Chapter 6
Women and Science: Outlook from an Italian School Competition

Ilaria Di Tullio and Lucio Pisacane

Abstract This chapter presents the results from a high-school competition fostering students' critical reflections on women's roles in science. The competition was organized in the framework of the GENERA European project and the first "Gender in Physics" day of the National Research Council of Italy (CNR) and the Italian National Institute for Nuclear Physics (INFN). One hundred twenty Italian high schools and more than 830 students produced tales, reports and videos about gender equality in scientific careers and women's roles in the physics disciplines. An ex-post questionnaire explored how participating students perceive the "women-science" association. This chapter presents students' views on gender equality in science along with an analytical tool developed to explore learner-generated contents. It proposes a tool for analyzing students' products, in collaboration with school teachers, to raise awareness and sensitize students regarding Responsible Research and Innovation topics.

Keywords Learners generated contents · School competition · Women in science

6.1 Introduction

This paper presents, in the framework of the GENERA European Horizon 2020, the results and the lessons learned from a high-school competition fostering the critical reflections of students regarding women's roles in science and proposes a useful tool to analyze digital learner-generated contents (Kearney 2011). The school competition stemmed from a collaboration between the National Research Council of Italy (CNR) and the Italian National Institute for Nuclear Physics (INFN), aiming

I. Di Tullio (✉) · L. Pisacane
Institute for Research on Population and Social Policies, National Research Council, Rome, Italy
e-mail: ilaria.ditullio@irpps.cnr.it

L. Pisacane
e-mail: lucio.pisacane@irpps.cnr.it

P. Sandu et al. (eds.), *Co-creating in Schools Through Art and Science*,
SpringerBriefs in Research and Innovation Governance,
https://doi.org/10.1007/978-3-030-72690-4_6

to improve female participation in science, starting from the high-school educational level.

The study aimed to:

- investigate how high-school students perceive the personality of women researchers, what they think about some aspects of female scientists' personality and professional life; what is their idea about the role of women scientists in the scientific progress;
- investigate how high-school students consider cultural and social prejudices on women in science and in which way this could affect the career paths of young women scientists;
- propose an evaluation tool, a student-generated contents framework to be used by researchers to analyze student competition products.

6.2 Theoretical Framework

Learning theories, such as the cognitive constructivist theory (Bruner 1966) and the social constructivist learning theory (Vygotsky 1978), support the idea that meaningful learning happens when students are actively interacting with the learning materials (Long et al. 2016). The importance of images and the power of videos as potential tools to increase awareness and motivation concerning specific themes have been recognized since first movies were used as a training tool for soldiers during the Second World War (Cruse 2006). Furthermore, according to some authors, the process of generating and editing videos encourages a deeper level of understanding in students (Swain et al. 2003).

Several studies notice the role of technology in stimulating reflection and raising awareness in schools and how technological devices can be considered as a new tool developed for pedagogical use (Kearney 2011), able to transform the learning environments (Goldman 2004). These studies demonstrate that learner-generated videos and digital storytelling constitute a "valuable, transformative tool for learners in a range of curricula and discipline contexts" (Kearney 2011, p. 172). Furthermore, they sustain that enhancing learning through digital video projects improves motivation, social skills, self-expression and creativity, critical and reflective thinking and self-esteem (Kearney 2011).

6.3 Methods

A multidisciplinary team of physicists from INFN and sociologists from CNR designed both the school competition and the Gender in Physics Day event. The school competition was selected as a method to explore Italian students' prejudices, with the final aim of highlighting the perceptions and ideas of younger generations. The competition required students, individually or in group, to create an innovative project (in form of a tale, reportage, video or comics) about stereotypes regarding women and science, highlighting female contribution to the advancement of scientific research. The competition targeted the last three-year classrooms of all types of high schools; students were requested to be mentored by at least one teacher.

The school competition explored students' perceptions regarding the prejudices embedded in the dominant culture concerning the role of female scientists in society. The contest was specifically addressed to high-school students because, as European data shows (European Commission 2015), the percentage of women who choose studying Science, Technology, Engineering and Mathematics (STEM) at university and at doctoral level is dramatically low (compared with men), while preferences and motivation for this career path are determined during high school (OECD 2015). Moreover, female researchers in universities and in laboratories still account for only 33% of the total research staff (European Commission 2015) and, even if women represent 47% in doctoral scientific paths, only 1/3 of them choose to study STEM disciplines.

Dissemination and advertising of activities for the school competition were performed using different channels: CNR and INFN institutional websites, social networks and a number of selected target groups mailing lists (schools, teachers, journalists, science magazines, etc.). An evaluation board composed by eight CNR and INFN staff—physicists and sociologists with experience in evaluating students' products and gender equality—ranked the students' results, using an evaluative grid specifically developed for this purpose. The criteria, presented in Table 6.1, included contents, creativity and the communication efficacy. For each criterion, a score from 1 (min) to 10 (max) was assigned.

The competition results and the winning products were presented during the first Italian Gender in Physics Day, held in Rome on May 10, 2017. The most relevant products were mainly videos, confirming the strong inclination of young students in using this kind of media. In addition, smartphone cameras and open software for video editing allowed students to produce quality products at no cost. This led the research group to focus on video contents, even though several kinds of products were also accepted. Therefore, the framework on how to read student-generated content presented below applies only to the videos submitted in the competition.

An ex-post questionnaire was sent to the students participating in the competition to explore their opinions regarding the competition experience and its impacts. A set of Likert-like scales were designed to collect students' opinions on women and science issues; the rating scale was defined between 1 (totally disagree) and 5 (totally

Table 6.1 Evaluation grid criteria for ranking the students' products

Adherence to the general competition focus on gender in science	Score from 1 (min) to 10 (max)
Originality and creativity	Score from 1 (min) to 10 (max)
Communication efficacy	Score from 1 (min) to 10 (max)

agree). In building the Likert-like scales, we considered the most popular expressions and themes resulting from the video analysis. Although an extensive content analysis of the videos was carried out, the current paper presents only the framework developed to evaluate student-generated contents.

6.4 Results

6.4.1 Structural Data About Participating Schools

A significant number of students participated in the competition and the ex-post questionnaire completed by participants showed a very positive impact on students' perceptions. We registered a great participation: 120 high schools, from all over Italy, and more than 830 students were involved producing tales, reportages, videos and comics. Six schools were awarded with different honorable mentions (best tale, most original message, best technical production, best reportage, most original expressive choice, best research of multimedia contents), and four schools were placed on the first three places (two schools with equal merit were awarded the third place). The winning products were broadcasted live for the Gender in Physics Day large audience and uploaded on a dedicated YouTube channel (https://goo.gl/9ukD48).

In this section, we present the composition of the participating schools sample. The data was collected by using the participation form sent to apply for the competition. Almost half of the participating schools were from the Southern regions of Italy (46%), followed by the northern regions (33%) and the central ones (19%). As shown in Fig. 6.1, a massive presence of Scientific High Schools was registered due to the proximity to the proposed theme. The pie chart shows the participation ratio per school type.

Figure 6.2 presents the gender composition of the individual teachers supporting the students in developing products for the competition and submit a proposal. Most

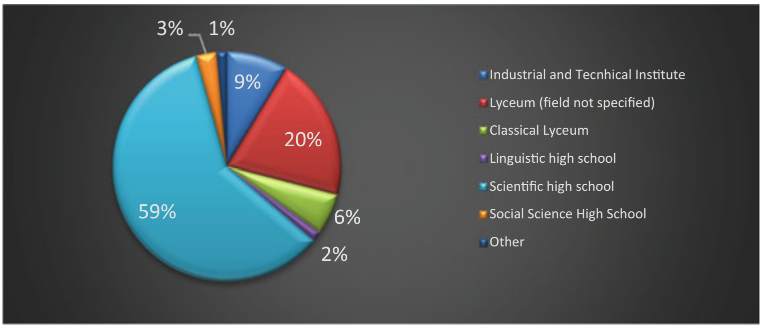

Fig. 6.1 Distribution of the types of schools participating in the school competition

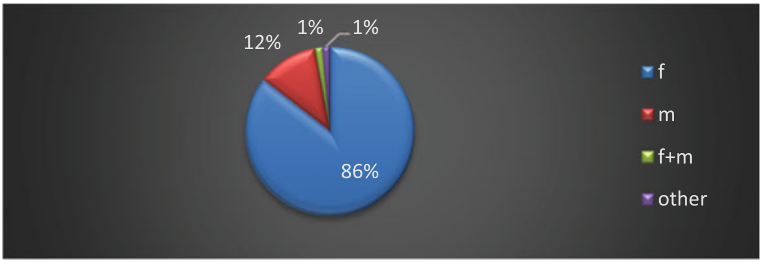

Fig. 6.2 Gender distribution of teachers coordinating students' projects

of the coordinating teachers were women (86%), only 1% of the groups being led by a mixed-gender group of teachers.

6.4.2 Preliminary Findings: Students' Approval Rating on Stereotypes

In the ex-post questionnaire sent to the participating schools, we registered responses from 125 students, including 45 males (36%) and 80 (64%) females aged 15–18 years old. The results related to students' reflections following their participation in the school competition are presented below.

The first question was "Did you enjoy participating in the school competition?". For this question, no relevant gender-related differences were registered concerning the interest and involvement of students in this activity: Girls' average rank was 4.51 of the Likert scale, and boys' rank was 4.36.

The second question was "Have you ever thought about becoming a scientist in STEM?". The answers to this question highlight the male tendency to be more willing in pursuing a scientific career. Even if the absolute number of male and female students' declaring "very probable," their future as scientists was similar, remarkable differences appeared in the items "somewhat improbable" and "not probable," where the females exceed the males (Fig. 6.3).

The third question was: "In your opinion, what is the most relevant obstacle in choosing a scientific faculty at the university?". Girls declared that the major obstacle was the complexity of scientific disciplines (30%), followed by "do not perceive any obstacle" (25%) or the necessity to face off prejudices or other difficulties (15.6%). On the other hand, boys declared that the major obstacle is the complexity of scientific disciplines (20%) and the fact that scientific faculties are very demanding in terms of commitment (20.5%).

The fourth question was "In your opinion, do your family and your teachers encourage you in choosing scientific disciplines?". The results of this question showed that there are no relevant differences between girls and boys regarding family or school support.

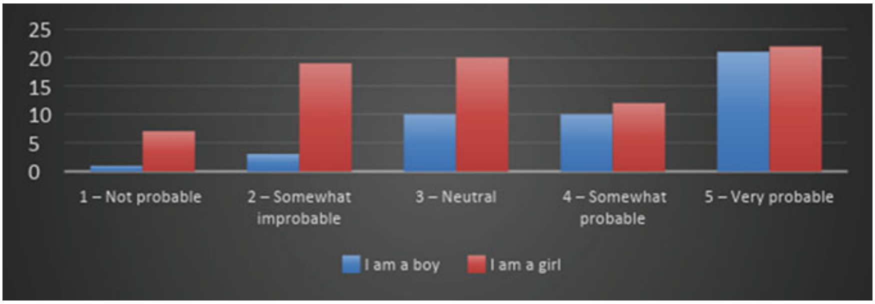

Fig. 6.3 Distribution of answers to the question "Have you ever thought to become a scientist in STEM?" for boys and girls (absolute numbers)

In the last section of the questionnaire, students were asked to express their opinions concerning some of most common stereotypes identified (by evaluators from CNR and INFN) during the evaluation of the products presented in the school competition.

As shown in Fig. 6.4, there is a general disagreement with the stereotype "Boys are more likely to succeed in scientific matter." These answers are certainly biased by students' participation in the competition and by the preparatory work done with the reference teachers. Nonetheless, they remain relevant judgments despite being formulated by students who have been informed about the topic.

However, we registered a strong disagreement between males and females on the stereotype "Girls do not fit with scientific career because they badly manage anxiety and stress" (Fig. 6.5). The stereotype according to which females badly manage anxiety was disagreed by a percentage of females that was almost double compared with the percentage of males.

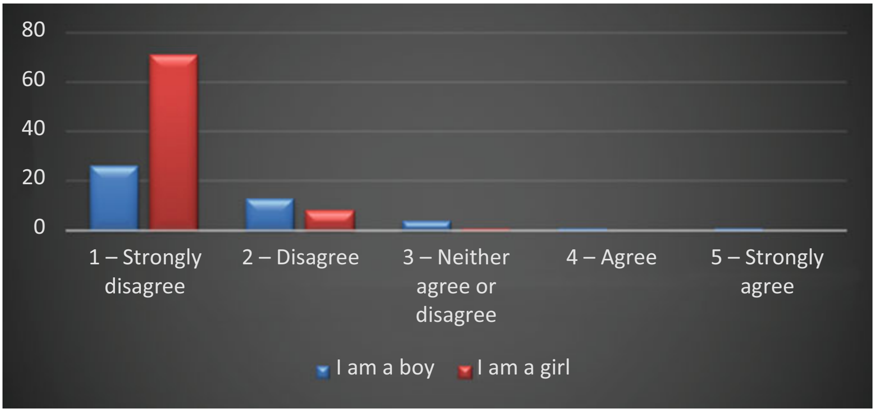

Fig. 6.4 Gender distribution of answers to the statement "Boys are more likely to succeed in scientific matter" (absolute numbers)

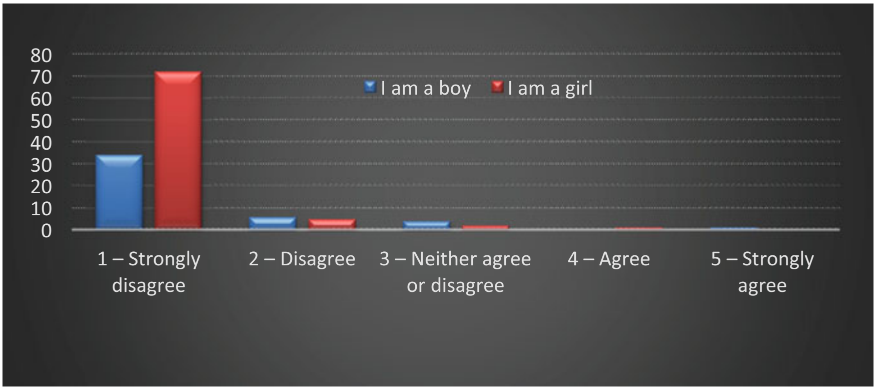

Fig. 6.5 Gender distribution of answers to the statement "Girls do not fit with scientific career because they badly manage anxiety and stress" (absolute numbers)

With the last item we aimed to explore social prejudice on how students perceive the stereotype according to which women should do a more flexible job, having to take into more consideration family-care responsibilities. Even if data showed that there is no prejudice concerning this issue, it is relevant to underline the high polarization of girls (almost the 50% of the sample) that expressed a very strong disagreement (Fig. 6.6).

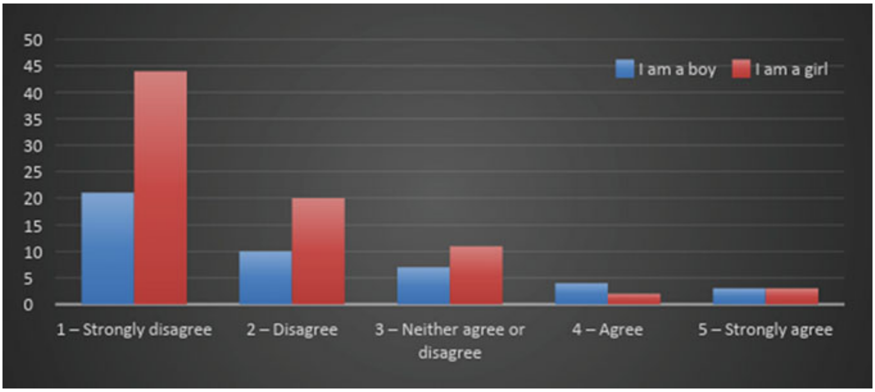

Fig. 6.6 Gender distribution of answers to the statement: "Scientific work presents complex working hours, women should have a more flexible job to take care of family" (absolute numbers)

6.4.3 How to Read the Student-Generated Contents/Products

Research teams from INFN and CNR produced a framework to analyze the student-generated contents, which had already been tested on the videos produced within the school competition. The student-generated contents framework aimed to analyze the relevant contents dimensions of the videos produced by students revealing the different communication layer and the characters' profiles and roles.

The framework presented below allows the analysis of the women in science theme but can also be used for contents in other disciplines.

The structure covers the following thematic areas:

- Editor's demographic data
- Demographic data of the characters presented in the storytelling
- Target audience
- Abilities (extraordinary/ordinary) of the characters present in the storytelling
- Characters' costumes and clothes
- Characters' social status (power in relationships, workplace or social group)
- Characters' transformation (modification of the status or of the explicit rules during the storytelling) (Fig. 6.7).

6.5 Discussion

The current study presents the results and the lessons learned from a high school competition organized with the aim of fostering students' critical reflections on women's role in science.

The preponderant participation of scientific high schools in the competition could be attributed to the topic of the competition, as well as to the closer presence of science teachers to the "gender in science" theme. It is relevant to take into account the relative low number of the participants from the classical lyceums, revealing a lower interest among the teachers and the students of those types of schools for the competition topic.

The high participation of female teachers highlights that women are closer to this kind of theme. Relevant is also the low percentage of groups led by mixed-gender groups of teachers (only 1%), revealing how difficult it is for different gender teachers to work together on such a topic and competition. Possible explanations could refer mainly to logistical reason (in organizing a double presence in the classroom) and secondly to the resistance of teachers for working in mixed-gender groups. This aspect would need to be further analyzed to better understand the causes behind the low collaboration among teachers.

The higher percentage of female students (compared to males) that answered "somewhat improbable" and "not probable" with reference to the possibility of becoming a scientist in STEM can be related, considering the OECD (2015), to

Structural data:		
Title of the product		
School typology		
Classroom		
Number of students by gender		
Number of foreign students by gender		
Town		
Town dimension		
Gender of the teacher coordinating the project		
Field of science of the teacher coordinating the project		
Synthetic product description:		
Title analysis	Language, title style, other.	
Topic: video refers to STEM or only to Physics		
Description of narrative and technical features:		
Narrative style	Presence or absence of the music	
	Music genre	
	Opinion about the music chosen	
	Use of animations:	Drawing
		Filming
		Technical difficulties
Typology of narrative style:	Fiction (students are actors)	
	Documentary	
	Personal testimony	
	Interview	Interviewed students,
		Interviewed university students,
		Interviewed teachers,
		Interviewed researchers
		Interviewed scientists
		Press report
	Other	
Women and men social representation:		
Historic reconstruction (it talks about the professional life of major female scientists)		
It takes evidence form statistics:		
It uses female scientists examples:	Historic (e. g. Marie Curie.)	
	Living person	
	Female scientists who succeeded during their life	
	Female scientists who got recognized after passed	
	Not so popular female scientists	
	List of the names of the scientists cited	
Female scientist images:	Iconic	
	Popular	
	Classic	
How female scientist images are represented:	Youth or elderly	
	At work, or somewhere else (to be specified)	
Visual traits, how they are represented:	Smiling	
	Serious	
	Peevish	
	Others (to be specified)	
The use of language:		
Cited values (e.g. culture, freedom)		
Use of adjectives while referring to women or men in the video		
Use of idioms		
Attention paid in using a neutral language		
Presence of prejudices		
Other		
Final message:		
Clear		
Emphasized		
Exhortative		
Metaphoric		
Other.		
Audience:		
The video is directed to a specific audience/target?		
If yes, to whom?	Students, general public, other.	
Students roles in end credits:		
Production		
Direction		
Editing		
Actors		

Fig. 6.7 Framework proposal on how to read student-generated contents

the low female perceived self-efficacy (Bandura 1977). Women tend to underestimate their skills and capabilities, and for this reason, they do not consider themselves as capable in fulfilling a scientific position. In what regards perceived obstacles for pursuing a scientific career, a factor that may hold back students, especially girls, is a lack of confidence in their own abilities and self-beliefs that could have an impact on learning and performance on cognitive, motivational, affective and decision-making levels (Bandura 1977; OECD 2015).

Regarding the perception of students in being supported by teachers and parents in becoming a scientist, equally registered for boys and girls, in our opinion, it reflects the gender-neutral support that teachers and parents offer during high school. In this sense, most of the prejudices are built in social contexts along with some early masculine characterization of the society, transmitted already at kindergarten and elementary school level (Bian et al. 2017).

The general disagreement with the stereotype "Boys are more likely to succeed in scientific matter" registered in the participating students can reasonably be strictly correlated to the participation in the school competition that raised awareness among students and stimulated dialogue within the classrooms and with the teachers regarding gender stereotypes. Agreement with this stereotype is still persistent in a small number of respondents, but this could in part be related to a spirit of adolescent conflict that has no relationship with the "gender in science" topic (Blankenburg et al. 2016).

Studies conducted by Long et al. (2016) show that students enjoy video creations as a learning tool because they can control the experience and they easily understand contents. It is also proved that this media instrument is more effective than the abstract way of analyzing the contents usually put in place by traditional school education (Buckingham 2007; Hobbs 2011; Hobbs and Moore 2013).

As suggested by Valente (2009), adding value to a process that leads from a crystallized knowledge (usually instilled by traditional scholastic scheme) by using fluid knowledge (provided by new learning tools) enhances meaningful knowledge. For these reasons, researchers, educators and teachers should consider the possibility of inserting new learning tools in the school curricula, shifting from a traditional way of conducting classes (instructor centered) to a more collaborative approach that enhances creativity and enthusiasm.

In our experience, the school competition turned out to be a very effective tool to sensitize students regarding Responsible Research and Innovation (RRI) topics and gender equality as a specific case study. According to our results, school competitions could be used as an educational tool for high-school students, with a relevant impact on group learning dynamics, increased awareness and active involvement of teachers.

Even if the results of this study are in line with those of similar studies, the context of the implementation of this case study limits the generalizability of the findings. The preliminary findings from the ex-post questionnaires, aimed at investigating the opinions of the students participating in the competition, represent an Italian case study, including a random sample of schools around Italy.

The evaluative student-generated contents framework we produced was tested on the specific topic “women in science” so further research is necessary to test the proposed framework with reference to other topics.

Finally, another relevant aspect of this experience is represented by the innovative collaboration between two major Italian research institutions on the specific topic “women in science” which also led to an internal debate on how to best tackle gender equality and gender prejudice in research organizations.

References

Bandura A (1977) Self-efficacy: toward a unifying theory of behavioral change. Psychol Rev 84(2):191–215. https://doi.org/10.1037/0033-295

Bian L, Leslie S, Cimpian A (2017) Gender stereotypes about intellectual ability emerge early and influence children’s interests. Science 355:389–391. https://doi.org/10.1126/science.aah6524

Blankenburg J, Hoffler TN, Peters H, Parchmann I (2016) The effectiveness of a project day to introduce sixth grade students to science competitions. Res Sci Technol Educ 34(3):342–358. https://doi.org/10.1080/02635143.2016.1222361

Bruner JS (1966) Toward a theory of instruction. Belkapp Press, Cambridge

Buckingham D (2007) Beyond technology. Children’s learning in the age of digital culture. Polity press, Cambridge

Cruse E (2006) Using educational video in the classroom: theory, research and practice. M.Ed., Curriculum Director, Library Video Company

European Commission (2015) She figures

Gender in Physics Day YouTube Channel: https://goo.gl/9ukD48

GENERA Website: https://genera-project.org

Goldman R (2004) Video perspective meets wild and crazy teens: a design ethnography. Camb J Educ 34(2):157–178

Hobbs R (2011) Digital and media literacy: connecting culture and classroom. Corwin, Thousand Oaks

Hobbs R, Moore DC (2013) Discovering media literacy. Teaching digital media and popular culture in elementary school. Corwin/Sage, Thousand Oaks

Kearney M (2011) A learning design for student-generated digital storytelling. Learn Media Technol 36(2):169–188. https://doi.org/10.1080/17439884.2011.553623

Long T, Logan J, Waugh M (2016) Students perceptions of the value of using videos as a pre-class learning experience in the flipped classroom. TechTrends 60:245–252

OECD (2015) The ABC of gender equality in education: aptitude, behaviour, confidence. OECD Publishing, Paris

Swain C, Sharpe R, Dawson K (2003) Using digital video to study history. Soc Educ 67(3):154–157

Valente A (2009) Dal Metaplan all’Open Space Technology: integrare un percorso partecipato nella scuola. In: Valente A (ed) Science from specialists to students and back again. Biblink Editori, pp 39–56

Vygotsky L (1978) Mind in society: the development of higher psychological processes. In:. Cole M, John-Steiner V, Scribner S, Souberman E (eds). Harvard University Press, Cambridge