Girl empowerment in STEM education by means of Summer Camps

Farrugia, J.¹, Evagorou M.², Kreuz, D.³ and Jonker V.⁴

 ¹University of Malta, Malta e-mail: josette.farrugi@uni.edu.mt
²University of Nicosia, Cyprus e-mail: evagorou.m@unic.ac.cy
³University of Pedagogy Freiburg, Germany e-mail: dita.kreuz@ph-freiburg.de
⁴Utrecht University the Netherlands e-mail: v.jonker@uu.nl

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1. Abstract

Around half of Europe's population is female, yet only 15% work in tech sectors and even less, 2,4% in ICT related fields. Only around 20% of the females are entrepreneurs. The untapped source of female technology, innovation and entrepreneurial potential leaves Europe with a huge and growing gender and skills gap in these sectors. Education certainly is the most important lever to enable and encourage girls to pursue studies and careers linked to STEM, particularly information and communication technology (ICT), and entrepreneurship.

The project 'Girl empowerment in STEM Education' (GEM) focussed on increasing girls' interest in STEM and ICT subjects, studies and careers, by organising summercamps for girls in 10 European Countries and by establishing a network of European institutions with the same objectives.

Higher education institutions from 10 European countries organized summer camps for girls, piloting various learning activities, which specifically supported the development of a diverse range of STEM related and personal skills. Skills that enable girls to contribute to Europe's digital innovation processes.

In this workshop we like to start with an overview of the pedagogical starting points used in the summer camps, and the case studies we carried out in the different countries. We like to share some of the learning activities used in the camps, and we finalize with some evaluation results from the different countries, and some questions.

Why STEM for girls summer camps

The GEM project¹ (with 10 European countries involved) used an out of classroom context to support female students towards STEM. The decision to focus on out of school context is supported by previous studies based on which such a context has more possibilities to enhance young students' interest in STEM (Heeg, Smith & Avraamidou, 2022; Wieselmann, Roehrig & Kim, 2020) as opposed to a formal setting because a formal setting (i.e. school) might limit the authenticity of the experience (Braund & Reiss, 2006). The activities developed as part of the summer schools afford the ability to blair the boundaries between the STEM disciplines in a way that provides authentic integration. Additionally, the summer school setting allowed us to design activities that are longer in duration, provide authentic experiences through visits and field trips, and make it possible to work with scientists from multiple STEM disciplines because of the flexibility of the schedule. Previous

¹ https://icse.eu/international-projects/gem/

studies report that summer schools and after class STEM activities should include hands-on nature of activities, collaboration, and opportunities to fail without the stress of being evaluated in a formal setting (Moore et al., 2014). The evaluation of previous summer schools and afterclass activities highlight that they are successful in increasing students motivation and STEM career aspirations (Kitchen, Sonner & Sadler, 2018), they empower students (Habig, Gupta, Levine & Adams, 2020) and can improve students' knowledge and interest in learning (Chen, Tomsovic & Aydeniz, 2014; Pitri, Evagorou & Stylianou, in print).

Pedagogical starting points for summer camps

In the context of this GEM collaboration the different European partners agreed on some pedagogical starting points:

• Inquiry-based learning

All activities will be based on collaborative activities, where girls have freedom to choose, to hypothesize, to collect, etc. And, as stated above, avoiding activities that resemble classical old-school STEM practices.

• Context

The contexts used in the summer camps were choosen from a wide range of socioscientific issues, like energy transition, sustainability, waste problem, etc.

• Culture

When you only bring girls together another environment is created than a normal classroom situation. In all summer camps extra attention was given to a safe learning environment and a feeling of belonging

• Role models

In all summer camps female role models (from the workplace, from education) were central to the activities and workshops, in order to have this important input and environment for all girls.

• Entrepreneurship

This is strongly connected to the first issue mentioned: inquiry-based learning. It is putting the girls in their strength, putting extra effort into a growth mindset that entrepreneurs need.



Three examples of summer camps: Cyprus, Malta and the Netherlands

Cyprus: Observations, comments and reflections from the first implementation of the STEM summerschool were used by the local research group in Cyprus to prepare the new version that was implemented in June 2022. The main objectives of the new materials were to: engage young students with different STEM disciplines; make students understand STEM stereotypes, bring students in contact with female STEM professionals as role models; help students appreciate different aspects of STEM professions, engage students with skills linked to STEM (i.e. creativity, programing, inquiry-based learning, problem solving), engage students in problem solving and entrepreneurial activities.

Malta: In september 2022 about 60 girls joined for a Girls4STEM Week, and they worked in small groups of 6 to 7 students at a time. They were accompanied by a young female mentor. Activities like: Electromagnetics in medical diagnosis and treatment; Science in the investigation and preservation of Malta's national cultural heritage; NASA's Moon Survival Challenge, and of course some Coding activities.

The Netherlands: To get a good and meaningful learning environment we decided to have the three 'Autumn Girl Days' associated with 'bigger ideas'

- Trees Monday: measuring and calculating trees, practical 'exciting surfaces' and drawing a pythagorean tree;
- The Eye Tuesday: eye-tracking, medical physical research on eyes and building and using a camera obscura; and

• The Design Wednesday: mathematical folds, pseudo-coding and heights Each day there was a meeting between the 20 participating girls and a so-called Girl of the Day talking about her scientific research and a speaker combining a workshop with a super interesting presentation. On the last day, as a group activity, the physics topics around forces, gravity and altitude were combined with a climbing workshop.

Examples of learning activities used in the summer camps

In the GEM Consortium we collect the learning activities that were used throughout the summer camps, in order to get an online collection that can be used in different situations (new summer camps, extra school activities, etc.), see Figure.



Figure - Online repository of learning activities - https://www.fi.uu.nl/publicaties/subsets/girls4stem_en/

In all learning activities we collect the central idea, the way the activity was used in the camp, the materials used, the experience. We take an example from Cyprus: How colors can be used to improve the wellbeing of scientists (Working towards prototypes (ideas), supported by the so called design thinking process).



Figure - Example of a learning activity https://www.fisme.science.uu.nl/toepassingen/29141/

This collection of activities can be used for free, and can be found at the ICSE and GEM website.

Results from the evaluation of the summer camps

Data were collected across all summercamps (both in 2020 and in 2022), a final report on the evaluation results will follow in early 2023 (and will be included in the EtE IV workshop). A questionnaire was used to ask girls about their interest in STEM before and after the summer school (pre- and post), and based on these findings we can already state that students show an increase in their interest in learning about STEM, with the most important change in their views linked to the fact that after engaging with the curriculum most of the students report that now they understand how STEM can help them in their future careers and they everyday life. Furthermore, students were asked to provide their feedback for the learning activities. The students commented very positively on the fact that they worked in groups most of the time, with one of them reporting that "My favorite activity was working on the product that we had to prototype and I enjoyed it because we worked as a group and had fun at the same time". Working on prototypes and presenting (half)products was reported by all students as a positive aspect of the curriculum.

How we like to organize the GEM workshop during Educating the Educators

We will introduce ourselves and the project outline, then we focus on the pedagogical starting point. We do this by working on (a part of) one of the learning activities from the Summer Camps, in small groups, to have an experience and a source for discussion with the whole group.

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