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Fostering Women to STEM MOOCs

The FOSTWOM Toolkit

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In the context of the *Fostering Women to STEM MOOCs* (FOSTWOM) project, we present here the general ideas of a gender balance Toolkit, i.e. a collection of recommendations and resources for instructional designers, visual designers, and teaching staff to apply while designing and preparing storyboards for MOOCs and their visual components, so that future STEM online courses have a greater chance to be more inclusive and gender-balanced. Overall, The FOSTWOM project intends to use the inclusive potential of Massive Open Online Courses to propose STEM subjects free of stereotyping assumptions on gender abilities. Moreover, the consortium is interested in attracting girls and young women to science and technology careers, through accessible online content, which can include role models' interviews, relevant real-world situations, and strong conceptual frameworks.

1 Introduction

The *Fostering Women to STEM MOOCs* (FOSTWOM) project (FOSTWOM – Connecting Women & STEM) is a three-year initiative approved for funding under the European Commission's Erasmus+ Projects. The project is coordinated by UPV, Universitat Politècnica de València, and the other partners are IST, Instituto Superior Técnico, CNAM, Conservatoire National des Arts et Métiers, KTH Royal Institute of Technology, METID, Politecnico di Milano, and two high schools, Colégio Amor de Deus (Cascais, Portugal), and I.I.S. Benedetto Castelli (Brescia, Italy). The FOSTWOM project intends to use the inclusive potential of Massive Open Online Courses (MOOCs) to propose STEM subjects free of stereotyping assump-

tions on gender abilities. Moreover, the consortium is interested in attracting girls and young women to science and technology careers, through accessible online content, which can include role models' interviews, relevant real-world situations, and strong conceptual frameworks. We consider that the usage of good practices in videos and online courses' design can give that sense of belonging that female students seek when entering STEM areas and encourage a new generation of women and girl scientists [12].

Universities and workplaces have made enormous progress in terms of gender equality⁵ in the past fifty years. Even historically male fields as business, law and medicine have greatly improved gender-balanced recruitment, and retention. Science, Technology, Engineering and Mathematics (STEM) areas have had less success in recruiting and retaining women in a gender-balanced way [6]. Women are still largely under-represented in these areas [27]). Globally, less than 30% of the world's STEM researchers are women [5]. Why are there so few women working as scientists and engineers, in particular in the digital fields, as only 18% of ICT European specialists are women⁶?

According to the European Schoolnet, STEM skills are becoming an increasingly important part for basic literacy in today's knowledge economy, since they are requested in order to ensure the citizens' confidence, knowledge and competences to participate actively in an increasingly complex scientific and technological world [11, 10]. However, the percentage of young women studying in computer sciences (CS) by 2018 in EU is around 24%⁷, of which only 60% go on to work in the digital sector (EU Commission Report, 2018). With this framework, European policies are demanding to build capacities and develop innovative ways of connecting STEM to society, namely among young people intending to attract them to STEM subjects in secondary and higher education and related careers [10]. Moreover, it is also known that there are multiple disparities in participation in STEM education across regions, cultures and gender in Europe which are blocking the full involvement and the empowerment of all citizens and talents.

Education, gender equality and reduced inequalities are an integral part of the 2030 Agenda for Sustainable Development, adopted by the United Nations General Assembly in 2015⁸, as distinct Sustainable Development Goals (SDGs) but also as catalysts for the achievement of all other SDGs. STEM underpins the 2030 Agenda

⁵See definition by the European Institute for Gender Equality, <https://eige.europa.eu/gender-mainstreaming/concepts-and-definitions>.

⁶<https://ec.europa.eu/digital-single-market/en/women-digital-0>.

⁷The numbers of female students in CS by 2018 in the UK and Brazil, for instance, are lower, being respectively 19% and 11% <https://www.stemwomen.co.uk/blog/2021/01/women-in-stem-percentages-of-women-in-stem-statistics>; <https://ec.europa.eu/digital-single-market/en/women-digital-0>.

⁸<https://en.unesco.org/sustainabledevelopmentgoals>.

for Sustainable Development, and STEM education can provide learners with the knowledge, skills, attitudes and behaviours required for inclusive and sustainable societies. Women and girls have the same/equal right as boys and men to know how STEM can be used to make a difference in the world.

Thus, special attention must be paid to science education of girls and young women, since their voices, expertise and creativity are crucial elements for sustainable development progress. However, they are being held back by discrimination, biases, social norms and expectations that influence the quality of education they receive. Although scientific studies show that there are no significant differences between boys' and girls' brains that are relevant to learning or education [9, 26], this misconception is still widespread in society, leading to boys' abilities in Maths and science being supported while discouraging girls who study these subjects/discouraging girls from studying these subjects [21, 14]. With this context in mind, FOSTWOM intends to use the inclusive potential of MOOCs [18, 25] to propose STEM subjects free of stereotyping assumptions on gender differences in abilities. Moreover, the consortium is interested in fostering young women's participation in science and technology, through accessible online content with relevant real-world applications within strong conceptual frameworks.

The motivation behind this project is based on the project team members' experiences on an everyday basis while teaching in STEM Higher Education Institutions (HEI), designing and producing MOOCs, and also applying MOOCs in blended learning methodologies. We know from experience that a lot of students are using MOOCs in flipped classroom strategies within UPV, IST and POLIMI's curricula [7, 13, 25, 22].

Based on the results and the analysis of data from previous research [12], and the project teams' own experiences, we propose some recommendations for filling the gap, and in particular, we advance several conclusions that we consider to be the important actions to take into account while building a gender balance Toolkit and the project's MOOCs. By a gender balance Toolkit, we mean a collection of recommendations and resources for instructional designers and teaching staff to apply while designing and preparing MOOC content, so that future MOOCs have a greater chance to be more inclusive and gender balanced. The FOSTWOM Toolkit has been disseminated through conferences⁹, the project's trainings and is still open for contributions on the website (can be accessed through FOSTWOM Toolkit (https://fostwom.eu/?page_id=2170)).

⁹It has been presented and discussed in sessions of Open Education Week 2020, Open Education Week 2021 (<https://www.openeducationweek.org>).

2 Gender Balance Toolkit

A MOOC, in our definition and practice¹⁰, is an online course aimed at unlimited participation and open access via the web and nowadays it often includes validated academic content designed and produced by faculty members and MOOC teams located at Universities. Within the FOSTWOM consortium, almost all HEI partners are MOOC producers with online courses designed in a multidisciplinary collaboration between teaching staff and the development team. Content experts, instructional designers, graphic designers and video editors, ideate and design the STEM content according to the pedagogical-scientific model of each online course [23].

It is our responsibility as MOOC developers and designers to promote gender equality and provide better opportunities for MOOC participants to access high-quality content in a gender-balanced environment. In addition, the virtual classroom offered by MOOCs may provide a more comfortable learning space for many female students [19] and the free and easy access to the online courses provided by universities may be providing opportunities for female participants to take STEM courses, especially females from less gender-egalitarian and less economically developed countries [6].

2.1 Key Principles

The FOSTWOM Toolkit does not seek to judge a MOOC and give it the status of “good” or “bad” or say this is right or this is wrong. Rather, it seeks to raise awareness around gender balance indicators and to get people to reflect, to use their critical sense and to be able to design MOOCs’ content in a more inclusive way, so that the content of the MOOCs reach more people (and, specifically for STEM MOOCs, to reach more girls) who want to learn. The Toolkit will also provide practical examples of what gender-biased and gender-discriminatory communication is and how to avoid it. The guidelines that are included in it are still an on-going process: in the first stage we defined the key guidelines according to the conclusions of the project’s needs analysis [12]; in the second stage, based on our experience as MOOC teams and producers, we defined the stakeholders to be addressed in the guidelines; and presently the toolkit is a work-in-progress tool under evaluation by the MOOC teams that are producing the FOSTWOM’s online courses and the MOOC community, at large.

¹⁰According to Wiki’s definition this will be a close definition of a xMOOC.

During our previous research that constituted the needs evaluation analysis [12], we were able to identify several principles to fostering young women into science and technology education and careers [16]¹¹, specifically through MOOCs.

For making awareness of gender stereotypes in STEM content and activities, we shall avoid female invisibility in STEM subjects and STEM MOOCs, in particular, help girls to recognise their relevant skills, use a discourse that value growth, not “born talents”; also use of inclusive MOOC graphic design that do not resonate exclusively with male participants, and other key online activities for building self-confidence and career aspirations [16]. More specifically, thinking on the identified stakeholders the FOSTWOM Toolkit should provide tools to:

- Make women working in the STEM subjects, researchers and other role models more visible;
- Make women involved in STEM MOOCs, female teachers, professors and lecturers more visible;
- Avoid gender stereotypes in STEM content and activities;
- Use inclusive graphic design: images, colours, avatars and videos, that break gender norms and are not aimed solely at male participants;
- Use real-life applications of relevant content for STEM careers, which include both women and men;
- Design assessment and learning activities in a gender-conscious way;
- Make visible the diversity and variety of competencies (both soft and hard skills), experiences, perspectives and representations needed among practitioners in the STEM area;
- Promote a gender equality discourse that highlights and problematizes women’s under-representation in STEM, and points to the consequences it may have for problem formulation (e.g. risk of lack of a broad user perspective), product design, research, innovation, etc.

Then, as MOOC producers, thinking practically on a toolkit that could help to design and evaluate gender balance in online courses, we have identified the following MOOC stakeholders: content experts, MOOCs’ team development members, participants/students. Finally, not only in analysing existing STEM MOOCs so that they can raise their awareness on biases, but also in helping them to contribute to future STEM MOOCs free of gender stereotypes.

¹¹See also Microsoft Action Guide in <https://www.microsoft.com/en-us/corporate-responsibility/skills-employability/girls-stem-computer-science>

2.2 Toolkit for Whom?

The checklist within the Toolkit can be used by any person or institution that wants to develop MOOC content with gender balance or check if the offered MOOCs respect gender balance. We expect the Toolkit to be especially useful to institutions wanting to create an institutional policy of gender balance in their MOOCs and online learning production. Institutions willing to do so will find in the FOSTWOM Toolkit a great starting point in devising their own policies.

If you were considering designing and developing a MOOC that incorporates gender balance, we recommend reading the guidance before beginning this process. If your question is to what extent a given MOOC has a comprehensive gender balance level, then you could use the checklist tool. The FOSTWOM Toolkit can be found at our website https://fostwom.eu/?page_id=2170. It is presently, and during the all period of the project, open to comments and suggestions from the public: the aim is to collect feedback to be analysed before every new release during the project lifecycle. At the end of the project, the Toolkit will be released with a CC license so that anyone can adopt and adapt it to their own scenario. The role you play in the creation and development of the MOOC is also an essential element in the identification of the approaches you should consider. Next, we describe different points of view when addressing the task of defining the content, images and videos of a MOOC.

Content Experts

The autonomy of the content expert may vary widely according to the approach defined by the MOOC team, or the production process followed by the HEI. In general, MOOCs provide a natural environment for a constructive alignment of teaching and learning with more students enrolling from a wider diversity of background [4, 24]. In STEM areas this is also the case, since STEM MOOCs enrollees range from “surface learners” (only concerned with memorization of definitions) to “deep learners” (engaged in understanding and ultimately changing as a person), having in between “strategic learners” (who aim for good grades with minimal effort) [20]. FOSTWOM project aims for the “deep learners”, not forgetting that we want to have among them a significant group of female students [12].

A good answer for dealing with the challenge of current diversity of students, in particular female students, is therefore the theory of constructive alignment, which is based on aligning the principle of students’ learning by doing with the teacher’s goal of obtaining significant learning outcomes from teaching [3]. This principle of alignment can also be found in the Universal Design for Learning

(UDL) Guidelines¹², which is a tool used in the implementation of UDL, a general framework to improve and optimize teaching and learning based on scientific insights into how humans learn, involving as many people as possible in the process. Both methods underline a discourse that value growth over “born talent”, consider a diversity of approaches over “lecturing”, and are capable of foster online activities for building self-confidence based on experimentation.

On the other hand, besides applying a constructive alignment of content, learning methodology and assessment activities, the teacher must adopt the role of a facilitator of learning [15]. Not only because the learning process is linked to sharing personal and common experiences with students, but also because students in a MOOC lack, even more than in face-to-face classes, the sense of self-monitoring and self-regulation which can lead to poor learning outcomes [15]. Since the development of all these competences is a challenging goal for the majority of content experts, those with higher levels of communications skills along with expertise in the field would be perfect candidates for being the advocates of a gender balance discourse in STEM subjects [12].

Visual Designers

The role of the visual designer of the MOOCs may not be evident for people who are not involved in the creation and development of courses. Since online learning has to be prepared to be performed in a variety of platforms, a professional task needs to be done. In addition, they can create better graphical representation for concepts based on creative briefs through artwork and layouts for digital projects.

The communication between content experts and visual designers, often facilitated by the instructional designer assigned to the MOOC project, is crucial for avoiding misunderstandings as regards to gender biased, stereotypical, images and/or videos. Besides, the visual designer should be aware of the importance of selecting or creating gender-balanced situations.

The main tasks of the visual designer usually include:

- Ask questions to the content expert(s) in order to catch the spirit of the MOOC (or course) project and – when possible – propose gender-balance oriented solutions to each choice to be made from a visual perspective;
- Accompany the content expert, with the support of the instructional designer, in choosing an appropriate graphic coordinated image for the course, also in consistency with any already existing elements; it is beneficial to have a gender-conscious perspective throughout the process of designing logos, colours and

¹²See more details in <https://udlguidelines.cast.org>.

fonts to avoid the graphics contributing to stereotypical gender markings of the subject;

- Provide suggestions and examples for the graphic and video elements to be creatively designed from a diversity perspective;
- Read carefully all storyboards provided by the content expert from a visual perspective, in order to verify if the balance between spoken text and images and keywords is effective in videos, attractive to a heterogeneous audience;
- Provide suggestions and alternatives whenever possible if there is a lack of (not only gender related) balance in the storyboard.
- Receive graphic elements from the content expert and provide alternatives consistent with the intended learning outcomes in order to improve the final product, as far as possible, using image stock libraries in a gender-aware way.

Instructional Designers

Instructional designers create effective, engaging learning experiences, working side by side with content experts and visual designers. Their role is to coordinate the efforts provided by all professionals involved so that the final result is as effective and pleasant as possible, according to all elements and variables considered. They draw on best practices from education, design, educational psychology, pedagogy theories, systems theory, and creative writing to provide learning experiences for multiple and diverse target users.

While trainers or teachers deliver instruction to a live audience, instructional designers work behind the scenes. The instructional designer role determines how the learning experiences and materials should be created so that learners achieve the expected learning outcomes. Usually, they are responsible or involved in tasks related to the (re)definition of courses, or even the development of entire new courses. The elaboration of new training materials and curricula, such as teaching manuals, tutorials and student guides, is also one of their main responsibilities. Overall, the instructional designer may be the person in charge of controlling characteristics of the course that cannot be controlled by the content expert.

The following are tasks usually tackled, among others, by instructional designers when involved in MOOC design and production (FOSTWOM elaboration starting from [17]):

- Assist faculty in discovering methods of improving their instructional design skills with and without technology;
- Guide content experts in designing their courses with the support of innovative learning methodologies so that the design works for all participants;

- Guide content experts in understanding the opportunities and challenges related to the MOOC platform in use also in terms of accessibility for a heterogeneous student body;
- Coordinate the dialogue between the content expert and the visual designer in order to support both of them in finding the most effective solutions to accompany learners in their path, also from a gender balance perspective;
- Support the visual designer in making choices around images and video elements (or already existing content) when parts of them – in addition to graphics – need an improvement, also when related to gender balance;
- Design and choose/adapt templates for key documents to be used by content experts: storyboards, exercises, short explanations, instructions, etc.
- Keep track of the design process and support the content expert in monitoring the consistency between the intended learning outcomes and the content of the MOOC, including assessment, during the whole process.

Thanks to the FOSTWOM Toolkit, we hope the Instructional designer can effectively support the content expert also in taking constantly into account all the gender balance variables that can be considered along the way.

Other Roles

There are more roles involved in the successful development of a MOOC, namely Teaching assistants, Mentors/community manager, System Administrators. Since they are of key importance in the development of MOOCs, we want to stress the importance of considering gender balance in MOOC production since the beginning.

For all these roles it is important to have in mind that they should be inclusive to both genders in all communications. Gender-aware language considerations are a must. A good reference for this is the Toolkit on gender sensitive communication from the European Institute for Gender Equality [8].

2.3 Evaluating the Toolkit

In summary, the Toolkit will provide a useful set of tools for online courses considering gender balance during its design and development. We think developing inclusive and stereotypes-free MOOCs about STEM subjects that can attract and support girls and young women to study and work in these fields. Furthermore, we hope that the use of this Toolkit promotes gender-equality training and can help

all genders to recognize situations of gender inequality in careers soon enough to correct them or implement alternative solutions.

The FOSTWOM Toolkit has been already disseminated through conferences and the project's webinars and website. We count to include the most relevant comments from the audience of those conferences, webinars and trainings into the final version of the Toolkit. Moreover, we are currently producing a MOOC targeted at teaching staff, instructional and graphic designers. This MOOC will include awareness of gender-balanced STEM content and activities, will give examples that help to analyse former MOOC practices through the lens of inclusion, as well as instructions on how to use the FOSTWOM Toolkit. Naturally, all the examples come from our MOOC experience, but the final version will be released with an open licence so it can be reused and adapted to different cultures and also to different MOOC production processes.

Since the purpose of evaluating FOSTWOM Toolkit is primarily to improve and to develop, the focus will be on qualitative methods for evaluation where opinions and views can emerge continuously during the process in dialogue with stakeholders and reference groups. [1, 2]. In a longer time perspective to see what benefit and what effects it can have in the long run, we will report both on the spontaneous individual feedbacks, informal conversations, and on the answers to focus groups interviews applied to MOOCs' partners teams and other MOOCs teams willing to use the Toolkit.

3 Conclusion

FOSTWOM Toolkit (see https://fostwom.eu/?page_id=2170) is designed to be easy to apply in everyday usage. In order to fulfil that requirement, we recognize that the different roles in the MOOC production process may have a limited scope in what they may do. Thus, we have built two different checklists: one for content experts and another for visual designers. Instructional designers are expected to use both, together, and keep under control the consistency between the two.

In applying FOSTWOM Toolkit checklists, follow the main principles. REFLECTION from a gender and diversity perspective is the guiding principle. It is a process (learning new skills and professional development) that requires time. A good starting point is to go through the checklist, preferably together with other people involved in MOOCs, to get started thinking and reflecting on how inequality affects teaching and learning in your specific teaching subject. Sensitive contexts may require an inclusive approach as the one proposed in the Universal Design

for Learning (UDL) Guidelines¹³, taking into account different perspectives. Local culture and language are important. Consider how this checklist applies to your culture and specific language issues, but also consider that MOOCs may be used by anyone in the world.

Finally, do not look at single items, but at the overall result of having a better gender-balanced MOOC. All questions should be written affirmatively, so that all respondents understand the content easily. Consider also adopting the Toolkit and adapting it to your own institutional scenario: it will be released with an open license to allow anyone to do it.

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¹³See more details in <https://udlguidelines.cast.org>.

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