

A Best Practice for Attracting Female Students to Enrol in ICT Studies

Claudia Canali¹, Tindara Addabbo¹ and Vasiliki MOUNTZI²

¹University of Modena and Reggio Emilia, Modena, Italy

²ViLabs OE, Thessaloniki, Greece

claudia.canali@unimore.it

tindara.addabbo@unimore.it

mova@vilabs.eu

Abstract: The extremely low rates of females compared to men, enrolled at Computer Sciences (CS) and Information Systems Universities result not only in a massive loss of talent for companies and economies but also perpetuate gaps in gender inequality in the ICT field. To face this, Universities and Research Organizations are gradually taking initiatives to address such gender imbalance, trying to intervene and raise the awareness on a complex set of rooted cultural/societal gender stereotypes, including gender bias and linking ICT with masculinity that are permeating early school education, STEM teaching practices and parents' attitudes. This approach is based on several studies on the current students that highlight how female bachelor students in CS have lower levels of self-confidence compared to their male counterparts which can negatively impact on their plans to continue their studies. Towards this direction, the Horizon 2020 EQUAL-IST (Gender Equality Plans for Information Sciences and Technology Research Institutions) project supports six Universities across Europe (Italy, Lithuania, Germany, Ukraine, Finland, Portugal) to design and implement actions towards gender equality, with a specific focus on the ICT/IST area. The Universities have settled up several concrete initiatives to attract female students towards ICT studies. Specifically, this paper presents the best practice implemented at the University of Modena and Reggio Emilia, (UniMORE) the Summer Camp namely *Ragazze Digitali* (Digital Girls). The summer camp offers to female students of third and fourth grade of the high schools a first-hand experience based on a learn-by-doing approach to coding applied to creative and innovative fields, as well as inspiring female role models from the academia and the industry. For its scope, nature (free for the girls to participate) and duration (four entire weeks), the Summer Camp *Ragazze Digitali* represents a unique experience not only in Italy but also in Europe and, at the best of our knowledge, in the world. The paper describes the Summer Camp experience, highlighting the impacts of this experience on the female students, with particular attention to changed attitudes and plans for their future studies and careers.

Keywords: gender segregation, ICT summer camp, gender stereotypes, learn-by-doing approach

1. Introduction

The gender gap in science, technology, engineering, and math (STEM) engagement is large and persistent. However, there are large variations in women's under-representation among STEM fields, and the gender gap is significantly larger in technological fields such as computer science and engineering than in math and science (Cheryan et al. 2017). According to Organisation for Economic Cooperation and Development (OECD, 2016) analysis on the *Programme for International Students Assessment* PISA 2015 data about 15 years old students' expectations about their future, boys are more likely than girls to see themselves as working in ICT: on average 0.4% of girls and 4.8% of boys have the expectation to become employed as ICT professionals. According to Eurostat 2018 data (Eurostat, 2018), about 1,3 million of people in Europe are enrolled in ICT courses (in different levels of education), but only 16.7% are women (13% in Italy). Moreover, a focus on tertiary education allows to see that in 2015 amongst graduates in Europe only 3.6% are graduated in ICT, and only 19% of them are women, therefore (European Commission, 2018) men graduate 5-7 times more than women in ICT on average in Europe.

The recent statistics on the proportion of women students at Bachelor, Master and PhD courses of the Department of Engineering 'Enzo Ferrari' (DIEF) confirm this gender gap, showing percentages of women much lower with respect to all the other university courses. While at the university level the percentage of women in UniMORE courses is around 55%, which is consistent with the national average (Bartoloni, 2018), the percentage at the department level drops down at around 20%. At the national level the percentage of women in courses of the scientific and technological area is about 35%, which is much higher of the percentage at DIEF. However, this can be easily explained because the national data include all STEM disciplines, while the DIEF department is strictly related to the technology and engineering part, where it is well-known that women are less represented with respect to the other STEM fields. If we further focus the analysis on the ICT courses, DIEF department presents an additional reduction in the presence of female students, as shown in Table 1 (note: the results for doctoral courses are very variable also due to the very limited numbers of students in the course).

Table 1: Students of ICT courses at DIEF Department

Proportion of women of students			
	Doctoral-ICT	Master-ICT	Bachelor-ICT
2010/11	18,18 %	6,25 %	10,64 %
2011/12	0,00 %	13,51 %	11,88 %
2012/13	8,33 %	18,92 %	15,45 %
2013/14	10,00 %	17,07 %	14,49 %
2014/15	10,00 %	8,11 %	12,50 %
2015/16	0,00 %	7,14 %	17,68 %

The observed gap should be addressed by a set of policies that include breaking gender stereotypes that appear to limit women's access to ICT by means of awareness-raising campaigns and concrete actions, as also suggested by the European Commission (European Commission, 2018). Research results actually show that on the observed gap in ICT is related to gender stereotypes about the perception of subjects of study and professions in terms of masculines or feminine: to prevent the observed segregation by gender in Tertiary education, these stereotypes must be addressed by means of earlier interventions in students life including awareness-raising campaigns and training (OECD, 2015a; Davaki, 2018). Even the later girls' exposure to computer can be associated to non-material barriers in the access to digital learning (OECD, 2015b).

The University of Modena and Reggio Emilia (UniMORE) took the initiative to boost the women enrolment at the DIEF department and developed its Gender Equality Plan (GEP), through its participation at the European funded H2020 project EQUAL-IST.

This paper provides a first analysis of an original best practice aimed at addressing the problem of women's underrepresentation in ICT in Italy: the summer camp Ragazze Digitali (Digital Girls), that is a key action of the UniMORE (GEP).

The 'Ragazze Digitali' (Digital Girls) Summer Camp is organised annually by the Department of Engineering 'Enzo Ferrari' of the University of Modena and Reggio Emilia in collaboration with the association European Women Management and Development (EWMD). The summer camp has the main goal of encouraging female students to enrol in Computer Science/Informatics programs and to attract girls towards computer science through a creative learning-by-doing approach based on team-based activities. It is dedicated to girls of third and fourth grade of the high schools and it is free for them to participate. No previous competences are required in terms of coding or ICT skills. During the summer camp, which lasts for 4 entire weeks between June and July, the girls learn how to program video-games in Python. Moreover, they are exposed to female role models represented by women expert in the ICT field who intervene as speakers on dedicated topics. The Summer Camp represents a highly innovative best practice to promote female participation in ICT studies: its long duration (4 weeks) and the fact that it dedicated to girls and free for the participants makes this initiative unique, not only in Italy but, at the best of our knowledge, in Europe and in the world. In this paper we describe the Summer Camp experience, highlighting the impacts of this experience on the participating female students, with a specific focus on their changed attitudes and plans for future studies and careers.

2. Addressing the problem of gender inequalities

The Summer Camp is a result of the advanced research methodology for participatory gender audit in ICT/IST research institutions (Canali *et al*, 2017), applied by UniMORE in the context of the EQUAL-IST project to identify the main challenges related to gender equality.

Following this methodology, UniMORE implemented the internal gender audit that took place between December 2016 and April 2017. The internal gender audit included different activities, such as a quantitative data collection of gender-disaggregated data, individual semi-structured interviews with key people and decision makers, and participatory workshops. As a result of the audit, several challenges were identified, and some solution proposed to address them. These challenges and solutions were uploaded as an initial input into the CrowdEquality online platform (Gorbacheva *et al*, 2017) to trigger a collaborative crowdsourcing process

leading to the proposal of additional solutions aimed at addressing the identified challenges, according to the bottom-up ideation approach envisaged by the EQUAL-IST project.

After having analysed and internally discussed the results of the gender audit and crowdsourcing exercise (Gorbacheva *et al.*, 2017), the UniMORE working group organized online and face-to-face meetings with the main stakeholders involved in the GEP implementation, namely the Rector of the University, the Head of the Department, the President of the CUG (Unified Committee for Guarantees, the Responsible of the Research Office, the members of the Interdepartmental Center CRID (Research Center on discriminations and vulnerability). The meetings had a twofold objective: on one hand, to discuss with the stakeholders how to translate the solution, emerged on the crowdsourcing process and formulated in general terms, into concrete actions that are feasible and effective at the same time to address the specific challenges within the UniMORE institution; on the other hand, the involvement of the stakeholders in the design phase of GEPs was aimed at engaging them to have their support in the following implementation phase.

3. From challenges to actions

According to the methodology for participatory gender audit in ICT/IST research institutions [2], the challenges identified should be categorised into particular intervention areas. One of the areas that UniMORE focused has been the Teaching and Students Services that contrasts gender segregation in ICT studies choices. More specifically, UniMORE identified that while graduate enrolments generally evidence a substantial balance or even a female predominance, girls are definitively reluctant to pursue ICT academic studies: in these courses, girls typically account for 10% to 20% of students at every level (bachelor, master, doctoral degree). The following table shows the percentage of female and male students enrolled in the Bachelor, Master and PhD ICT courses at the Department of Engineering ‘Enzo Ferrari’ during the period 2013-2015. On the other hand, the percentage of women overall enrolled in the UniMORE courses (considering all courses, not only the ICT ones) is between 51, 30% and 56, 04% for the same period, showing a prevalence of female students.

Table 2: Percentage of female and male students enrolled in the Bachelor, Master and PhD ICT courses at the Department of Engineering ‘Enzo Ferrari’

	2015		2014		2013	
	Men	Women	Men	Women	Men	Women
Bachelor	93,62%	6,38%	86,67%	13,33%	90,00%	10,00%
Master	77,78%	22,22%	90,63%	9,38%	93,48%	6,52%
PhD	100,00%	0,00%	72,73%	27,27%	90,91%	9,09%

According to the results of the gender audit in UniMORE and to existing studies, the under-representation of women within the student population of ICT courses appears to be mainly caused by cultural issues, including gender stereotypes and lack of female role models in ICT fields (phenomenon known as “stereotype threat”, meaning that gender stereotypes have negative consequences for girls’ performance and interest in STEM and technological fields - Régner *et al.*, 2014). These disciplines are perceived as “male” courses by the students, differently from many other academic disciplines and even from some STEM discipline, like mathematics. Programming is mostly seen as a male activity, only attracting nerds and geeks. Another issue is represented by the lack of computer science disciplines in the Italian primary and secondary schools: the lack of knowledge of what computer science and ICT actually are tends to reinforce the stereotype about ‘male’ disciplines among the youngest generations. Indeed, the gap between girls and boys in terms of interest and attraction towards technology fields apparently starts to become evident during the middle schools, then tends to increase with the age. These observations are confirmed by recent results in literature about gender gaps in STEM and in particular in ICT studies. The study in (Barker and Aspray, 2006) underlines how a possible reason for girls showing lower attraction than boys towards computer science and engineering is because they have fewer experiences with technology to generate interest and build self-efficacy. As early as elementary and middle school, indeed, girls spend less time playing with computer games and technological toys (Cherney & London, 2006) with respect to boys.

On the other hand, the study in (Master *et al.*, 2016) claims that interventions aimed at increasing young girls’ interest and self-efficacy in technology-related activities have the potential to reduce the gender gap in participation. (Master *et al.*, 2017) describe the results of providing 6-year-old girls and boys with a brief

experience in programming robots, and report how this can affect girls' immediate interest and self-efficacy in computer science and engineering, drawing the following conclusions:

- Girls given programming experience showed higher technology interest and self-efficacy.
- Experience eliminated gender differences in technology interest and self-efficacy.
- Providing girls with positive STEM experiences is beneficial.

Another important aspect to counteract the gender gap is the lack of female role models in technological fields that contributes to reinforce stereotypes. An interesting study (Shin et al., 2016) showed that role model exposure had positive effects on both STEM and non-STEM students' interest in STEM as well as their perceived identity compatibility between the self and STEM. Moreover, role model exposure had a positive impact on academic sense of belonging, and a positive impact on academic self-efficacy among STEM students.

On the basis of the results of the gender audit in UniMORE and of existing studies, the UniMORE research unit identified the Summer Camp Ragazze Digitali as a key action of the UniMORE Gender Equality Plan (GEP) developed in consequence of its participation to the European H2020 EQUAL-IST project.

The summer camp will be described in details in the following section of this paper.

4. Detailed description of the ICT summer camp

The summer camp "Ragazze Digitali" is an innovative project: in Italy, it represents the first and only summer camp entirely dedicated to girls. Its long duration (4 weeks) and the fact that it is free for the participants, no previous competencies are required regarding coding or ICT skills, makes this initiative unique, not only in Italy but also in Europe and, at the best of our knowledge, in the world.

The total number of female students taking part to the five last Summer Camps editions (from 2014 to 2018) of the summer camp is 282, with a substantial growth trend, while more than 3.000 girls have been engaged in the raising awareness events before the Camp.

During the summer camp, the girls learn how to program video-games in Python. Laboratory activities focus on a learning-by-doing approach with a two-fold goal: 1) smoothly and nicely introduce girls to computer science and a "smart" technological world; 2) give girls a better understanding of what ICT is and how it can be applied to different and multidisciplinary fields. Moreover, the girls learn how to work in team through team building activities performed at the beginning of the camp and through the collaborative development of team projects.

Finally, during the summer camp dedicated seminars with speeches are done by external experts and women who have reached leadership positions because of scientific studies will help to promote existing female role models. The goal of such seminars is to expose girls to examples which are disruptive with respect to the well-known social gender stereotypes, and to present the concrete opportunities that ICT-related competences may offer in terms of studies and careers at the local and national level.

To summarize, the main activities carried out during the summer camp were:

- Introduction to the basic tools supporting programming and management of software projects, such as OS Linux, shell bash, IDE Python (Pycharm), Google Gmail, Google Drive.
- Principles of programming in Python
- Video-games development in Python (PyGame library)
- Principles of graphics, animations and audio in PyGame
- Seminars on ICT topics such as cybersecurity, digital communication on Web and social networks
- Speeches of experts and entrepreneurs of local ICT companies to inform girls about career opportunities of in this field

Before the camp, preliminary and promotional activities were carried out:

- Promotional events organized in the high schools to present the project to teachers and students: during the events we talked about gender stereotypes among young generations with many interventions from the students attending the events, showing interest and curiosity about the topic.

- Public events to give visibility to the summer camp - press review at the link <https://www.ragazzedigitali.it/category/parlano-di-noi/>

Finally, in order to better promote the summer camp, the dedicated Web site of Ragazze Digitali (www.ragazzedigitali.it) was recently completely renewed: the improved online version was published online at the beginning of February 2018. The online subscriptions were opened on February 27th, 2018, very early with respect to the beginning of the summer camp.

The above described summer camp “Ragazze Digitali” has been included as a concrete action to attract female students towards ICT studies in the Gender Equality Plans of our University developed with the support of the European Project Horizon 2020 EQUAL-IST. The impacts of the initiatives are described in the following section.

As a final note, we add that the summer camp has also been selected as a best practice in the context of the project Gender aware education and teaching (Gender4STEM), a research project co-funded by the Erasmus+ Programme of the European Union whose objective is to promote and support teachers in dealing with gender balance and diversity in their classroom.

5. Evidence of impacts

In this section we describe the main impacts of the summer camp Ragazze Digitali.

First of all, we consider as an important measure of the achieved impact the number of female students involved in the summer camp, both reached from the promotional events and directly involved in attending the camp. The number of schools from which the students came is another important factor to consider, because it reveals how many institutions our activity was able to reach on the territory. Finally, we take in consideration the geographic origin of participants and schools that we expect to change over time including a larger territory. In its first editions, indeed, the summer camp was mainly promoted within the cities of Modena and Reggio Emilia (locations of UniMORE), but then the promotional activities were extended to include close by cities within the same region Emilia Romagna (e.g., Parma and Bologna). Moreover, the initiative was disseminated through social networks channels (mainly Facebook and Twitter), the Web site, local and national press, and a promotional speech in Rome.

The second metric that we consider to measure impact is the feedback of the participants on the summer camp experience. During the last three editions, feedbacks were collected through an online survey both before and after the camp to investigate: the previous (before the camp) programming experience of the girls; the appreciation for the team work and the activities carried out during the camp; their attitude towards programming after the camp; the change in their knowledge about computer science; their increased technological and coding skills.

The third and final considered metric is the impacts of the summer camp experience on participants’ future choice of studies. To this purpose, an online survey was conducted in 2018 over the participants to the first 4 editions to collect the information about the girls’ choice of academic studies (for girls who already got their diploma) or about their future intentions (for girls who are still at the high school).

To summarize, we measure the main impacts of the summer camp in terms of:

- a) number and geographic origin of participants and of high schools involved
- b) feedbacks from the participants collected through a survey conducted for the last three editions
- c) impact of the summer camp on participants’ future choice of studies

a) number and geographic origin of participants and of high schools involved

Every year at least 5 promotional events were organized to present the summer camp in different high school located in Modena and Reggio Emilia: from 2014 up to now, more than 3000 students of the high schools attended the promotional events.

The total number of female students that participated to the 4 previous editions (from 2014 to 2017) of the summer camp is 202, with an increasing trend from the first to the last edition.

The participants came from 43 different high schools not only of the city of Modena (15 schools) and of its province (11 schools), but also from other Italian cities, both belonging the same region Emilia Romagna (Reggio Emilia: 6 schools, Bologna: 5 schools, Parma: 1 school, Rimini: 1 school) and located in other regions (Mantova in Lombardia: 1 school, Rome in Lazio: 2 schools, Lecce in Puglia: 1 school). Many girls, indeed, come every year from outside of the city of Modena, where the camp is located. Specifically, the percentage of participant coming from outside the province of Modena was:

- 4% in 2014
- 27% in 2015
- 25% in 2016
- 45% in 2017

We see a major increase in participants coming from outside Modena for the 2014 and 2015 editions; the trend is maintained in the 2016 edition and followed by another major increase in the 2017 edition. Moreover, the average distance travelled by the participants is increasing from the 2015 edition to the 2016 edition. In fact, while the percentage of non-local participants was rather stable between the two editions, in 2016 the 58% of the non-local participants came from more distant locations with respect to the previous year. In the 2017 edition, not only the number of non-local participants but also the travelled distance increased. This increase is to be attributed to a gain in popularity of the summer camp outside of Modena. In conclusion, while in the early editions of the camp the participants came mostly from Modena and its province, the newest editions saw a significant increase of participants coming from outside the province, both in terms of number and travelled distance. Given the uneven and heterogeneous distribution of ICT skills, access to broadband (as stated also in the World Economic Forum *Global Information Technology Report*; and in Istituto Nazionale di Statistica, Istat, 2017) and gender stereotypes across Italian regions, we believe that the increase in the flow of students from other regions can produce a even more relevant improvement in gender equality in terms of access to ICT.

b) feedbacks from the participants collected through a survey conducted for the last three editions

Overall, feedbacks from the participants to the three past editions were highly positive, especially considering that their skills in programming before the Summer Camp were rather poor: 70% of the participants in 2016, 62% in 2017 and 82,6% in 2018 weren't able to program at all before this experience. After the camp, 80% of the girls in 2016, almost 70% in 2017 and in 2018 stated they had definitely understood more clearly what computer science actually means. However, what makes us really proud about this project is that 100% of the girls in 2016 and more than 95% in 2017 and in 2018 declared they had acquired new technical and coding skills thanks to the Camp's activities. Moreover, 95% of the participants in 2016 and 2017, and 97% in 2018 rated the team working and the collaborative projects carried out within the Summer Camp very positively; team activities have been rated from very positive to excellent by 47 % in 2016, 55,3 % in 2017 and 63% in 2018. Finally, after the camp the girls declared a high appreciation for programming (data shown in Table 3 for the last three years).

Table 3: Attitudes of participants towards programming

Do you like to program?			
	2016	2017	2018
I like it a lot	36,8%	34,2%	33,9%
I like it	42,1%	42,1%	43,2%
I am indifferent to it	21,1%	18,4%	17,8%
I dislike it	0%	5,3%	5,1%
Not at all	0%	0%	0%

c) impact of the summer camp on participants' future choice of studies

To evaluate the impact of the summer camp on the participants' future choice of studies, a survey was conducted in 2018 over the participants to the first 4 editions. The 34% of the girls answered to the survey with the following results.

Among the girls who got their High school diploma and who carried on their studies:

- 31,6 % chose a Faculty from the Information Technology area (that is, Information Technology Studies or Computer Engineering)
- 15,8 % went for a Faculty from the Engineering area other than Computer Engineering
- 15,8 % chose another different Scientific Faculty not belonging to the Information Technology Department
- 36,8 % opted for a Faculty from other different areas.

One of the most relevant comments on the questionnaire was about the influence of the Camp on the girls' decisions about their future careers: 50% of those who have chosen IT or Computer Engineering studies at University declared that the Summer Camp experience had a major influence on the choice of the Faculty.

The data concerning the Digital Girls who haven't still finished High school are encouraging as well:

- 30 % of the girls are going to apply for a Faculty from the Information Technology area (that is, Information Technology Studies or Computer Engineering)
- 5% are going to apply for a Faculty from the Engineering area other than Computer Engineering
- 37,5 % are going to apply for another different Scientific Faculty not belonging to the Information Technology Department
- 7,5 % are going to apply for a Faculty from other different areas

It is important to note that there are also additional positive impacts to be evaluated connected to the high number of girls who took part to the summer camp who, even if they did not choose to carry out a STEM tertiary education after the high school, did state to have acquired a better training in ICT: they will disseminate their increased digital competences amongst peers and within their families, therefore positively contributing to the contrast of gender stereotypes.

Finally, as regards the enrolment of female students in the ICT courses offered by the University of Modena and Reggio Emilia, we registered a positive trend: while in 2014 the percentage of enrolled women was 11,37%, in 2017 we reached the 15,37%, with an increase of 4 percentage points.

6. Conclusions and future work

The summer camp Ragazze Digitali has been proposed as a concrete action to counteract gender stereotypes about computer science and to attract female students towards ICT studies. At the summer camp can participate for free, girls of third and fourth grade of the high schools who do not have any previous competences of coding or ICT skills. The summer camp lasts four entire weeks and the girls learn how to program video-games in Python. Its main scope is to promote the participation of women in Information and Communications Technologies (ICT) studies. This initiative was included as a positive action in the Gender Equality Plans of our University developed with the support of the European Project Horizon 2020 EQUAL-IST (2016-2019). So far, the summer camp involved up to almost 300 female participants with very positive results in terms not only of appreciation of the experience but also of increased knowledge about computer science, technological and coding skills, and improved attitude towards programming of the girls as a consequence of their participation to the camp.

As a future work, we plan to extend the initiative in two main ways. First, we aim to continue to involve more girls in the UniMORE summer camp. To this purpose, in 2018 we started an additional camp in the city of Reggio Emilia, in collaboration with the local Municipality and foundations: during this camp, that lasted for two weeks in July 2018, the girls learned how to program robots with Arduino. Second, we aim to extend the summer camp to other cities and universities, promoting the camp's format through our networks of contacts and colleagues and providing them with support, guidance and teaching materials to replicate the summer camp in their institutions. The efforts spent towards this direction already gave a first result with a camp of three weeks organized during July 2018 in Cesena (as part of Bologna University) and based on programming video-games in Python. Finally, promising contacts have been taken with the Universities of Rome and L'Aquila to replicate the summer camp in their universities in 2019. A more structured survey will then allow us to get further information on the impact of the summer camp on the girls attending it and on their social environment.

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