 shows the results.

As Table 8 shows, those pupils who choose studies in Computing emphasize the positive characteristics of the CS-based profession, such as great career opportunities, financial gain, job security, employment prospects, creative work, competitive work in industry and the security provided by the Public sector. Among those pupils who choose studies in Computing, it can be seen that more males than females imagine a great career in the Computing Industry, with employment prospects and financial gain, whereas females choose (Public Sector) job security over financial gain. Additionally, males find Computing

Table 7 Media influence on taking computing studies

THE INFLUENCE OF THE MEDIA ON PUPIL DECISIONS TO STUDY COMPUTING								
INFLUENCING STATEMENTS	PUPILS WHO DO NOT CHOOSE				PUPILS WHO CHOOSE			
	Number		Percentage (%)		Number		Percentage (%)	
	M (N1)	F (N2)	M (N1/73)	F (N2/101)	M (C1)	F (C2)	M (C1/40)	F (C2/34)
Advertising/promotion of computer technology	10	14	13.70	13.86	13	15	32.50	44.12
Information about jobs in computing	4	1	5.48	0.99	1	1	2.50	2.94
TOTAL POSITIVE INFLUENCE	14	15	19.18	14.85	14	16	35.00	47.06
Insufficient information about computing–Other job promotion	10	13	13.70	12.87	0	1	0	2.94
Unemployment–Saturation	2	0	2.74	0	0	0	0	0
Hard job	1	0	1.37	0	0	0	0	0
TOTAL NEGATIVE INFLUENCE	13	13	17.81	12.87	0	1	0	2.94
NO INFLUENCE	46	73	63.01	72.28	26	17	65.00	50.00
TOTAL	73	101	100	100	40	34	100	100

Table 8 The profile of a computing professional as seen by pupils

THE PROFILE OF A COMPUTING PROFESSIONAL: AS SEEN BY PUPILS				
STATEMENTS	Number		Percentage(%)	
PUPILS WHO CHOOSE COMPUTING STUDIES	M (C1)	F (C2)	M (C1/40)	F(C2/34)
Great career in computing	9	7	22.5	20.6
Financial gain	8	4	20	11.8
Job security	3	5	7.5	14.7
Computing diversity: employment prospects	5	3	12.5	8.8
Good future/creative	5	4	12.5	11.8
Prestige	1	0	2.5	0
Working in the industry	8	3	20	8.8
Public sector employment	1	8	2.5	23.5
TOTAL	40	34	100	100
PUPILS WHO DO NOT CHOOSE COMPUTING STUDIES	M (N1)	F (N2)	M (N1/73)	F (N2/101)
Computing diversity: Employment difficulties	2	5	2.7	4.9
Insecure–Unemployment	13	4	17.8	4
Behind a screen–Computer Addict	3	10	4.1	9.9
No financial gain	2		2.7	
Boring	5	8	6.9	7.9
Won't choose–Don't know	48	74	65.8	73.3
TOTAL	73	101	100	100

diversity an attractive challenge, whereas the same characteristic makes females regard it as being a demanding profession.

On the other hand, pupils who do not choose studies in Computing emphasize the negative characteristics of the CS-based profession, including employment difficulties, unemployment and no financial gain as well as its being isolated and boring work behind a computer. It is worth mentioning that, of these pupils, males stress the negative quantitative characteristics of the CS-based profession while females emphasize its negative qualitative work conditions.

Eighth question "*Do you believe that a Computer Science-based profession suits both men and women equally?*" This question aimed at revealing pupil perceptions of the gender

Table 9 Is the computing profession suitable for individuals of both genders?

IS COMPUTING PROFESSION SUITABLE FOR INDIVIDUALS OF BOTH GENDERS?				
	MALES		FEMALES	
ANSWERED	Number (NI)	Percentage (N1/113%)	Number	Percentage (N2/135%)
YES	68	60.18	115	85.2
ONLY FOR MEN	36	31.86	0	0.00
ONLY FOR WOMEN	0	0.00	11	8.14
NOT ANSWERED	9	7.96	9	6.66
TOTAL	113	100	135	100

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most suited to the profile of a Computer professional. Table 9 depicts the answers of both males and females.

Almost half of the males who answered this question (68 out of 113) and most of the females (115 out of 134) believe that a profession related to CS suits both men and women. A respectable percentage of males (31.86%) believe that men are better suited to this kind of profession, while correspondingly few female pupils (8.14%) believe that women are better suited.

4 Discussion

The relationship between gender differentiation and the decisions that female and male pupils in secondary level education make when choosing whether or not to take Computing as a profession is the core of this study. In the following section, essential issues arising from data analysis exploring the decisions these pupils make are presented and discussed. These issues are: 1) gender differentiation and the choice of Computing as a profession, 2) the role of the social environment in pupils' decision making: family, school, friends and the Media, 3) pupil perceptions of their futures after studying Computing and 4) pupil perception of the gender that best fits the profile of a computer professional.

1) *Gender differentiation and the choice of Computing as a profession*. Of the total sample participating in this study, one-in-three pupils had made a decision to become candidates for undergraduate Computing programmes, the percentage of males being 10% greater than that of females. The most important factors that *positively affect* the decisions of both sexes are: a) increased interest in Computing as a subject of study and b) employment opportunities in the CS-based profession. In addition, previous experience with computers positively affects male decisions while the challenge of Computing as a technology of importance has a great influence on female decisions. 50% more females than males focus on job security while 38.7% more boys than females focus on their experience with computers.

The most important factors that *negatively affect* pupil choices are: a) reduced interest in Computing as a subject of study, b) limited access/experience in using computers and c) difficulties in gaining an undergraduate place in a Computing department. About 9.35% more females than males are *negatively* influenced, mainly because they view Computing as being an uninteresting subject of study in which to major, due to its qualitative characteristics (too many working hours, work in isolation and competitive environment). On the other hand, about 21.6% more males than females are negatively influenced by the unemployment opportunities and saturation of this profession

2) *The role of social environment on pupils' decisions: family, school, friends and media.* Pupils seemed to be unaware of the role played by their social environment on their decisions, the majority of them inexplicitly expressing the influence on their career choices by their family, school, friends and the Media.. However, we can draw on pupils' explicit statements to create a picture of the role of the surrounding social context in their choosing whether or not to study Computing.

Family seems to have a greater effect on females and males who choose studies in Computing than on those who do not. More specifically, about half the pupils who choose to study Computing expressed a positive family influence. In contrast, a limited percentage (maximum 19.2%) of those pupils who do not choose to study these sciences expressed a

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positive family influence. The ways that parents can positively/negatively affect their children's decisions are: a) communication within the family, b) the infrastructure provided/not provided and c) living examples/no examples of family members. Parents seemed to encourage/discourage their children from choosing Computing as a major by linking these values to CS-based jobs. More specifically, family values in terms of job security/unemployment and saturation, financial gain and needful work seemed to influence pupils' decisions. Here, it is worth mentioning that a small number of parents discourage their daughters from choosing Computing as a major by labeling it 'not suitable for females'. In addition, the provision of an appropriate infrastructure seems to play a significant role on the decisions of male pupils, as parents appear to provide their sons with computers and related activities to a greater extent than they do their daughters (twice as many males as females). Finally, living examples of family members who use computers effectively or study/have studied Computing seemed to have a positive effect on females more than males.

The context of *school* seemed to provide motives for and against taking up Computing as a profession. The most essential motives for and against expressed by pupils were: a) the teacher as a mentor or not and b) the school's infrastructure (adequate or not). School seemed to positively affect the decisions of more females than males in choosing studies in Computing (50% more). In addition, more females (32.5%) who choose to study Computing reported a positive influence from their schools than those females (15.8%) who choose not to study this profession.

Friends also seemed to play the role of mentors by expressing: a) their high/low interest in Computing and b) the opinion that there is a strong relationship between Computing and job security/unemployment and saturation. More specifically, their high interest in Computing seemed to affect the decisions of more males than females who choose to study Computing, and vice versa. Moreover, more males than females choosing to study Computing were positively influenced by their friends. In addition, a higher percentage of females who choose to study Computing were positively influenced by their friends in comparison to the percentage of females who do not choose such studies. On the whole, friends seemed explicitly to affect males more than females.

The *Media* seemed to influence female and male pupils through: a) advertisements promoting Computer Technology and b) the information about jobs in the Computing Industry that the Media provide. Pupils who choose studies in Computing experience greater positive influence from the Media in comparison to pupils who do not. Approximately 50% more females than males who choose studies in Computing seemed to be positively influenced by the Media. The Media were seen to be playing a negative role through not providing sufficient information on Computing, promoting other jobs and demonstrating the Computing profession as being hard work with the additional disadvantages of unemployment and saturation.

It is worth noting that the impact of the social environment on the decisions of pupils presented here has been based on the analysis of their responses to the corresponding items in the questionnaire. The possibility that a considerable number of pupils may have been inexplicitly influenced by the factors addressed in the corresponding questions could mean that these pupils have little or no awareness of the factors that actually affect their decisions regarding their choice of undergraduate studies.

3) *Pupils' perceptions of their future after studying Computing.* Based on the results of this study, we can state that both male and female pupils imagine their future as Computing professionals in terms of: a great career, prestige, creativity, financial gain, job security and employment prospects. It also seems that more males than females

imagine their future after studying Computing to be in a profitable career in the Computing Industry. A considerable percentage of females expressed an interest in a CS-based career mainly to attain job security (Public Sector). Additionally, males find Computing diversity an attractive challenge, while the same characteristic leads females to regard it as a demanding profession.

4) *Pupils' perception of the gender that best fits the profile of a Computer Professional.* Almost half the male pupils and most of the females believe that a profession related to Computing suits both men and women. A respectable percentage of males (about 32%) believe that men are better suited to this kind of profession, while few females (8.14%) are of the opinion that women are better suited to this kind of work.

It is worth noting that the motivating factors for male pupils and anti-motives for females regarding Computing emerging from this study confirm the corresponding factors reported in the literature. However, the positive motivating factors in females choosing Computing as a subject of study emerging from this study, and the positive influences they reported from the surrounding social environment, expand the literature on the whole, the investigation of the kind of arguments that females used to document their positive choices about Computing as a subject of study and the kind of positive influences expressed by these females, have not yet been reported.

5 Conclusions

In this paper, the critical factors that influence pupils' decisions of whether or not to study Computing as a profession have been presented in terms of gender differentiation. The results are quite illuminating: more male pupils than females choose to study Computing. Basic motivators for males included an interest in Computing as a subject, employment opportunities, and a great career in the Industry, financial gain and experience with computers. Basic motivating factors for females were also an interest in Computing as a subject, job security and good living examples, such as charismatic teachers, successful family members in Computing and mentors projected by the Media. Males are also motivated by their former experience in using computers, and vice versa, while the challenge of Computing as a technology of importance has a significant influence on females' decisions. On the whole, males and females mainly choose/do not choose to study Computing depending on: a) the extent to which they find the subject interesting, b) the employment opportunities they see/do not see in Computing. Based on these motives, and despite the fact that the majority of males and females agreed that the profile of a Computing professional is suitable for both men and women, different perceptions of their future after studying Computing were formed. It is worth noting that both negative and positive images about computers and the Computing profession are diffused by the surrounding social environment, including the pupils' families, schools, friends and the Media. More pupils who choose studies in Computing were positively influenced by their surrounding social environment than those who do not. Of these pupils, more females than males expressed the opinion that they were positively influenced by family, school and the Media while more males than females in this category expressed being positively affected by their friends. Encouragement/discouragement from the surrounding social environment was in the form of: a) the positive/negative image of a Computing profession that was projected through verbal, written and visual communication and living examples that

played/did not play the role of mentors and b) the adequate/inadequate infrastructure provided.

Regarding the specific factors that may influence a pupil's choice to take up a Computing profession, we can state that pupils at this age have probably not reached a high enough level of self-consciousness to be able to address the factors that affect their choices explicitly.

As a final point, it is worth noting that, despite the limitations of this study, due to the fact that this was performed only in one country (Greece) and limited to three provincial schools in Patras, these results can be exploited to take appropriate future actions to decrease gender inequality in Computing.

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