STEAMigPOWER: Empowering Migrants Through Inclusive STEAM Education Introduction: Education as a Lifeline in the Migration Crisis

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Abstract. This paper presents the development of a web-based Virtual Learning Environment (VLE) designed to provide migrants, refugees, and asylum seekers—particularly women and upper secondary school students (aged 15–18)—with access to STEAM education. These groups are underrepresented in STEM fields due to widespread educational inequalities, limiting opportunities for marginalized populations. The initiative aims to address gender disparities in STEM education and empower women with the skills necessary for academic and professional growth. The five core STEAM courses, delivered both online and in person, will exploit the versatility of the VLE, and will cover Climate Change, Sustainable Development, Eco-Building Construction, the 5Rs (Reduce, Reuse, Recycle, Refuse, and Rot), and Sustainable and Renewable Energy. These thematic areas have been chosen according to the European educational priorities, addressing critical skill gaps in the home countries of the participants. The curriculum is designed in order to facilitate the student integration into the European workforce, at the same time equipping them with the knowledge and tools necessary to contribute to the sustainable reconstruction of their home nations. The VLE fosters inclusivity and accessibility, ensuring that displaced learners can acquire essential STEAM

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competencies regardless of geographical or socio-economic barriers. This initiative aspires to become a transformative force in migrant education, bridging skill gaps, promoting gender equality in STEM, and empowering learners to actively participate in shaping a sustainable future.

Keywords: STEM/STEAM education · web learning · inclusion and diversity · climate change

1 Introduction: Education as a Cornerstone in the Global Migration Era

The concerning list of global challenges of the 21st century include migrations as one of the main issues, arising as a consequence of wars, recurrent economic crises, political instability, and climate change. The United Nations High Commissioner for Refugees (UNHCR) in facts reports that over 26 million refugees and 4.2 million asylum seekers were displaced worldwide until 2020. Particularly, the Mediterranean region is a critical gateway for those seeking safety and opportunity in Europe [1]. The International Organization for Migration [2] estimates that 281 million people—amounting to 3.6% of the global population—lived outside their country of origin in 2020, giving an estimate of the scale of human mobility (IOM, 2021). For these individuals, education is not just an academic endeavor; it is a lifeline that offers pathways to rebuild lives, gain skills for self-sufficiency, and integrate into new societies. However, migrants face significant educational barriers, including disrupted schooling, lack of credential recognition, gender disparities, and limited access to technology. The UNHCR's Stepping Up report (2019) reveals that only 3% of refugees access higher education, compared to a global average of 37%. This gap represents a profound loss of potential, with the World Bank [3] estimating that excluding migrants from education costs economies billions in untapped human capital, hindering innovation and growth. In Europe, where the Mediterranean migration crisis has brought over 1 million arrivals since 2015 (Frontex, 2020), the need for inclusive education is acute. Southern European nations like Greece, Italy, and Spain have become frontline states, grappling with the dual challenge of humanitarian response and long-term integration (see Fig. 1).

The digital divide further exacerbates these challenges, and almost 3.7 billion people, half of the world's population, remain offline, particularly in regions where many migrants originate [4]. The COVID-19 pandemic highlighted this divide, as online education became the norm, leaving many migrants unable to participate [1]. STEAMigPOWER, an innovative initiative funded by the European Union's Erasmus + program, addresses these challenges by leveraging web-based learning to provide Science, Technology, Engineering, Arts, and Mathematics (STEAM) education to migrants, particularly women and youth aged (15–18 years old). By focusing on STEAM fields—critical for addressing global challenges like climate change, urbanization, and renewable energy—STEAMigPOWER empowers migrants to become contributors rather than burdens, aligning with the United Nations' Sustainable Development Goals (SDGs), notably SDG 4 (Quality Education) and SDG 10 (Reduced Inequalities) (United Nations, 2015).

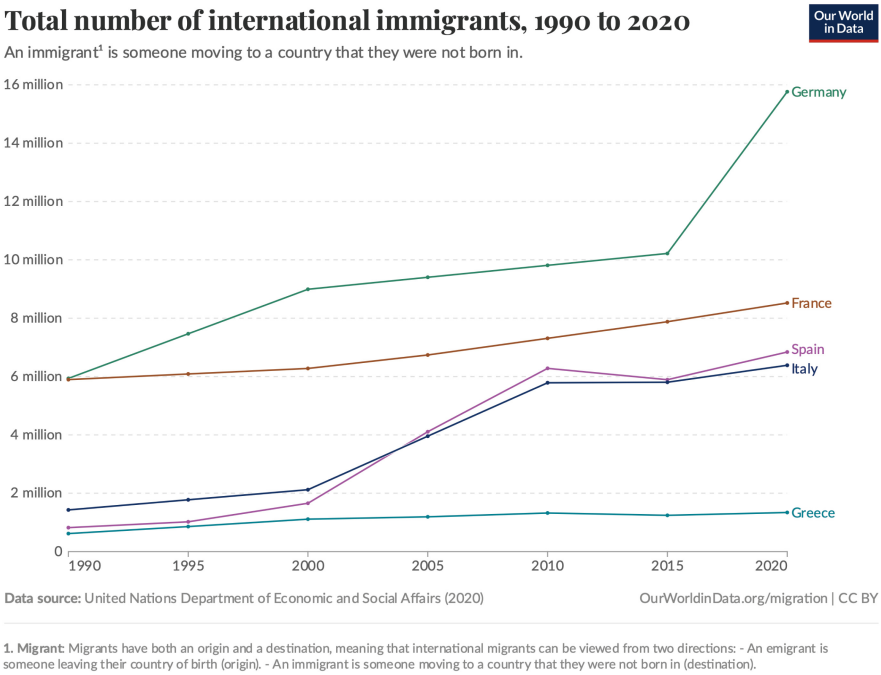


Fig. 1. The trend of total immigrants in the main EU countries in the last 30 years (source: Our World in Data).

One of the main pillars of the present initiative is the Virtual Learning Environment (VLE), a web-based platform designed to allow access to STEAM education for migrants worldwide. Built on the Open edX platform, the VLE crosses geographical, linguistic, and socioeconomic barriers, leveraging the flexibility, scalability, and interactivity of online learning to provide education to those who need it most. This attempt relies on the role of web learning and the VLE in transforming migrant education, emphasizing its design, functionality, and impact.

2 The Context: Migration, Education and Opportunity in Europe

The Mediterranean basin has historically been the intersection area of migration fluxes, where waves of human movement sparkled by wars, extreme poverty, and environmental crises, were heading north. For example, since the Syrian conflict erupted in 2011, over 6.6 million Syrians have fled abroad, with Turkey hosting 3.6 million—by far the largest refugee population globally [1]. Greece and Italy have seen the arrival of hundreds of thousands of migrants, after crossing unsafe sea routes. Spain, too, has seen a surge in crossings from North Africa, with over 40,000 arrivals in 2020 alone [5]. These migrants bring, in principle, a wealth of potential—engineers, teachers, entrepreneurs—that has to be unlocked:

- Educational Disruption: Conflict and displacement shatter schooling. UNICEF [6] reports that in Syria, over 2 million children remain out of school, their foundational education fractured by years of war. For youth arriving in Europe, this gap often persists due to language barriers and resource shortages.
- Credential Recognition: Highly skilled migrants struggle to get their qualifications recognized. The Organization for Economic Cooperation and Development (OECD) [7] found that 60% of tertiary educated migrants in Europe work in low-skill jobs, a phenomenon called "brain waste".
- Gender Disparities: Migrant women face compounded challenges. Cultural expectations, caregiving responsibilities, and discrimination restrict their access to education and employment. The European Institute for Gender Equality (2020) notes that migrant women are twice as likely as men to be unemployed, even with comparable qualifications (see the report "Gender Equality Index 2020: Digitalization and Future of Work").
- Digital Divide: Technology access remains uneven. The International Telecommunication Union, (ITU) in his report "*Measuring Digital Development: Facts and Figs. 2021*" shows that only 47% of households in developing countries have internet, a disparity that follows migrants to Europe, limiting their participation in digital learning.

These barriers have far-reaching consequences. Europe faces a growing STEAM skills shortage: the European Centre for the Development of Vocational Training, see [8], projects a need for 1.2 million additional researchers and engineers by 2030. Migrants, if empowered, could fill this gap—a fact demonstrated by countries like Germany and Sweden. Germany's vocational training programs for refugees have boosted employment rates, with 54% of participants finding work within two years (OECD, [7]). Sweden's Komvux system, offering adult education to migrants, has similarly enhanced integration, reducing welfare dependency (Swedish National Agency for Education). STEAMigPOWER builds on these successes, tailoring its approach to Mediterranean realities and targeting underrepresented groups—women and youth—to maximize both individual and societal impact.

3 STEAMigPOWER Unveiled: A Collaborative Vision Across Borders

STEAMigPOWER is a testament to the power of collaboration, uniting five Mediterranean Higher Education Institutions (HEIs) with complementary strengths:

- University of Minho (UMinho), Portugal: A leading institution in sustainable development, UMinho plays a key role in the project's focus on eco-building, contributing across all designated areas. Its team comprises members from four distinct research centres and multiple fields of expertise, including Environmental Biology, Civil Engineering, Electronics, Molecular Biotechnology, Materials Science, Physics, and Mathematics. The university conducts cutting-edge fundamental and applied research to advance sustainable development (UMinho, 2021).

- University of Perugia (UniPG), Italy: The main expertise of the Perugia unit is in the field of computational chemistry (see e.g. [9–14]). Known for its digital humanities expertise, UniPG anchors the digital storytelling component. Its Digital Humanities Lab has produced award-winning multimedia projects, blending narrative with technology (UniPG, 2021).
- Aristotle University of Thessaloniki (AUTh), Greece: AUTh's climate science programs inform the curriculum's environmental focus. Its researchers have contributed to the Intergovernmental Panel on Climate Change (IPCC, [15]) reports, grounding STEAMigPOWER in cutting-edge science.
- Middle East Technical University (METU), Turkey: METU's top-ranked engineering faculty shapes the STEAM intensive, emphasizing practical applications like robotics and renewable energy systems (METU, 2021).
- University of Barcelona School of Formative Sciences (UBSF), Spain: UBSF's pedagogical expertise ensures the project's teaching methods are innovative and inclusive, drawing on decades of teacher training experience (UBSF, 2021).
- S.E.A.L CYPRUS (Cyprus Organization for Sustainable Development and Active Learning), Cyprus, Turkey.

These HEIs partner with NGOs like Greece's SolidarityNow, Portuguese Refugee Support Platform and Red Cross, which support migrant communities with legal aid and vocational training, ensuring the project remains responsive to real-world needs.

A concise prospect of the key expertise of the participant HEIs is shown in Table 1.

Table 1. Summary of the main expertise of the STEAMigPOWER participant HEIs

HEI	Key Expertise
UMinho	Sustainable Development
UniPG	Digital Humanities,
AUTh	Computational Chemistry
METU	Climate Science
S.E.A.L CYPRUS	Renewable Energy Systems
	Sustainable Development, Active Learning

4 The Educational Framework: Blending In-Person and Online Learning

4.1 STEAMigPOWER's Goals

The name "STEAMigPOWER" encapsulates its dual mission: empowering (POWER) migrants through STEAM education while harnessing their potential to enrich societies (Migration).

The main objectives of the project are centered around in person intensive programs and online learning. Two in person event have been programmed.

A 2-Day Blended Intensive Program: combines social inclusion workshops with digital storytelling training.

A 5-Day On-Site STEAM Intensive Program: covers five thematic areas through hands-on learning.

The online learning is based on the Virtual Learning Environment (VLE), an open-access platform targeting 500,000 learners worldwide. The online modules adapt in-person content for global scalability.

The Educational Framework has been designed to blend in-person and online learning, the STEAMigPOWER's dual delivery model, integrating in-person and online education, so to ensure flexibility, accessibility, and impact. Details of the in person and online education activities are outlined in the following.

4.2 2-Day Introductory Program

EU Social Inclusion: Participants explore legal rights (e.g., asylum processes), cultural norms (e.g., workplace etiquette), and civic duties (e.g., voting). Drawing on Sara Goodman's [16] framework of immigrant membership, the module emphasizes active citizenship as a pathway to belonging. Digital Storytelling:

Guided by Joe Lambert's methodology [17], learners create multimedia narratives. Imagine a Syrian teenager crafting a short film about her family's escape, linking it to sustainable energy solutions she designs in class. This fusion of personal and technical storytelling builds both skills and confidence.

4.3 5-Day STEAM Intensive Program

Rooted in constructivist learning theory (Piaget, 1950), where knowledge is constructed through experience, the curriculum uses project-based learning (PBL) to engage students actively:

- Climate Change: Learners analyze local climate data—say, rainfall patterns in Thessaloniki—and propose adaptation strategies, mirroring IPCC methodologies [15].
- Sustainable Development: Inspired by Copenhagen's bike-friendly urban design, participants draft sustainable community plans, integrating social and environmental goals (UN Habitat, 2020).
- Eco-Building Construction: Hands-on workshops integrating sustainability principles with hands-on engineering challenges, focusing on sustainable construction practices. These workshops encourage participants to consider environmental impacts in construction activities (Eurostat, [17]).
- The 5Rs (Reduce, Reuse, Recycle, Recover, Redesign): Upcycling projects turn plastic waste into functional items, embodying circular economy principles (Ellen MacArthur Foundation, [18]).
- Renewable Energy: Participants build small-scale solar panels or wind turbines, gaining practical insights into clean energy transitions (IRENA, [19]). These activities cultivate critical thinking, creativity, and collaboration—cornerstones of STEAM success (National Academy of Sciences, 2011).

4.4 The Virtual Learning Environment (VLE): Education Without Borders

Built on the Open edX platform (Open edX, 2021), the VLE expands the reach of STEAMigPOWER to a global audience. Its design prioritizes culturally responsive teaching (Gay, 2018), tailoring content to diverse learners:

- Microlearning Modules: Short, focused lessons (e.g., a 10-min video on solar panel basics) accommodate disrupted schedules or limited internet access.
- Multilingual Support: Courses launch in six languages (English, Portuguese, Italian, Greek, Turkish, Spanish), with plans for Arabic and French to reflect migrant demographics.
- Interactive Features: Discussion forums, virtual labs, and group projects foster a global learning community.
- Accessibility Standards: Compliance with WCAG 2.1 ensures usability for learners with disabilities (W3C, [21]).

The VLE also serves as a digital archive, hosting participant stories that blend personal narratives with STEAM innovations.

5 Digital Storytelling: Amplifying Marginalized Voice

One of the communication approaches adopted by STEAMigPOWER is Digital Storytelling, with the aim of stimulating participants to share their experiences through multimedia. Imagine a young woman from Eritrea producing a podcast about designing a low-cost irrigation system, weaving in her journey across the Sahara. This method can produce multiple benefits:

- Technical skills: learners master proper tools like Adobe Premiere or Audacity, boosting digital literacy (Robin, 2008).
- Emotional Resilience: crafting narratives fosters identity and action, as Nick Couldry argues [16], giving voice to those often silenced.
- Cultural Bridge: Published stories - shared through the VLE – challenge stereotypes, fostering empathy among host communities (UNHCR, [1]).

Globally, digital storytelling has proven capable to promote transformations. UNICEF's Voices of Youth platform amplifies adolescent perspectives on issues like climate change, while Canada's Digital Storytelling Project with Indigenous communities has preserved cultural heritage (see UNICEF, [6]; Lambert, [17]). STEAMigPOWER adapts this model, merging narrative with STEAM to create a powerful tool for inclusion. Social Integration: From Skills to Belonging. The civic integration module equips participants to navigate their new societies:

- Legal Knowledge: Covers EU asylum laws, labor rights, and access to health-care and education (European Commission, 2016).
- Cultural Competence: Explores social norms—e.g., punctuality in professional settings or community traditions—easing everyday interactions.
- Civic Engagement: Encourages volunteering or local advocacy, fostering a sense of ownership (see Bilgili et al., [23]).

The benefits extend beyond individuals. Research shows that integrated migrants enhance social cohesion and economic productivity—integrated refugees in Germany contribute € 1.5 billion annually in taxes (OECD, [7]). By pairing civic education with STEAM training, STEAMigPOWER creates well-rounded contributors who enrich their communities.

6 Empowering Women and Youth: Addressing Inequity at Its Roots

STEAMigPOWER targets two groups facing systemic barriers:

– Women:

The Challenge: Globally, women hold just 28% of STEM jobs (UNESCO, [24]). Migrant women face additional hurdles—gender-based violence, early marriage, and educational exclusion (OECD, 2018). The Strategy: Mentorship from female STEAM leaders provides role models. Dr. Ellen Stofan, former NASA Chief Scientist, famously said, "You can't be what you can't see" (Stofan, [25], a principle STEAMigPOWER embodies through workshops and networking.

– Youth (15–18):

The Challenge is to attract the interest in STEAM, that often declines in adolescence, especially among girls (Microsoft, 2018). Migrant youth face added disruptions from trauma or language barriers (Dryden-Peterson, [26]). The Strategy is based upon PBL, that ignites curiosity—building a wind turbine, for instance, could spark a lifelong passion for engineering. Early intervention ensures these learners enter adulthood equipped for STEAM careers. Diversity in STEAM drives innovation. McKinsey (2020, [27]) found that companies with diverse teams are 35% more likely to outperform peers, a lesson STEAMigPOWER applies to education.

7 Implementation: Turning Vision into Reality

The success of the Virtual Learning Environment (VLE) depends on a thoughtful and well-executed implementation strategy that prioritizes accessibility, usability, and engagement. At its core, the platform is designed with a user-centered approach, ensuring that every aspect—navigation, interface design, and content presentation—is intuitive and welcoming. A clean, visually guided layout makes learning straightforward, while beta testing with migrant communities allows developers to refine the platform based on real user feedback.

One of the technical challenges to learning is linguistic diversity, for this reason the VLE incorporates a robust multilingual support system. Whether through a live agent chat, email, or an extensive helpdesk, learners will easily access assistance for both technical issues and content-related queries. This ensures that no user is left alone in practicing with the platform, producing an inclusive digital space where education remains the primary focus.

Being not only a mere repository of knowledge, the VLE fosters a sense of community, which is critical for sustained engagement. Interactive elements such as virtual meetups, webinars, and Q&A sessions with experts in STEAM fields create an environment of collaboration and encouragement. These features transform the platform from a passive learning tool into an active, dynamic network where learners feel a sense of belonging and motivation to progress.

8 Outcomes and Impact: A Catalyst for Change in Web-Based Learning

The accessibility of the VLE is granted by the web-based nature of the interface. The quality STEAM education can be accessed by migrants and refugees from across the globe. From refugee camps in Jordan to urban centers in Germany, learners can access structured educational resources that fill gaps in traditional learning opportunities.

The state of the platform is also continuously evolving, leveraging integrated data tracking and analytics, to improve its approach based on user performance and engagement. By monitoring progress, educators and developers can identify areas that require additional support, tending to ensure a tailored experience to every learner. This data-driven methodology allows the VLE to evolve organically, adapting to the unique needs of its diverse user base.

Scalability is a cornerstone of the platform's design. Built on an open-source foundation, the VLE can expand with ease, accommodating new languages, subjects, and strategic partnerships. This adaptability allows for future growth, potentially turning the platform from an educational tool into a global hub for migrant education. In the long run, it could provide recognized certifications, career pathways, and micro-credentials, empowering learners with qualifications that hold real-world value in the job market.

9 Challenges and Innovations: Adapting Web Learning for the Future

Despite its many advantages and versatility, web-based learning is not without its difficulties. A common issue is many migrant learners may have little or no experience with online platforms, facing an initial barrier to engagement. To address this risk, the VLE integrates various introductory tutorials that are intended to drive the users into the digital learning experience. These initiatives create a supportive learning environment, ensuring that technical inexperience does not become an obstacle.

Furthermore, the engagement in an online setting presents itself also potential challenges, think about the digital fatigue and to keep alive the student interest. In this respect VLE incorporates interactive features such as virtual laboratories, immersive simulations, and feedback mechanisms. These elements are designed to create a dynamic learning experience that goes beyond passive content consumption, making education not only more effective but also more enjoyable. Thanks to its adaptability to the emerging technologies and to the evolution of the learner needs, the VLE remains at the forefront of innovative education. Through a combination of strategic planning, community-driven design, and forward-thinking solutions, it has the potential to redefine how migrant communities access and benefit from STEAM education.

10 Conclusions

The result of the project and of the VLE is a Model for a "Connected World Through Web Learning". STEAMigPOWER's Virtual Learning Environment transcends traditional education, offering a scalable, inclusive model for empowering migrants through web-based STEAM learning. By leveraging the flexibility, reach, and interactivity of online platforms, it transforms lives and communities, proving that investment in digital education yields progress for all. As global migration and education policies evolve, the VLE stands as a beacon, illuminating a path toward equitable, sustainable futures.

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