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DOI: 10.3217/978-3-85125-668-0-17

Students' Vision and Representation of Gender-Inclusiveness in Science

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Abstract

The contribution presents data and lesson learned on a national high school contest fostering students' critical reflections on the role of women in science. The contest, that involved 120 high schools and more than 830 students, was organized in the framework of the H2020 GENERA project (https://genera-project.com/) and it constitutes one of the outcomes of the first Gender in Physics Day (GIPD) event, organized by the Italian National Research Council (CNR) and the Italian National Institute for Nuclear Physics (INFN). The contest required the candidates to create a project about the issue of gender equality in physics with the aim to explore students' perceptions on the prejudices embedded in dominating culture concerning the role of female scientists in society. The contest produced tales, reportage and videos about gender equality and scientific careers. The results support the idea that meaningful knowledge raises when students are actively involved with learning materials. The outcomes show that school contests could be used as educational tools as well as awareness raising activities for high school students with a relevant impact on group learning dynamics and on teachers' active involvement. Preliminary analysis on the videos produced by students show that 1) students were direct performers/actors of their message, 2) interviews were chosen as main information source by students, 3) 1 out of 5 videos cited gender statistics pointing out that students are reached by relevant statistics source on gender, 4) the most interviewed testimonials were female scientists and the least interviewed were the teachers.

Keywords: gender equality, school competition and school contest, women in science, group learning dynamics

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1 Introduction

Social cognitive constructivist theories sustain that knowledge and culture are framed and produced through several dimensions and variables which contribute to construct the meaning of the culture we live in (Bruner, 1966; Vygotsky, 1978). In line with the constructivist theories and within the mass communication scenario, learning theories enhance the idea that the more people are actively connected with learning materials, the more they develop a deeper level of understanding (Hall, 2001; Long et. al, 2016).

Many studies found that students learn better with multimedia messages than with single resources such as text (Goldman, 2004). Alongside previous studies (Buckingham, 2007; Hobbs, 2011; Hobbs e Moore, 2013) that relate critical analysis to students' own concerns, tastes and identities, active learning is more effective than engaging them in the abstract analysis of ideology. Media production activities contributes to developing a greater awareness of media languages as well as encourage learning (Swain et al., 2003) and critical thinking (Ranieri e Fabbro, 2016).

Furthermore, Jenkins' theory (2006) examines how storytelling can contribute to learning process through technology-supported educational environments (Kearney, 2011).

Under a different perspective, there is an increasing interest on the impact that science learning experiences outside of school curricula have on the improvement of science literacy and interest in scientific careers (Miller et al., 2018). These experiences encompass students' participation in science outreach events, fairs, competitions and contests, which have been analysed in different studies showing improvement in both reasoning and communication skills as well as in boosting motivations to take up scientific careers (Cruse, 2006). In this perspective Research Performing Organizations (RPO) are increasingly adopting contests[1] in outreach activities to boost their impact on targeted audiences, including high school students.

Based on these premises the current paper presents data and lesson learned on a national high school contest fostering students' critical reflections on the role of women in science. The "Women and physics" contest involved 120 high schools and more than 830 students, was organized in the framework of the H2020 GENERA project (https://genera-

1. In the current paper the words **contest** and **competition** are used as synonymous

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project.com/) and it constitutes one of the outcomes of the first Gender in Physics Day (GIPD) event, organized by the Italian National Research Council (CNR) and the Italian National Institute for Nuclear Physics (INFN). Both these Italian research organizations have a long-standing experience in outreach activities addressing school and university students as well as general public. Within these activities a student competition proved to be one of the best ways to stimulate students' creativity and at the same time fostering their learning on topics not usually addressed within regular curricula.

A further motivation to adopt school contest has been: 1) the possibility to enhance the gender reflection in science careers by a direct students' involvement, 2) the opportunity to explore their vision and representation of gender-inclusiveness in science analysing the contents produced. Our aim was to explore, on the one hand, students' understanding and representation of stereotypes present in the research environment, and, on the other, to test how science outreach activities could be modified to include gender issues. Moreover, in our view the choice of the subject as well as of the media to use, could give students a variety of possibility to be engaged, express their creativity and work in groups. The paper presents the contest design, the analysis methods and steps along with the relevant lesson learned.

2 The competition "Women and physics" within INFN and CNR outreach activities

The Italian Ministry of Education, University and Research (MIUR) guidelines supported RPO to foster media skills development as an essential part of the training program to be offered to Italian students specifically to improve: "the ability to elaborate new messages, offering its own contribution to the media system and therefore being creators of information and communication and not mere passive elements[1]". The contest "Women and physics" followed this vision and was framed within the outreach strategy of the two RPO organizations.

The National Institute for Nuclear Physics (INFN) is the Italian research organisation dedicated to the study of the fundamental constituents of matter and the laws that govern them. It conducts theoretical and experimental research in the fields of subnuclear, nuclear

1. https://www.miuristruzione.it/3087-la-media-education-nelle-scuole-ecco-perche-e-importante/

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and astroparticle physics. The INFN is fully committed to promoting scientific culture. It takes part in all the main dissemination activities in Italy and yearly organises various exhibitions and events throughout the country. In addition, INFN organizes several activities targeting high school students, with a clear educational focus. Competitions involving students have been proposed over the years both at local (i.e. in the National Laboratories) and national level. At national level, the INFN web site devoted to outreach (called "Scienza per Tutti") promotes each year a competition in which students are invited to present a “product" on an assigned subject (proposed subjects in the past years were: the vacuum, broken symmetries, the light, the time etc.). At local level, both the INFN units, the national centres and laboratories organize outreach activities. The GENERA consortium took advantage on Gran Sasso National Laboratory’s, long-standing experience in disseminating and promoting its activities towards students.

The Italian National Research Council (CNR) is the largest public research institution in Italy performing multidisciplinary activities. Part of the CNR activities are devoted to the dissemination of science, with the aim of stimulating public knowledge. These activities include the organization of scientific travelling exhibitions and events addressed to the public, as well as specific initiatives targeted to schools such as: Science in a box, Kidseconomics, Scienziati e studenti, work-linked trainings/young apprenticeship programme. The goal is to enhance the public interest and involvement towards science and technology, of young generations in particular, so contributing in promoting the advancement of the knowledge.

The INFN and CNR were both partners of the GENERA project that aimed to contribute to overcoming the under-representation of women in physics research and foster gender equality in science in general. The GENERA strategy, beside the adoption of Gender Equality Plans by RPOs, was the integration of gender equality in the outreach activities in the partner organization through public events named Physics Day (GIPD).

3 The experience: methods and techniques

When we started thinking of an Italian Gender day inside the GENERA project we thought of involving students for two reasons: our experience in outreach activities and the consciousness that if we speak of the necessity of a cultural change, we have to start from

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schools. When it was decided to propose a school contest on the subject of women in physics research and on gender stereotypes, top-down approaches were discarded in favour of initiatives where students could freely express themselves, becoming the leading figures of the actions.

The theme of the competition was "Women and research in physics: stereotypes and prejudices". Students, from high school, were asked to create a product (video, photo report, story, book) on three different subjects: encourage young women to pursue a scientific career; learn about the personality of woman researchers and explore aspects of their personal and professional life; highlight any stereotypes and prejudices that still influence the role of women in research. In this scheme the students become the leading actors: the ‘Gender day’ program was built around their presence, foreseeing enough time to discuss student’s works.

Our aim was to explore students’ understanding and representation of stereotypes in research environment. Furthermore we tested how science outreach activities could integrate gender dimension. Moreover, in our view the choice of the subject as well as of the media to use, could give students a variety of possibility to be engaged, to express their creativity and to work in groups. The only constrain was the length of the videos (no longer than 5 minutes).

The competition advertisement was opened to all typologies of high school. It was advertised on the official CNR and INFN web sites, on the Gran Sasso National Laboratory and on the GENERA project web sites. However, the direct contact with teachers proved to be more valuable. Therefore, for a capillary spread of the information we used the list of teachers with whom we had collaborated in the past and asked for help to the Italian Association of Physics Teachers (AIF). We think that the direct involvement and the encouragement from the teachers were much more effective in conveying the successful adhesion to the competition, than the bare publication of the initiative on a web site.

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Out of 120 schools participating to the contest, the majority of them were scientific high school (59%), followed by classic lyceum and industrial and technical institutes (Di Tullio, Pisacane, 2019). More than 830 students were involved producing tales, reportage, videos and comics. Videos were the preferred media chosen by students (58%).

Each product has been separately evaluated by three referees on the basis of a grid that considered originality/creativity and communicative effectiveness of the content presentation. Moreover, video technical skills were also taken into consideration. In a final team meeting the collected grid was analysed to reach a common decision toward the award of the three best products. Given the high quality of products received, 6 videos were awarded with special mentions (i.e. best reportage, originality of the expressive mode, technical quality and originality of the contents).

After the successful Gender Day, in which 120 students together with their teachers participated to the event, the INFN-CNR team decided to carry out an in-depth analysis of the videos that constituted the majority of the products received. The aim was to explore whether similar patterns in representing gender issues could be detected both in terms of content construction, stylistic features, images and music chosen.

To achieve this goal, an interpretative tool was developed that analysed the following:

• Structural Data (type of schools, gender and role composition of the team producing the videos, teachers' gender and education subjects);

• Typology of narrative style adopted (interview, use of statistics, acting, biography) including music;

• Woman and man representation (female and male scientists' images, role models, facial expressions, workplace representation);

• The use of language (style of the title, expressions used to describe female and male scientists' traits/characteristics);

• Final Message (whether students had a specific target audience and/or final conclusion deriving from the storytelling).

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The tool was tested on a selection of videos by the INFN-CNR interdisciplinary team and then randomly assigned to three team components. In a one day workshop all results gathered were discussed to align divergences.

4 Preliminary Findings

The interpretative tool was then used to analyse the 58 videos selected as the information universe of the study. Preliminary findings are presented in this paper focusing in particular on the narrative style adopted by the students in the videos that represents just one section of the interpretative tool.

A first result showed that, among the possible narrative styles, the students choose to be direct performers/actors of their message. In 31 out of 58 videos female students were acting and in 15 of those, they were acting as scientists. The direct acting in the video represents a strong involvement approach of the students and proves how the “gender and science” topic could emotionally involve students (see Figure 45). This results shows how the contest was able to mix aspiration, biography, expectation and a self-identity process, especially for young girls that put themselves into the shoes of future women researchers.

A second result showed that students used interviews as the main information source in structuring the narrative messages within the videos. In 21 out 58 videos interviews to female scientist were displayed. The interviews mainly targeted female scientists and were performed both in-person (on the workplace as laboratories, research facilities, offices) and via Skype. Both the options required the students working group to prior design a number of questions to be asked and gave the opportunity to visit a number of research facilities, at least in the case of an in-person interview. The large use of interviews in the videos can be interpreted as strong students’ willing to explore the “woman in science” topic from the leading actors and to collect direct opinions from female researchers on their careers and their motivation behind the will to become a scientist.

In third place a relevant use of gender statistics raised as the narrative style in the videos, 1 out of 5 videos cited gender statistics (see Figure 46 as an example). This aspect is particularly relevant because it shows how pervading the “data issue” became on the gender in science discourse. The most cited statistics were from the National Statistical Office, but also from the OECD or the European Commission. It is not known through

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which channels the students collected the information (websites, publications, reports, direct research on databases) and which was the teachers' contribution towards the use of statistics.

Finally, the most interviewed were the female scientists and in very few cases the interviews also collected male colleagues' opinions (1 out of 3 cases), this in line with the subject of the contest. More relevant is the data of the interviews with the teachers. They were, in fact, the least interviewed figures, probably because they supported the students' work to be open to the outside world rather than to the school context. In any case, the relevant teachers' contribution was unfortunately somehow invisible to the analysis, because it was not possible to detect whether they supported, orient or informed the student's work.

Fig. 45: *Students performers/actors of their message – Source: Screenshot from the video "Fisica allo specchio", IVD Liceo Statale "G. Galilei" di Dolo (Venice).*

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Fig. 46: *Videos cited gender statistics – Source: Screenshot from the video "Refrigerator Ladies", VB Liceo Statale Duca degli Abruzzi, Treviso*

In the video analyses, a frequency counting of female scientists was performed to identify the most represented and cited. The count encompassed both women represented (in the cases where the students performed as actors) and the cases were woman scientists were cited. Figure 47 shows a word cloud dig out from the mentioned name's frequency. The most cited was by far Marie Curie followed by the Italian physicist Gianotti, the astrophysicist Hack and the neurologist Levi Montalcini. Marie Curie's role is linked to the great role model she played in the European Commission communications and outreach activities on women and science. The following two cited scientists are famous Italian researchers: Fabiola Gianotti with a renowned international career, and Margherita Hack, who is also well-known for her commitments in science dissemination activities. This result shows how important and pervasive are the female role models in science and how strategic they can be in inspiring the younger generations.

Fig. 47: *The most represented and cited woman scientists – Source: Word cloud from the most represented and cited woman scientists in the videos. Produced with WordArt software*

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The analysis also considered the use of music in the videos. The music was detected using the Shazam application and player and style were reported in the interpretative excel sheet. The videos have then been divided into two macro categories: 1) piano music, instrumental and slow rhythms and 2) rock, upbeat music. The first group of videos used the music mainly as background to narrate woman difficulties in earning the right credit in science. The music in these cases was associated with biographies of female scientists, who gained no recognition in their life time or with an intimate description of wishes and aspirations of many young girls depicted in the videos.

In the typology rock, upbeat music the video used the sound as a background for an enthusiastic approach to the topic “gender and science”. In many videos, the music was used as part of a positive and encouraging message as “yes we can!” or “science is open to everyone”.

5 Conclusion

The school contest organised by the INFN-CNR team within the GENERA project prompts some reflections on the lesson learned when promoting science outreach along with gender awareness. This twofold aim was accomplished taking advantages of pre-existing experiences in outreach activities as well as in gender issues, and was based on a fruitful long-standing collaboration with schools. These were the ingredients that made the school contest a successful event, in terms of number of students involved and high quality of the products received. In particular, videos production, even if facilitated by the current available technologies, implies a close team work in the selection of topics to address, in the construction of the storytelling, in the choice of music and additional technical and narrative features. This certainly stimulates students’ creativity in the learning process providing the opportunity to address topics, such as gender issues, which are generally not often addressed in curricula.

The analysis of the videos, whose preliminary results are reported in this paper, shows a variety of narrative styles chosen by students to explore gender issues in science and in particular in physics. Their active involvement is evident in particular when they choose to have a performer/actor role in the videos, in many cases as women scientists, outlining a self-identity process, especially for young girls. Moreover, the choice of making interviews indicates a strong personal commitment in carrying out a “field work” to find out directly

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woman scientists' motivations and experiences and explore the environment where they work. A common feature in the construction of content was the frequent mention of well-known past and present women scientists that convey role models that may encourage girls in taking up scientific careers mitigating gender stereotypes. An additional result, with a direct policy implication, has been the frequent use of gender statistics as information source in the videos (in more than 20% of the works appeared statistics). This aspect is particularly relevant because it shows the "data issue" pervasiveness in the gender in science discourse. The importance of data evidence to guide gender equality policies influenced many videos that described the state of art using gender statistics from different sources (both from national statistical office and EU/OECD databases). This results is an outcome on years of public and institutional information outreach on gender inequality in RPO grounded on data evidences and data driven polices that need to be further supported and boosted for the benefit of future researcher generations. A final consideration to these preliminary results concerns improvements that may be introduced in future school contests, such as the possibility to have a feedback from the teachers, who supported students' activities offstage, or from involved students afterwards, so to get deeper insight of content design and ideas' developments in the team.

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