Digital Transformation in Adult Education: Empowering Educators to use DigComp with a MOOC

Natalia Spyropoulou, Sofia Tsitou, Gerasimos Vonitsanos, Rozalia Kalantzi, Achilles Kameas
Daissy Research Group, Hellenic Open University
Patras, Greece
{nspirop,gvonitsanos,rkalantzi, kameas}@eap.gr, stsitou@daissy.eap.gr

***Abstract*— In the digital age, the need for digital proficiency has expanded beyond conventional job roles, marking a new era where fundamental digital literacy and higher-level competences, particularly in Artificial Intelligence (AI), are indispensable in various sectors, especially within STEM (Science, Technology, Engineering, and Mathematics) disciplines. This evolution necessitates enhancing digital competence training and ongoing professional development for adult educators to effectively navigate and impart knowledge in this rapidly evolving digital realm. In response to this need, we introduce a Massive Open Online Course (MOOC) specifically designed for adult educators and education providers, focusing on developing and delivering educational programs using the DigComp framework, which outlines essential knowledge, skills, and attitudes for digital competence across five key areas. This paper presents the MOOC's development, structure, and preliminary assessment. The curriculum spans seven modules, covering the nuances of the DigComp framework, its application in educational strategies, and skill recognition. The evaluation, combining quantitative and qualitative methodologies, reveals the program's impact and areas for improvement. This study underscores the crucial role of digital literacy in modern education and professional development, offering insights for advancing adult digital skills education.**

Keywords—digital competences; adult education; DigComp Framework; competence development; professional development

I. INTRODUCTION

In an era of rapid technological progress and widespread digitalization, digital competence has become a cornerstone of lifelong learning [1]. Digital skills are indispensable for thriving in our increasingly digital society, shaping how we interact with technology and approach information, communication, and problem-solving [2]. Digital literacy goes beyond technical proficiency, encompassing technical-procedural, cognitive, and socioemotional skills necessary to navigate the complexities of the digital age [3]. It enables individuals to engage meaningfully with technology, access information effectively, and participate fully in digital communities. For adults whose careers and livelihoods are increasingly intertwined with technology, developing and honing digital skills is essential for professional growth and adaptability [4]. The significance of digital literacy in today's job market cannot be overstated, especially within STEM-related fields [5] [6].

As technology evolves and society increasingly digitizes, adapting and acquiring digital skills becomes paramount for remaining competitive in the job market [7]. In addition, integrating digital literacy into STEM equips workers with the necessary technical know-how and fosters a deeper understanding of the tools and technologies prevalent in the modern workforce [8].

Furthermore, the importance of digital literacy in promoting equal opportunities cannot be overstated. Access to digital skills enables individuals from varied backgrounds to participate equally in the digital world, opening doors to information access, employment, and both personal and professional growth [9]. Adapting to the digital world presents unique challenges in adult education, where many learners did not grow up immersed in digital technologies. Therefore, it is essential to embed digital literacy comprehensively within adult learning programs, equipping learners with the skills and support they need to succeed in an increasingly digitalized society.

Moreover, for digital literacy initiatives to achieve their full potential, a focused effort is required to integrate them into educational frameworks and ensure that educators are proficient and confident in these skills [10]. Educators are crucial in guiding learners through the digital landscape, making it imperative to provide them with ongoing training and resources. This approach enhances their teaching capabilities and ensures that they can effectively impart digital competences to learners, preparing them for the demands of the modern world.

Competence frameworks play a crucial role in shaping educational programs that cater to the specific needs of adult learners. They guide curriculum development and instructional design by outlining the essential skills and competences required for success in various fields [11]. A prime example is the Digital Competence Framework for Citizens - DigComp framework (https://joint-research-centre.ec.europa.eu/digcomp/digcomp-framework_en), developed by the European Commission JRC to equip individuals with the digital skills necessary for the 21st century. DigComp encompasses a range of competences, including information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving [6]. DigComp is regularly updated to reflect the latest technological developments, ensuring learners are equipped with informed digital skills relevant to contemporary challenges, such as artificial intelligence (AI) [7].

The DigComp framework has official guidelines offering comprehensive explanations and practical examples [12]. However, no publicly available online courses have been designed specifically to utilize the DigComp framework by educators to design, assess, and evaluate educational programs for adult learners. Despite the growing importance of digital skills, there is a notable lack of accessible courses tailored to help educators implement DigComp in adult education. Although DigComp provides a structured framework for developing and evaluating digital competences

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in adult learners, educators without focused training may struggle to harness their potential fully when creating effective digital education programs.

To address this gap, our study introduces a Massive Open Online Course (MOOC) designed for adult educators and education providers who utilize the DigComp Competence Framework. The course aims to enhance participants' knowledge and skills regarding DigComp, enabling them to develop and implement effective digital education programs across educational settings.

This paper contributes to the discourse on digital literacy and competency development by outlining the structure and methodology of a course focusing on the DigComp framework and its application in adult education. It provides detailed information on the course content development phase and offers an initial evaluation conducted with participants. By assessing MOOC effectiveness and adaptability, this study provides valuable insights into designing and delivering online courses for adult educators, emphasizing the pivotal role of structured frameworks like DigComp in contemporary education and professional development.

As digital skills become increasingly crucial in STEM careers, it is imperative to empower adult learners with the competences needed to excel in these fields. By continuously incorporating participant feedback, this course will evolve to meet the changing needs of adult learners, offering a valuable pathway for career development in the digital era.

II. Course Development Methodology

The development of the MOOC involved a collaborative approach. We employed a team-based methodology rooted in the ADDIE model principles described in Spyropoulou et al. [13]. This collaborative approach brought together diverse expertise, with subject matter experts contributing their in-depth knowledge of the DigComp Framework, instructional designers ensuring pedagogical soundness, and technical specialists providing a robust digital architecture for the course platform.

Based on the ADDIE model, the methodology followed five key phases: Analysis, Design, Development, Implementation, and Evaluation. Agile principles were incorporated during development to enhance flexibility and iterative progress. The LLAMA (Looks a Lot Like Agile Methods Approach) framework [14] was embedded, enabling rapid and iterative cycles [15]. Initially designed for software projects, Agile emphasizes adaptability, dynamic management, and incremental improvement. Thus, educational activities and content of the MOOC were organized into manageable sprints to address specific tasks, facilitating continuous assessment and teamwork [16]. This hybrid methodology balanced meticulous planning with responsive design, creating a flexible, learner-centric model essential for modern educational content.

The MOOC structure adhered to best practices for MOOCs [17], incorporating modules, units, and learning activities to create a clear and accessible learning pathway. A module represents a self-contained topic of study focused on a particular theme, ensuring a coherent and in-depth exploration of the subject matter. Each module includes one or more units, separating the content into manageable sections. Each unit's learning activities encompass various educational content such as videos, PowerPoint presentations, infographics, study materials, resources, and hypertext. These materials are designed to provide foundational knowledge and advanced insights into the topic.

Additionally, interactive activities such as forum discussions encourage active participation and collaboration among learners. To ensure comprehensive understanding and retention, each module concludes with an assessment quiz for evaluation. Fig 1. illustrates the structure of the course.

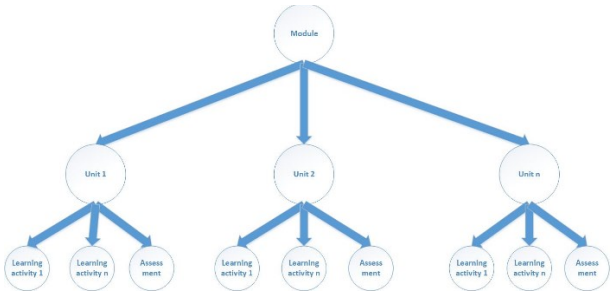

Fig. 1. Course development structure

Regarding the course instructional design methodology. We adopted a "outcome-based" approach [18] focused on the competences learners would gain. The Analysis phase identified specific competences, which became the course's learning outcomes. Learning Objects (LOs) were meticulously crafted to align with these outcomes, and subject matter experts employed specific templates to develop educational materials that were autonomous, retrievable, reusable, and shareable. Designed as a self-paced course, it allowed adult learners to progress at their speed, accommodating their unique learning characteristics. This flexible structure was vital in meeting the diverse needs of adult learners [19], [20].

III. Course Structure and Content

A. Overview of the MOOC

The course aims to provide insight into the European Digital Competence Framework for Citizens (DigComp) by offering practical guidance on its application in the design and delivery of adult education programs. It covers three core knowledge domains: Digital Competences, Adult Education, and Instructional Design. The primary audience includes adult education professionals and trainers, such as trainers of trainers, managers, planners, strategic decision-makers, curriculum designers, educators, tutors, and individuals responsible for formally assessing learning achievements. Additionally, the course is valuable for stakeholders interested in digital competence development, such as policymakers, HR professionals, and certification providers.

Hosted on a Moodle-based platform (https://platform.alldigitalacademy.eu/), the course front page is organized into modules, each containing units that outline the learning path of the associated learning activities (see Fig. 2). Participants earn badges upon completing each module assessment quiz, helping them track progress, and receive a certificate of attendance after completing all modules successfully. The estimated study time for the entire course is 14-16 hours per cycle, ensuring that learners gain a comprehensive understanding of DigComp while advancing their skills and knowledge in a structured, practical manner.

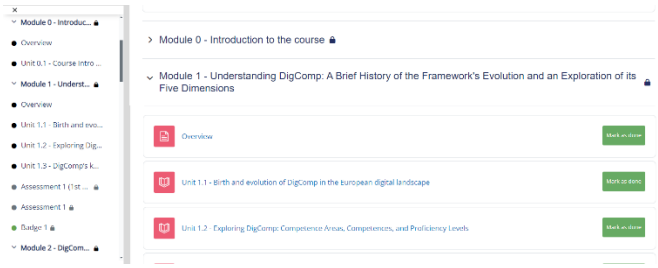

Fig. 2. Course development structure

B. Module design process

The official DigComp framework guide outlines six sequential steps for integrating digital competence initiatives into educational programs [21]. However, these steps do not specifically address adult education and the pedagogical perspective of using DigComp. Therefore, we have adapted these steps, adding additional sections and content tailored to adult learning and pedagogy to better meet the needs of adult learners in this course.

Regarding the official guide, the first step introduces the principles of DigComp by offering comprehensive descriptions of digital competence and learning outcomes at different proficiency levels. This step familiarizes stakeholders with the framework and provides translations to enhance accessibility.

In the second step, training goals are set based on a thorough needs assessment, which analyzes the target audience's objectives and digital competence levels. Educators analyze the target audience's needs and objectives, develop training goals aligned with these needs, and identify digital competence levels. Ensuring alignment with DigComp enhances training program effectiveness and contributes to the broader European digital competence development agenda [9,10].

The third step focuses on designing and developing the educational and training (E&T) offer, including curriculum design in the DigComp implementation process. It consists of two main stages: Curriculum design and development of educational materials.

The fourth step involves promoting and delivering the education and training (E&T) offerings. This step encompasses two key aspects. Firstly, educators must align courses or learning activities with the DigComp framework to foster digital competence education. This involves demonstrating how the content addresses contemporary digital challenges outlined in DigComp, such as interacting with AI systems and teleworking, to engage learners effectively. Secondly, although not explicitly prescribed by DigComp, training delivery can be enhanced by incorporating innovative teaching approaches such as project-based learning, inquiry-based learning, peer feedback, personalized learning, and AI-driven adaptive learning. These methods enable educators to address learners' needs more effectively and enhance their digital skills, leading to more meaningful learning outcomes in digital competence.

The fifth step involves recognizing and certifying digital competence, which consists of two main stages. Firstly, learners' digital proficiency can be evaluated at different points: at the beginning (diagnostic), during (formative), and at the end (summative) of their learning process. These assessment tools can be developed using the DigComp framework to evaluate learners' digital skills accurately. In addition, recognition of learning achievements can take various forms, such as badges or digital competence [22] certificates.

The last step involves evaluating the educational activity. This information allows for implementing corrective actions if needed [21].

C. Detailed overview of the MOOC modules.

The course is divided into one introductory and six main modules, totaling 18 units. The introductory module, "Introduction to the Course," provides trainees with an understanding of the program's objectives and prerequisites. In this module, participants will find a dedicated unit featuring a presentation that explains the course's objectives, structure, and learning goals. It also includes guidance on navigating the e-learning platform and a discussion forum where participants can introduce themselves and meet the course tutors and facilitators.

In Module 1, "Understanding DigComp: A Brief History of the Framework's Evolution and an Exploration of its Five Dimensions," trainees are provided with a detailed view of the digital competence landscape in Europe. In the first unit, participants are introduced to DigComp through presentations that overview its historical development and five key dimensions. The second unit explains competence areas and individual competences within Dimensions 1 and 2 of DigComp 2.2, offering detailed insights into information and data literacy, communication, and collaboration skills. In the third unit, participants explore a document illustrating the main features of Knowledge, Skills, and Attitude (KSA) examples in DigComp 2.2, focusing on Dimension 4 and new themes such as citizens' interactions with artificial intelligence systems.

Module 2, "DigComp applications & benefits," provides an overview of DigComp's European application. The first unit analyzes the various stakeholders involved in the DigComp ecosystem, the sectors where the framework is applied, and the overarching aims of its implementation. The second unit examines the advantages and positive outcomes of using the DigComp framework in different contexts. Additionally, participants can access a glossary to mention a specific benefit of the DigComp framework in adult education, providing further clarity and understanding of its potential applications and impacts. The last unit outlines the critical steps in integrating DigComp into educational and training initiatives. Fig. 3 presents an example of the academic content, showcasing an infographic detailing the DigComp implementation process.

Fig. 3. Module 2. – Unit 2.3 Steps of the DigComp implementation process

Module 3, "Assessing digital competence levels and needs and setting educational goals with DigComp," explores how DigComp can identify the relevant digital competencies and the levels learners need to develop. The first unit focuses mainly on delineating professional digital profiles. Transitioning to the second unit, the focus centers on the hands-on application of DigComp for assessing and measuring the digital competence of specific target groups. Lastly, the third unit focuses on how DigComp can be employed to analyze and evaluate the effectiveness of existing digital education and training (E&T) courses.

Module 4, "Using DigComp to Design and develop educational and training activities for adult learners," centers on curriculum design by establishing clear learning outcomes that align with educational goals. The initial unit focuses on curriculum creation, stressing the significance of defining clear and measurable learning outcomes (LOs). Moving to the second unit, attention shifts to the unique traits of adult learners and the principles guiding adult education. Lastly, the third unit introduces diverse educational methodologies for cultivating digital competences, such as Project-Based Learning and Collaborative Learning.

Module 5, "Designing and delivering effective learning activities for developing DigComp competences," introduces the fundamental design principles and delivery approaches that create impactful learning activities and content aligned with DigComp and contribute to developing DigComp competences. The first unit aims to design principles and delivery approaches to create engaging educational experiences that promote DigComp competences for adult learners. The second unit discusses the significance of academic materials in the learning process, covering various types such as textbooks, online resources, and multimedia presentations.

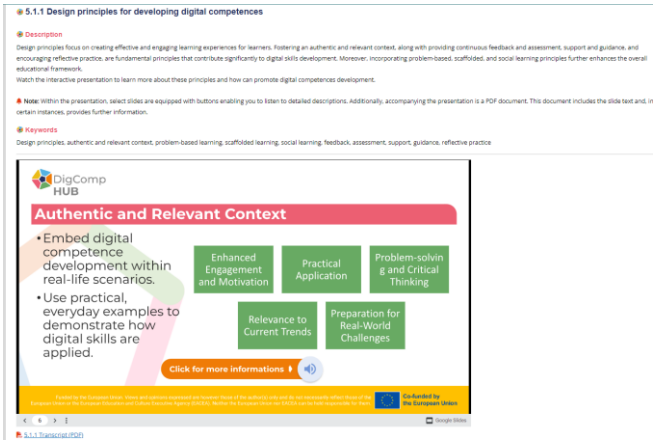

Fig. 4. Module 5. – Unit 5.1 Design Principles and Delivery Approaches for Engaging E&T offers

Finally, Module 6, "Assessment, Recognition, and Certification," discusses the significance of assessing and recognizing learning achievements, emphasizing the benefits and opportunities provided by digital competence certification. The first unit offers trainers comprehensive guidance on evaluating digital competence, explicitly focusing on end-of-course assessments of individual learning achievements within the DigComp framework. Moving forward, the second unit focuses on recognizing achievements in digital competence, underscoring the importance of digital competence certification. Lastly, the third unit underscores the significance of digital competence certification in acknowledging achievements while exploring how to evaluate training programs in adult education using DigComp.

IV. Evaluation Methodology

To effectively assess the MOOC's impact and potential, we implemented an evaluation methodology comprising two main stages: a pre-course survey and a post-course assessment. The pre-course survey measured participants' expectations and baseline understanding of the course topics. This initial survey featured closed and open-ended questions to capture participants' prior knowledge and motivations. Upon completion of the course, a corresponding post-course assessment was administered. This assessment mirrored the pre-course survey in structure and content, utilizing a blend of closed and open-ended questions to ensure consistency.

The pre-course survey was structured into sections to comprehensively capture participants' demographics, expectations, and goals for the MOOC. In the first section, the survey gathered demographic information to create a detailed profile of learners. The questions asked about participants' age, gender, highest degree or level of completed schooling, current occupation, and country of residence. Additionally, participants were asked to self-assess their current level of expertise in the DigComp Framework.

The second section evaluated participants' expectations concerning the anticipated goals and impact they hoped to achieve for the MOOC course through 15 questions (Table I: Q1-Q15). These questions were presented on a 5-point Likert scale, ranging from "Not at all interested/desirable" to "Extremely interested/desirable." Participants could use this scale to express varying interest levels in specific aspects of the course. This stage aimed to understand learners' motivations and the perceived desirability of different course features. The final section included two open-ended questions to capture additional insights into participants' personal goals and expectations. They were encouraged to articulate any other objectives they hoped to achieve from the course, offering qualitative data that provided depth to the structured survey results.

TABLE I. Close-ended questions of the pre-course survey

No	Question	Type
What goals do you hope to gain by attending the DigComp Hub course?		
Q1	To acquire new skills and knowledge related to DigComp	Likert scale
Q2	To understand the dimensions and components of DigComp	Likert scale
Q3	To get in touch with experts in the field of DigComp	Likert scale
Q4	To collaborate with people that share the same interests on the subject as I do	Likert scale
Q5	To get a certification	Likert scale
Q6	To access educational resources about DigComp	Likert scale
Q7	To learn how to design effective training for digital competence	Likert scale
Q8	To learn how to define educational goals aligned with DigComp	Likert scale
Q9	To learn how to design assessment and evaluation activities that align with the DigComp	Likert scale
What impact do you expect this course to have on you?		

Q10	To be able to apply what I have learned to my job	Likert scale
Q11	To be able to change how things work in my organization	Likert scale
Q12	To be able to affect regional and national policies on the subject	Likert scale
Q13	To be able to get a better job	Likert scale
Q14	To be able to improve my current job	Likert scale
Q15	To be able to get more job opportunities	Likert scale

Following the pre-course survey, a post-course questionnaire was administered to assess the impact of the course on participants' learning and experiences. The survey maintained participant anonymity and was only available to those who completed the course successfully. The first section of the post-course questionnaire mirrored the pre-course survey, collecting identical demographic data. Following the pre-course survey, the second section aimed to measure the impact of the DigComp Hub course on participants' knowledge and experience (Table II: Q16-Q36). Participants responded to a series of statements using a 5-point Likert scale ranging from "Strongly disagree" to "Strongly agree" and "Completely dissatisfied" to "Completely satisfied." This alignment with the pre-course survey structure ensured consistency in assessing the progression of participants' learning outcomes and satisfaction levels.

The third section assessed participants' experiences as MOOC learners across five categories: MOOC perceived quality, learning process quality, usefulness, continuance intention, and satisfaction (Table II: Q37-Q41). Each category included four to five questions, answered using a 5-point Likert scale ranging from "Strongly disagree" to "Strongly agree." This section provided crucial indicators of the course's value by revealing how effectively it met participants' expectations and needs. The final section invited participants to respond to four open-ended questions regarding their gains from the DigComp Hub course, the most positive aspects, and suggestions for improvement. These open-ended responses provided qualitative insights into the course's overall impact and identified potential areas for enhancement.

TABLE II. CLOSE-ENDED QUESTIONS FOR POST-SURVEY

No	Question	Type
What did you gain most from taking part in the DigComp Hub course?		
Q16	New skills and knowledge related to DigComp	Likert scale
Q17	Knowledge about the dimensions and components of DigComp	Likert scale
Q18	I got in touch with experts in the field of DigComp	Likert scale
Q19	I manage to collaborate with people who share the same interests on the subject as I do	Likert scale
Q20	I gained a certification	Likert scale
Q21	Access educational resources about DigComp	Likert scale
Q22	Learn how to design effective training for digital competence	Likert scale
Q23	Learn how to define educational goals aligned with DigComp	Likert scale
Q24	Learn how to design assessment and evaluation activities that align with the DigComp.	Likert scale
What impact do you expect this course to have had on you?		
Q25	I will be able to apply what I have learned to my job	Likert scale
Q26	I will be able to change how things work in my organization	Likert scale
Q27	I will be able to affect regional and national policies on the subject	Likert scale
Q28	I will be able to get a better job	Likert scale
Q29	I will be able to improve my current job	Likert scale
Q30	I will be able to get more job opportunities	Likert scale
How do you rate the knowledge/experience you acquired through the course in the following areas?		
Q31 – Q36	Module 1 – Module 6	Likert scale
MOOC Learner		
Q37	Please evaluate your learning experience for the MOOC perceived quality	Category scale
Q38	Please evaluate your learning experience for the learning process quality	Category scale
Q39	Please evaluate your learning experience to determine the usefulness of the MOOC content.	Category scale
Q40	Please evaluate your learning experience to determine your intention to continue the MOOC.	Category scale
Q41	Please evaluate your learning experience for the satisfaction of the MOOC	Category scale

V. RESULTS AND DISCUSSION

A. Completion rate

The pre-course questionnaire received responses from 102 trainees at the start of the course, while the post-course survey was completed by 43 individuals who successfully finished the entire course. This resulted in a completion rate of 42%. Relevant research [23] shows that MOOCs typically have a dropout rate of approximately 90%, with only around 10% of enrolled students completing the course. Factors like participant availability, varying levels of engagement, and differing personal goals influence this trend. However, with a 42% completion rate, this MOOC significantly outperforms the 10% average reported in the existing literature on MOOC dropout rates.

B. Trainees's profile

The pre-course survey identified 35-44 (26%) and 45-54 (25%) as the dominant age groups, while the majority of participants (57%) were female. This cohort brought diverse professional backgrounds, with 36% identifying as educators and tutors, 22% as managers, planners, or strategic decision-makers in education and training, and 11% involved in curriculum design or formal assessment and certification of learning achievements. Additionally, undergraduate students interested in adult education and researchers and professionals from fields like librarianship were present.

The post-course survey revealed a demographic shift among the 43 participants who completed the course. The primary age groups now included those over 55 (33%) and those aged 45-54 (30%), indicating that older learners were more likely to persist. Women remained the majority at 58%. Regarding job profiles, there was a slight increase in the percentage of educators and tutors, rising from 36% before

the course to 37% after completion. This suggests that this group found the course relevant to their roles.

Furthermore, the post-course cohort showed a notable presence of managers, planners, and strategic decision-makers, comprising 28% of participants. This reflects the course's appeal to individuals involved in educational strategy and policy. Although there was a slight decrease in the number of curriculum designers and assessment professionals, dropping to 7% post-course, those who remained likely appreciated gaining advanced insights into integrating the DigComp Framework into educational planning and assessment. Future course iterations could consider offering more specialized content to better address their specific needs.

C. Pre- and post-expectations

Before starting the course, participants were asked: "What are the goals you hope to gain by attending the DigComp Hub course?". As shown in Fig. 5, roughly 80% of participants expressed the desire to acquire proficiency in designing assessment and evaluation activities consistent with DigComp, developing educational objectives in line with DigComp standards, designing effective digital competence training, accessing educational resources about DigComp, and acquiring new skills and knowledge related to DigComp. Approximately 70% indicated their desire to understand the dimensions and components of DigComp, engage with experts in the field of DigComp, and collaborate with people who share the same interests on the subject. Additionally, around 65% expressed an interest in obtaining certification.

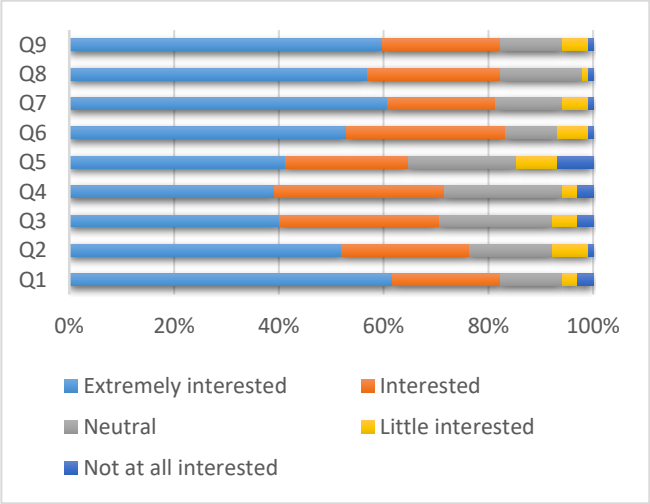

Fig. 5 Responses to the question about the pre-course expected goals

After completing the course, trainees were asked: "What did you gain most from participating in the DigComp Hub course?". As illustrated in Fig. 6, the vast majority of trainees (around 80%) agreed and strongly agreed that they had successfully acquired the ability to design assessment and evaluation activities, set educational goals, develop effective training for digital competence, access educational resources about DigComp, acquire new knowledge and skills about the dimensions and components of DigComp, and obtain certification. About 60% managed to get in touch with experts and collaborate with people with the same interests, while only about 7% answered that they did not achieve the course objectives.

These results highlight the course's effectiveness in meeting most participants' goals, particularly in skill acquisition and knowledge enhancement related to DigComp. The lower percentage of participants who managed to engage with experts and collaborate with peers is understandable, given that the course was self-paced and collaborative activities were optional, resulting in many participants not completing them. Notably, based on pre-course responses, collaboration with others was among the three lowest-scoring goals participants hoped to achieve. This aligns with existing literature, which suggests that in self-paced courses, engagement with the content is more crucial than collaboration [24]. However, this may suggest a potential improvement area by facilitating more or alternative networking opportunities for those interested in greater engagement in collaborative activities. Overall, the course has proven successful in equipping participants with the competences necessary for implementing the DigComp standard.

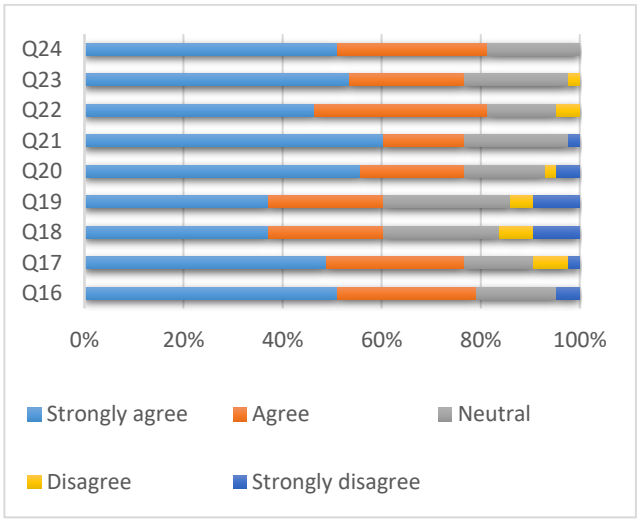

Fig. 6 Responses to the question about the post-course expected gains.

Before starting the course, participants were asked: "What impact do you expect this course will have on you?". As shown in Fig. 7, a significant majority of participants (ranging from 70% to 80%) expressed agreement or strong agreement regarding their ability to apply new knowledge to their jobs, change how things work in their organization, and enhance their current job functions. Approximately 40% to 50% of participants expressed confidence in their ability to influence regional and national policies, secure better jobs, and gain more job opportunities.

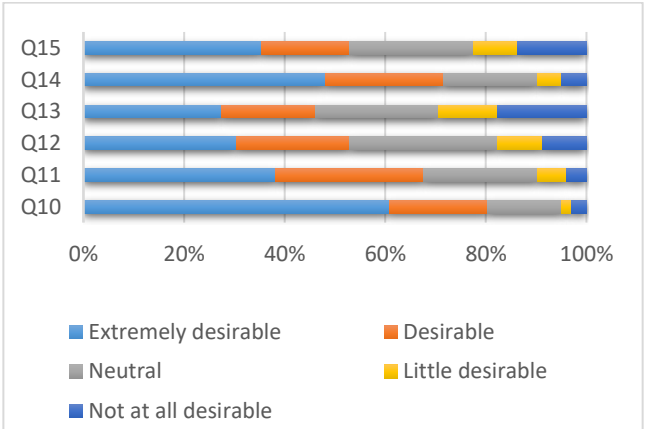

Fig. 7 Responses to the question about the pre-course expected impact

Trainees in the post-course survey were asked: “What impact do you expect this course had on you?”. As shown in Fig. 8, most trainees (80%) expressed confidence in applying the acquired knowledge to their jobs and strengthening their current job responsibilities. Approximately 60% said they can change how things work in their organizations, gain more job opportunities, and secure better jobs. Only 10% of trainees answered that they cannot apply these dimensions. Most participants generally maintained or exceeded their initial expectations regarding the course's impact.

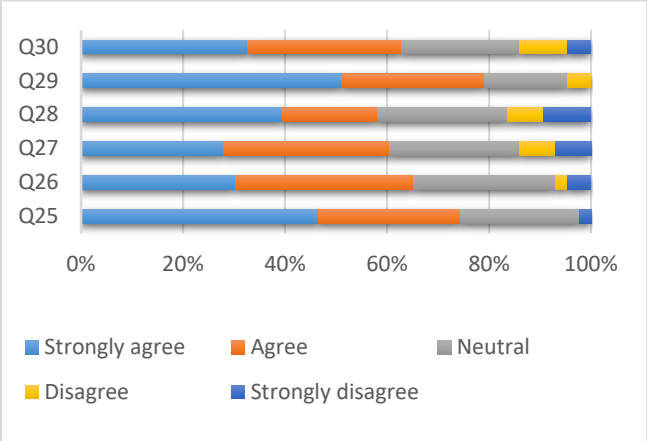

Fig. 8 Responses to the question about the post-course expected impact

Trainees also evaluated the knowledge and experience gained through the course across the six main modules (Fig. 9). The overwhelming majority (around 80%) rated their acquired knowledge in all six modules as entirely satisfactory, indicating a high level of contentment with the learning outcomes. Only a tiny percentage (around 3%) rated their knowledge unsatisfactory. Module 4, "Using DigComp to Design and Develop Educational and Training Activities for Adult Learners," garnered the highest level of satisfaction among all modules. This suggests an apparent demand among participants for deeper insights into integrating DigComp into pedagogical practices. This observation aligns with the fact that DigComp itself does not extensively cover the pedagogical aspect of its application, and existing guides do not prioritize this area. Therefore, the enthusiasm for Module 4 underscores the necessity for educational initiatives to bridge this gap and provide more comprehensive guidance on utilizing DigComp within pedagogical frameworks.

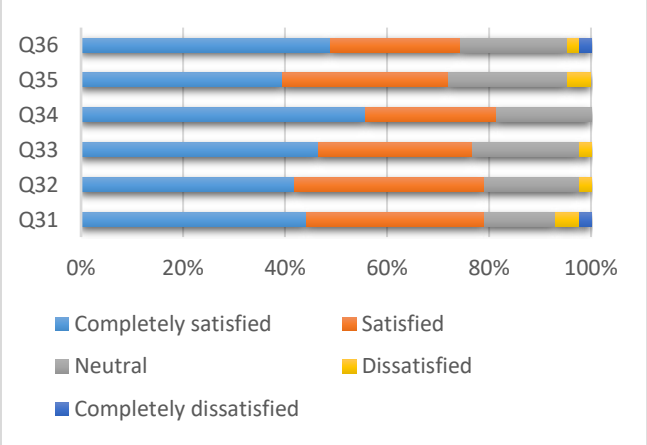

Fig. 9 Responses to the question about the knowledge/experience they acquired through the course

Moreover, trainees evaluated their learning experience from participating in the MOOC based on the five categories. Fig. 10 presents the responses. The vast majority (90%) of trainees evaluated the MOOC content as high quality, and the usefulness of the MOOC content was highly rated by 73% of trainees. In addition, 75% responded that the learning process was high quality. Finally, trainees evaluated the continuance intention and satisfaction of the MOOC very highly (about 80%). The quality content category (Q37) received the highest satisfaction score, indicating a high level of satisfaction with the quality of the content provided. However, the usefulness category (Q39) scored lower than the others. This suggests the importance of delving deeper into the responses to open-ended questions to understand the learners' needs better.

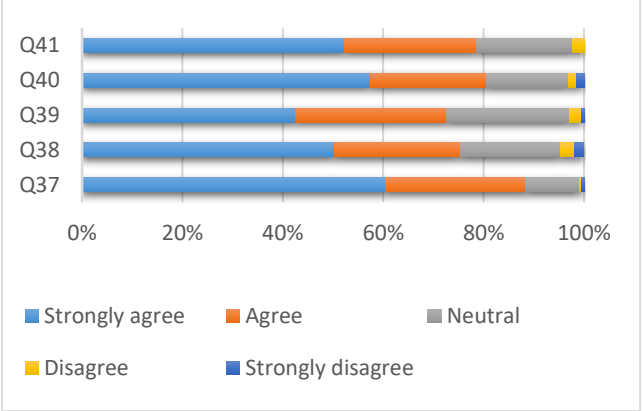

Fig. 10 Responses to the question about the learning experience of the MOOC

Regarding the open-ended questions, Table III summarizes the overall categories and themes from the content analysis, reflecting the expected outcomes from the pre-survey and the gains and suggestions from the post-survey.

TABLE III. TABLE OF OPEN-ENDED THEMES AND CATEGORIES

Survey Stage	Open-ended themes and categories	
	Themes	***Categories***
Pre-Survey	Enhancing Digital Competence	- Digital competence - Content creation
	Acquiring New Skills and Knowledge	- New skills and knowledge
	Refining Problem-Solving Abilities	- Problem-solving abilities
	Exploring New Technologies	- New technologies - Different Artificial Intelligence tools
Post-Survey	Gains in Knowledge	- Knowledge about adult learning - Integrating digital competences with engineering skills -Knowledge in curriculum design aligned with DigComp
	Enjoyment of Course Content	- Range of course topics - Acquired new skills and experiences
	Suggestions for Improvement	- More interactive tools, labs, examples, and exercises - Promoting active participation and engagement

In the pre-survey, trainees shared their anticipated goals and expectations, focusing on themes such as enhancing “digital competence” and “content creation,” acquiring “new skills and knowledge,” and refining “problem-solving

abilities." Additionally, they expressed a desire to delve deeper into "new technologies" and explore "different Artificial Intelligence tools." After the course completion, trainees reported significant gains in "knowledge about adult learning," "insights into integrating digital competencies with engineering skills," and "knowledge in curriculum design aligned with DigComp." They most enjoyed the range of course topics and acquired new skills and experiences.

From the open-ended questions, one can conclude that the trainees entered the program with diverse goals, reflecting their aspirations to enhance various aspects of their professional skill set. These goals ranged from improving digital competence and content creation skills to exploring emerging technologies like Artificial Intelligence. However, upon completing the course, trainees reported significant gains in specific areas, such as adult learning principles and curriculum design aligned with DigComp standards. This suggests that the course effectively addressed participants' initial expectations while providing unexpected insights and experiences.

Suggestions for improvement included that they asked for "more interactive tools, labs, examples, and exercises" and promoting "active participation and engagement." These proposals, in conjunction with the results of the close-ended questions, remarkably where the usefulness of the content category was rated the lowest, highlight participants' desire for a broader range of educational content and additional examples to enrich their learning journey. Despite being a self-paced course, where participants primarily navigate the main content independently with optional activities for engagement, the feedback indicates a need for increased interaction and engagement throughout the course. This also aligns with a preliminary study suggesting that dropout rates will be lower when learners engage in repeated and frequent social interactions [25]. Addressing these suggestions for improvement could further enhance the learning experience and ensure that the course meets participants' evolving needs. However, based on the overall post-evaluation of the course, trainees provided positive feedback regarding the different aspects of the course, making the successful implementation noticeable.

VI. Conclusions and Future Directions

This work presents the design, development, and delivery of a MOOC aimed at training educators of adult learners to use DigComp, the European framework for digital skills. The course helps them integrate these skills into educational programs' design, access, and creation phases. As the first published initiative targeting adults that apply this framework, this study proposes how to develop an online course for adult learning based on the DigComp Framework. It also reports the initial findings from the first cohort.

Analyzing pre- and post-course surveys offers valuable insights into the course's effectiveness and impact on participants' learning experiences and outcomes. Trainees entered the program with varying expectations, seeking to enhance their digital competence, acquire new skills, and explore emerging technologies. Throughout the course, they reported substantial gains in several areas, such as understanding adult learning principles, integrating digital competences with engineering skills, and aligning curriculum design with DigComp standards. The positive reception to the course content highlights its success in meeting participants' diverse interests and needs. Some avenues for improvement and future direction arise from the survey results. First, incorporating more hands-on activities and practical applications could deepen participants' understanding and engagement with the course material.

Additionally, exploring opportunities for collaboration can enrich course content by providing valuable real-world insights. Therefore, in the next cycle, we plan to refine and adjust some of the content to better reflect participants' feedback and preferences. These findings contribute valuable insights to the research and educational communities. The pre- and post-survey analysis provides empirical evidence of the course's effectiveness in achieving participants' learning goals and objectives. This data can guide future research on digital competence, adult education, and curriculum design.

Moreover, identifying areas for improvement and future directions offers essential guidance for educators and policymakers to enhance similar programs' quality and effectiveness. Given the increasing demand for digital skills and upskilling in STEM careers, there is a critical need to empower adult learners with the competences required to thrive in these fields. By incorporating these strategies and leveraging participant feedback, the course can continue to evolve and adapt to meet the changing needs of adult learners, providing them with a valuable pathway for career development in the digital era. Through ongoing innovation and improvement, this course will remain a vital resource for professionals seeking to enhance their skills and stay current with advancements in STEM-related digital competence and adult education.

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