STEM Education for Young Women via Heroic Narratives: Evaluating the Heroine's Learning Journey

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ABSTRACT

The Fostering Women to STEM MOOCs (FOSTWOM) project aims to increase the number of women in STEM careers through the participation of young women through free-access Massive Open Online Courses (MOOCs). One of its actions was the conception of the Heroine's Learning Journey (HLJ), a framework structured into 3 acts and 12 stages, which employs a heroic narrative to inspire and empower young women, between ages 15 to 21, to persist in their pursuit of STEM studies. This framework is strategically tailored for online learning environments, specifically MOOCs. This study assesses the effectiveness of the HLJ through a survey involving 12 educational specialists affiliated with the FOSTWOM project. Results reveal that in terms of motivation capacity, all HLJ stages received a minimum of 60% positive ratings, and it was pointed out the need for improvement of two stages. Educators can harness the HLJ model to develop MOOCs that cater to gender equality needs within STEM fields.

CCS CONCEPTS

• **Social and professional topics** → Computing education.

KEYWORDS

Women, STEM, Heroic Narratives, FOSTWOM, MOOCs, Gender Equality, Education

1 INTRODUCTION

Women in Science, Technology, Engineering, and Mathematics (STEM) face challenges encompassing the social construction of ideas they have been exposed to since childhood. Girls are often told to be better suited for caregiving activities [29], while STEM provides lower expectations for success by themselves, peers, teachers, and parents [36]. Upon entering a STEM-focused course, in addition to the negative perception they have received throughout their lives, women still encounter predominantly masculine language, prejudice, and exclusion due to being minorities, with their ideas not being heard equally or even having space to express themselves. Therefore, it is crucial for any course aimed at training women in STEM to pay special attention to motivating young women, both for their initial entry and their continued engagement throughout their education.

The Encouraging Women to STEM Massive Open Online Courses (MOOCs) Project (FOSTWOM) [16] is a three-year initiative that began in early 2020, partially funded by the European Commission's Erasmus+ program – KA2 Cooperation for Innovation and the Exchange of Good Practices – Strategic Partnerships for Higher Education. Among its objectives, the project aims to harness the inclusive potential of MOOCs to propose STEM areas free from gender stereotypes regarding skills. The consortium is committed to attracting women and increasing the number of young women pursuing careers in STEM.

The consortium has been committed to promoting the participation of young women through accessible online content and freely accessible MOOC courses, with relevant real-world applications clearly explained from a conceptual perspective. Among the project's top priorities are the outcomes aimed at increasing the number of female students and learners enrolled in STEM courses, both at the higher education level and as participants in STEM MOOCs. The FOSTWOM project involves several deliverables, including a report on best practices for gender balance in MOOC courses, a toolkit for producing inclusive MOOC courses, the creation of new MOOC courses in collaboration with partners, a MOOC analyzing gender balance perspectives, training sessions for educators on making inclusive MOOCs, and the dissemination of project results through events, webinars, and conference presentations.

One of the main contributions of the FOSTWOM project discussed in this article is using a framework to motivate young women to enter STEM fields. The reference model used was the Heroine's Learning Journey (HLJ), which aims to empower young women, primarily between the ages of 15 and 21, by helping them improve their STEM skills and motivating them to continue their studies. In this work, we present the evaluation of the HLJ, carried out by 12 teachers and MOOC content experts, who are part of the FOSTWOM Project. We expect that educators can use the HLJ model to produce MOOC courses that address gender equality needs in STEM areas. The evaluation methodology can also be adapted to evaluate new educational models, especially the ones focused on presenting narratives to stimulate students.

This work is organized as follows: section 2 discuss related research to this work. Section 3 provides a theoretical background about the Heroine's Learning Journey. Section 4 presents the methodology used to evaluate the HLJ. Section 5 shows results, which are

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discussed in Section 6. Section 7 presents our conclusions about this work and research opportunities.

2 RELATED WORK

To analyze the data on female participation in Europe, the FOSTWOM Project has identified, for example, that the percentage of young women studying computer science in the European Union is around 24% as of 2018, of which only 60% pursue careers in the digital sector [21]. Recognizing the field of Computer Science, particularly Machine Learning and Data Science, as crucial for current and future activities in the global society, the project believes that women should have equal access to higher education and careers in these areas.

Aligned with European policies that require capacity building and the development of innovative ways to connect STEM fields to society, the FOSTWOM project proposes to engage with young women, attracting them to STEM disciplines in secondary and higher education and related careers [21]. Girls and young women should be encouraged in STEM education, as they have an equal right to understand how the field can positively impact the world [2]. Jacqmin et al. [2] state that discrimination, biases, social norms, and expectations hinder young women's education quality. Female contribution is crucial for advancing sustainable development [2].

We highlight the research from Reis et. al [31], which explores the development of a strategy for incorporating issues related to the female gender into a computing introductory course. Their methodology has 13 phases and has been implemented since 2019. The primary objective is cultivating computational, critical, and systemic thinking skills. The course is organized on the Moodle platform, where each phase represents a topic comprising a narrative, challenge, instructions, and a survey. Student activities are submitted online, creating a portfolio within the "Delivery Forum." The teaching approach involves a flipped classroom method, encompassing pre-class, in-person class, and activity review segments. Student progress is assessed using XP, with a cumulative total of 100 XP. In Phase 13, self-assessment converts XP into a final grade, calibrating scores achieved in phases 01 to 12. To integrate a gender perspective into the course, two pivotal themes related to the feminine context were selected. These themes align with the objectives outlined in the United Nations' Sustainable Development Goal 5: female empowerment and discrimination against women. The course content is structured to address these gender-related issues throughout its phases, emphasizing the importance of fostering awareness and understanding of gender-related topics from the outset of the computing curriculum.

Outside the FOSTWOM project in Europe, we also gathered several initiatives in the Brazilian context that have emerged nationwide to promote the inclusion of young women, aiming to provide equal opportunities and combat gender inequalities. In this text, we will present three initiatives, highlighting their main characteristics and impacts on the lives of young Brazilian women.

The Hack Grrrl [30] is an initiative to address women's low representation in hackathons, even within multidisciplinary teams. The authors developed an exclusive event for female participants to identify potential motivational differences between men and women to create a more inclusive and appealing environment. The Hack Grrrl is based on previous studies and has stood out for encouraging women's participation in technology, enabling them to develop their skills and showcase their talents.

The Meninas Digitais (Digital Girls) Program [24] promotes Computer Science in elementary and secondary education and strategies to implement the initiative throughout Brazil. According to the article, male participation is essential to promote the inclusion of women in the field, as it is beneficial for all involved, including the growing interest of companies in supporting the movement. Through the Meninas Digitais Program, young female students can develop skills and competencies in technology and meet professionals who can serve as role models in their careers.

The Meninas na Ciência (Girls in Science) project [1] encourages high school female students to pursue careers in Science and Technology in Brazil, believing that practical experiences such as workshops and research projects can spark their interest in the field. The study selected four girls between the ages of 15 and 17 to participate in workshops on Sustainable Energies, Educational Games, and Satellites. They conducted workshops alongside a Basic Robotics Course and a Sustainable Manufacturing Course comprising ten classes. Through their participation in the Meninas na Ciência project, the students can learn and engage in technology-related activities, which can motivate them to pursue careers in this field.

3 THE HEROINE LEARNING JOURNEY

The Heroine's Learning Journey (shown in Figure 1) is a learner-centered methodology around the Heroine. Character-centered learning Journeys focus on using stories or fictional characters to help students understand complex concepts in a more accessible and memorable way. In this context, the HLJ serves as a narrative for STEM students' internal challenges as they strive to overcome their fears and challenges in the educational environment, ultimately becoming learner heroines. The HLJ aims to empower young women, primarily between the ages of 15 and 21, by helping them improve their skills and motivating them to continue their studies. This empowerment of young women is achieved by guiding the acquisition of new skills and knowledge, presenting inspiring role models, and supporting the confidence and self-regulation of young learners. The HLJ was developed as a methodology to address the challenge of low female participation in STEM fields.

The Heroine's Learning Journey is divided into 3 acts and 12 stages. A brief description of each stage is provided on the Heroic Journeys' website[1], and below, we present the 3 acts:

The HLJ uses – besides Narratives – several motivational theories, including Self-Determination Theory, Project-Based Learning, and Self-Regulated Learning [18]. We briefly explain these motivational theories:

(1) **Act I - Empowerment (Stages 1-5):** In the initial phase, the learner must face the challenge of transitioning from their ordinary world, acknowledging the present state of their beliefs, to a new realm that promises fresh insights and life perspectives. This stage employs motivational strategies to enhance confidence and convert fear into strength. The outcome of Act I is the emergence of an empowered learner.

[1] https://heroicjourneys.life/journey-heroine/

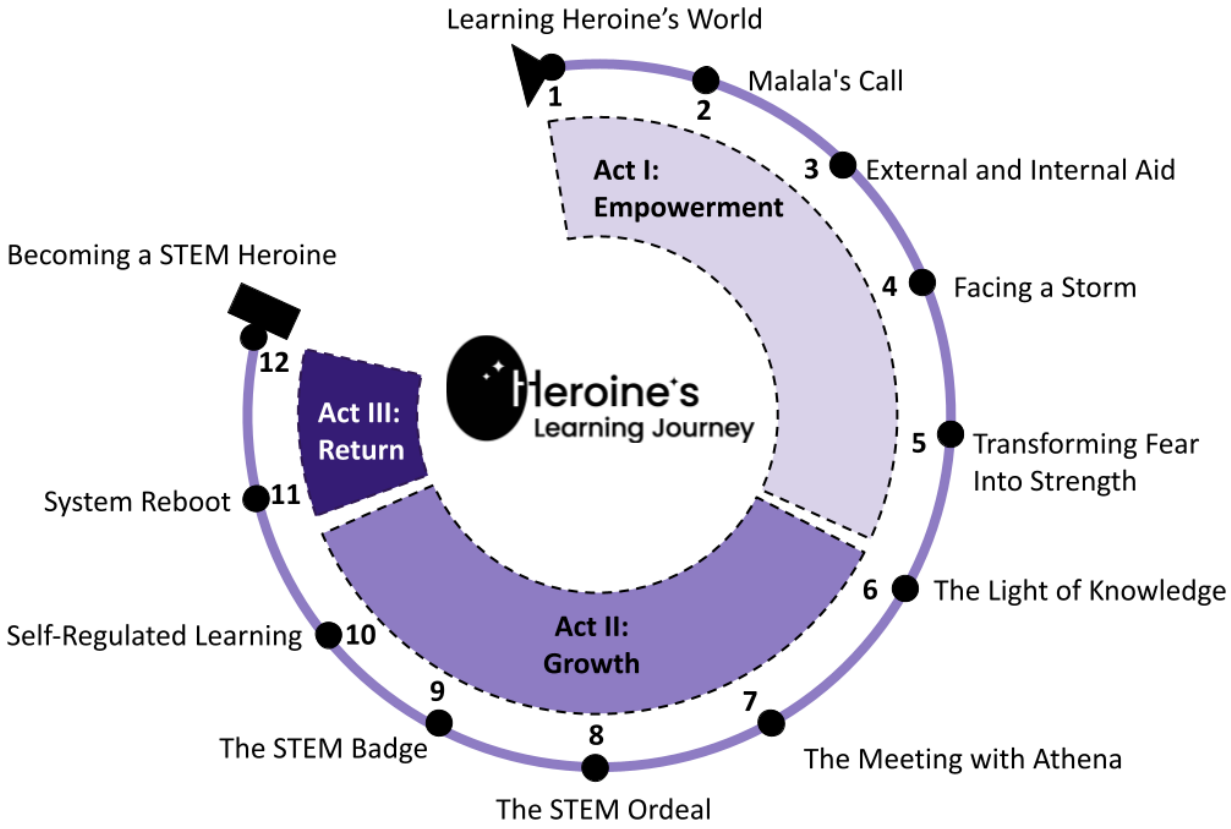

Figure 1: The Heroine's Learning Journey Acts and Stages.

(2) **Act II - Growth (Stages 6-10):** The second act encapsulates the journey itself, facilitating skills acquisition. If necessary, the learner is encouraged to identify and collaborate with allies to surmount diverse tests and challenges, ultimately attaining a rewarding outcome for their dedicated efforts. Throughout Act II, students evolve into a renewed and improved version of themselves. Should the need arise, stages 4, 6, 8, and 9 can be revisited to optimize the course structure, supporting subtopics or extended programs.
(3) **Act III - Return (Stages 11-12):** The third act is characterized by a definitive transformation and recognition of the learner as true heroines. These heroines subsequently extend their support to other learners embarking on their journeys. Act III culminates in the Heroine's return, equipped to assist other young women.

We highlight that while some courses may opt not to depict students as heroines in subsequent editions, it is essential to provide students with an opportunity to reflect on their learning. Consequently, stages 11 and 12 can be alternatively implemented by soliciting a learning report, wherein the learner delineates their acquired knowledge and narrates their journey experiences.

For each stage, we define four main characteristics: Challenge, Mission, Story, and Aid. On the other hand, the learning structure of each stage involves planning, learning, and reflecting on the progress of acquired skills [18].

The narrative features a central conflict, encounters with fictional characters, underlying mystery stories, and many other details, most of which have been previously applied as motivational tools in education [4]. Feedback moments are designed to strengthen students' confidence and enhance their additional motivation [32, 33]. The epic scenario provides intrinsic motivation [25]. The HLJ is inspired by the Hero's Journey [10] and the Heroine's Journey [28], and it follows the traditional three-act structure [39], consisting of twelve stages.

The Heroine's Learning Journey uses – besides Narratives – several motivational theories, including Self-Determination Theory, Project-Based Learning, and Self-Regulated Learning [18]. We briefly explain these motivational theories:

- **Self-Determination Theory** (SDT) was proposed by Ryan and Deci [33] as an empirically-based organismic theory of human behaviour and personality development. The theory emphasizes the importance of competence and autonomy as key elements. When these needs are met, intrinsic motivation can arise, whereas when they are not fulfilled, intrinsic motivation is undermined [33]. Intrinsic motivation is associated with pursuing novelty and challenges, aiming at

exploration and learning, which can lead to creativity, task performance, and optimal experience [20, 33]. In educational settings, intrinsic motivation is crucial in high school [22, 38] and higher education, including STEM fields and women's education [19, 26, 27, 35, 41, 42]. According to Chua et al. [15], "the progress of our goal pursuit is influenced not only by what we do but also by what we receive." The importance of goals and their relationship with student performance has been studied in education [5–7, 15]. Additionally, online learning environments, which play a significant role in attracting students, have also been explored in the application of SDT [12–14].

- **Project-Based Learning** is a comprehensive teaching approach that engages students in investigation [9]. Within this framework, students seek solutions to non-trivial problems by asking and refining questions, debating ideas, making predictions, designing plans or experiments, collecting and analyzing data, drawing conclusions, communicating ideas and findings to others, asking new questions, and creating artifacts. However, implementing it requires a skilled teaching force [11]. Project-based learning in STEM fields focuses on measurable outcomes and can improve students' cognitive profiles and social skills, aligning with the demands of STEM careers [11, 37]. Project-based learning allows for identifying different moments where students must perform various tasks, thus playing a vital role in breaking down student activities into stages. Project-based learning has been extensively investigated and applied in software engineering education programs to improve students' cognitive profiles and social skills, aligning with the current demands of STEM careers that require social abilities such as communication, analysis, problem-solving, and teamwork [37].
- **Self-regulated Learning** refers to processes that students employ to transform their mental abilities, such as verbal aptitude, into academic performance skills, such as writing, to establish goals, select and deploy strategies, and self-monitor their effectiveness [44]. Zimmerman's Cyclical Model of Self-Regulated Learning divides students' learning processes and motivational beliefs into three self-regulatory phases: Forethought, Performance, and Self-reflection [44]. This model aligns with the separation of activities in project-based learning approaches, as activities in such courses can be categorized into these three self-regulatory phases. Zheng et al. [43] propose five cognitive processes of self-regulated activities: observation, formulation, reformulation, analysis, and evaluation. They indicate that reformulation and analysis are two self-regulatory activities that can improve learning. However, excessive observation, which can be mapped to self-reflection [44], may hinder learning [43].

To implement the HLJ model in a STEM course through an integration process, we have developed the Heroine's Learning System (HeLaS). HeLaS consists of a web application that allows educators, tutors, and educational teams to create and manage course materials following the methodology imposed by the HLJ. Specifically, HeLaS provides a way to develop materials for a course that follows the HLJ and integrate these materials into an existing Learning Management System (LMS), blending the information the LMS displays with display elements provided by HeLaS. The HeLaS diagram composed of all its modules is shown in Figure 2.

We make the HeLaS framework available on the Heroic Journeys' website. In this portal, we present concepts related to Heroic Journeys and provide the HLJ application framework in an agile and easy-to-use manner, containing instructions for use. This framework functions as an essential support system for educators, tutors, and educational staff, providing all the necessary elements to associate the candidate course with the stages of the journey. In addition to these usage instructions, we also introduce the roles played in applying the model. Among these roles, one noteworthy character is Athena, a fictional character who assists students throughout their journey. Athena provides crucial knowledge and information for the success of the Heroine candidate. Athena also represents Stage 7, "The Meeting with Athena." Unlike other allies, Athena embodies the sharing of knowledge and serves as a source of wisdom. The guidance this character provides always offers accurate information, essential tips, and direct access to relevant knowledge in the field of study.

Adapting HLJ to a candidate course allows the integration of all the course's didactic content into a separate infrastructure from the MOOC platform. The total time for information registration and combination in HLJ is estimated to be 2 to 5 hours, depending on the number of topics and course activities. This registration process can be carried out in stages and on different days and times, as the information is saved in the database after each registration step. To use the HLJ framework, we suggest a designated expert with prior knowledge of HLJ and the course content to occupy the role of Journey Designer and record information. Without a dedicated person for this task, the course instructor can perform it, but it is recommended to have a specific person designated as the Journey Designer. In addition to the course instructor and Journey Designer, HLJ offers optional roles called Allies, who are subject matter experts and can participate in extra activities to support students, such as mentoring through the Discord app, for example. The Discord app allows students to communicate instantly by exchanging text, audio, and video messages. Allies can also conduct extra classes, such as practical or pre-scheduled discussions, as informed by students. Another role provided by HLJ as an option is Tutors. Those with this role have a higher hierarchy than Allies, with the same rights but greater responsibilities. They are responsible for dedicating themselves throughout the course to supporting students on the online teaching platform, addressing doubts in the forums, and assisting with specific exercises in the Discord group. Each step includes a help link that provides instructions on registering for each stage to ensure a clear understanding of the information-filling process. Figure 3 presents examples of a course structured with the framework's support and examples of HLJ elements.

4 METHODOLOGY

The evaluation methodology for the Heroine's Learning Journey was conducted during a workshop organized by FOSTWOM, titled "Flipped Classroom with Gender Inclusive STEM MOOCs." The main objective of the three-day training session was to discuss

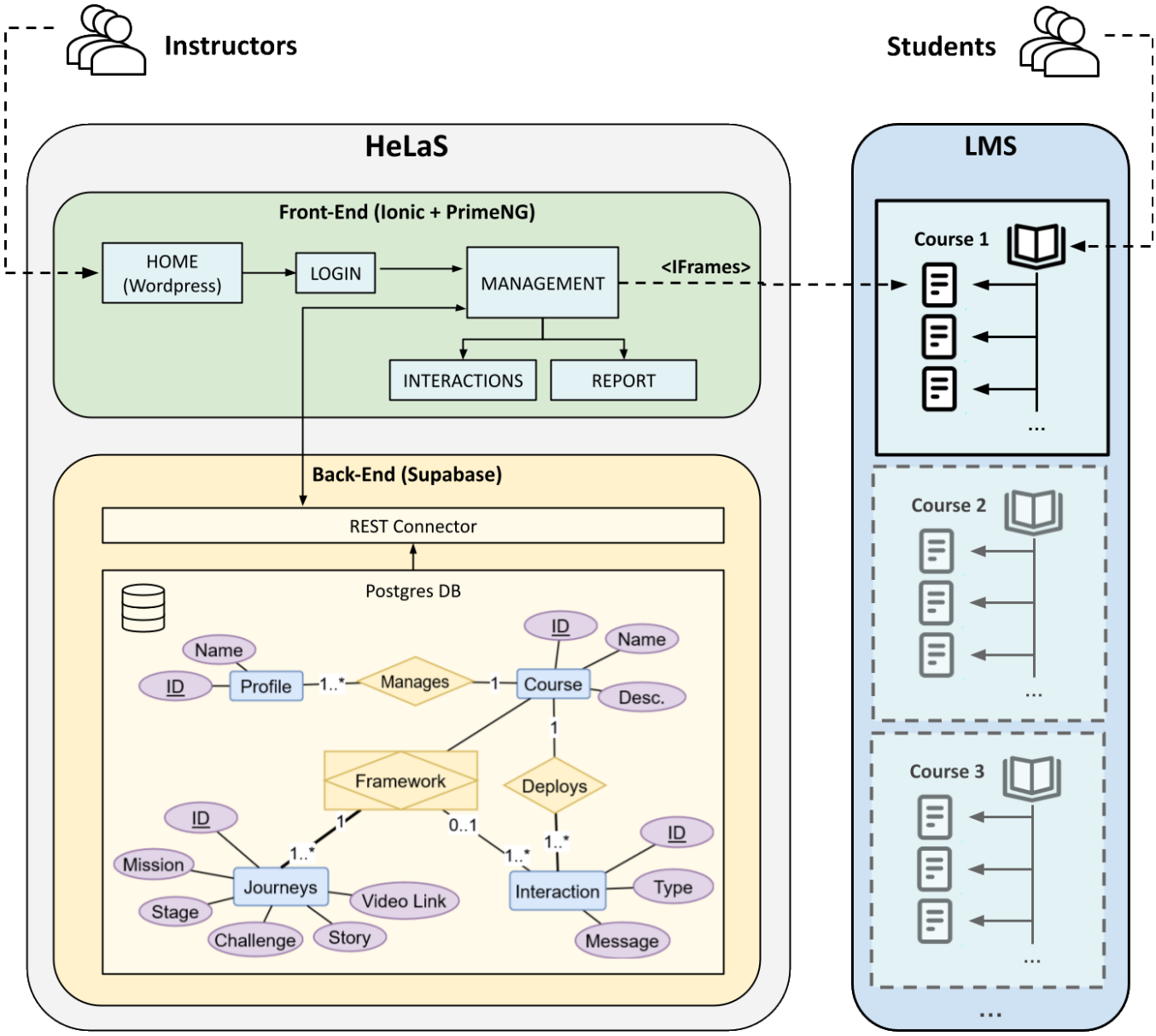

Figure 2: The HeLaS Diagram.

different strategies using STEM MOOCs, using the flipped classroom method [8, 23], to increase awareness of gender inclusion with online academic content. The "Challenges and Motivational Approaches: Heroine's Learning Journey" evaluation session aimed to conceptually assess the HLJ and its 12 stages (Figures 4 and 5).

We created an online module to share the content and discuss topics on the Technical MOOC platform of the University of Lisbon, and all experts were required to register in advance for the face-to-face sessions. We provided them the video presenting the HLJ (from PASC 2022 [3]), the poster presented at the 1st Pedagogical Conference of the University of Lisbon [34], and an article about the Brazilian case of gender equality initiatives in education [17].

During the workshop, the activities began with the organizers' personal and institutional introduction, followed by an overview of the event's agenda and individual introductions of each participant. Next, we provided an overview of the current gender equality situation in STEM, including data on women's barriers to entering and remaining in this field. Then, we conducted a persona development exercise for the target audience of the HLJ. We divided the participants into two teams, each responsible for creating a persona for one of the age extremes for which the HLJ was developed. We characterized the 12 workshop participants through the questionnaire to assess their demographic and professional characteristics, as shown in Table 1.

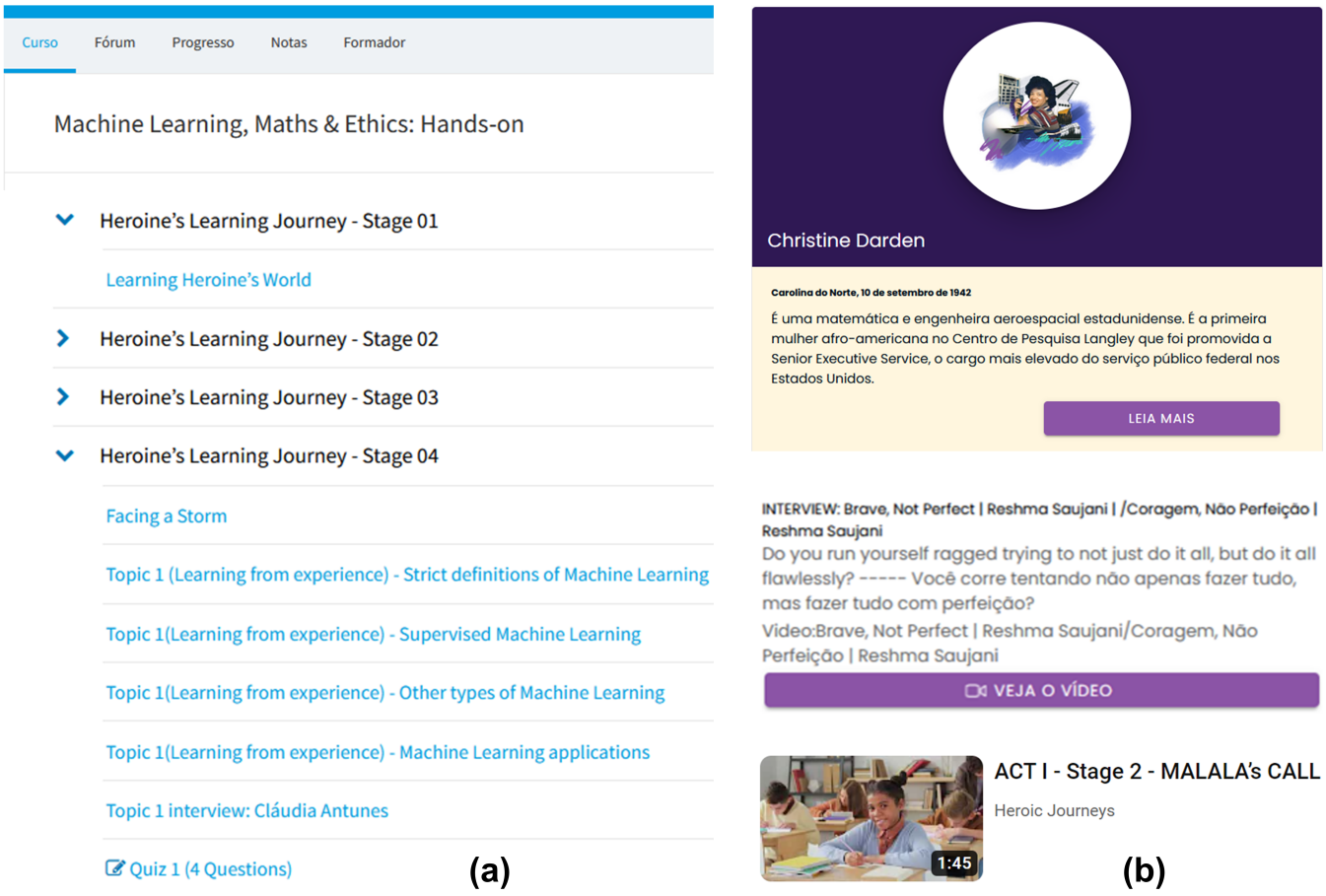

Figure 3: Course restructured with the HLJ model: (a) course structure with the stages, and (b) some of the elements of the HLJ inserted.

Table 1: Demographic and professional characteristics questions

Section	Question	Type
Demographic	In which country do you reside?	Open
Demographic	What is your age?	Open
Demographic	What gender do you identify as?	Closed (Female/Male/Other/Decline)
Professional Experience	What is your current position?	Open
Professional Experience	Where do you currently work?	Open
Professional Experience	How long have you been working in the Education sector? (in years)	Open
Professional Experience	Do you work in the STEM sector?	Closed (Yes / No)
Professional Experience	How long have you been working in the STEM sector? (in years)	Open

Afterward, we presented the motivational theories used by the HLJ, including Self-Determination Theory, Project-Based Learning, and Self-Regulated Learning and Narratives [18]. The heroic journey was presented, including the roles, narrative, and the process/software for adapting a course with the journey. A student's journey in a course applying the HLJ was then presented and evaluated. The group was divided into two teams again to assess the journey based on their respective persona.

Participants completed a questionnaire section at each journey stage, as shown in Table 2. They watched a video of the stage, accompanied by narrative, mission, challenge, and support information as needed to complement the video.

At the end of the stage evaluations, participants were asked to assess the HLJ as a whole, answering the questions presented in Table 3. Finally, the activity concluded with a farewell, announcements about future interactions, and collecting feedback.

Figure 4: Group of educators analyzing a HLJ stage

Figure 5: Environment organization

Table 2: List of questions made at the end of each HLJ Stage.

Question	Type
I LIKE! (things you find remarkable about this step of the HLJ)	Open
I WISH... (things you wish were different about this step of the HLJ)	Open
Please rate the following statement: "I believe that this step of the HLJ is important to motivate women to participate in a STEM course."	Likert
Please rate the following statement: "I believe this step of the HLJ needs to be improved to achieve the goal of motivating women to participate in a STEM course."	Likert

Table 3: List of questions made at the end of the session "Challenges and Motivational Approaches: Heroine's Learning Journey."

Question	Type
Please rate the following statement: "I believe the HLJ, as a whole, has great potential to motivate women to participate in a STEM course."	Likert
How would you evaluate the workshop?	Closed (1-5)
What did you like the most about the workshop?	Open
What did you like least about the workshop?	Open
Would you like to leave any suggestions for future workshops?	Open

5 RESULTS

The 12 participants of the workshop completed the questionnaire. An initial set of questions was asked to better understand the participants in terms of demographic and professional characteristics. The responses to this set of questions are presented in Table 4. We highlight that the participants mainly hold positions as teachers and educational content developers in universities from four European countries. The female gender is predominant, with 8 participants, followed by three males and one who declined to answer. All participants have at least six years of experience in education, with an average of 18.5 years. Lastly, 10 participants who work with STEM have a minimum of 5 years of experience and an average of 17.3 years.

During the workshop, participants were asked to answer four identical questions for each of the 12 stages of the HLJ. Two of the questions were qualitative, requiring free-text responses. The first of these questions asked participants to mention what they liked about the video for that particular stage of the HLJ, while the second question aimed to gather suggestions for improvements for each video. Table 5 presents the responses to each question for the 12 stages.

The other two questions were quantitative and asked participants to indicate their level of agreement with a specific statement using a Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The statements were: "I believe this stage of the HLJ is important for motivating women to participate in a STEM course" (Figure 6) and "I believe this stage of the HLJ needs improvement to motivate women to participate in a STEM course effectively" (Figure 7).

We highlight that the last question has reversed values – i.e., strongly disagree is the "best" answer. We use this valuation to reduce the effects of acquiescence. Acquiescence is a common response bias related to an individual's tendency to agree with a statement regardless of its content [40].

Figure 6 shows that in terms of motivation capacity, all stages received a minimum of 60% positive ratings (options 4 and 5), and at least 75% of ratings indicated no disagreement with the motivational impact (options 3, 4, and 5). Stages 1, 4, and 5 have over 83% agreement.

Figure 7 shows that in terms of the need for improvement, the higher the agreement, the greater the need for improvement for the evaluated stage. In this case, 9 out of the 12 stages received at least 50% neutral or disagreeing ratings regarding the need for improvement. Stage 6 needed the most improvement, with 75% agreement with the statement. Stages 3 and 11 also deserve attention, with 58.4% of ratings indicating a need for improvement.

At the end of the stage evaluations, participants were asked to assess the HLJ as a whole, agreeing or disagreeing with the statement: "I believe that HLJ, as a whole, has great potential to motivate women to participate in a STEM course." The result of this question shows that 66% of respondents fully agree (8%) or agree (58%) with the statement that HLJ has excellent potential to motivate women to participate in a STEM course, as shown in Figure 8. No participant selected the option "strongly disagree" when evaluating the statement.

Table 4: Demographic and professional characteristics of the participants

Position	Country	Age	Gender	Education Experience	Works in STEM	STEM Experience
Professor	Portugal	46	Male	14	Yes	23
Assistant Professor	Portugal	47	Female	23	Yes	23
Researcher	Italy	38	Male	8	Yes	10
Assistant Professor	Spain	57	Female	33	Yes	33
Assistant Professor	Portugal	47	Female	25	Yes	25
Media Producer	Sweden	57	Male	20	Yes	8
Instructional Designer	France	58	Female	10	Yes	5
Instructional Designer and Project Manager	Italy	30	Female	6	No	N/A
N/A	Sweden	35	N/A	10	Yes	10
Assistant Professor	Spain	57	Female	33	Yes	33
Instructional Designer	Italy	32	Female	7	No	N/A
Pedagogical Coach and Video Coach	Sweden	57	Female	34	Yes	2.5

Table 5: Examples of responses to the "I Like" and "I Wish" questions.

Stage	"I Like!"	"I Wish…"
1	The effort to know the target public and understand what captures their attention	I wish the video explained her story better
2	I really like the video because it makes me believe in myself and that I can succeed in a STEM field	Maybe more details on course content
3	I like this video because it makes me feel like I have lots of learning possibilities and that there will be people ready to help me	I wish the self-knowledge path were clearer with examples and tools
4	I like this video because it shows that there will be initial difficulties, but they can be overcome	More tips about time management should be given
5	I liked the mention of the importance of finding balance and knowing how to compromise	I wish I could have gotten some hands-on tools on how to cope with fear
6	I like this video because I'm an influencer, and I think knowing that there's a community of women is important	I wonder if reality is that "easy and happy"?
7	This is me! I have all of these attributes! I am Athena!	I would prefer that the conditions to reach the reward were thoroughly enumerated
8	I like the power of the video: it let me understand that the journey is long, but I can overcome it	Maybe how to increase my self-confidence, how to do it?
9	"Success and comfort can't coexist": I like this sentence because it pushes me to go out of my comfort zone	To know how to manage the pressure and improve self-confidence
10	I like to understand how the feeling of fear is a "normal feeling": it helps me start reflecting on that feeling and how to overcome it	The presence of the explanation of self-regulated means
11	This is really important – the ethical perspective – to put science to good use	I wish the title reflected more on the idea. Maybe restart (cycle idea) and not reboot (starting from scratch). It also seems to have a lot of mixed ideas.
12	I like this video because it made me feel that I can accomplish something, be a role model, and shape a better world	I wish the video had a distinct message from the previous one

6 DISCUSSION

This work presents an assessment of the HLJ model, a learning method designed to encourage young women to engage in STEM courses. This model was evaluated by education experts involved in the FOSTWOM project.

Before starting the evaluation of the stages of the journey, we conducted small presentations to allow participants to understand better the current scenario of female participation in STEM fields, the importance of motivation in these areas, as well as the research behind the thesis, translated through the content of the HLJ website and the viewing of all 12 videos available in the HLJ 's infrastructure that integrates with the Technical MOOC of the University of Lisbon.

After this introductory activity, we guided the participants in creating a persona representing one of the extremes of the age

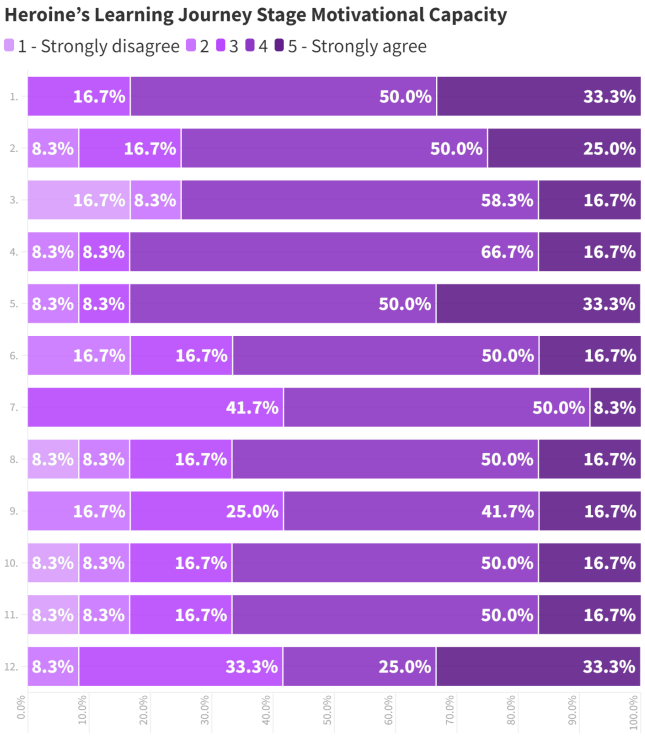

Figure 6: Evaluation of Motivational Capacity by Stage.

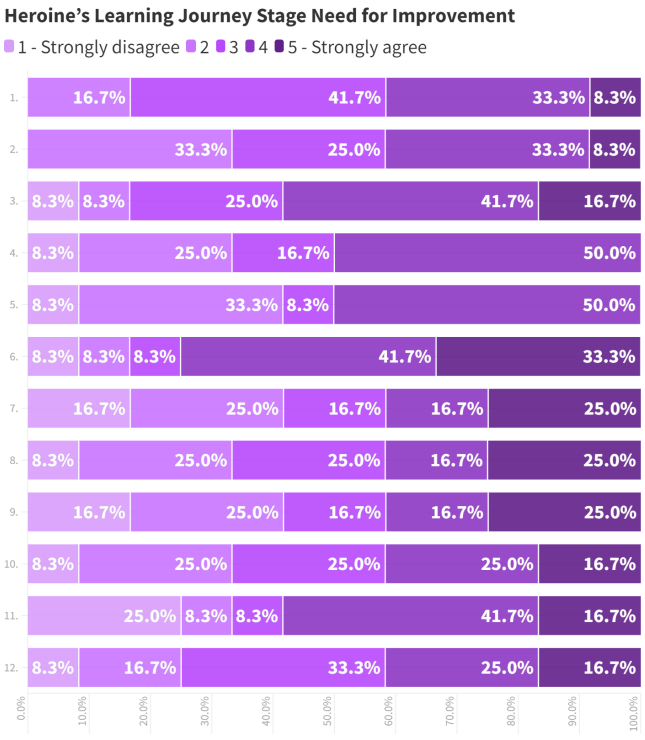

Figure 7: Evaluation of Need for Improvement by Stage.

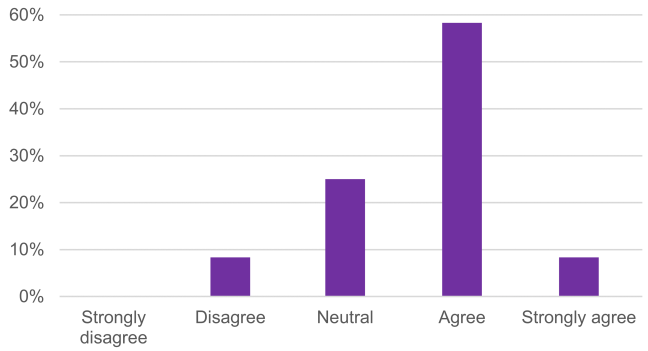

Figure 8: Agreement with the statement "I believe that HLJ, as a whole, has great potential to motivate women to participate in a STEM course.".

range for which HLJ was developed (15 to 21 years old). The persona activity was necessary for participants to understand better the pains and desires of a young woman and how she could be motivated to enter the STEM field through the stimulus provided by HLJ.

The evaluations of the stage videos were positive. The results show that all stages have a median rating of 4 regarding motivation on a scale of 1 to 5. The highlight goes to stage 1, with an average rating of 4.2, and stage 5, which had an average rating of 4.1. The video of stage 1, which received the highest rating, may indicate the initial impact of the journey, which aims to arouse curiosity and motivation. The other video with a higher rating, the one from stage 5 called "Transforming Fear into Strength," was expected and desired to be motivating. In stage 5 of the journey, students are presented with content about female role models in STEM, including three videos and 13 stories of great Brazilian, Portuguese, and global figures.

Despite the promising results, there is room for improvement. Two stages of the HLJ require improvement because, while most stages garnered positive feedback for their motivational capability, certain stages, such as Stage 6 (The Light of Knowledge), were noted as challenging to comprehend outside the context of the online course . This stage deals with the practical application of theoretical STEM knowledge, which can be complex to envisage outside the direct context of the learned content, and Stage 3 (External and Internal Aid) addresses seeking help from supportive individuals or relying on one's inner strength. Thus, these stages necessitate refinement to better foster motivation and engagement among students in the online and practical realms of STEM education.

7 CONCLUSION

Evaluating the 12 stages of HLJ is an essential part of the validation process of the HLJ model. In this research phase, expert evaluation from MOOC content specialists, educators, and individuals directly involved in the field of education can provide insights into the quality of each stage of the journey and identify areas for improvement. The evaluated videos are the ones that appear throughout the online course Journey and serve as a guide for young students,

informing them about how each stage of the journey contributes to their motivation for studying STEM subjects.

As observed, the participants in this research have a high level of experience in the field of education, with an average of 18.5 years of experience. Additionally, 10 participants have a minimum of 5 years and an average of 17.3 years of experience in the STEM field. This experience level among the participants is crucial for obtaining reliable and valuable results, as they bring a wealth of knowledge and expertise in developing courses on MOOC platforms. We highlight that while stage 5 (Transforming Fear into Strength) received a higher rating due to its motivating nature, stages 3 (External and Internal Aid) and 6 (The Light of Knowledge) require attention and improvement. These stages have proven more challenging to grasp outside the online course context.

We highlight that these participants are part of the FOSTWOM project and understand the topic *gender equality in education*. They have been involved in the project for three years, engaging in knowledge exchange, product development, and capacity building among the participating countries, with support from the European community. Although the FOSTWOM project did not develop the HLJ, their involvement in the assessment further enhanced their understanding and expertise in gender equality in education.

The evaluation of the Heroine's Learning Journey model, executed by a panel of 12 specialists in Massive Open Online Courses (MOOCs) engaged in the FOSTWOM Project, provided two main contributions. The first contribution is the HLJ assessment itself, which can be used to improve MOOC courses that address gender equality needs in STEM areas worldwide. The second contribution is the evaluation methodology used in this work, which can be adapted to evaluate novel educational models, particularly models based on narratives to engage students in learning.

The workshop and participant feedback offer valuable insights into the Heroine's Learning Journey, but it's important to acknowledge limitations. The study primarily involved participants from four European countries, potentially limiting generalizability. Secondly, the small sample size of 12 workshop participants may impact the feedback's representativeness. Thirdly, participants were mainly teachers and educational content developers, introducing a potential bias towards educational perspectives. Additionally, focusing on individuals with STEM experience may not fully capture the experiences of those without such backgrounds. While rich in insights, the qualitative nature of the feedback poses challenges in quantifying and prioritizing improvement areas.

A future work that could result from the analysis of the results and best practices applied in MOOC courses for gender equality is to incorporate the findings into developing interventions aimed at addressing the barriers to STEM education in secondary schools and higher education institutions. Additionally, it could provide an overview of the best practices implemented in other countries and institutions, which would be valuable for future similar projects. Combining the insights gained from the analysis of data on needs assessment and the successful approaches used in MOOC courses, it is possible to create comprehensive and effective strategies to promote gender equality in STEM education. New evaluations of the HLJ diversifying the participant pool and monitoring long-term impact remain unexplored and are an avenue for further research.

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