A New Paradigm in Non-Formal Education: Social Inclusion and Information Filtering Skills with a STEM Approach

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SUMMARY

Persistent gender stereotypes and the social exclusion of disadvantaged groups in STEM (Science, Technology, Engineering, and Mathematics) fields are a global obstacle to young people achieving their full potential. These challenges not only restrict girls' access to these critical disciplines but also negatively impact young people's overall social adjustment and self-confidence.
In response to these challenges, the Erasmus+ programme supported "My Diversity , Our The " Strength " (My Diversity, Our Strength) project has been launched. The project aims to alleviate stereotypes that restrict young girls' access to STEM disciplines and to increase young people's competencies through a multi-dimensional approach. To achieve this goal, the project utilizes game-based learning, gamification, and inclusive non-formal education. It adopts an innovative and interdisciplinary approach that combines the strengths of its methods.

This article examines the project's innovative approach and explores how non-formal education can be used as a concrete tool to achieve social inclusion goals. In particular, data from the pilot phase with youth workers and educators demonstrates how these tools have yielded promising results in addressing complex social problems such as peer bullying, school absenteeism, and the integration of immigrant/refugee students. is putting.
light on practical and applicable steps for professionals working in education and youth to create more equitable, inclusive, and encouraging learning environments . The article highlights the central role of youth workers and teachers in this transformation process and explores how they can be empowered as agents of change. focuses on.

Keywords: STEM, social inclusion, critical peer bullying, characteristics of education, engineering design process, game-based learning, problem-based learning, project learning

About the Article

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Introduction

Persistent gender stereotypes and the social exclusion of disadvantaged groups in STEM (Science, Technology, Engineering, and Mathematics) fields pose a global obstacle to young people achieving their full potential. These challenges not only restrict girls' access to these critical disciplines but also negatively impact young people's overall social adjustment and self-confidence.

Furthermore, the intense and uncontrolled flow of information brought about by the digital age (infodemic) has shifted the focus of education systems: The real challenge is no longer the scarcity of information, but rather the need for young people to acquire the ability to distinguish which information is accurate, valuable, or applicable—in other words, to filter information using a STEM approach. In recent years, STEM education has begun to be perceived as the ability to combine theoretical knowledge with concrete technological solutions, paired with educational tools such as robotics and coding (Chung , Cartwright , & DeRose , 2017; Tuluri , 2017).

Throughout human history, knowledge has been a symbol of accumulation and control, and those who possess it have created a realm of virtue. However, the intense flow of information brought about by the digital age has fundamentally altered this paradigm. Today, the fundamental challenge is not the scarcity of information, but rather its overabundance. Young people must acquire the ability to discern which information is accurate, valuable, or applicable amidst the constant barrage of data. This transformation necessitates a shift in the focus of education systems: shifting from traditional approaches centered on memorization and the transmission of information to 21st-century skills such as filtering information, critical thinking, evaluation, and problem-solving has become critical.

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In response to these multi-layered challenges, "My Diversity ," supported by the Erasmus+ programme , Our Strength " (My diversity, Our Strength) project to life has been passed. Project, It aims to alleviate stereotypes that restrict young girls' access to STEM disciplines and enhance their competencies through a multi -dimensional approach. To achieve this goal, we use an innovative and interdisciplinary approach that combines the power of game-based learning, gamification, and inclusive non-formal education methods. has been adopted.

This article examines this innovative approach of the project and explores how non-formal education can be used as a concrete tool to achieve social inclusion goals.

Method

This study employed a mixed-methods research design. The project's methodology was developed through a four-phase approach that combined game-based learning, gamification, STEM disciplines, and non-formal education techniques to address gaps in traditional STEM education and achieve social inclusion goals. The project began with a multi-level needs assessment:

More than 50 surveys and focus groups were conducted with young people aged 16-26. These studies examined the existence of stereotypes regarding girls' access to STEM disciplines, their STEM skill levels, and their desire to apply these skills. More than 50 youth workers participated in the project design survey, which highlighted the lack of adequate educational tools to encourage girls to pursue STEM. Extensive academic research from the United Nations, the European Commission, and national information sources was conducted to understand trends and challenges in STEM. These analyses determined that the project would focus on both enhancing youth worker competencies and addressing the need for young people to engage in immersive experiences in STEM and social inclusion.

Following the needs assessment, the main outputs were designed: Based on field research, it was designed to identify youth workers' current competencies in game-based learning, gamification, and STEM non-formal education. This framework formed the basis of all training materials to be developed. Compass was created to guide youth workers in designing and implementing new non-formal educational activities that reduce gender biases and develop STEM skills . This tool included the CF , an interdisciplinary project approach, and an impact assessment tool. The partners conducted four online co- design sessions to create a methodology that combines game-based learning, gamification, STEM, gender stereotype reduction techniques, and an inclusive approach .

Four pilot studies were conducted to test the quality and suitability of the developed educational approach. Nine professionals, including facilitators, psychologists, and teachers working with young people, aged between 25 and 55, participated in the pilot study in France. The participants' average STEM knowledge was 3.88 out of 5, while their STEM teaching experience was only 1.66. The pilot study was conducted online on March 7th (via Google Meet) in a one-hour session. Participants were introduced to Compass and a thematic workshop was conducted on the relationship between STEM activities and social inclusion issues such as peer bullying, social adaptation, and school absenteeism. Both quantitative and qualitative data were collected during the pilot study.

The Critical Role of Non-Formal Education in Social Cohesion

The findings from the pilot report demonstrate how effective this approach can be shows:

STEM for Peer Bullying: Professionals participating in the pilot (teachers, psychologists, and facilitators) assessed that game-based STEM activities would help students, particularly those struggling with peer bullying, more easily express their inner worlds and represent a significant step in preventing bullying. Studies show that hands-on STEM tasks requiring collaborative work in heterogeneous groups challenge students to understand each other's strengths and weaknesses, increase empathy, and reinforce a culture of shared purpose, which reduces the exclusionary behaviors that underlie bullying. The challenges and "failures" that inevitably arise in engineering or science projects teach students the skills to receive constructive criticism within teams, resolve conflict, and develop solution-focused thinking. This helps replace bullying behaviors with constructive communication skills.

Integration of Immigrant and Refugee Children: Inclusive STEM activities have been recommended as a tool to support refugee students' social adaptation to school and classroom culture and to integrate them with their peers. Furthermore, it has been stated that bringing students from different countries together through social, cultural, and athletic activities will be beneficial in fostering cultural integration and solving problems.

Reducing School Absenteeism in Crisis Situations: Traditionally, school absence or reluctance to attend school is associated with academic failure or disciplinary problems. However, in disadvantaged students facing situations such as crisis and migration, the root causes of this situation are often psychological trauma, lack of self-confidence, and social adaptation difficulties . It is thought that the success of STEM activities can be effective in reducing school absenteeism among disadvantaged immigrant and refugee children who experience reluctance to attend school due to psychological trauma and lack of self-confidence.

The Importance of STEM Education and Its Relationship with Inclusion

STEM (Science, Technology, Engineering, and Mathematics) education goes beyond simply representing academic disciplines; it's a holistic approach that equips individuals with core 21st-century competencies such as critical thinking, complex problem-solving, and innovation. International organizations like the Organization for Economic Co-operation and Development (OECD) emphasize that STEM competencies are vital to the competitiveness of the future workforce and their capacity to address global challenges.

Basic of Innovation and Employment

In today's rapidly changing technological environment, STEM education responds to two basic needs:

1. ***Employability:*** *Women are underrepresented in STEM fields. In Italy, only 18% of students enrolled in STEM university courses are women, while in Spain, only 0.7% of professionals interested in digital technologies are women . The project aims to strengthen young people's (especially girls') competencies and basic skills in STEM fields. These skills include problem-solving, critical thinking, and collaboration skills, all of which are sought after in the labor market . Guiding young people (especially girls) toward these fields is a priority for strengthening their employability and ensuring integration into the labor market. is one of its targets.*

Economic forecasts indicate that a significant portion of future employment opportunities will be directed at individuals with STEM competencies, particularly in areas such as digitalization, artificial intelligence (AI), green energy, and technological innovation. STEM is seen as one of the sectors where the most job creation will occur. This means that young people with STEM skills will have broader career options and higher salary potential than their peers in other fields. At the European Union level, acquiring digital skills and engaging with STEM fields is critical for both individual and EU competitiveness and overall economic growth. Increasing women's participation in STEM will bring diverse perspectives to innovation processes, contributing to the creation of more robust and comprehensive solutions. will provide.

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2. ***Critical Engagement:*** *In the information age, individuals must critically evaluate media, artificial intelligence, and technology. STEM education equips students with the skills to question the accuracy of information, gather evidence, and analyze the ethical implications of technology use. This forms the basis for developing active and informed citizens rather than passive consumers of information. It transcends its traditional importance and embraces it as a social STEM fields are traditionally "for men" and are therefore a powerful tool for promoting inclusion and diversity. Cultural stereotypes that hold that STEM fields are traditionally "for men" prevent young girls from pursuing these disciplines. The project's game-based and hands-on approach to STEM makes mathematics and physics more accessible, preventing them from becoming "hostile disciplines," and aims to alleviate stereotypes . In this context, STEM not only opens career paths but also supports social cohesion by teaching cooperation, respect, and acceptance of different ideas among young people. The project's methodology aims to maximize this potential of STEM designed*

Information Filtering and Critical Thinking Skills

Information filtering means not only debugging errors but also the ability to transform the information gathered into a concrete solution. In today's digital age, where information is rapidly proliferating and accessing it becomes easier, individuals' learning processes have shifted from the virtue of "retaining information" to the competence of "selecting accurate and valuable information." In this context, STEM education plays a central role in equipping young people with these critical information filtering skills. Students interpret information in science, technology, engineering, and mathematics by identifying, analyzing, and integrating the relevant information. This allows students to approach the information they read with a critical approach. By evaluating the different sources they use, they gain the ability to gather concrete evidence regarding the accuracy of information. This process not only helps young people learn what already exists but also develops their ability to distinguish what is valid from what is invalid in the overwhelming flow of information they encounter.

In the learning environment, technology, content learning, and professional career education are often intertwined and inseparable. The technology component (T) in STEM refers to the tools and presentation methods that help students become technologically competent learners, users, and consumers (Tamim et al., 2011). Students should learn knowledge in more in-depth and personalized ways using technology (digital platforms, simulations, applications, etc.). They should be able to effectively use technology to solve concrete problems and accomplish tasks. This includes not only operating software but also knowing which tool is most appropriate for which problem. They should be able to critically evaluate the impacts, risks, and ethical implications of technology. This requires developing a critical and informed approach to technology, rather than a passive acceptance.

The project's main output, the "Escape Box," is an educational tool and presentation method rather than a traditional textbook. This game-based tool transforms abstract STEM content into a concrete, hands-on, and collaborative experience, becoming an extension of the technology component. The aim of the study is to develop youth workers' skills in designing and managing STEM-related informal educational activities. This positions youth workers as competent professionals who can transform learning environments using technological tools (gamification and digital resources).

Daily interactions with the online environment and the integration of technology into the educational environment require the rational and appropriate use of technology. The key role of the teacher here is to manage information technology and create connections between students and information technology. Teachers should strengthen students' critical thinking skills by questioning the credibility of information sources and providing guidance on digital ethics.

They should also encourage them to use technology not merely as a consumption tool but also as a platform for active learning, collaboration, and the creation of innovative solutions.between students and information technology. Teachers should strengthen students' critical thinking skills by questioning the credibility of information sources and providing guidance on digital ethics. They should also encourage students to use technology not merely as a tool for consumption, but also as a platform for active learning, collaboration, and the creation of innovative solutions.

The Role of Early Participation and Impact in Inclusion

Research shows that ensuring that students participate in STEM practices starting from primary school will not only increase their interest in STEM practices but also eliminate inequalities in education (LittleBits , 2018; Tran , 2018).

Early Participation: *In the context of educational and developmental psychology, it refers to initiating a learning or social development process at an early and sensitive stage in an individual's life. This concept is a preventative and constructive intervention strategy that supports the main objectives of your project, particularly in areas such as STEM and social inclusion . Especially for young people who are reluctant to attend school due to psychological trauma or low self-esteem (e.g., refugee children), early and hands-on participation provides them with a tangible sense of accomplishment, demonstrating their ability to do what they can. This strengthens their confidence and adaptation to school and their social environment.*

Early Impact: *In the field of education and development, an intervention or practice is initiated at a critical, early stage of an individual's development to produce long-term and profound positive effects. It refers to creating results. This concept is particularly important in STEM education and social inclusion. Early impact is a strategy for intervening in a problem before a negative stereotype becomes established or a developmental deficiency deepens. It is time- oriented because it involves taking action at the early or sensitive stages of individuals' development, when they are most receptive to learning and social adaptation.*

It aims to prevent the problem from occurring and establish a constructive infrastructure. creates. Early STEM practices help young girls develop a positive perception of science and technology before gender stereotypes become ingrained in their minds. In this respect, they have the potential to prevent persistent prejudices. Furthermore, engaging students in STEM practices starting in elementary school not only increases their interest in STEM practices but also supports the reflection of this interest in their career choices . In this respect, applied STEM competencies (collaboration, problem-solving, design-oriented thinking) acquired at an early stage provide a solid foundation for young people to pursue STEM careers, which offer high employment opportunities in the future.

The imperative for implementing an early impact model is based on the principles of cost-effectiveness and crisis intervention: Once an individual's core beliefs (e.g., "I'm not good at math" or "This is a man's thing") become ingrained, breaking them takes much longer and requires more resources. Early intervention prevents these beliefs from forming, offering lower-cost and higher-performing solutions in the long run. Children and adolescents , in particular, are extremely sensitive to the signals they receive from their environment. Positive STEM experiences at an early age teach them the message, "I can do it," which makes them more resilient to the challenges they will face in later years.

Case Study: "My Diversity , Our Strength " Mars Colony Design

1. Phase: Story Selection and Problem Definition

The event, themed around colonizing Mars, was designed to raise awareness about astronomy and space sciences through accurate information . It was designed to provide a democratic learning environment where students could express themselves freely. having fun studies their participation And dream power of depths with The aim was to meet. The students were provided with the necessary materials to design the colony called "New Horizon." The team members who will establish the colony come from different ethnic backgrounds and areas of expertise. At the same time, individuals with social and physical difficulties, including one with mobility limitations and one with hyperactivity symptoms, were included in the project. participated.

The main problem of the story is that shortly after landing on Mars, the colony's life support system is compromised by a scarce and rapidly depleting water supply.

Component	***Connection***
Diverse Team	*Gender and social inclusion priorities.*
Scarce Resource/Difficulty	*Problem-solving skills in crisis situations, rational use of technology.*
Psychological/Social Needs	*School absenteeism and psychological trauma*

Table 1.

2. Phase: Colony Design and Engineering Solutions (STEM & Problem Solving)

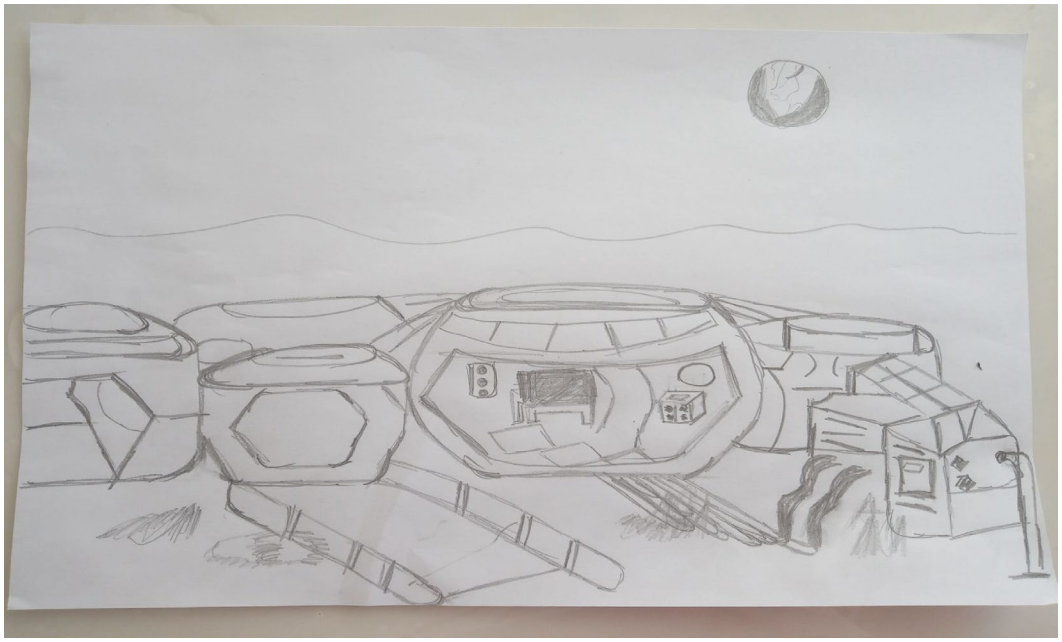
The young people were divided into small, heterogeneous groups. They were tasked with designing a colony capable of surviving on Mars and solving the problem of water scarcity. This phase directly targets applied STEM skills:

- *Life Support (Science): This back transformation system This scarcity to the problem as a solution defined.*
- *Accommodation (Engineering): Module designs not only meet basic needs but also provide accommodation for individuals with limited mobility in the team. infrastructure to be fully accessible was created.*
- *Energy (Technology): To the colony strength to ensure for Anthem to the environment suitable innovator proposals for an energy source targeted.*
- *Social Areas (Social Inclusion): Providing psychological support and intercultural interaction areas that are especially needed by young people who are refugees and victims of trauma. In order to be included in the study, sample design ideas and thoughts were transferred to the digital environment by being written in the form of a picture and a story. In this process , young people interacted by filtering which sources were reliable and applying engineering principles.*

3.Phase: Visualization of Design (STEAM and Creativity)

Once the technical feasibility of the design was determined, the groups transformed the colony into a visual output that supported creativity and freedom of expression by integrating the Art component (STEAM approach).

Technical Drawing: The groups prepared detailed plan drawings showing the layout of the colony modules they designed and basic mechanisms such as the water purification system .



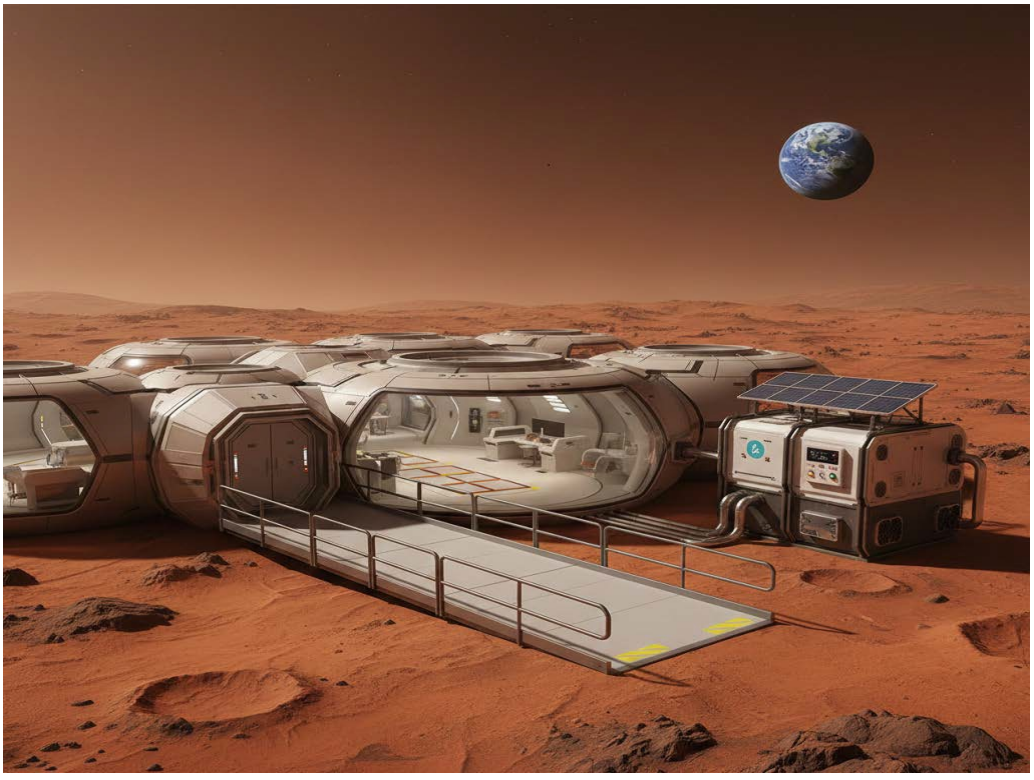
Picture 1.

The modules are designed as a combination of hexagonal and hemispherical shapes. These shapes provide the highest resistance to Mars' low atmospheric pressure and the lowest surface area-to-volume ratio (Engineering design). The saved materials and energy are transferred to vital systems (e.g., water recycling). This is one solution to the colony's survival problem.

• Social Cohesion Spaces: Promoting social cohesion using art workshops that encourage intercultural communication and social adaptation. was done.

• Projecting Empathy and Safety: Visualization fostered social and self-confidence by creating a safe, non-judgmental environment that prevented bullying or exclusionary behavior. This prioritized not only the colony's survival but also its social well-being. observed.

• Inclusive Design: Technical drawings were then converted into a digital collage and 3D model depicting the colony's appearance on the Martian surface (atmosphere, colors, and harmony with the surroundings). The colony layout highlighted accessible ramps for individuals with disabilities, wide corridors for ease of movement, and modules that adhere to universal design principles for all residents. The layout demonstrates a modular and functional structure designed to support vital functions and foster social interaction on the Martian surface. These technical details were analyzed with sensitivity, demonstrating the integration of STEM with social responsibility. was done.



Picture 2.

The focal point of the visual is the largest and most detailed structure. Its large window/observation area makes it not only a control center but also a shared living and interaction space where colonists gather and socialize.

The presence of flat or gently sloping pedestrian paths/ramps providing access to the modules demonstrates that the colony is fully accessible to individuals with mobility impairments. This detail visually reflects the project's inclusive design principle. Connecting the modules via tunnels or bridges allows colonists to collaborate safely and quickly and access common areas without being exposed to the hazardous conditions on the Martian surface. This integrates a collaborative work environment into the physical design. The spacious and bright structure of the central module suggests that social inclusion spaces, such as shared art workshops and meeting rooms, will be located in this area to support cultural interaction and post-traumatic healing.

The Key Role of the Teacher in STEM Education: Process Manager and Facilitator

The STEM education approach moves teachers from their traditional role as knowledge transmitters to those of facilitators and managers of the learning process. This role is particularly crucial in projects focusing on technology and applied design . In today's environment, where technology is intertwined with content learning and career education, the role of teachers is becoming increasingly critical .

Process of conception	Rôle de l'enseignant	Relationship
1. Definition of problem and research	*The teacher facilitates the formation of groups in heterogeneous environments (various settings) and ensures that students are included in criteria such as accessibility..*	***Inclusion social :*** *Guaranteed that diversity (immigrants , people with disabilities) is taken into account in the design process .*
2. Solution development and brainstorming	*The teacher creates a caring environment where students can freely share their technical and artistic ideas. The teacher distributes tasks in a way that encourages participation, even from shy students.*	***Prevention of harassment between peers :*** *Manages THE conflicts At breast of group and promotes cooperation and respect by demonstrating that each The idea has value .*
3. Prototyping and construction	*The teacher oversees the creation by the students of a artwork artistic Who reflects the philosophy inclusion while presenting of the details techniques (ramp , geometry) of the modules).*	***Integration :*** *By combining knowledge techniques and expression creative , the students are encouraged to address THE problems with a language oriented solutions and aesthetics .*
4. Tests and evaluation	*The teacher makes sure that THE students evaluate their solution (colony development plan) according to of the criteria engineering , art , and inclusion . The teacher encourage the use of progress tracking sheets .*	***Quality and impact :*** *Measure the effectiveness of the experiment learning by comparing it to results concrete (data).*

Conclusion and Recommendations

The "My Diversity, Our Strength" project clearly demonstrated the potential for multifaceted success in reducing gender stereotypes and promoting social inclusion by combining STEM education and non-formal learning methods. By presenting STEM through a game-based learning and engineering design process, the project simultaneously fostered both academic interest and social skills. The project's solution was evaluated as promising for highly sensitive and complex social issues such as peer bullying, school absenteeism, and the integration of immigrant/refugee students (Overall feedback from the pilot implementation was 4.44 out of 5).

Gamified STEM experiences (such as the Mars Colony Design) made an early impact in preventing the ingraining of gender-based biases by making science and technology accessible and fun for young girls. Collaborative STEM activities were particularly effective in supporting the social adaptation of international refugee students to school and classroom culture and enabling them to communicate across language barriers. Teachers and psychologists have stated that group-based STEM outcomes can lead to a reduction in bullying behaviors and lower rates of school absence due to psychological trauma. Educational institutions have recognized that equipping youth workers and teachers with tools like Compass, as the project aims, plays a critical role in creating inclusive and dynamic learning environments.

Integration and Dissemination of the Methodology

Easy Integration into the School Curriculum: As suggested by one participant, the project's results should be developed into a second follow-up project or a series of modules to facilitate easier integration into schools.

Open Access and Sustainability: The project results (CF, Compass, Escape Box) should be made freely and openly available on online platforms for five years. This will ensure maximum dissemination of the methodology at national and European levels.

Focus on Target Groups: Broader Scope of Application: The project is highly recommended, especially for colleagues working with migrant and refugee children and for schools and organizations focused on preventing peer bullying. Future studies should focus on these groups.

Source

Adams, A. E., Miller, B. G., Saul, M. ve Pegg, J. (2014). Supporting elementary pre-service teachers to teach STEM through place-based teaching and learning experiences. Electronic Journal of Science Education, 18(5), 5.

Examining teacher talk in an engineering design-based science curricular unit. Research in Science Education, 50(2), 469-487.

teaching of the science supported by approaches contemporary : Guide to activities from theory to practice (pp . 2-22). Pegem A. Editions .

Fukuyama, M. (2018). Society 5.0: Aiming for a new human-centered society. Japan Spotlight, 1, 47-50.

Furner, J. M. ve Kumar, D. D. (2007). The mathematics and science integration argument:

Guzey, S. S., Moore, T. J. ve Harwell, M. (2016). Building up STEM: An analysis of teacher-developed engineering design-based stem integration curricular materials. Journal of Pre-College Engineering Education Research (J-PEER), 6(1),

Article 2.Gülgün, C., Yılmaz, A. ve Çağlar, (2017). Teacher opinions about the qualities

Han, S., Rosli, R., Capraro, M.M. ve Capraro, R.M. (2016). The effect of science,

Krajcik, J. ve Blumenfeld, P. (2005). Project-based learning. R. Sawyer

The cambridge handbook of the learning sciences (s. 317-334). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511816833.020

Morrison, J. (2016). TIES STEM education monograph series, attributes of STEM education. Baltimore, MD: TIES.National Academy of Engineering & National Research Council. (2009).

Engineering in National Research Council. (2020).

Standards for K-12 engineering education. National Academy of Engineering.National Research Council. (2012). A framework for K-12 science education: Practices, crosscutting concepts, and core ideas.

Washington D.C.: The National Academies Press.Sanders, M. (2009). STEM, STEM education, STEMmania. The Technology Teacher, 68(4), 20–26.

Siew, M. N., Amir, N. ve Chong, C. L. (2015). The perceptions of pre-service and in- service teachers regarding a project-based STEM approach to teaching science. Springer Plus, 4(8), 1-20.

Siverling, E. A., Suazo- Flores, E., Mathis, C. A. ve Moore, T. J. (2019).

Students' use of STEM content in design justifications during engineering design- based STEM (2020).

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