Digital Girls Summer Camp: Bridging the Gender ICT Divide

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Abstract Women are currently severely underrepresented in the ICT field of study and in the ICT professions. This brings about severe gender gap at disadvantages in the access to new employment and wages and increased the risk to be left out from the digital revolution. Not only EQUAL-IST maps the gaps in ICT at the disadvantage of women in the different institutions and contexts involved in the partnership, but it also promotes actions to close the digital divide. One of these actions is a Summer Camp that is reserved to girls attending the third or fourth year of high schools to acquire knowledge in ICT by active learning implemented at the University of Modena and Reggio Emilia (UniMORE). The activity has shown to be successful in a twofold way: a) in terms of diffusion and replication, increasing the number of involved girls from the initial 35 participants of the first edition in 2014 in Modena to almost 130 girls participating in 2018 to the summer camps located in an increased number of sites, including locations outside of the region Emilia Romagna; b) in its capacity to reduce the digital divide with a real change in girls' ICT knowledge and in their expectation with regards to future education and professional roles.

Keywords Gender segregation. ICT Summer Camp. Gender stereotypes. Learn-by-doing approach.

Summary 1 Introduction. – 2 The Reduction of the Gender Digital Divide as a Key Objective in UniMORE GEPs. – 3 'Digital Girls' Summer Camp as a key Action to Reduce the Gender Digital Divide. – 4 The 'Digital Girls' Impact. – 5 Concluding Remarks

1   Introduction

As PISA (*Programme for International Students Assessment*) OECD data clearly show, 15 years old girls show much lower expectations than 15 years old boys to see themselves in ICT professions and of the 1.3 million of people that in Europe are in ICT women represent only 16.7% (Eurostat 2018). Women under representation in STEM fields is shown by data together with a larger gender gap in technological fields such as computer science and engineering than in math and science (Cheryan et al. 2017).

This trend is also reflected within the University of Modena and Reggio Emilia data that, in the 2015/16 academic year, shows only 18% women amongst those students enrolled in ICT at bachelor level, going down in the Master degree at only 7% and to none at the Doctoral level.[1]

The aim of increasing the presence of women in ICT Departments is shared by the European Commission (European Commission 2018) that points to a series of policies that could reduce the gap by tackling the gender stereotypes by using awareness-raising campaigns and concrete actions. The need to address earlier than in Tertiary education gender stereotypes on 'masculine' and 'feminine' subjects of study and professions has been stressed by the literature (OECD 2015a; Davaki 2018) together with the lower access to computer for women (OECD 2015b).

Within the EQUAL-IST project the challenge to increase the number of women enrolled in the ICT Department of Engineering Enzo Ferrari (DIEF) has therefore been taken and actions to address this challenge have been implemented. A key action of the UniMORE GEP to achieve this goal is analysed in this Chapter: the Summer Camp 'Ragazze Digitali' (Digital Girls).

The '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 and innovative 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 and the approach is

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1 The results for doctoral courses are very variable also due to the very limited numbers of students in the course.

based on learn-by-doing and team working. During the summer camp, which lasts for 4 entire weeks between June and July, the girls learn how to program video-games in Python. 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 Chapter 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 The Reduction of the Gender Digital Divide as a Key Objective in UniMORE GEPs

The advanced research methodology for participatory gender audit applied within the EQUAL-IST project (Canali et al. 2017) to Uni-MORE between December 2016 and April 2017 identified the increase in the presence of women in ICT field as one of the main challenges related to gender equality in UniMORE.[2]

UniMORE EQUAL-IST unit 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.

According to the methodology for participatory gender audit in ICT/IST research institutions, 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

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2 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.

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). 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.

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 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 middle school, then tends to increase with age. These observations are confirmed by recent results in literature about gender gaps in STEM and in particular in ICT studies. For example, a study underlines how a possible reason why girls may show lower motivation than boys for computer science and engineering is because they have fewer *experiences* with technology to generate their interest and build self-efficacy (Barker, Aspray 2006). As early as elementary and middle school, indeed, girls spend less time playing with computer games and technological toys (Cherney, London 2006).

On the other hand, research also 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 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 within the European H2020 EQUAL-IST project.

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

3 'Digital Girls' Summer Camp as a key Action to Reduce the Gender Digital Divide

'Digital girls' can be considered as an innovative practice in Italy and, to our knowledge, in the world. In fact:
- it represents the first and only summer camp entirely dedicated to girls.
- It is characterized by a long duration (4 weeks)
- it is free for participants,
- no previous competencies are required regarding coding or ICT skills.

A success factor can be envisaged in the significant increase in the number of female students taking part to the five Summer Camps editions (35 participants in the initial edition in 2014 up to almost 130 girls involved in 2018). Together with the Summer Camp, a wide raising awareness campaign took place every year involving more than 3.000 students and teachers overall in the promotional activities.

During the summer camp, the girls learn how to program videogames in Python.

The laboratory activities focus on a **learning-by-doing approach** that has 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,

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

Moreover, 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/`.

Moreover, the Web site of the Summer Camp 'Ragazze Digitali' (`www.ragazzedigitali.it`) was 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/Digital Girls' 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 ed-

ucation and teaching (Gender4STEM), a research project co-funded by the Erasmus+ Programme of the European Union and included in the on line learning platform[3] created within the project, **to promote** and **support teachers** in dealing with gender balance and diversity in their classroom. In that framework, dedicated Guidelines for teachers to customize and tailor 'Digital Girls Summer Camps' to lower education grades and middle schools in particular, have been delivered and disseminated at the EU level (Sangiuliano, Cescon, Canali 2018).

4 The 'Digital Girls' Impact

The success factors of the 'Digital Girls' Summer Camp can be summarized in numbers, participants' feedback and their expectations' fulfilment.

The first important metric we considered is the number of girls reached by the programme, both in the camp and in the awareness campaign. Also the number of schools reached by the action and their location is another metric used to assess the impact.

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. To collect feedbacks an online survey both before and after the camp has been produced 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.

As the literature on the gender gap in STEM shows, one of the main problems in generating digital divide is also connected to the expectations of girls as regard to their future involvement in ICT. To check the 'Digital Girls' Summer Camp impact we have carried out an online survey in 2018 over the participants to the first 4 editions to collect 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).

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[3] The Gender4STEM Teaching Assistant platform can be consulted at `https://www.gender4stem-project.eu/teaching-assistant/`.

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 3,000 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.

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. We also saw 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. In terms of the uneven and heterogeneous distribution of ICT skills and 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 the increase in the flow of students from outside region can indeed produce a relevant improvement in the gender equality in the 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 1   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.

Data concerning Digital Girls participants who haven't finished High school yet 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.

In July 2018 also Cesena (as part of Bologna University) held a three weeks camp on programming video-games in Python. In the summer of 2019 all the three camps will be replicated.

5   Concluding Remarks

The Summer Camp 'Ragazze Digitali' has been considered by Uni-MORE as a best practice to achieve one of the GEP's aims: increase the presence of women in the ICT area to reduce the gender digital divide at women's disadvantage. In this Chapter we have analysed the extent of the challenge that UniMORE faces also with regards to the international data and within the EQUAL-IST partnership that leads to include 'Ragazze Digitali' as a best practice to counteract

gender stereotypes about computer science and to attract female students towards ICT studies as a positive action in the Gender Equality Plans of our University developed with the support of the European Project Horizon 2020 EQUAL-IST (2016-19).

By using different metrics we can state that the action has been largely successful both because of the number of girls involved and because of the extension of the area in the country included in the action.

Success was also confirmed by by analysing the results of the feedback surveys on the programme

In fact, not only participants evaluate the experience positively, but their knowledge about computer science, technological and coding skills and on the whole their attitude towards programming have improved.

With this positive assessment 'Ragazze Digitali' is expected to experience new challenges:

- By further replicating the camp in new locations (we wish to reach new areas even outside Italy)
- By including, as already done in 2018, also activities on robotics
- By improving the evaluation design with an extended analysis of participants' proficiency in different fields of study and on the cultural background and gender attitudes in their family that, according to the literature,[4] are found as key determinants in producing gender gap in different areas of knowledge.

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