SpicE

Special EduCation **STEAM Academy**

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Contents

Session: The SpicE project

Significance and achievements of the SpicE project

Achilles Kameas - Hellenic Open University, Greece

This presentation show the major achievements and impact of the SpicE project.

SpicE is a 3-year project co-funded by the European Union under the Erasmus+ Teacher Academies action, aiming to support the inclusion of students with mild disabilities in STEAM education by strengthening primary school teachers' competences in Inclusive STEAM Education.

The challenges that the project faced were to identify the necessary competences and use them to describe educational perspectives and roles, to upskill educators (pre-service & in-service) so that they are able to design and realize STEAM education activities for special needs classes, to make available a comprehensive toolset to assist educators, including knowledge, skills and online tools, to establish a community of educators and enable them to collaboratively achieve practical results, and to increase the impact and ensure the sustainability of the outcomes.

The project's final outputs are:

- STEAM Educators Competence Framework
- STEAM Educational Framework
- 8 Inclusive STEAM occupational profiles
- Open digital training content (76 learning units), translated in 4 languages (English, Greek, Bulgarian, Spanish)
- New modular curriculum for inclusive STEAM Education, consisting of a Massive Open Online Course (MOOC), blended learning courses, and mobility program. 826 educators participated in the MOOC, 108 participated in the blended learning course, and 49 participated in the mobility program.
- SpicE "Community of Practice" and "Inclusive STEAM Alliance" networks and knowledge repositories for continuous learning and improvement in inclusive STEAM education
- Policy recommendations for the implementation of inclusive STEAM education in the classroom
- >1500 teachers reached through the project's activities
- The SpicE Book, with best practices from the project partners and invited guests

Perspectives of Inclusive STEAM Education for students with Mild Disabilities in the context of an evolving school reality

Ioannis Agaliotis - University of Macedonia, Thessaloniki, Greece

Interventions for the successful Inclusion of students with Mild Disabilities (MD) in STEAM Education are demanding undertakings, the perspectives of which depend decisively on the successful management of the following key issues:

- Due to the cognitive and learning inadequacies they usually exhibit, students with MD cannot meet the demands of STEAM – learning, unless they receive effective personalized support. Such a support includes the consistent use of: (1) Educational Assessment for specifying student's individual learning profile, before the commencement of the intervention, (2) SMART instructional goals reflecting student needs precisely, (3) Well – balanced instruction with regard to (a) high vs minimal student guidance and (b) personalized vs inclusive teaching, and (4) Timely individual feedback, and frequent evaluations of the interventions.
- Existing curricula and commonly used instructional practices may obstruct Inclusive STEAM Education of students with MD. Universally designed transdisciplinary (or at least interdisciplinary) constructs should be used, in combination with evidence- based instructional practices that may ensure the meaningful and measurable progress of students with MD. The mere provision of access to the curriculum is necessary but not sufficient condition for school success. Furthermore, a considerable number of ostensibly effective interventions are in fact not evidence-based. Presently, evidence – based interventions for the successful Inclusive STEAM Education of students with MD are extremely scarce.
- The challenges posed by the very nature of Inclusive STEAM Education for students with MD impose the immediate adoption of certain educational and instructional innovations by the schools, such as: team teaching, differentiated instruction, emphasizing "big ideas" while at the same time considering fundamental knowledge, and using new models for measuring school success.
- The teachers trying to implement Inclusive STEAM Education for students with MD should be able to combine old and new qualities, such as those mentioned in the Educational– and the Competence Framework produced by the SpicE project.

Provided that the aforementioned recommendations will guide future practice of Inclusive STEAM Education for students with MD, the perspectives of this challenging and promising enterprise may be bright!

The STEAMComp InclEdu Competences framework

Georgia Sakellaropoulou, Natalia Spyropoulou & Achilles Kameas - Hellenic Open University, Greece

In recent years, the demand of an inclusive and transdisciplinary education for all students led to the development of the educational approach of Inclusive STEAM (Science, Technology, Engineering, Arts and Mathematics) Education. Recognizing both the role of educators as pillars of the success of any educational intervention and the potential of Inclusive STEAM Education in all students' multidimensional development, the current presentation introduces the Competence Framework for Inclusive STEAM Educators (Inclusive STEAMComp Edu). The presentation outlines the theoretical background, the need and the research methodology that led to the development of Inclusive STEAMComp Edu, presenting, in parallel, its components and its practical applications.

The Inclusive STEAMComp Edu is a competence framework that describes the necessary competences (attitudes, knowledge, skills) that qualified educators should develop and be able to apply in Inclusive STEAM classrooms, for the success of any educational intervention. Based on the STEAM Educators' Competence Framework (STEAMComp Edu) (Spyropoulou & Kameas, 2024) and the Gap analysis implemented in the context of the project SpicE (Special Education STEAM Academy) (University of Macedonia, 2023), the Inclusive STEAMComp Edu was developed through an adaptation of an existing methodology concerning framework's development (Fong et al., 2013).

As a result of the implementation of this methodology, the Inclusive STEAMComp Edu (Sakellaropoulou et al., 2023) concluded to consist of five different educators' roles, namely perspectives. Those roles were those of a) Educator as Inclusive STEAM Teacher/ Trainer/ Tutor, b) Educator as Inclusive STEAM Designer and Creator, c) Educator as Inclusive STEAM Orchestrator, d) Educator as a Community Member and d) Educator as a growing Inclusive STEAM professional. Across these roles, 16 dimensions (namely competence areas) were identified, comprising 42 competences, which were, further, described through 203 practical examples. All those framework components aim to a) facilitate the design, implementation and assessment of Inclusive STEAM Educational procedure, b) adequately equip educators with necessary competences (attitudes, knowledge and skills), c) act as a self-assessment tool for educators in Inclusive STEAM Education and d) act as a valuable guide for policy makers and educational providers for the effective support of educators in knowledge development and practice.

For highlighting framework's potential, the current presentation concludes with the applications of the Inclusive STEAMComp Edu. The framework has, already been used as a) a guide for the design, implementation and assessment of an educational program, b) the basis for the definition and description of the occupational profiles of primary educators needed in an Inclusive STEAM classroom for the success of any educational intervention (Sakellaropoulou et al., 2024), c) a guide for the development of SpicE training program (Pavlou et al., 2023, 2024) and d) an educators' assessment tool during training.

Keywords: Competence Framework, educators, Inclusive STEAM Education, applications

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The development of teachers' inclusive STEAM education competences in the context of the SpicE project

Marios Papaevripidou & Yvoni Pavlou – University of Cyprus, Cyprus

This presentation introduces the instructional design process of the Joint Curriculum for STEAM (Science, Technology, Engineering, Arts, Mathematics) in Special Education, created in the context of the SpicE project to address the professional development needs of pre- and in-service teachers. The Curriculum aims to build teacher competences for implementing inclusive STEAM approaches in mainstream classrooms, focusing on the inclusion of learners with mild disabilities.

The Curriculum design process followed a team-oriented, outcome-based approach (Spyropoulou et al., 2019; 2022) by primarily applying the Analyze, Design, Develop, Implement and Evaluate (ADDIE) model. The Curriculum was structured in three progressive training phases: a Massive Open Online Course (MOOC), a Blended Learning Program, and two in-person Exchange Programs. The first two phases emphasized foundational knowledge and reflective practice, while the third supported hands-on collaboration and exposure to good practices across countries. Competences were selected from the STEAM Educator Competence Framework for Special Needs (Sakellaropoulou et al., 2023) and learning outcomes were developed for aligning training content with identified professional development needs from participating countries.

The presentation will highlight how learning pathways were differentiated for pre- and in-service teachers, ensuring flexibility and responsiveness to their unique contexts. It will also discuss how various delivery modes (asynchronous, blended, face-to-face) were leveraged to support the gradual development of teachers' competences, and how curriculum adaptability was ensured to allow for institutional customization.

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Active methodologies for STEAM teacher training from an inclusive perspective

Rosabel Martínez – University of Alicante, Spain

The aim of this article is to present an educational experience based on active methodologies for the development of the STEAM model. Specifically, it describes the work carried out during a training stay at the University of Alicante, aimed at current and future teachers from various European countries, within the framework of the Erasmus+ SpicE project on STEAM and inclusion.

The methodology combined active learning strategies with co-creation dynamics, pedagogical reflection, and collaborative work. The activities were structured to include short theoretical sessions, experiential workshops, observation in real educational settings, and joint design of teaching proposals. The main methodologies applied were project-based learning, gamification, design thinking, and collaborative learning. These methodologies were both the subject of analysis and the foundation of the entire training experience.

The objective was to significantly enhance participants' understanding of the inclusive STEAM approach, as well as their ability to transfer what they had learned to their own educational contexts and to strengthen the role of teachers as agents of change within their educational communities.

The results suggest that the use of active methodologies in teacher education processes fosters greater engagement among participants. This represents a shift away from more traditional training approaches, as it focuses on experiential learning and collective problem-solving in education. The international and multicultural composition of the group enriched the exchange of perspectives.

It is concluded that teacher training in STEAM for inclusion should go beyond theoretical instruction and provide real opportunities for experimentation, creation, and collective reflection.

Building the Future - Inclusive STEAM in Bulgaria

Vera Todorova & Mariya Zhelyazkova - Trakia University, Bulgaria

This presentation showcased Bulgaria's contributions to the SpicE project and the development of inclusive STEAM (Science, Technology, Engineering, Arts, Mathematics) education. Through a multilayered approach involving analysis, training, and international mobility, the project examined the current landscape and potential of inclusive practices in STEM/STEAM settings. The presentation touched on the gap in the initial stages of teacher training and in-service teacher training or the needs of children with mild disabilities in Bulgaria. This gap highlighted the urgency of integrating inclusive strategies in STEAM from the outset. The experience served as a catalyst for ongoing development, new training courses, and policy-oriented advocacy toward equitable STEAM education for all learners. By promoting international collaboration, facilitating inclusive innovation, and sustaining discourse among educators, the Bulgarian team reinforces the equation: STEAM + Inclusion = Accessible, Engaging, and Meaningful Learning. This experience acts as a catalyst for continuous development, the establishment of new training programs, and advocacy oriented towards equitable STEAM education for all learners.

Presentation of the SpicE Virtual Learning Environment (VLE)

Odysseas Vlahonickolos – Readlab, Greece

The presentation offered an overview of the SpicE Virtual Learning Environment (VLE), beginning with an introduction to its goals and educational purpose. It then described the structure and features of the SpicE VLE, highlighting its user-friendly design aimed at supporting inclusive and engaging online learning. The registration process was explained as simple and accessible, followed by an outline of the MOOC available on the platform, including its content, format, and flexibility for learners. Evaluation methods such as quizzes and assignments were discussed, along with the criteria for receiving a certificate upon successful course completion. The presentation concluded with a look at the analytics tools used to monitor user engagement and learning progress, demonstrating how the platform supported both effective learning and continuous improvement.

Session: New technological approaches in Inclusive STEAM education

Educational Robotics and Inclusivity in Education

Manolis Wallace, **Emmanouil A. Demetroulis, Vassilis Poulopoulos & Evi Togia** –
ΓΑΒ LAB – Knowledge and Uncertainty Research Laboratory, University of Peloponnese, Greece

Educational Robotics is conventionally employed in order to convey science and technology concepts in an applied manner via the co-development of small-scale projects by groups of students. But this is limiting and excluding for some students in a variety of ways, some of which being that only some of the students get to be involved in the projects, even fewer have leading/core roles and introvert students or students with less developed collaboration skills are most often excluded. As a response, herein we summarize an alternative way to teach educational robotics. This proposed approach addresses the exclusion of said students not only during the specific class but also more generally, by fostering the growth of their yet underdeveloped collaboration skills.

Keywords: Educational Robotics, Collaboration Skills, Inclusive Education

Artificial Intelligence in Education: Applications and Tools for Supporting Educators and Students

Marios Papaevripidou & Theodoros Karafyllidis – University of Cyprus, Cyprus

In this talk, we will introduce education professionals to two innovative AI applications, "Teacher Mate" and "Study Buddy," developed under the AI4EDU project (https://ai4edu.eu). Funded by the EU, AI4EDU aims to create and evaluate next-generation intelligent educational assistants powered by advanced AI and language technologies. These tools are designed to support teaching and learning through engaging, flexible, and effective interactions while reducing the administrative burdens educators face in their daily activities.

Both applications leverage Large Language Models (LLMs) and techniques like Retrieval-Augmented Generation (RAG) to provide practical, reliable, and context-specific support. "Teacher Mate" is an AI-powered assistant designed to optimize teachers' daily tasks, including lesson planning, formative assessment, and administrative documentation. It offers personalized suggestions, generates tailored teaching materials, and supports classroom management by automating routine processes. This allows educators to focus more on meaningful interactions with students, thereby enhancing the overall learning experience.

Similarly, "Study Buddy" acts as a personalized learning assistant for students, helping them study, complete assignments, and review concepts effectively. It offers customized educational content, interactive exercises, and revision support based on individual learning needs. By integrating national school textbooks from four European countries (Greece, Sweden, Ireland, and Cyprus) for both a science and a humanities subject, Study Buddy ensures that the generated materials are not only practical and reliable but also aligned with local curricula and educational standards.

Throughout our talk, we will explore the functionalities of both applications and demonstrate their potential for planning, developing, and implementing teaching, learning, and assessment activities. We will also share insights from pilot implementations across diverse educational settings in Europe, highlighting the real-world impact of these AI tools in supporting both educators and learners.

Specifics of learning difficulties – new technological approaches

Iva Boneva – Trakia University, Bulgaria

Inclusive STE(A)M education requires tailored approaches for students with specific learning difficulties (SpLDs), including ADHD, dyslexia, and dysgraphia. These neurodevelopmental conditions, often invisible, affect 10–17% of learners and significantly influence academic performance, organization, memory, and self-esteem. Misinterpretation of such learners as lazy or disruptive can lead to exclusion unless proactive strategies are implemented.

This work aims to explore and demonstrate how innovative digital technologies can empower learners with SpLDs while promoting equity in education. The objective is to present accessible tech-based tools that foster inclusion, reduce cognitive load, and support differentiated instruction across STE(A)M subjects.

The methodology involved reviewing peer-reviewed research, analyzing teacher feedback, and evaluating tools such as text-to-speech software (NaturalReader, Read&Write), speech-to-text systems (Dragon NaturallySpeaking), and adaptive learning platforms (Khan Academy). In addition, mind mapping applications (e.g., MindMeister, Canva, Coggle), AR/VR tools, and productivity apps (Todoist, Focus Keeper) were reviewed for their effectiveness in addressing executive function challenges and enhancing engagement.

Results reveal significant improvements in comprehension (24% increase from read-aloud tools), learner autonomy, and participation. Teachers report increased motivation, independence, and the ability to personalize instruction effectively. Multisensory and gamified learning formats further enhance retention and focus among students with SpLDs.

This presentation concludes that to unlock the full potential of inclusive STE(A)M education, technology must be matched with pedagogical commitment, systemic support, and a relational mindset. Educators must not only understand the barriers but also embrace practical tools to transform them into bridges for learning and participation.

Keywords: Specific learning difficulties, educational technology, inclusion, assistive tools, STE(A)M education

Advanced technology-enhanced Inclusive STEAM Education

Spyros Papadakis - Hellenic Open University, Greece

In the 21st century, STEAM (Science, Technology, Engineering, Arts, and Mathematics) education has emerged as a critical pathway for fostering innovation, economic development, and essential skills such as critical thinking, problem-solving, creativity, and collaboration. This presentation explores the importance of inclusive STEAM education, which aims to create learning environments that are accessible, equitable, and engaging for all students, regardless of their diverse learning needs, backgrounds, abilities, socioeconomic statuses, genders, ethnicities, or other characteristics.

The presentation outlines pedagogical frameworks for inclusive STEAM education, emphasizing the role of educators as facilitators who translate theory into actionable strategies. It highlights the Universal Design for Learning (UDL) and collaborative, real-world problem-solving as key frameworks. Additionally, the presentation discusses how technology serves as a powerful enabler for inclusivity in STEAM by breaking down traditional barriers to access and learning. Key technologies discussed include personalized learning paths, automated assessment and feedback, predictive analytics, accessibility tools, immersive learning environments, prototyping and design thinking, real-time data collection, adaptive interfaces, and assistive robotics.

A particular focus is given to the Learning Activity Management System (LAMS), an open-source web-based platform that allows educators to create, manage, and deliver individual and collaborative learning activities online. LAMS' visual authoring environment enables teachers to sequence different learning activities and tools into structured learning designs. The presentation provides examples of how LAMS can be used to create inclusive STEAM learning designs, including a detailed example of teaching the concept of 'speed' in an inclusive elementary classroom using a STEAM approach.

The presentation concludes with a demonstration of how generative AI can be used within LAMS to create inclusive STEAM lesson plans, showcasing the potential of AI to enhance educational design. The overarching message is that inclusive STEAM education is not just about using technology but about leveraging sophisticated tools to create personalized, accessible, and engaging learning experiences that empower all students to succeed.

Keywords: Inclusive STEAM Education, Technology-Enhanced Learning, Universal Design for Learning, LAMS, Generative AI

Session: Presentations by educators – I

What if…I observe, think and act!

Elisa Ripamonti - State Comprehensive Institute Koine, Italy

What if one day, in 2021 schools are closed again because of Covid 19 virus, but the Italian government decides to open the schools for disabled pupils and their teachers. What to plan staying in presence with disabled ones, but at distance with other pupils?

I decided to focus mostly on the skills of the pupil I am working with, a child who cannot speak, but makes sounds that are communicative, someone who has difficulties with fine and gross motor skills, with a need to strengthen her concentration.

So, what can be more natural than to start with something I love as a teacher and a woman: I love reading, and every time we do something we adore, we connect deeply with others, because they can feel our enthusiasm, they can stay and perceive our well-being, and this is contagious, this allow us to cope with difficulties, and give us a boost. We read, a lot of stories, and one day, there it was, the perfect story for us and our classmates, something we could read, rewrite, change and shape at will.

The craft was something that could engage a lot of pupils, especially the one I was working with, so we immediately started working on the characters of our story. It is decided, it will be a story programmed using Scratch, a free visual programming language that helps children to code, so she can entertain herself as other children read a book. Let's break down the actions, let’s create instructions that could be followed easily. We prepared the communicative string using a visual code with AAC (Augmentative Alternative Communication). This was a very important part of our inclusive work, because it pushed us to grasp the real needs of our classmate.

She can paint, but in an uncontrolled way, so we decided to avoid brushes or hands paint, we started with stamps! We made them with simple shape. This was not easy at all, she was used to drawing wide, irregular lines, but this time we wanted her to use a slow, sharp and repetitive movement to fill the whole space. We took time, we tried, and tried again, we repeated the actions, e discussed and together we found a better way to let her improve, we were cooperating for her, but actually we learnt something meaningful for us, as a working team.

That was just the beginning. Once we had the characters (“sprite” in scratch.mit.edu) we needed the background (“stage” in scratch.mit.edu) and this time we wanted to use her passion for collecting. The story was set in a wood, so our garden was the best place to collect natural objects. Once again, we showed her pictures in order to let her understand what we needed. A recognisable and repetitive structure was effective to achieve our goal and make the child autonomous. Everything was ready, we needed to start working on the digital part, taking photos, and obtaining sprites and stages from the real created drawings.

Next step was the voice over, but that seemed too difficult for our classmate. She couldn’t reproduce the right sound when we wanted her to. We had to think out of the box and find a solution. And so we started: first we listened to her throughout the day and day after day, in order to record all the

communicative sounds she made, then we added them on scratch in the desired order. After writing the code, we tested it and we realised that our classmate was losing concentration, because the story was too long for her anyway. Since I was working on the concept of cause and effect, we introduced a "stage" that was as a page turner: the story pauses but when you touch the screen it goes on. The sequence got shorter and every time she saw a green screen she had to touch the tablet screen in order to keep the story going. (We chose green because it is one of the few colours she can recognize). In such case she was even more involved because she likes to be interactive and this very simple action is like a game for her.

We did it, she had her tale!

In the details I can affirm that the main benefits were the following ones:

For the pupil with disability:

- Identify and choose images
- Understand verbal communication supported by strings in aac
- Refine gross-motor skills
- Strengthen the concept of cause and effect
- Learn to entertain oneself

For the class mates:

- Activate problem solving skills
- Recognize the needs of the others
- Learning to compare and share opinions
- Look for solutions and test them
- Learn simple programming commands in scratch.mit.edu.

This is not the only time we have prepared engaging activities for everyone. Having disabled pupils included in normal classes asks us to design with them and for them daily. We were pushed to start from something concrete, but reality is actually too complex for some pupils, so we had to extract useful information from the context and then simplify it and create achievable sequences. This is much more challenging if it involves everyone in a meaningful purpose.

As a special needs teacher, I can assure that this activity is useful for children not only on an ethical and social level, but also because it unconsciously spurs them to think, be divergent, collaborate, be forward-looking. These are useful skills for their lives and for their future but they can make a difference in the here and now of their disabled friend.

We were not immediately successful, it took time. Here and in all the other our projects, even the "mistake" was useful. It was a starting point, because solving problems in real life is not about applying little rules, but about thinking, reasoning, getting involved. Mistakes can become a shared moment of exchange and debate to find new ways forward.

"If ants get together, they can move an elephant" says an African proverb. This is the teacher power: to not be alone to make the difference.

The Role of Art in the Inclusion of Students with Special Needs in STEAM Environments

Luis Mesquita da Fonseca - Agrupamento de Escolas de Esmoriz, Portugal

Introduction: STEAM education is an interdisciplinary approach that blends Science, Technology, Engineering, Arts, and Mathematics into an integrated learning model. This approach encourages creativity, innovation, critical thinking, and collaboration among students, which can help them develop essential skills for the modern world. However, students with special educational needs (SEN) often face significant barriers to accessing the standard curriculum. Students who require Additional Measures and Selective Measures often encounter excessive personal or school-related barriers that disrupt the teaching and learning process, hindering their full participation in conventional educational activities. In the context of Decreto-Lei n.º 54/2018, which aims to ensure the inclusivity of education in Portugal, Additional Measures refer to a range of personalized interventions designed for students with long-term and complex educational difficulties. These students typically require individualized curriculum modifications, assistive technologies, and specialized support to facilitate their participation in educational activities. On the other hand, Selective Measures are intended for students who show early signs of academic underachievement but do not have significant long-term disabilities. These measures are typically temporary interventions aimed at promoting academic success. This study examines the role of art in promoting the inclusion of students with Additional Measures and Selective Measures within the STEAM educational framework. The research is based on the experiences of students from the Agrupamento de Escolas de Esmoriz - Ovar Norte, a public school in Portugal. The goal is to understand how integrating art into STEAM activities can foster an inclusive environment that caters to students with diverse needs, ultimately contributing to their academic success and social integration.

Objectives: As a school psychologist, the primary aim of this study was to investigate how art-based STEAM activities can support the inclusion of students with Additional Measures and Selective Measures. More specifically, the study sought to explore how various forms of art—such as visual arts, music, and digital arts (including LED environment design)—can enhance students' cognitive, emotional, and social development. The integration of art into STEAM activities was seen as an opportunity to engage students in a nonverbal and more accessible manner, helping them to overcome barriers that may exist in more traditional subjects like mathematics or science. Additionally, the study aimed to assess how the Additional Measures provided to students with special disabilities, including those with intellectual disabilities and autism spectrum disorder (ASD), can be effectively supported by creative processes. The study also explored the potential of art-based STEAM activities to improve students' self-esteem, academic participation, and peer interactions. For students with Selective Measures, who generally have less severe learning challenges, art activities offered a means to engage more deeply with the curriculum and build confidence in their abilities.

Methodology: The research was conducted over the first semester of the 2024-2025 academic year,

from September 2024 to February 2025. It employed a mixed-methods design, combining both qualitative and quantitative research approaches. The sample consisted of 47 students with SEN, aged between 10 and 18 years, including 12 students with Additional Measures who attended specialized multidisciplinarity support classrooms. These classrooms are specifically designed to accommodate students with special disabilities, providing a highly individualized curriculum tailored to each student's needs. Students with Additional Measures often experience significant challenges in accessing the standard curriculum and benefit from support in areas such as speech and language therapy, behavioral interventions, and adaptive learning tools. Data collection included a combination of direct observation, standardized assessments, and monitoring by the EMAEI (Multidisciplinary Support Team for Inclusive Education). The EMAEI team was responsible for overseeing the implementation of art-based STEAM activities, ensuring that they were appropriately adapted to meet the diverse needs of the students. Observations were conducted during interdisciplinary STEAM activities that incorporated various forms of art. These activities included visual arts (e.g., drawing, painting, sculpture), music (e.g., rhythm exercises, sound composition), and digital arts (e.g., LED environment design). These art activities were designed to engage students in creative problem-solving tasks that integrated scientific, technological, and artistic concepts. Results: Preliminary results from the research indicate that the integration of art-based activities into STEAM learning had a significant positive impact on students with Additional Measures and Selective Measures. For students with Additional Measures, the tailored curriculum, which was designed to address their specific educational needs, was enriched by the inclusion of creative arts. These students, many of whom struggle with traditional verbal communication, found that art provided a powerful means of self-expression. For example, students with "severe" autism spectrum disorder (ASD) were able to "better self-regulation" and to demonstrate their understanding of complex scientific concepts through visual representations, such as drawings and hands-on LED environment installations. This approach allowed students to explore their creativity and convey their ideas in ways that traditional assessments might not have captured. Furthermore, art-based STEAM activities had a positive impact on the emotional and social development of students with special disabilities. Teachers and support staff reported improvements in students' social interactions, as group art projects encouraged cooperation and peer communication. These activities helped foster a sense of belonging and teamwork, which is often a challenge for students with Additional Measures who experience difficulties with social skills. Students with Selective Measures also benefited from art-based STEAM activities. These students showed increased engagement with the curriculum, as the creative projects allowed them to explore subjects like technology in a more hands-on and enjoyable way. The integration of art helped them connect with content that might otherwise have seemed abstract or difficult.

Conclusions: The findings of this study highlight the significant role that art can play in fostering the inclusion of students with Additional Measures and Selective Measures in STEAM education. The study confirms that the integration of art into STEAM activities enhances students' ability to engage with complex topics and express themselves in ways that traditional teaching methods may not allow. Art-based learning provided a flexible and inclusive environment that supported the cognitive, emotional, and social development of all students, regardless of their educational needs. For students with

Additional Measures, the personalized curriculum designed for their specific needs was complemented by the creative opportunities that art provided. These students demonstrated an improved understanding of academic content and showed enhanced social skills and emotional regulation. Additionally, the study underscores the importance of Selective Measures in preventing academic failure and ensuring that students at risk of underachievement receive timely support. The positive outcomes from the study suggest that more schools should consider incorporating interdisciplinary STEAM activities that include art as a central component of the curriculum, particularly for students with Additional Measures and Selective Measures. Given the promising results, it is recommended that our educational institution continue to develop and implement inclusive STEAM programs that integrate art in order to support the diverse learning needs of all students. This approach can contribute to creating a more inclusive, engaging, and supportive learning environment that allows every student to reach their full potential.

Keywords: inclusive education, STEAM, art, multidisciplinarity

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Empowering Educators for Inclusive STEAM Pedagogy in Primary Education: A Multi-Phase Professional Development Model Inspired by the SpicE Academy

Aikaterini Nikolakopoulou - Directorate of Primary Education of Achaia, Greece

Introduction: Inclusive and equitable education has become a central concern in educational policy and practice. STEAM education offers a powerful interdisciplinary approach that can foster creativity, critical thinking, and engagement among diverse learners. However, implementing inclusive STEAM practices in primary education remains challenging. Teachers often lack the necessary training, resources, or confidence to address diverse student needs within STEAM frameworks. This abstract presents a structured, two-phase professional development (PD) model inspired by the European SpicE-Academy project. It is designed to support Greek primary school teachers in integrating inclusive strategies into STEAM pedagogy.

Objectives: The main objectives of the presented model are:

- To enhance teachers' understanding of inclusive and student-centered STEAM education.
- To build teachers' confidence and competence in designing and implementing inclusive STEAM learning scenarios.
- To foster a school network that will function as s sustainable professional learning community among educators.
- To identify enablers and barriers in the practical integration of inclusive STEAM in diverse classroom settings.

Methodology: A qualitative case study methodology was adopted to explore the development and implementation of the PD model. The model involved 75 primary school teachers from five school clusters and an initial training phase attended by 147 participants. The PD unfolded in two main phases:

Phase I – Theoretical Training: Teachers attended four two-hour on-site sessions per school unit. Training focused on key topics: introduction to STEAM and inclusion, holistic and learner-centered pedagogy, inclusive strategies, differentiation and assessment in STEAM, and professional networking. Learning was supported by asynchronous digital materials and group reflection activities.

Phase II – Classroom Implementation: A follow-up workshop allowed teachers to collaboratively design, implement, and refine STEAM scenarios. This phase included the presentation of good practices, peer feedback, joint planning, and classroom experimentation. Teachers were encouraged to adapt content to their learners' profiles and reflect on the outcomes.

Data were collected using questionnaires, classroom observations, and feedback forms. Thematic analysis was applied to identify recurring patterns in teacher responses and classroom experiences.

Results: Preliminary findings show positive outcomes in several areas:

Increased Teacher Confidence: Participants reported greater self-efficacy in using inclusive practices in STEAM classrooms. Many described a shift from uncertainty to proactive experimentation.

Improved Collaboration: The intervention promoted stronger links between educators within and across schools. The formation of teacher networks enhanced peer support and the sharing of ideas, although collaboration sometimes remained a challenge for teachers.

Evidence of Inclusive Practices: Teachers implemented differentiated teaching strategies, resulting to more active engagement of students with different learning and cultural profiles.

Challenges Identified: Time limitations, inadequate resources, and the need for ongoing support were Identified as ongoing barriers. However, these were partially mitigated through team collaboration and school-level planning.

Conclusions: The SpicE-inspired PD model provides a practical, flexible framework for embedding inclusive practices in primary STEAM education. Its structure - combining theoretical training with classroom application - proved effective in empowering teachers and, in most cases, fostering collaboration. While challenges remain, the model highlights the potential of professional learning communities as drivers of pedagogical innovation. Its adaptability and focus on real classroom practice make it a strong candidate for wider adoption and policy support. Future iterations should include mechanisms for long-term mentoring and infrastructure support to ensure sustainable impact.

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Inclusion in the Context of Interdisciplinary Learning

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Introduction: In teaching, we encounter students who have learning difficulties, and teaching needs to be adapted in such a way that abstract concepts and processes are taught using concrete examples from everyday life. This example shows an interdisciplinary approach to teaching mathematics and science subjects in extracurricular teaching with the aim of developing science and mathematical skills from an early age. The activities carried out with students have shown that students with learning difficulties (intellectual difficulties) achieve the desired outcomes by working on practical tasks in a group with their peers, thus achieving student inclusion. Depending on the type of student difficulty, tasks can be differentiated according to the student's abilities (e.g. visual support, shorter tasks, etc.). During the implementation of these activities, cooperation between students spontaneously develops. Teaching assistants can also be included in the teaching. During the nature lessons and by learning about nature and mathematics using concrete examples, students with disabilities showed greater motivation and engagement, successfully solving the assigned tasks, which is important for creating a positive self-image. Working in groups enabled students to develop social skills through collaborative learning, and encouraged empathy and acceptance of diversity among other students. An interdisciplinary approach was achieved in the teaching topics of Science and Biology, where students learn about cycles in nature and the circulation of substances in nature (lower primary school age) and about the role of autotrophic organisms in the carbon cycle and carbon storage (upper primary school age and high school), and by applying mathematics, they estimate and measure the size of trees, calculate the age of trees and stored carbon. In this way, they compare the roles of older and younger trees in cycles in nature. Before going to the field, the biology and mathematics teacher prepares worksheets for work and gives instructions to students on how to work. Classes can take place in any city park with the presence of biology and mathematics teachers who monitor the students' work. This type of class is conducted as a review and systematization of topics from Science and Biology (e.g. interrelationships in nature and the carbon cycle, life cycles, producers - key organisms, etc.)

Methodology: By performing simple practical work in nature, we teach preschool children to compare and estimate different sizes, the mutual relationships of living beings, and the role of trees for life on Earth. Children compare sizes with their palm prints or their height, e.g. the circumference or height of a tree, and then transfer the estimated sizes into another form, i.e. a drawing or sketch. Children with disabilities work successfully in all activities because the activities include the movement of students in nature when estimating sizes, and due to direct assessment and physical contact with natural objects, more sensory stimuli and learning with the activation of all senses are enabled, which ultimately leads to active learning. Namely, in addition to observing and comparing sizes, children can listen to sounds in nature, feel the smell of a tree, and touch a tree. Children work with work materials adapted to their age. For younger school age, activities include measuring the circumference of a tree using a measuring tape, calculating the age of a tree, and monitoring the life cycle of a tree. Students

use mathematical methods (pencil, correspondence) and a measuring tape to measure the approximate height of trees, compare trees by height, circumference and age, and conclude about the number of cycles and the importance of trees for life on Earth. Measurements and assessments are performed using practical and simple methods, and students with difficulties successfully solve such tasks. In older elementary school and high school, students will use measurements and mathematical knowledge and methods to recognize measurable characteristics of planar and spatial shapes in nature (mathematical methods - mirror, shadow, similarity, circle), calculate the height, age of a tree and breast diameter in order to investigate the carbon cycle and the role of trees in the ecosystem. Students also use applications for biological measurements and analyze differences in the measurement results obtained. High school students apply the acquired knowledge in mathematics and measure tree height using the tangent of the angle (calculating the tangent or using a clinometer), calculate the age of the tree, describe the carbon cycle and conclude about the role of autotrophs. Students with difficulties perform practical measurements with an adapted clinometer with the angle tangent already written. Activities with all ages take place in groups, and it is recommended that there are 4 to 5 students in a group per class of 20 to 25 students in total.

Results: In the presented example of working with students, it was shown that students with disabilities successfully complete tasks independently and in groups at all ages. Students who are integrated into the system as newcomers from another language area also successfully complete all tasks because all activities are carried out on concrete examples, which allows for easier understanding. All students easily use the application for determining plant species (Pl@ntNet) and the application for determining tree height (GLOBE Observer). In the activities carried out, all students learn to think critically, interpret observed phenomena and interrelationships based on the study of nature and simple research, and draw conclusions based on measurements taken, while developing natural science, mathematical and digital competences. In this form of teaching, it was shown that students with disabilities participate equally in group work and that they successfully achieve the given outcomes because understanding and connecting measurements of real sizes in space is facilitated, as is connecting size with the role of trees in the ecosystem. All measurements are made on specific examples in nature (trees), which allows understanding and connecting the scale with real, concrete examples from everyday life. Students use measuring tools (tape measure, triangle, etc.) to measure quantities, which benefits the development of psychomotor skills. The work also emphasizes the accuracy of reading measurements, so students with difficulties develop skills in which it is necessary to focus on the activity being performed. In addition, spending time in nature allows students to learn in pristine nature, in a healthy and green environment, which develops positive attitudes towards preserving nature, which is important for the personal well-being of each individual. The evaluation was carried out in a way that groups of students make posters on which they show the life cycles of plants and the role of plants in the ecosystem, the results of measurements, and draw conclusions. Younger students use worksheets for field work and use them to solve tasks related to cycles in nature. At the end of all activities, a self-evaluation of student work was conducted, where all students with difficulties stated that they actively participated in the group work, that they adopted the given outcomes, and that they found the lessons extremely interesting.

Conclusion: An approach based on interdisciplinary, experiential learning and working in a natural environment encourages the development of scientific, mathematical and digital skills, but also provides a framework for the inclusion of students with difficulties and the integration of students from other language areas. This form of teaching shows that inclusion is not just a matter of adaptation, but of creating an environment in which every student can experience success and feel a valuable member of the community.

Keywords: Inclusion, Interdisciplinary Teaching, Outdoor Learning

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STEAM Education and Teacher Professional Development: A Study of Arts Integration Strategies

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Inclusive STEAM education is an approach to teaching and learning that integrates the disciples of Science, Technology, Engineering, Arts, and Mathematics (STEAM) in a way that values diversity, equity, and inclusion. The goal is to create a learning environment that is accessible, engaging, and effective for all students, regardless of their background, ability, or identity. The integration of arts into STEAM education has gained significant attention in recent years, with a growing recognition of its potential to enhance student learning outcomes. The arts can bring a unique perspective to STEAM subjects, fostering creativity, critical thinking, and problem-solving skills. However, teachers often lack the training and support needed to effectively integrate arts into their STEAM instruction. This study aims to address this gap by investigating the impact of a professional development program on teachers' ability to integrate arts into STEAM education.

This study has two primary objectives. First, it seeks to investigate the impact of a professional development program on teachers' ability to integrate arts into STEAM education. Second, it aims to explore the strategies and practices that are most effective in promoting arts integration.

The study is guided by the following research questions: 1. To what extent does a professional development program focused on arts integration strategies impact teachers' confidence and ability to integrate arts into STEAM instruction? 2. What strategies and practices are most effective in promoting arts integration in STEAM education? A mixed-methods approach was used, combining both quantitative and qualitative data collection and analysis methods. A total of 50 teachers participated in different workshops that focused on arts integration strategies. The workshops were designed to help teachers develop the knowledge, skills, and confidence needed to integrate arts into their STEAM instruction. Participants completed surveys and interviews before and after the workshops, and a subset of participants also participated in focus groups and observations. The results showed that teachers who participated in the professional development workshops organized at different times demonstrated a significant increase in their confidence and ability to integrate arts into STEAM instruction. The most effective strategies and practices included: 1. Project-based learning: Teachers reported that project-based learning was an effective way to integrate arts into STEAM education, as it allowed students to work on real-world problems and develop creative solutions. 2. Collaboration with arts educators: Teachers reported that collaborating with arts educators was helpful in developing their own arts integration skills, and in identifying effective strategies for integrating arts into STEAM instruction. 3. Use of technology: Teachers reported that technology was a useful tool for supporting arts integration, particularly in terms of providing access to digital tools and resources.

This study provides evidence that targeted professional development can enhance teachers' ability to integrate arts into STEAM education. The findings highlight the importance of providing teachers with

the training and support needed to effectively implement arts integration strategies. The study also identifies key strategies and practices that are most effective in promoting arts integration, including project-based learning, collaboration with arts educators, and use of technology. The study's findings have several implications for practice and policy. First, they suggest that professional development programs focused on arts integration can be an effective way to enhance teachers' ability to integrate arts into STEAM education. Second, they highlight the importance of providing teachers with ongoing support and coaching to help them develop their arts integration skills. Finally, they suggest that policymakers and educators should prioritize the development of STEAM education programs that integrate arts and STEAM subjects in a meaningful way. However, the study also has several limitations. First, the study's sample size was relatively small, and may not be representative of all teachers. Second, the study's focus on three different workshops may limit its generalizability to other contexts. Finally, the study's reliance on self-reported data may introduce bias into the findings. Future research should seek to build on this study's findings by exploring the impact of arts integration on student learning outcomes. Additionally, researchers should investigate the effectiveness of different professional development models and strategies for promoting arts integration in STEAM education. By exploring these questions, researchers can help to develop a more comprehensive understanding of the role of arts integration in STEAM education, and identify effective strategies for promoting arts integration in a variety of contexts.

Keywords: STEAM, teacher professional development program, Arts integration

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Session: The future of Inclusive STEAM Education

Supporting Integrated STEM Education and Inclusion through Scientix®

Elisavet Vlachou - European Schoolnet, Belgium

This presentation will showcase Scientix' efforts to support the mainstreaming of Integrated STEM education across Europe, with Inclusion as its core. Participants will be introduced to the wide range of opportunities that Scientix® offers to educators, and how these directly contribute to achieving the goals of the SpicE project.

The session will provide an overview of the Scientix portal, a central hub that hosts a vast repository of multilingual teaching resources and project outcomes. Key features such as networking opportunities, training offers, and community initiatives will be introduced, demonstrating how educators can engage, collaborate, and grow within this vibrant network.

In addition, the presentation will explore flagship initiatives like the STEM Discovery Campaign, which amplifies the impact of projects' results within and beyond Euorpe, bringing together hundreds of thousands of educators to celebrate STEM activities. By the end of the session, participants will understand how Scientix supports innovative teaching and fosters collaboration in advancing Integrated STEM education.

The SpicE Alliance

Magda Spella - Hellenic Open University, Greece

The “Inclusive STEAM Alliance” (https://steamalliance.eu/) will be the legacy of SpicE project. It will be a collaborative, open platform to unite Educators, Schools, Networks, Organisations, and other relevant stakeholders in the field of STEAM Education and Inclusive Education under a common goal: to promote Inclusive STEAM Education, not only in primary but also in secondary education.

The “Inclusive STEAM Alliance” is presented and inaugurated during the SpicE final conference “Inclusive STEAM Education”. The “Inclusive STEAM Alliance” will ensure the continuation, exploitation, and upscaling of the project results. The Alliance platform will offer open educational resources for the educators (for the classroom, for professional growth, for research needs), developed during the project and beyond, training opportunities, collaboration opportunities, etc. More importantly, the “Inclusive STEAM Alliance” welcomes three (3) types of memberships: Ambassadors, for educators who want to stay updated on inclusive and STEAM education methodologies, have access to educational best practices from all over Europe, share their classroom practices, find open educational resources, etc.; Labeled schools, for schools which want to be recognised as pioneers in inclusive and STEAM education, train their teachers in inclusive STEAM methodologies, and disseminate and support the Alliance; and Allies, for organisations such as Universities, Ministries of Education, educational networks, etc., which will disseminate and support the Alliance.

In conclusion, the “Inclusive STEAM Alliance” will be the cornerstone of the project’s approach “from the community and for the community”: The platform will create and nurture a permanent network of educators and organisations, working collaboratively for the promotion of inclusive STEAM education in schools, to embrace all students in equity.

Policy Development in Inclusive STEAM Education

Maria Konstantinidou - Ministry of Education, Sport and Youth, Cyprus

The SpicE project addresses a pressing challenge in the European education system: the indirect marginalization of students with mild disabilities due to a lack of inclusive STEAM instruction. The project's main goal is to empower primary education teachers with the tools, skills, and methodologies to create inclusive classrooms using STEAM as both a method and objective. The results of the project can inform policy direction. This presentation will provide policy recommendations to shape inclusive, future-oriented education systems.

While many European countries have made significant strides in promoting STEAM education, students with Special Educational Needs (SEN) remain underrepresented and underserved in these areas. According to the European Agency for Special Needs and Inclusive Education (EASNIE, 2018), the integration of SEN students in STEAM learning environments faces several persistent challenges. These challenges include: Fragmented policies, Inadequate infrastructure, Insufficient Teacher Training, Cultural and Attitudinal Barriers, and others.

Based on the SpicE pilot training outcomes, the following recommendations can be considered:

1. Developing a STEAM-in-Special-Education Competence Framework.
2. Mandating inclusive pedagogy modules in teacher education.
3. Funding inclusive curriculum and learning environment innovation.
4. Establishing national benchmarks for inclusive practice.
5. Supporting inclusive assessment methods and tools.

With these policy recommendations, we envision more inclusive and innovative schools, empowered teachers equipped for diversity, SEN students thriving in STEAM pathways, long-term transformation of school culture and practice.

In conclusion, inclusive STEAM education is a right, not a privilege. The future of education must be inclusive by design, not exception. Policy makers and educational systems need to use proactive rather than reactive approaches to inclusion in order to reduce physical, sensory, cognitive, and emotional barriers to participation. We need to turn good intentions into action—by developing inclusive policies that make classrooms welcoming and accessible for everyone.

Session: Presentations by educators - II

EİRENE - Cosmic Citizenship: Creative Thinking and Sustainable Society Design

Nasiye Yamaç Şahin, Feyza Öncüoğlu & Zeynep Varol - Antalya Science and Art Center, Turkiye

The EIRENE project is an interdisciplinary educational model developed for gifted secondary school students attending Science and Art Centers (BILSEM) in Türkiye. The project aims to foster students' creative thinking, strategic problem-solving, and civic literacy while raising awareness about designing sustainable and inclusive societies. It is aligned with the United Nations' Sustainable Development Goal 11: Sustainable Cities and Communities.

Throughout the project, students engaged in holistic and interactive activities based on an imaginary planetary scenario, supported by an inclusive educational approach that addressed diverse learning styles and encouraged equal participation. Using digital tools such as Canva, Padlet, Thinglink, StoryJumper, and Tinkercad, learners designed societies by considering the needs of different age groups (children, youth, elderly), developed social norms, built democratic institutions like a national assembly, and drafted constitutions reflecting equity, justice, and sustainability.

The project explicitly integrated STEAM education, combining science, technology, engineering, arts, and mathematics through real-world problem-solving and creativity. For example, students used Tinkercad to simulate eco-friendly urban planning, designed digital posters and storybooks to represent cultural values, and created virtual exhibitions and games to raise awareness about digital citizenship and environmental responsibility. Artistic components included the preparation of a cultural calendar, theatrical performances, and digital storytelling, all of which contributed to multidimensional learning.

A mixed-methods research design was employed, utilizing pre- and post-tests on experimental and control groups, along with qualitative data collected through student interviews. The findings revealed significant improvements in students' creative thinking tendencies, digital awareness, and socio-environmental responsibility. Participants demonstrated the ability to produce innovative solutions to social issues, actively engage in democratic processes, and design inclusive and sustainable community structures.

The EIRENE project empowered students to develop a sense of cosmic citizenship by encouraging them to take responsibility not only for their own societies but also for global and interplanetary futures. As such, the project presents a replicable educational framework that cultivates responsible, creative, and globally minded citizens prepared for the challenges of the 21st century.

Keywords: Creative Thinking, STEAM Education, Inclusion, Sustainable Society, Digital Citizenship, Cultural Heritage

Technology-Assisted Learning: A Computer Game to Develop Fine Motor Skills in Students with Autism

Ahmet Şahin - Yüreğir Science and Art Center, Turkiye

This study presents a technology-assisted learning scenario designed to improve fine motor skills, particularly in students with autism. The scenario is based on an adaptable computer game and a sensor-equipped glove system tailored to students' interests and age groups. By engaging with the game, students not only enjoy the activity but also strengthen targeted muscle groups. The program includes three difficulty levels (basic, intermediate, advanced) for students aged 8–18, each incorporating engineering and coding tasks. Results demonstrate the method's effectiveness, with observed score improvements and positive teacher feedback.

In today's world, innovative methods are needed to support the development of students with special needs, particularly those with fine motor skill challenges. This project offers a technology- and game-based approach to enhance hand coordination in students with autism and other fine motor difficulties. The scenario is customized based on teacher observations and includes designing interest-based games integrated with sensor gloves.

The project combines an Arduino microcontroller and flex sensor-equipped glove with a computer game. Students wear the glove to control the game and complete tasks using finger movements. This process simultaneously develops physical skills and achieves learning objectives (e.g., environmental awareness, music notes, foreign languages). The program is structured for gradual difficulty progression, fostering creativity and problem-solving skills.

In conclusion, this scenario provides an engaging and interactive method for students to develop fine motor skills while offering teachers a personalized teaching tool.

Teaching ‘Speed’ in an Inclusive Elementary Classroom: A STEAM Approach for Diverse Learners

Spyros Papadakis - Hellenic Open University, Greece; **George Fakiolakis** - Metamorfosi-Heraklio High School, Greece; & **Spyros Lazaropoulos** - 1st Experimental Primary School of Pyrgos, Greece

Introduction: The STEAM educational approach (Science, Technology, Engineering, Arts and Mathematics) through the integration of multiple disciplines, provides flexible educational options, enhancing students' active participation, critical thinking and creativity, making it particularly suitable for students with diverse educational needs. This article presents the implementation and impact of a STEAM educational approach in teaching the concept of "speed" in an inclusive elementary school environment. Recognizing the diverse learning needs of all students, including those with mild disabilities, the article examines how the Learning Activity Management System (LAMS) can support differentiated instruction and personalized learning pathways within a STEAM curriculum. Specifically, the article presents a STEAM educational scenario on "speed," including engaging interdisciplinary activities such as the design, construction, and analysis of the motion of self-propelled vehicles (Engineering), measurements of distance and time to calculate speed (Science and Mathematics), use of sensors and digital tools for data collection, recording and representation (Technology) and expression of understanding through visual and kinesthetic means (Arts), all organized and supported by appropriate learning activities provided by the LAMS platform.

Objectives: The main goal of the article is to present an inclusive educational proposal—a scenario following the STEAM approach—to enhance elementary students' understanding of the concept of speed. Specifically, the primary goal of the educational scenario is to effectively support students with diverse needs in understanding, experimenting, and calculating speed by appropriately integrating constructional and digital tools along with practical inquiry-based learning activities. Secondary goals include evaluating students' ability to formulate hypotheses, collaborate in systematic experimentation and develop metacognitive skills regarding their learning processes.

Methodology: The educational scenario follows the STEAM educational approach and was implemented in December 2024 by an Information Technology teacher within the Robotics Club attended by 18 students from the 5th and 6th grades (aged 10-12), two of whom have learning difficulties. The implementation occurred in the computer lab, where students were grouped into teams of 3-4 with distinct roles. Each team had access to a Lego Wedo 2 educational robotics kit, tablets and PCs with internet access, accounts on Scratch and LAMS platforms, distance measuring tools (measuring tape) and time (stopwatch), as well as personal art and craft supplies (cardboards, glues, markers, paints, scissors, etc.). The scenario's learning activities were supported by appropriate tools provided by LAMS. During a two-hour lesson, students initially watched an introductory motivational video and completed short questionnaires to assess their prior knowledge and formulate initial hypotheses about speed. Subsequently, teams used Lego Wedo2 robotics kits to create racing

cars and build tracks using their tools. They programmed the cars' movements with Scratch and experimented by investigating factors affecting speed, particularly wheel size and engine power. Each team systematically recorded their experimental data using spreadsheets supported by LAMS. Following experimentation, students reviewed their initial hypotheses via brief questionnaires and participated in self-assessment and peer-assessment activities, including sharing their project images with the class and voting for the most effective and engaging projects. The scenario concluded with a comprehensive knowledge evaluation and metacognitive self-assessment. Throughout the scenario, the teacher's role was to provide encouragement, support and scaffolding during students' exploration and experimentation.

Results: Quantitative analysis of metadata from LAMS learning activities considering the initial and final questionnaires revealed improved understanding of the concept of speed and calculation methods, with students effectively recognizing the role of specific variables (wheel size, engine power) in vehicle speed. From a qualitative point of view, STEAM activities significantly increased the interest and active participation of all students, effectively supporting diverse learning needs, particularly those of the two students with mild learning difficulties. Additionally, students' reflections indicated increased confidence and interest in STEAM subjects, along with a more mature understanding of experimental and computational processes, especially when supported by digital tools like LAMS. Recommendations for further improvement include co-teaching with general classroom teachers and other specialists and extending the scenario with additional learning paths.

Conclusions: The successful implementation of this educational scenario highlights the effectiveness of an inclusive STEAM educational approach in elementary education, supported by advanced digital learning environments such as LAMS. Collaborative, practical activities significantly enhanced understanding of the speed concept and developed essential skills like hypothesis formulation, experimentation, critical thinking, collaboration and metacognitive reflection. The STEAM approach proved particularly beneficial for supporting students with diverse learning needs, enhancing both their participation and confidence. Furthermore, the ease of supporting all of the scenario’s learning activities through LAMS, demonstrates the LAMS's maturity in supporting contemporary educational practices and strategies promoting active learning. In summary, the findings support broader adoption of similar pedagogical strategies, emphasizing the value of interdisciplinary inclusive approaches supported by technological tools like LAMS in elementary school classrooms.

Keywords: elementary school, speed, inclusive education, STEAM, LAMS

STEAM Education in Practice: A Case Study from Escola Montessori Rubí

Erica Köchig - Universitat Rovira i Virgili, Spain **& Beatriz Lores-Gómez -** Universitat Jaume I, Spain

Introduction: In line with the European Union's agenda for social and economic transformation, integrating Science, Technology, Engineering, Arts, and Mathematics (STEAM) in Early Childhood Education (ECE) is gaining momentum (UNESCO, 2024). This study emerges from doctoral research focused on designing an assessment tool for evaluating STEAM materials in ECE. Escola Montessori Rubí, a public school with ongoing STEAM projects, offered a unique context for examining how such integration unfolds in practice.

Escola Montessori is a public school located in Rubí, a town near Barcelona known for its cultural diversity. The school serves a multicultural student attendance, reflecting the blend of backgrounds as well as the inclusion of students with mild disabilities. This diversity brings unique opportunities for fostering inclusivity and collaboration, particularly in educational projects like STEAM.

Since 2015 the educational institution has been working on different projects rooted in STEAM education, such as the Programa Magnet (2017-2021), Xarxa centres Magnet (2017-2025), Xarxa Coordinació Digital Centre (2024-2025), Xarxa d'Innovació d'Educació Bàsica (2017-2024), Xarxa Escoles Verdes (2015-2025), and Projecte PMOE PROA+ (2021-2024). Each project is supported by specialists in their areas who aid and teach the educators about specific content.

As a public institution, Escola Montessori is committed to providing accessible quality education to all, aligning with broader educational goals in Catalonia that emphasize innovation, equity, and active learning methodologies. From 2017, the Educative Project was introduced, and the school's approach integrated the Montessori philosophy with modern educational practices, creating a dynamic environment for both students and teachers to engage deeply with STEAM themes and focusing on the inclusion and inclusivity of children in the school.

Objectives: The main objective guiding this research was to examine how STEAM materials are implemented in schools within a Montessori pedagogical approach. Methodology

The study used qualitative methods, primarily implementing a participant observation approach (Cohen et al., 2007) and informal interviews with teachers and members of the school's principal team to gain insights into their experiences, challenges, and strategies in integrating STEAM projects within a multicultural educational context (Swain & King, 2022). After an unstructured interview with the principal, a week of fieldwork was carried out. Classroom practices were observed as well as STEAM workshop classes that blend groups (3-6, 7-9 and 9-12 years old), focussing on three dimensions: classroom dynamics, teaching methodologies, and the implementation of STEAM activities. The main tools to acquire data were field notes, logs of field experience and reconstructions of conversations. For the data analysis a descriptive methodology was implemented, considering the gathered data and exploring the public documents the school provides on the website and social media.

Results:

STEAM as a transdisciplinary process

Teachers adopted a flexible, transdisciplinary approach to STEAM. Rather than isolating disciplines or encapsulating STEAM activities in the workshop plan, learning experiences flowed naturally from children's questions and interests. For example, five-year-olds selected their group name (The Submarines) and explored the oceans through storytelling, drawing, science experiments and visiting the beach, blending art and science seamlessly. These experiences are connected with broader themes like ecology, community, and activist actions.

Digital Education

In the case of preschool, tablets were adopted to work on mathematics content, while interactive boards supported teachers' documentation, search, and storytelling. In primary school workshops, the Tinker classroom was used to introduce children to digital design and 3D printing. In another group, children worked with basic programming and robotics. These tools were not stand-alone but embedded in wider projects, such as fixing the school board game, making their use meaningful and contextualised.

Gender and Intersectionality

The school's commitment to gender equality and diversity was visible in both materials and discourse. Teachers used inclusive language, avoided stereotypical role assignments during collaborative work, and intentionally highlighted contributions of women scientists and artists during storytelling and project work. The multicultural composition of the student body—many from migrant families—also encouraged a pedagogy rooted in social skill development. In the case of students with mild disabilities, the school counts on a team of specialists to support teachers work and track children's development in all the groups.

Conclusions: The study revealed that it is possible to harmonise the Montessori method with contemporary STEAM goals when teachers receive adequate training and institutional support. The school's emphasis on gender equity and diversity offered a living example of how early interventions can challenge bias and promote inclusive citizenship. Additionally, digital tools, when used creatively and ethically, enhanced children's ability to express and investigate complex ideas.

This case study suggests that policy frameworks aiming to promote STEAM education from an early age account for pedagogical diversity and provide support for teacher professional development. The findings also contribute to the broader discussion on how ECE can serve as a foundational space for building technologically literate societies.

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Inclusive STEAM Adventures: Designing a digital learning quest for primary education through art and accessibility

Dobrin Peltekov - "St. Patriarch Evtimiy" Primary School, Bulgaria

Introduction: The project presents an original interdisciplinary digital quest designed for students completing Grade 4, combining inclusive STEAM education with storytelling, gamification, and artistic integration. At the core of the experience is an interactive assessment, structured as a quest with animated characters and narrative progression. The project offers a universal and adaptive model aimed at both mainstream students and those in inclusive education. With two distinct versions – standard and adapted – it addresses challenges such as engagement, differentiated instruction, and accessible assessment, focusing on creativity and playful learning. Although data collection is planned for the next academic year, the project builds on established inclusive design practices and allows for early projections of strong impact and learner motivation.

Objectives: The main objectives of the project are:

- To develop an interactive digital quest for Grade 4 students with integrated STEAM content;
- To create an adapted version for students with Special Educational Needs (SEN), including simplified content and multimodal accessibility;
- To promote cross-curricular learning by embedding elements from mathematics, science, music, geography, and literacy in the assessment;
- To evaluate the effectiveness of narrative-based and gamified approaches in improving comprehension, knowledge retention, and motivation;
- To offer a replicable model for teachers in inclusive classrooms that combines accessibility with creativity.

Methodology: The test-quest is divided into thematic zones based on school subjects. When students provide correct answers, the main characters, Maya and Alex, progress through imaginative worlds supported by AI-generated assistants: the Owl (wisdom), the Archivist (knowledge), the Guardian of Knowledge (teacher and inspirer), and the Nightingale (music). Incorrect answers lead to "reflection rooms," giving students the opportunity to review content and try again. The project includes two versions: a standard version for all Grade 4 students and an adapted version for students in inclusive classrooms, featuring simplified questions (2–3 answer choices), extended response time, and visual-auditory aids. The pilot phase will be implemented in classrooms that include both general education and inclusive learners. Data will be collected via pre- and post-activity questionnaires, observations, and teacher feedback. A mixed-methods approach will evaluate engagement, performance, and emotional response, with attention to accessibility indicators such as time on task, retries, and visual-auditory comprehension.

Results: The project complements existing practices by creating an inclusive digital resource that integrates the arts with STEAM content through narrative-based and gamified approaches—elements

rarely found in tools for primary education. Improved student motivation, better knowledge retention, and enhanced interdisciplinary reasoning are expected outcomes. SEN students will have the opportunity for active participation and success in a supportive environment. Teachers will utilize rubrics and observation forms, while students will receive instant visual and audio feedback. The resource encourages metacognitive thinking through retry mechanisms after incorrect responses and aligns with formative assessment principles. The project has the potential to be implemented in diverse educational contexts, promoting sustainable practices for accessible and innovative teaching.

Conclusions: The interactive quest demonstrates how accessible design, art, and storytelling can transform assessment into a motivational and inclusive experience. Through its interdisciplinary and flexible approach, the project contributes to the advancement of inclusive STEAM education, offering an adaptive, innovative, and replicable model for the primary level. It promotes not only the acquisition of knowledge but also the active engagement of students in their own learning process.

Keywords: inclusive education, STEAM learning, digital quest, gamification, primary education

Co-designing Research Directions for Inclusive STEAM Education in Europe

Sabrina Bresciani & Francesca Rizzo - Politecnico di Milano, Italy

Introduction: While STEM (Science, Technology, Engineering and Mathematics) education is considered a key driver for nations' competitiveness, scientific evidence on both inclusive education and STEAM (which is STEM through the use of artistic approaches, involving creative thinking and applied arts; Joint Research Centre, Mazzeo Ortolani, Pokropek et al., 2024) is still lacking. A recent report of Europe' Joint Research Center (2024) outlines that one key factor for improving STEM education and uptake is increasing the number of well-designed studies on the effectiveness of STEAM and STEM (pg. 5). They note that the vast majority of research on STEM education originates outside Europe and call for well-designed experimental and longitudinal studies on STEAM and STEM to support evidence-based policies. The EU STEM Education Strategic Plan, published in March 2025 outlines three key objectives, one of which is "build a stronger and more inclusive EU STEM talent pipeline (LEVEL up)" (pg. 6). Yet, the STEM Education Strategic Plan' inclusiveness actions are focused on gender participation, while other dimensions of inclusion are lacking. In particular, the document mentions only once "special education" and there is no mention of disability, autism, ADHD, anxiety, mental health, accessibility due to distance or physical/social ability. The scarcity of research on inclusive STE(A)M education does not provide policy makers with the needed evidence for including inclusive STEAM practices in strategic actions. As EU's Framework Program 10 (FP10) will soon shape Europe's research until 2034, a stronger support on assessing the economic and social benefits of STE(A)M inclusive education (more broadly defined) should be provided in order to identify the most effective inclusive STEAM practices.

Objectives: The aim of this work is to identify research directions on inclusive STE(A)M education that are based on pragmatic societal needs in Europe, theoretically relevant and methodologically well designed. This research is conducted as part of the EU funded project Road-STEAMer, aimed at crafting a roadmap for STEAM education in EU funding schemes.

Methodology: To identify relevant research directions that can provide useful evidence to guide EU's research programs on inclusive STE(A)M education, recent EU policies and strategic documents are contrasted with scientific evidence, stakeholder needs and best practices. The first step has been the analysis of STEAM literature (Yeomans et al., 2025) to identify key evidence and theoretical approaches, as well as to analyse extant STEM literature reviews (JRC, 2024). Next, several roadmapping workshops are conducted applying the technology roadmapping technique (Phaal, Farrukh & Probert, 2004), adapted for the purpose of the project. Participants are relevant actors of the STEAM education ecosystem, including industry players, program managers of tertiary education, students with autism spectrum disorder, special education teachers, administrators in public schools, digital education specialists, university students, school heads in and outside of Europe for a cross-cultural. The work of projects funded under the same call, SENSE and SEER, is mapped and two workshops are conducted. The mapping of all these resources is finalized with the 12 organizations

part of the consortium.

Results: The insights gained from the mapping is a list of actions categorized in priority areas, that can provide guidance on research needed for supporting policy making in inclusive STEAM education. Some of the actions are aligned with the EU' STEM Education Strategic Plan, providing actionable research ideas, while others provide novel ideas compared to the strategic plan. The complete list of actions can be found in the STEAM roadmap interactive version, while in the following sections, only actions related to inclusive STEAM are discussed.

Research topic: An economic case for inclusive STEAM education.

With a longitudinal study (control trial), calculate the economic case for developing learning paths and environment that are inclusive for underrepresented groups, including women and all genders, people with disabilities, autism, ADHD, sensory sensitivity, low socio-economic status, migration background, etc., in partnership with industry players and other organizations. Companies and programs with inclusive culture and programs include Auticon, Microsoft's Neurodiversity Hiring Program, SAP's Autism at work, IBM's Neurodiversity Advancement Initiative, Google Autism Career Program in collaboration with the Stanford Neurodiversity project, Specialisterne

Research topic: Effectiveness of STEAM and transdisciplinary learning paradigms to support learning preferences and needs of diverse learners to increase inclusivity and improve skills.

Research should test multiple STEAM and transdisciplinary (existing or new) learning approaches and evaluate which approach is most effective for which type of learner, including learners with disabilities or belonging to vulnerable groups (incl. intersectionality); such programmes could include Universal Design for Learning (to be applied to STEAM education), the International Baccalaureate with STEM.

Research topic: Investigate the efficacy of policies to increase hybrid and blended learning to make STEAM educational more accessible.

Investigate how hybrid and blended learning formats can address barriers, which can be physical or digital, to make STEAM curriculum, educational resources, tools, and facilities equally available to all students, in particular for learners with difficulty to physically access secondary and tertiary education or language barriers.

Research topic: Learning Environment design and its impact on learning outcomes.

Research on the physical environment impact on educational outcomes for a variety of students' needs and abilities (including disabilities) to design STEAM spaces that consider the overall quality of the learning experience alongside functionality, and promote participatory, reflective design strategies that create spaces reflecting the views and feelings of all participants.

Conclusions: In terms of implications for theory, this work provides suggestions for research avenues that are based on a co-designed list of actions for STEAM education in EU's funding schemes based on two and a half years of research in the project RoadSTEAMer and related projects. Results point toward the need to support and investigate a systemic change in that provides a range of learning options rather than a one-size fits all approach typical of national curricula. Similarly to the EU funded

Missions, a systemic change in education would require bold and orchestrated actions. Studying the systemic change of education is both a theoretically relevant and pragmatically crucial need to make Europe competitive as well as supportive of diverse needs that can increase the uptake of STEAM careers.

Keywords: research policies, inclusive education, STEAM, autism

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Session: STEAM and Inclusive Education

The SEER – A European Vision for STE(A)M Education

Elisavet Vlachou - European Schoolnet, Belgium

The SEER (STEAM Education European Roadmap) project is a three-year initiative (2022–2025), funded by the Horizon Europe programme of the European Union, set to conclude in August 2025. The project brings together a diverse consortium of experts from education, research, policy, and industry, all working toward a common goal: accelerating the systemic integration of STE(A)M education across Europe.

To support this goal, SEER provides tools and recommendations tailored to the needs of different stakeholders (schools, policymakers, researchers, and industry actors) by helping them navigate existing resources, highlight good practices, and identify areas for policy improvement.

The project follows a three-step approach:

Map: Identifying existing STE(A)M resources, research outcomes, and policies, along with stakeholder needs, through surveys and reviews.

Refine: Validating findings and shaping solutions via focus groups and high-level seminars.

Deliver: Producing practical, user-friendly tools to support implementation.

Key outputs of SEER include:

- The STE(A)M Roadmap, offering targeted recommendations and actions for various stakeholders.
- An Impact Assessment Mechanism to evaluate and improve STE(A)M initiatives.
- A Certification Framework concept to support the recognition of effective STE(A)M practices.

The SEER – An integrated STE(A)M Education European Roadmap

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The SEER (STE(A)M Education European Roadmap) project developed a comprehensive framework promoting an integrated approach to STEM and "A"ll other curriculum topics. Funded under the European Union's Horizon Europe programme, the roadmap addresses the critical need for structured implementation of STE(A)M education through evidence-based approaches and stakeholder collaboration. The roadmap was developed through a mix of various approaches, that include a vast analysis of projects collected by the European Schoolnet Scientix database, a Rapid Evidence Assessment (REA) that focused on the European STEM curriculum, teacher competencies, equity, and the role of various stakeholders.; a proof-of-concept validation through questionnaires administered in Italian schools; and through an extensive stakeholder input and consultation via focus groups, surveys, and policy gap analysis. This mixed methods approach ensures the alignment of the framework's recommendations and the practical relevance and feasibility for the single stakeholders. The framework identifies seven key areas of integration: integrated curriculum and learning design, professional development, teaching competency and pedagogy, industry and career exposure, technology enablement, leadership and organizational culture, and inclusion and equity. Each of the roadmap's key area includes measurable indicators, to path the way for an evidenced based comprehensive progress tracking.

The framework of the roadmap provides also self-assessment tools designed for the key stakeholders: teacher trainers, policy makers, industry partners, and educational practitioners. These tools guide the stakeholder through a structured reflection process. Based on a shared template format covering introduction, evidence, needs assessment, and actionable recommendations the roadmap provides for every stakeholder a tailored and actionable approach. Through the various indicators a focus is placed on inclusion and equity, recognizing that STEM talent gaps widen when learners—particularly girls, low-socioeconomic status students, ethnic minorities, and disabled students—are excluded from advanced STEM tracks. The framework integrates inclusive practices across all key areas promoting a culturally responsive pedagogy, and intersectional approaches to equity.

The SEER roadmap is one step to promote a shared language and method to promote inclusion, and sustainability across Europe's STE(A)M education ecosystem, providing educators and policymakers with practical tools for systematic improvement and evidence-based decision-making in STE(A)M

education implementation.

Keywords: Integrated STE(A)M, European Roadmap, Inclusion, Self-Assessment

Educators' Needs and Challenges for Inclusive STEAM Education

Natalia Spyropoulou - Hellenic Open University, Greece

This presentation focuses on the inclusive dimension of STEAM (Science, Technology, Engineering, Arts, Mathematics) education, drawing on findings from a large-scale needs analysis conducted in the framework of the SEER (STE(A)M Education European Roadmap) project (Spyropoulou et al, 2024). The survey engaged over 600 educators from across Europe, aiming to explore their current practices, barriers, and support needs in implementing STEAM education. While the overall study addressed STEAM broadly, this contribution highlights the results most relevant to inclusion and the challenges educators face in addressing learner diversity.

The analysis reveals that although many teachers are committed to STEAM education and recognise its potential to engage students through creativity, problem-solving, and interdisciplinary learning, they often struggle to make these experiences accessible and inclusive for all learners. Educators reported feeling underprepared to adapt STEAM activities to meet the needs of students with disabilities, migrant backgrounds, or those at risk of exclusion. Inclusive practices, such as differentiation, the use of assistive technologies, or co-teaching models, are not yet systematically integrated into STEAM-related professional development.

Key challenges identified include a lack of inclusive teaching resources designed explicitly for STEAM contexts, insufficient time for collaborative planning, and limited examples of inclusive STEAM approaches that can be transferred to different classroom settings. Respondents also pointed to the absence of school-level and policy-level support in embedding inclusive values into STEAM implementation.

Despite these barriers, the findings also highlight a strong motivation among educators to adopt more inclusive STEAM practices. Educators expressed a strong need for professional development that combines inclusive strategies (e.g., differentiation, Universal Design for Learning) with practical STEAM applications. Many emphasised the importance of peer learning, co-teaching models, and leadership support to facilitate inclusive and interdisciplinary collaboration. These findings are consistent with recent research showing that inclusive STEAM education depends not only on individual competences, but also on systemic and policy-level enablers (UNESCO, 2021; Ariza & Hernández, 2025).

The inclusive dimension of the SEER project builds on this evidence, proposing concrete actions to support educators in making STEAM education more accessible and equitable (Niewint-Gori et al., 2024). The results contribute to broader discussions on how inclusive education and digital/STEAM competences can be aligned in teacher training, curriculum design, and school strategy (Spyropoulou & Kameas, 2024).

This presentation contributes to ongoing efforts to design STEAM education strategies that do not reinforce existing inequalities but instead foster equity, participation, and innovation in education

across Europe.

Keywords: Inclusive STEAM Education, teachers ' needs, professional development

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The Role of Teachers' Collaboration in Advancing STEAM Education

Stefan Savov - Education Trade Union, Bulgaria

This presentation highlights the role of teacher collaboration in advancing inclusive and innovative STE(A)M education, based on the experience of the Trade Union of Teachers “Podkrepa” - a partner in the SpicE project. The focus is placed on how joint lesson planning, mentoring, and teacher networks contribute to the quality and inclusivity of interdisciplinary teaching.

The objective is to demonstrate that teacher collaboration enhances pedagogical confidence and coherence in the classroom, especially when implementing STE(A)M education for students with special educational needs. The methodology integrates policy analysis and practical insights from national initiatives such as Bulgaria’s “School STEM Environment” programme and international projects like SpicE and Scientix.

Results show that collaboration enables the integration of disciplines, promotes shared responsibility, and supports professional growth. Despite high collegial support in Bulgaria (86% of teachers report peer support – TALIS 2018), only 18% of novice teachers have mentors, revealing a structural need for more organized collaborative mechanisms. The SpicE MOOC and mentoring initiatives by Trade Union of Teachers “Podkrepa” demonstrate effective models for sustainable development and peer support.

In conclusion, systemic collaboration is a key condition for the success of STE(A)M education. Recommendations include institutional support for professional learning communities, time allocation for team planning, inclusion of teacher voice in policy, and strengthened EU-level support.

Keywords: STEAM education, teacher collaboration, mentoring, professional communities, inclusive education

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Session: Synergies with other Teacher Academy and STEAM education projects

European collaboration and mobility in STEM teacher education - ICSE Academy

Oliver Straser - University of Education Freiburg, Germany

Across Europe, the educational sector faces pressing challenges in the STEM (Science, Technology, Engineering, Mathematics) fields. These include declining student performance and interest in STEM subjects, a growing shortage of STEM-skilled professionals, reduced attractiveness of the teaching profession, and high attrition rates among teachers due to increasing workloads and undervaluation of the profession. Simultaneously, teachers face urgent demands to address key societal challenges such as sustainability, digitalization, and inclusion. To meet these challenges, innovative, high-quality professional development for STEM teachers is essential.

The ICSE Academy project, a European-funded Teacher Academy coordinated by the International Centre for STEM Education (ICSE), addressed these issues through an ambitious cross-European professional development programme for STEM teachers. The project targeted both pre-service and in-service teachers and placed a strong emphasis on three thematic priorities: sustainability, diversity, and digitalization. Over the course of the project, three core formats for professional learning were developed, implemented, and evaluated across multiple European contexts.

First, an online workshop series brought together STEM educators and teacher educators from various countries to explore interdisciplinary teaching approaches, contemporary challenges in STEM education, and digital tools for the classroom. Second, a one-week international summer school provided a vibrant, in-person learning environment for pre- and in-service teachers. Participants engaged in co-creative learning, exchange, and inquiry-based teaching strategies linked to real-world challenges. Third, a job-shadowing programme was implemented in which higher education professionals observed existing professional development activities in different institutions across Europe. These experiences were then transferred and adapted for use in their home institutions.

Each of the formats was rigorously evaluated. The online workshop series and summer school were assessed using pre-post designs focusing on changes in participants' self-efficacy in teaching STEM, motivation, demand for further professional development, and willingness to engage in international mobility. Results showed significant positive effects across all dimensions. The job-shadowing programme was studied qualitatively through interviews and participant reports. Findings highlighted not only high levels of perceived relevance and learning gains but also strong evidence of transferability: job-shadowed practices were successfully adapted and implemented in new institutional contexts. Furthermore, the programme stimulated new collaborations and research initiatives among participants, reflecting the potential of such formats to foster sustainable networks of educational innovation.

In sum, ICSE Academy demonstrated the effectiveness and scalability of well-designed professional development programmes that are thematically relevant, research-informed, and internationally

connected. The project provides evidence that such initiatives can address both individual and systemic challenges in STEM education and can contribute meaningfully to strengthening the teaching profession across Europe.

Keywords: teacher education, mobility, STEM, digitalisation, interdisciplinarity

SENSEI - Inclusion for all

Stefano Costantini - University of Florence, Italy, **& Mirela Redžić** - Vejen gymnasium, Denmark

The SENSEI project focuses on the inclusion of ALL students in education. Stefano Constantini (University of Florence, Italy) and Mirela Redzic (Association of History Teachers in Denmark) will present the project and its partners, which include universities, associations of history teachers, and a primary school from eight different European countries.

This presentation will highlight what the project has achieved over the past two years and outline the goals for its final phase. Below, we summarize the main results and current challenges.

Inclusive education requires daily, individualized attention to each student. It must always be approached from the student's perspective—because it is the student's sense of inclusion that truly matters. Methods for achieving this are various. In SENSEI, we address this complexity by focusing on relationships. The project explores how schools can foster a sense of belonging and how teachers can support students both as individuals and as part of a classroom community.

In this short presentation, we will share examples of how schools can support different types of students through various initiatives. Special attention will be given to students with a migrant or refugee background, and how schools can help them feel included and supported.

Re-thinking and Facilitating the Learning in the Future: the STEAME-PBL Pedagogy

Gregory Makrides – University of the National Education Commission, Poland

As one of the key factors supporting the development of competences and skills in school students, especially in grades 6-12, as well as in Higher Education students, is the known interdisciplinary and multi-science project-based learning activity. At the Higher Education level, it is leading to challenge-based-learning. In the last 20 years we have seen the development from STEM to STEAM and now to STEAME (Science, Technology, Engineering, Arts, Mathematics and Entrepreneurship) becoming the subject set that through project-based learning activity, is considered the kinetic energy for producing the creators and innovators of the future. The catalyst in making this a reality are the subject teachers, service teachers and schools and student teachers completing HE programmes leading to school teaching. These people, who we call STEAME teachers or future teachers need to develop related competences and skills.

The project STEAME Teacher Facilitators Academy (Ref. no: 101102619) developed a model through a network of regional STEAME Teacher Academies managed by the European Federation of STEAME Teacher Facilitators Academies, which can support the creation of the critical mass of professional STEAME teachers as a catalyst for changing the curriculum in future schools. The STEAME Teacher Facilitators Academies offer the training and support to serving school teachers, while the student teachers in Higher Education can become certified through a mentoring programme. The mentoring programme will create a networking between school education and university education and possibly industry, working together as co-creators for the sustainable development between teacher education providers, impacting the quality of education in Europe. This is supporting the continuous professional development of teachers providing a micro-credential certification programme.

Some results to be discussed in the presentation are:

1. STEAME Teacher Facilitators Competence Framework for teachers
2. STEAME PBL Teacher Facilitators Learning Resources in support of the Framework
3. International Observatory for STEAME Teacher Facilitators – The Federation Platform
4. Mentoring and Certification Programme

Keywords: STEAME, PBL, certification, training

The Equi-T project - First insights in the newly developed Criteria Catalogue for Open Educational Resources

Barbara Gasteiger-Klicpera - University of Graz, Austria

Introduction: Many students, especially those from marginalised groups, do not have equal access to learning resources, a.o. due to the high costs of learning materials. Open Educational Resources (OER) could be a possibility to overcome such shortcomings) (Pelletier et al., 2021).

The United Nations Educational, Scientific and Cultural Organisation (UNESCO) defines OER as materials that are freely accessible, reusable, adaptable and redistributable (UNESCO, 2019), usually under open licences such as Creative Commons (Otto et al., 2021). Furthermore, OER are "resources that are 'born digital' and that are freely available for students to access from anywhere and from any device" (Pelletier et al., 2021, p. 25). They offer valuable opportunities for equal and free access to quality education for all, including those in difficult situations and those with or without disabilities (UNESCO, 2022). This also becomes apparent with regard to the increasing digital transformation, which influences education (Otto et al., 2021), especially inclusive education, and the increasing inclusion of digital media and media infrastructures (Büker et al., 2014). In particular, the consideration of inclusion in the creation and quality assessment of OER is rarely taken into account (Berger et al., subm.). The potential of new technologies to enhance inclusive and equitable access to OER is significant, but it requires teachers to have the necessary digital skills, which should be integrated into teacher training programs (Büker et al., 2024).

The Erasmus+ Teacher Academies project "EQui-T" (European Quality Development System for Inclusive Education and Teacher Training) aims to enhance high-quality teaching by enabling teacher trainers, pre- and in-service teachers to identify, create and share high-quality inclusive teaching materials in the form of open inclusive educational resources (OIER) and by promoting transnational collaboration and exchange of good practices. Therefore, EQui-T brings together the competencies of a consortium from five European countries (Austria, Spain, Italy, Norway, and Estonia), and addresses the need for high-quality teaching approaches in an inclusive European context. Many teachers use online platforms for retrieving and sharing teaching materials. However, the quality of these teaching materials is highly diverse. There is a lack of an international system of quality assurance for these materials. Teachers would need:

- an easily applicable guidance on how to distinguish between high-quality and low-quality teaching materials.
- materials that should support their digital competence as well as their didactic competence for differentiation and individualization
- learning materials that should allow high quality teaching for all learners

Objectives: Therefore, EQui-T aims (1) to develop a comprehensive, multi-perspective criteria catalogue for assessing the quality of OIER for inclusive education, (2) to carry out courses for teachers on the design and testing of innovative teaching materials in the form of OIER for (technology-supported) inclusive education, (3) to identify and sustainably implement proven dissemination methods for OIER, and (4) to establish a network of teachers and other stakeholders in the field of inclusive education at national and international level to promote transnational cooperation and exchange of best practices for the identification and use of existing high-quality digital tools and materials (e.g. OIER).

Methodology: The basis for the development of the EQui-T-Framework for OIER development and quality assessment is a comprehensive review of international and European Union for OER (Hurtado-Torres & Iglesias Fernandez, 2025) and existing research on O(I)ER (Jiménez Hurtado, 2025). In the review of existing scientific articles, anthologies, and institutional documents on O(IER), out of approximately 100 reviewed articles, 72 focused on the quality of OER, with only 48 mentioning inclusion and/or accessibility. These 48 publications related to frameworks, checklists, or evaluations of the quality of inclusive and accessible OER were further analysed and recommendations as well as best practices for creating inclusive and accessible OER were extracted (Jiménez Hurtado, 2025).

Results: The analysis subsequently led to a comprehensive framework for policymakers, educators and stakeholders in which numerous quality criteria were collected and bundled under the five dimensions: (1) Policies and Guidelines, (2) Didactics, (3) ICT, (4) Diversity, and (5) Accessibility (Jiménez Hurtado et al., 2025) As this framework is also aimed at teachers and should support them in their daily lesson preparation, it was reduced and specified for the development and evaluation of O(I)ER in the form of recommendations.

In order to make the recommendations more suitable for everyday teaching, the dimension policy guidelines were reduced and fundamental information on OER was compiled in the section of Frequently Asked Questions (FAQ). The four remaining dimensions were specified as (1) inclusive didactics, (2) technical and technological dimension, (3) diversity sensitivity, and (4) accessibility (EQui-T-consortium, 2025). To increase usability, the recommendations were reviewed by teachers during the study visit (n= 37 participants) and in an international meeting (n= 66 participants), and subsequently adapted (e.g. wording) based on the teachers' feedback, and in line with their suggestions, a checklist was developed.

In the next step, the recommendations and the checklist will be piloted and evaluated as part of the teacher training program in the creation and quality assessment of OIER. The recommendations and checklist are available as open resources on the project website.

Conclusions: The Erasmus+ Teacher Academies project "EQui-T" addresses the critical need for high-quality, inclusive educational resources by developing a framework for assessing the quality of Open Inclusive Educational Resources (OIER). Despite the growing relevance of Open Educational Resources (OER), a significant gap in research and practice regarding compulsory (inclusive) education remains. The project's multi-perspective criteria catalogue, developed through an extensive literature review, provides guidance for educators, policymakers, and stakeholders. The framework offers practical

recommendations and a checklist. This ensures that OIER are not only inclusive, accessible and adaptable but also of high quality. The iterative process of refining these tools through teacher feedback and piloting enhances their practicality and usability for OIER development and quality assessment.

Keywords: Open Educational Resources, Inclusive Education, criteria catalogue, technology supported learning, accessibility

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STEAMbrace: Empowering future innovators through STEAM education. Bridging the gender gap in STEM fields

Juancho Pons - Edelvives, Spain

Introduction: STEAMbrace is a Horizon Europe CL2 project that's focused on reversing the loss of STEM professionals by engaging young students with a special effort in female and rural students, overcoming the lack of data on the level of implementation of STEAM approach in Europe and speeding the incursion of STEAM methods in current European education systems.

It's a 3-year project that started in January 2024.

Objectives:

1. Set up the STEAM Alliance for Europe.
2. Unravel the gaps of STEAM education in Europe (per country, age, gender, socio-cultural aspects).
3. Co-create and test STEAM activites for 11-18yo students to boost STEM studies & creative skills.
4. Set up the preparatory actions towards the first STEAM week.
5. Implement and monitor the pilot of the EU STEAM week.: "STE(A)M week for future women innovators".
6. Ensure the sustainability and reproducibility of project outcomes through solid exploitation activities.
7. Maximise the project impact via strong dissemination and communication activities & clustering synergies.

Methodology: The methodology is based on co-creation of activities by teachers, students and experts in education. A list of collaborators is being supported by the different partners in different partners and all this will be implemented in different schools in European countries.

Results: The results will be discussed in the STEAM congresses that STEAMbrace is organizing. The first one already took place in Gothenburg, Sweden, early this year, and we are having a second one in 2026 in Romania. There is a plan to continue once the project is over sustained by the STEAM Alliance for Europe.

Conclusions: Still in the middle of the project, STEAMbrace is a very ambitious project that's working hard in the academia in research, but also in private companies co-creating new materials which are going to be implemented in schools and with a vision to remain as the hub for STEAM education in Europe.

Keywords: STEAM, co-creation, sustainable education, female scientific vocations.

Road-STEAMer: Developing a STEAM Roadmap for Science Education in Horizon Europe

Vasileios Liakopoulos - Ellinogermaniki Agogi

Road-STEAMer aims to develop a comprehensive STEAM roadmap for science education within Horizon Europe and across educational policy frameworks throughout the continent. Its objectives include fostering a deeper understanding of Europe's specific educational needs and how STEAM approaches can effectively address them; exploring opportunities for integrated science learning approaches and synergies; and identifying policy gaps that hinder the impactful adoption of STEAM approaches in Europe's science education landscape. Road-STEAMer co-develops a participatory methodology that combines structured literature and policy reviews, analysis of existing and newly collected data, and evaluation of best practices in STEAM education. It emphasizes collaboration with diverse stakeholder communities through co-creation, dialogue, and mutual learning. The project applies a bottom-up approach focused on real educational conditions and practitioner agency, while highlighting exemplary STEAM cases to bridge open science and open schooling, enhancing science education's societal impact. The Road-STEAMer project develops a wealth of useful material in STEAM education and policy, with an emphasis on using art and creativity elements to deliver the Science, Technology, Engineering and Mathematics curriculum. Among the results are research studies, analytical reports, policy papers, practical toolkits, stakeholder engagement frameworks, and compilations of effective practices. In conclusion, Road-STEAMer proposes that the integration of STEAM in science education must address real-world contexts, civic life, media, economic and environmental concerns, and public health, aligning with EU policy priorities such as the Green Deal and Digital Transformation. The project highlights that bridging the gap between education, research, industry, and civil society demands a unified, student-centred approach that supports synergies across educational levels and societal sectors.

Keywords: STEAM education, open science, open schooling, applied arts, science education policy

Session: Presentations by educators - III

Designing a Renewable Energy Community

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Introduction: This paper presents an integrated STEAM scenario, as the result of a collaboration among four educators with different specialties: a Computer Science teacher with expertise in digital creation and data organization, a Literature teacher with experience in text development and critical analysis, a Music teacher with knowledge in audiovisual communication and creative expression and a Technology teacher with expertise in design and construction of technological projects with simple materials and models. Inspired by the need for holistic and differentiated teaching, the project used the STEAM approach to explore the topical issue of renewable energy, providing multiple stimuli and diverse learning opportunities for students with different needs and aptitudes.

The work was based on the principles of the holistic-disciplinary STEAM approach, which recognise the potential of integrating Science, Technology, Engineering, Arts and Mathematics to promote the all-round development of students. Under this approach, learning is not limited to memorizing facts, but extends to cultivating skills, developing creativity and encouraging personal engagement. As suggested by relevant research, the STEAM approach can be particularly effective in meeting the needs of students with special educational needs, as it offers a variety of activities and modes of engagement, allowing each student to participate and learn at his or her own pace and in his or her own inclusive way.

Objectives: The main objectives of our project were multi-level and focused on the all-round development of the students:

- *Cognitive Objectives*: to help students understand the basic operating principles of the main renewable energy sources (solar, wind, hydro, geothermal, biomass) and to distinguish their advantages and disadvantages. Become familiar with the technologies used to exploit these sources and understand the process of converting energy into electricity.
- *Research Objectives*: To practice effective use of the Internet for research purposes.
- *Cooperative Objectives*: to foster a spirit of teamwork, cooperation and solidarity by learning to work effectively in groups, to take on and fulfil roles, to communicate their ideas and to respect the opinions of others.
- *Creative Objectives*: To encourage students creative expression through the use of different artistic media, such as painting and model making, to visualise their knowledge and develop their imagination.
- *Communication Objectives*: To improve students oral and written communication skills, learning to organise information in a logical order and present it clearly and effectively to different audiences.
- *Inclusion and empowerment objectives*: an important objective was also to create an inclusive learning environment where all students, regardless of their learning needs, would have the opportunity to participate actively, express themselves freely and achieve significant learning outcomes.

- *Mathematical Objectives*: Enable students to apply basic mathematical concepts and skills (such as calculations, data and graph interpretation) to analyse the performance, efficiency and cost of renewable energy in the community they have designed.

Methodology: The project methodology was designed around differentiated teaching and the principle of multiple stimuli, recognising that students learn in different ways and have different needs. To achieve this goal, a wide range of activities were used, including video viewing and discussion, interactive information search, research projects, making mock-ups, creating artworks (painting, poetry, music) and using digital tools to create crosswords and clouds.

The activities were designed to offer different ways of accessing the content, different ways of engagement and different ways of expression, taking into account the different learning needs and interests of the students. For example, students were given the choice to present their work in different ways (oral, written, digital, artistic), different levels of support and guidance were provided according to students' needs and multiple sensory channels (visual, auditory, motor) were used to enhance learning.

In addition, the project was designed to be inclusive of all students, regardless of their learning difficulties or particular aptitudes. The activities were designed to be accessible to all and to allow each student to participate and contribute in their own way, promoting a climate of mutual respect and acceptance. More specifically:

- *Science*: the scientific dimension of the project focused on understanding the basic principles of renewable energy. Students investigated the scientific principles underlying solar, wind, hydro, geothermal, geothermal and biomass energy. In particular, emphasis was placed on familiarizing them with the technologies for harnessing these sources and the process of converting energy into electricity. In addition, students developed research skills, learning to search for, evaluate and select valid information from a variety of sources, such as scientific articles and official reports.
- *Technology*: The use of technology was an integral part of the project. Students used digital tools for research, communication, collaboration and creation. In particular, they practiced effective web research using multiple search engines and specialized websites. In addition, digital collaboration tools, such as shared documents, were used to facilitate the exchange of material. Finally, digital applications for creative expression, such as the crossword application, were used.
- *Engineering*: the engineering process of the project involved the design and creation of a community mock-up that meets its needs exclusively from renewable energy sources. Through this process, students were asked to solve problems, make decisions, and apply their knowledge of renewable energy in a practical context.
- *Art*: Students used art to visualize their knowledge, develop their imagination and communicate their ideas effectively. In the context of literature, students studied the poem "The Nightmare of Persephone" by Nikos Gatsos, focusing on the human-nature relationship and the consequences of climate change. The students had the opportunity to listen to the poem set to music by Manos Hadjidakis by the performer Maria Farantouri. They studied the myth of Persephone, emphasizing the relationship between man and nature. They explored the Eleusinian mysteries, identified the

difference between the region then and now, and created crossword puzzles with key words from the poem. They captured their thoughts and feelings in clouds after studying famous paintings using AI. They wrote their own poems and haiku and painted their own paintings. They came into contact with the artistic movement of impressionism as it was cultivated in the field of painting and influenced both literature and music.

- *Mathematics*: mathematics was integrated into the project through the application of basic mathematical concepts and skills to analyse the performance, efficiency and cost of renewable energy in the community designed by the students.

Through this STEAM methodology, students developed important skills such as teamwork, communication, critical thinking, problem solving and creativity. In addition, they gained in-depth knowledge of renewable energy sources and awareness of the importance of sustainable development

Results and evaluation: Evaluating the effectiveness of the STEAM approach in achieving the learning objectives and meeting the needs of all students was a critical part of the project. A variety of assessment methods were used to capture student progress in different areas.

Students' cognitive development was assessed through written assignments, presentations, participation in discussions, competitions and quizzes, while their skill development was assessed through the quality of computer lab work (for research and digital skills), observation of group work, self-assessment and peer assessment, as well as presentations (for collaborative and communication skills), originality of mock-ups and artistic creations, and justification of the choices they made.

In addition, students' participation and involvement in the activities were observed and recorded, and students were invited to express their opinions and feelings about the project through questionnaires and discussions. The evaluation results showed that the STEAM approach was effective in achieving the learning objectives and meeting the needs of all students. Pupils, regardless of their learning needs, actively participated in the activities, developed important skills and showed significant progress in their cognitive, social and emotional development.

The STEAM project "Designing a Community with Renewable Energy" proved to be an extremely successful educational experience. Not only did the students gain an understanding of renewable energy, but they also developed important skills necessary for success in the 21st century. STEAM's interdisciplinary approach allowed for the connection of different subjects and the provision of a more comprehensive and engaging learning experience. As teachers, we were pleased to observe the active participation, enthusiasm and progress of our students. We believe that this project contributed significantly to the development of their environmental awareness and to preparing them to become responsible and informed citizens in a world facing significant energy and environmental challenges. We plan to continue to incorporate similar interdisciplinary projects into our educational practice, recognizing their value for the all-round development of our students.

Keywords: STEAM project, renewable energy sources, solar energy, converting energy

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1. Scientific Articles and Studies: Together with the students we searched for articles in scientific journals and studies from research institutions specializing in energy and the environment. We mentioned, for example, the International Energy Agency (IEA), the European Environment Agency (EEA) through our school computer systems.
2. Official reports and data from governmental organizations: We guided students to search for reports from government agencies responsible for energy policy and environmental protection in Greece (Ministry of Environment and Energy (MoEEE)) and the European Union (http://www.eea.europa.eu), explaining how to find reliable statistics and strategies.
3. Websites of specialized organizations: We pointed out websites of organizations such as the Centre for Renewable Energy Sources and Energy Saving (KAPE), Greenpeace and WWF Greece (World Wide Fund for Nature Greece), emphasizing the accessibility of their content for students.
4. Books and Encyclopedias of Scientific Content: We encouraged students to consult the physics textbooks and encyclopedias of our school library that cover environmental topics, focusing on consolidating basic scientific concepts.
5. Art history books and websites: Students will love the artistic movement of Impressionism as it was cultivated in painting and influenced both literature and music.

Teaching Emotions in Sophocles' Antigone through Inclusive STEAM Practices: A Creative Approach with Masks and Emerging Technologies

Georgia Dimopoulou - University of Patras, Greece

This paper presents an inclusive, interdisciplinary educational initiative designed to integrate classical literature, emotional literacy, and emerging technologies to enhance student engagement with ancient texts. The project, centered on Sophocles' Antigone and developed within the pedagogical framework of the SpicE Academy, was implemented in a mixed-ability public high school in Western Greece. Drawing from Universal Design for Learning (UDL), Social-Emotional Learning (SEL), and STEAM (Science, Technology, Engineering, Arts, Mathematics) principles, the initiative seeks to reframe literature instruction as an emotionally resonant and participatory experience. Students engaged in a four-phase experiential process involving emotional dialogue, theatrical mask-making, collaborative scene creation, and augmented reality (AR) integration. This approach enabled multimodal expression and fostered inclusive participation, particularly among students with neurodivergent profiles or limited verbal communication. The outcomes indicate significant improvements in empathy, critical thinking, and artistic expression, highlighting the potential of classical texts as living frameworks for inclusive, emotionally meaningful, and socially relevant education.

Introduction: Classical literature, while central to the humanities, is often taught through traditional, text-focused pedagogies that can limit access for students with diverse learning needs. This project reconceptualizes literature instruction through a STEAM-based and emotionally-centered framework that positions the arts and emotional experience as vital to learning. Focusing on Sophocles' Antigone, the intervention engages students in ethical reflection, creative expression, and digital storytelling. The pedagogical design rests on the premise that ancient tragedy, with its rich emotional and moral terrain, offers a fertile ground for inclusive and transformative education.

Methodology and Framework: The project was structured around a pedagogical model that integrates three primary frameworks: Universal Design for Learning, which promotes flexible and accessible instruction; Social-Emotional Learning, which supports emotional development and interpersonal skills; and STEAM, which includes the arts as an essential component of interdisciplinary education. Implemented in a diverse classroom setting, the approach emphasized engagement across multiple modalities to accommodate a range of learning styles and abilities.

The educational intervention unfolded in four interconnected phases. In the first phase, students participated in close readings and facilitated dialogues centered on emotionally charged passages from Sophocles' Antigone. Themes such as justice, loyalty, fear, and defiance were explored in both the ancient and modern contexts. These discussions encouraged personal and ethical reflection, providing a foundation for deeper emotional engagement with the text.

In the second phase, students created theatrical masks representing specific emotions embodied by

characters in the play. The mask-making process served as a non-verbal, symbolic form of emotional externalization. Through the manipulation of materials—clay, paint, and mixed media—students translated internal experiences into tangible, expressive forms. This phase was particularly empowering for students with speech-language difficulties or neurodivergent traits, as it offered a means of expression beyond words.

The third phase involved collaborative scene creation and performance. Drawing on their emotional and literary insights, students wrote and staged original scenes inspired by or adapted from Sophocles' Antigone. These performances combined textual references, improvisation, and contemporary themes such as civil disobedience, protest movements, and family conflict. Performance became a medium for negotiation, identity exploration, and collaborative authorship, allowing students to engage with complex moral dilemmas through embodied learning.

In the final phase, students incorporated augmented reality technology to animate their masks and performances. Using platforms such as Artivive, they embedded digital elements including voice recordings, soundscapes, and visual overlays to create immersive AR scenes. This multimodal extension introduced students to digital storytelling and offered an alternative outlet for those less comfortable with live performance. AR integration bridged traditional artistic practices with contemporary media literacy, expanding students' expressive and technological competencies.

Findings and Impact: The outcomes of the project were most visible across three interrelated domains: emotional development, creative-critical thinking, and inclusive participation. Students demonstrated measurable growth in their ability to identify and articulate emotions. Mask-making, in particular, enabled emotional externalization in students who might otherwise struggle to verbalize inner experiences. Many students reported feeling "seen" and validated through their creative work.

In terms of critical engagement, students displayed the ability to reinterpret Sophocles' Antigone through ethical speculation and contemporary relevance. They grappled with questions of power, resistance, and social justice, linking ancient drama to modern sociopolitical realities. These interpretive activities cultivated higher-order thinking, including synthesis and evaluation, and revealed the capacity of classical literature to foster civic imagination and moral dialogue.

The inclusive design of the project ensured that all students could contribute meaningfully. Visual-tactile activities like mask-making supported students with diverse cognitive and communication styles. Collaborative performance encouraged peer-to-peer learning and built a sense of emotional safety within the group. Augmented reality tools enabled a broader range of expressive possibilities, particularly for students who experience anxiety or inhibition in traditional classroom settings.

Teachers involved in the implementation reported a significant shift in classroom dynamics—from hierarchical models of instruction to collaborative, co-creative learning environments. Lessons became more participatory and emotionally grounded, with literature serving as a medium for both cognitive and affective exploration. Educators also expressed increased confidence in adapting this approach to other subject areas, including civics, history, and digital media.

Conclusions: This project underscores the transformative potential of inclusive, arts-integrated

pedagogy in the teaching of classical literature. By positioning emotional literacy and creative expression at the core of learning, students are not only empowered to engage with ancient texts but to inhabit them—bringing historical narratives into dialogue with their own lives. The integration of performance, artistic creation, and digital technology demonstrates that classical texts like Sophocles' Antigone can serve as vibrant platforms for identity exploration, ethical reasoning, and communal learning. This model offers a replicable framework for educators seeking to bridge tradition and innovation in literature education through inclusive and emotionally resonant practice.

Keywords: Inclusive Education, STEAM, Emotional Literacy, Classical Literature, Arts Integration, Theatrical Masks, Antigone, Sophocles, Creative Pedagogy, Augmented Reality

The Parthenon in Minecraft: An Innovative Inclusive Action in 21st-Century SPICE STEAM Education

Maria Nimpi & Katerina Nikolopoulou – 21st Gymnasium of Patras, Greece

Introduction: In this context, the educational initiative "The Parthenon in Minecraft", implemented within an informal learning environment (UNESCO, 2024) and through the educational use of a digital game (Gee, 2007; Paraskeva & Papagianni, 2021) in an inclusive framework (CAST, 2018; UNESCO, 2024; SPICE, 2024), represents an innovative project that interdisciplinary integrates cultural heritage with technology, engineering, science, mathematics, and the arts. At the same time, it draws on historical sources, linguistic and literary expression, and creative production.

The initiative began with a philological starting point—the study of the poem "Hymn to the Parthenon" by Kostis Palamas—and evolved into a multifaceted, interdisciplinary, and inclusive project. At its core was the three-dimensional digital reconstruction of the Parthenon within the Minecraft game environment, enriched with a musical score generated by setting the poem's verses to music using artificial intelligence (AI), carried out by a mixed group of Greek lower secondary school students, with and without Special Educational Needs (SEN).

Purpose – Objectives: The aim of the initiative is to strengthen the connection between cultural heritage, digital learning, and inclusive pedagogy through the implementation of an interdisciplinary and playful project in an informal learning environment—one that is attractive and familiar to students and tailored to their needs, abilities, and interests.

Objectives of the initiative (based on Bloom's revised taxonomy):

- To identify key elements of cultural heritage and the Parthenon through philological and historical sources (knowledge – comprehension).
- To connect concepts from different subject areas (Technology, Engineering, Arts, Mathematics, Language, History), applying the principles of interdisciplinary STEAM education (comprehension – application).
- To collaborate effectively in a mixed group of 8 students with and without SEN, enhancing skills of empathy, interaction, and inclusion (social and emotional learning – behavioral level).
- To design and construct a 3D digital model of the Parthenon in Minecraft with a musical composition (setting Palamas's poem to music), creatively using technological and artistic tools, as well as artificial intelligence (creation – synthesis).
- To reflect on the learning experience, evaluating both content and process based on aesthetic, cultural, and inclusive criteria (evaluation – metacognition).

Implementation Framework and Methodological Approach: Eight students from the 9th grade of a Greek lower secondary school (approximately 15 years old), both with and without Special Educational Needs (SEN), in equal proportion, participated in an educational project centered on cultural identity and the promotion of an iconic monument of Greek cultural heritage with global significance—the

Parthenon. The initiative was implemented within the pilot application of the SPICE STEAM framework in the school.

The selected group collaborated to create a three-dimensional digital reconstruction of the Parthenon within the Minecraft environment, enhanced with a musical composition based on setting the verses of the poem to music using artificial intelligence (AI). Minecraft was chosen by the students themselves as a common area of digital interest—a criterion that shaped the formation of the mixed group.

The group included one student with dyslexia, two with learning difficulties, and one student with high-functioning autism. The implementation followed the principles of Universal Design for Learning (UDL) and the SPICE STEAM model, fostering active, inclusive, interdisciplinary, and playful learning, while cultivating 21st-century skills (4Cs).

The project was part of an officially approved school action plan under SPICE STEAM and was supported by differentiated, multisensory teaching methods, flipped classroom strategies, and co-teaching between a special education philologist (with expertise in educational technology) and general education teachers across disciplines (philologist, mathematician, engineer-technologist, physicist). It was enriched by a visit to the house of poet Kostis Palamas and by the use of a museum kit from the Acropolis Museum.

Evaluation and Results: The action was evaluated through a combination of qualitative and quantitative tools (observation, questionnaires, checklists, self-assessment, and reflection), directly linked to the educational goals. This allowed a comprehensive assessment of cognitive, social, and emotional skills.

The application of the SPICE STEAM methodology and the use of Minecraft significantly enhanced students' concentration, creativity, and engagement, regardless of their learning profile. The quantitative results were striking. Indicatively:

- 100% of students reported feeling they played an active and important role in their group (empathy – collaboration).
- 100% evaluated the project as highly creative and enjoyable (engagement – agency).
- 100% of students with SEN maintained consistent focus and recalled detailed information about the Parthenon (knowledge – comprehension).

All students expressed a desire for the SPICE STEAM approach and the educational use of Minecraft to be systematically applied in school (reflection – metacognition).

Students with SEN, in particular, felt safe and empowered. The familiar digital environment of Minecraft supported their participation, aiding memory, concentration, and authentic connection with cultural knowledge.

Their reflections revealed feelings of pride, teamwork, and creative collaboration. Key words and phrases that emerged included: companionship, co-creation, discussion, solutions, thinking, memorization, satisfaction, group, mutual support.

Identified Challenges:

- The pressure of the school timetable in relation to curriculum coverage.
- The need for the institutional integration of fixed weekly hours dedicated to SPICE STEAM.
- Students' expressed request for the structured pedagogical use of playful digital tools (e.g., video games), which are already attractive to teenagers and can serve as bridges for experiential learning and inclusion.

Extensions and Considerations for Further Study: Despite the positive reception, key concerns arise.

- Minecraft's appeal may reflect gaming familiarity rather than educational merit.
- Screen overuse and digital addiction risks call for pedagogical boundaries.
- Its block-based design challenges the accurate rendering of the Parthenon's curves and refinements.
- Further research is needed on its impact on historical and architectural understanding.
- When grounded in solid pedagogy, digital tools like Minecraft can enrich—but not replace—authentic cultural learning.

Conclusions: Approaching the Parthenon as an educational subject highlighted the interdisciplinary and cultural dimensions of the project, promoting collaboration, inclusion, and creativity. By integrating cultural content within a digital environment and applying the principles of Universal Design for Learning (UDL) and SPICE STEAM, the project shaped a modern, accessible, and engaging educational model.

The initiative confirmed the potential of digital games as tools for enhancing creativity, collaboration, communication, critical thinking, and cultural identity—especially for students with Special Educational Needs (SEN), who showed noticeable progress both cognitively and emotionally.

The outcomes align with current international research recognizing the capacity of cultural heritage digital games to transform playful experiences into authentic learning processes enriched with storytelling, exploration, and experiential approaches (Camuñas-García, Cáceres-Reche, Cambil-Hernández & Lorenzo-Martín, 2024).

The three-dimensional reconstruction of the Parthenon, enhanced with AI-generated musical compositions based on the poem's verses, functioned as a synthesis of knowledge and artistic expression. This demonstrates how STEAM education can bridge cultural heritage and digital skills, renewing school learning through participation and creativity.

Keywords: STEAM, inclusion, cultural heritage, digital educational games, Minecraft, informal learning environment

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Integrating Inclusive STE(A)M practices in primary Education: The Fizzy Q Application

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Introduction: In the beginning of the 21st century, a big challenge for the educational community globally is to create effective and innovative ways of teaching important skills for future citizens. In a rapidly evolving society some of these skills are critical thinking, creativity, problem solving, collaboration, communication skills, as well as, digital and scientific literacy. A useful approach that encourages educators to work in an interdisciplinary way and addresses 21st century skills is STE(A)M education. STE(A)M education improves teaching quality and effectiveness (Zhou & Liu, 2023) and triggers students' interest (Quigley, 2020).

Apart from the necessity of teaching important 21st century competences, another challenge that emerges in the current educational reality, is the management of multicultural classrooms in public schools. Migrant or refugee students with different cultural background struggle to follow the curriculum in a foreign country, since language constitutes a barrier in their school life. However, inclusive teaching and learning techniques can be incorporated within the STE(A)M framework. According to Wade et al. (2023), the promotion of equity and access for all children to learn is critical from a young age. Inclusive STE(A)M practices can be of great assistance for educators dealing with the challenges reported previously and are, also, interested in their personal and professional development.

The present work describes in detail a pilot educational project, implemented in primary education, using the Fizzy Q application. The project was implemented in collaboration with Scientix® and the representatives of the Fizzy Q app.

Objectives: The project's main objective was to test the application in the classroom and understand how to better use science digital tools in order to facilitate the learning procedure for migrant students. More specifically, the objectives of the project were for teachers to apply a digital tool in the framework of STE(A)M education, in order to foster inclusion for migrant students and enhance their active participation in science lessons. Moreover, students were expected to collaborate and learn through the use of a new and innovative digital tool that highlights the utilization of mobile devices (tablets or mobile phones) in the teaching and learning experience.

Methodology: Fourteen students of the 6th grade participated in the project, of which two were Ukrainian refugees and two were Albanian immigrants. The methodology of the implementation was based on the STE(A)M educational approach and included project-based learning, inquiry-based learning, collaborative-learning, mobile-learning and problem-solving.

Students were divided in four groups and worked with the schools' tablets. After participating in the preparation lesson, where they had the time to navigate and get familiar with the tool, implemented two activities which were relevant to the science curriculum of 6th grade.

During the implementation I was taking notes, while observing my students working with Fizzy Q and in the end all students completed a short questionnaire concerning their experience and the difficulties they encountered during the implementation of the project.

Results & Conclusions: The results showed that the interface of the Fizzy Q app was easy to navigate and students did not have problems working with it. The activities were engaging and all students enjoyed teamwork. The level of English was not difficult for the 6th-grade students to understand, and the four migrant students of the classroom found it easy to handle and participated actively. The activities promoted inquiry-based learning and stimulated students' interest and curiosity. It helped students organize their experimental work and thoughts on their tablets and conduct experiments using a digital tool.

Fizzy Q is a free and accessible application that can benefit many migrant and non-migrant students towards science and digital literacy. It is, also, a handful tool for educators to organize their science teaching lessons and create their own activities within an inclusive and creative learning environment.

Keywords: Inclusion, STE(A)M, Fizzy Q app, inquiry, mobile learning

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“The Power on My Plate”: A Project by 4th Grade Students of the 13th Primary School of Patras

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Introduction: According to official data from the World Health Organization (2022), Greece is among the countries with the highest rates of childhood obesity in Europe, with approximately one in five children being obese. The consumption of foods high in fat and sugar, the lack of daily physical activity, and the excessive use of electronic devices contribute to the increase in children's body weight, causing a wide range of serious effects on their health as well as their social life (HMAF, 2016).

The 4th-grade students of the 13th Primary School of Patras, recognizing that childhood obesity is an increasing challenge faced by National Health Systems worldwide, decided to design and implement a multidisciplinary inclusive project that highlights and emphasizes the importance of adopting healthy eating habits, under the title: “The Power on My Plate”.

Objectives: By engaging students in active, interdisciplinary learning through hands-on, experiential approaches that connect various subject areas, we aimed to achieve the following goals:

- To introduce students to the main food groups and help them understand their nutritional significance.
- To identify food products that contain high levels of sugar.
- To comprehend the health implications of excessive sugar consumption.
- To actively reduce the daily intake of sugary snacks and soft drinks.
- To shift their eating patterns toward more wholesome and nutritious options.

Methodology: Taking into account the composition of the class, which included children with a migrant background as well as children belonging to vulnerable social groups—and therefore presenting different levels of learning readiness and diverse cognitive profiles—we designed activities that addressed their varied needs and ensured equal learning opportunities.

We began by studying the nutritional value of foods through the lens of Science. Through brainstorming, we found that excessive sugar intake leads to weight gain, tooth decay, and an increased risk of diabetes. Next, we investigated the amount of sugar found in various snacks and soft drinks commonly consumed by children by examining their labels. We visualized these sugar amounts using granulated sugar, which we measured each time with a digital precision scale and compared them to the recommended daily sugar intake suggested by the World Health Organization (WHO). To our surprise, we discovered that many foods contained far more sugar than we had assumed, and most students reported that their daily intake significantly exceeded the recommended amount.

Taking advantage of the robotics kits distributed to schools during the current school year, we used the R3 kit, which included a robotic arm, to approach the topic of healthy versus unhealthy foods

through the lens of Engineering. The students became familiar with the operation and movements of the robotic arm and used the connected remote control in order to classify the packages as healthy or unhealthy, based on the sugar content they had previously recorded. Using the control buttons, they directed the robotic arm to "grab" a package and then place it in one of the designated areas we had set up for healthy and unhealthy foods. At the same time, the students were introduced to the concept of automated sorting, as the robotic arm could also perform pre-programmed movements through computer commands. In the end, they observed that the space designated for unhealthy foods was full, while the area for healthy foods was almost empty—leading them to realize that the overwhelming majority of packaged foods are harmful to our health.

Next, we aimed to explore—through a playful approach—the frequency with which students consumed the aforementioned food items within the broader school community. Using the appropriate digital tools provided by Technology, we developed a digital board game that featured questions regarding the frequency with which participants consumed soft drinks or sweets. The 4th-grade students wrote the questions and possible answers on paper, and then transferred them to the Genially digital platform by typing them on the classroom's interactive whiteboard. Once the game was completed, we gathered the other classes in the school's event hall and projected the game board using a video projector. By "rolling" the digital dice, the classes moved their game pieces along the board, answering a question at each step. The winning team was the one that reached the finish line first, successfully avoiding the "dietary traps."

The Arts also played a vital role in cultivating healthy eating habits. The students created slogans, which they wrote on large posters and presented in the schoolyard to their fellow classmates, raising awareness about the need to avoid consuming certain foods high in sugar content. Through drama-based activities, they took part in the "Trial of the Foods"—a performance in which students assumed the roles of the accused foods, lawyers, and judges. They argued in favor of healthy foods and "convicted" the harmful ones for the damage they cause to humanity. Finally, they embodied the negative effects of so-called "junk food" by acting out the difficulties faced by someone who does not maintain a proper diet.

To explore the extent to which students' eating habits had changed, we asked them to record their height and weight before and after the implementation of the Multidisciplinary Inclusive Project. They then calculated their initial Body Mass Index (BMI), followed by their current BMI, and finally the change between the two using Mathematical operations. They found that reducing sugary foods in their diet led to a 2.86% decrease in the class's average Body Mass Index (BMI). The girls showed a greater percentage reduction (3.10%) compared to the boys (2.62%), with BMI decreases of 0.6 and 0.7 units, respectively. They represented the data with bar charts and visualized the change, engaging in discussions about how their shift in dietary habits had influenced the results.

Results and Conclusion: During the implementation of the program, the students demonstrated increased interest in participating in the activities. The experiential nature of the tasks encouraged them to take initiative and explore learning in their own unique way. They engaged with the various fields of STEAM education and developed the 21st-century 4C skills: critical thinking, communication,

collaboration, and creativity. They worked collaboratively and inclusively, understanding that in a shared effort, each member plays a complementary role. They focused on a meaningful real-world issue and explored its different aspects through innovative activities. Inspired to create, they discovered new career paths related to technology. Ultimately, they changed their eating habits and became ambassadors of the healthy eating message, sharing it with others. Considering that the project followed a multidisciplinary rather than an integrated STEAM model, future iterations could evolve toward a more integrated STEAM design by aligning all disciplines around the central inquiry of promoting healthier eating habits by reducing the intake of high-sugar foods, fostering deeper connections between scientific, technological, artistic, and mathematical thinking.

Keywords: healthy, diet, sugar, inclusion, STEAM

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Creation of a Shadow Theater Performance with Bicycle Dynamo for Lighting

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Introduction: Interdisciplinary education and innovation in teaching are vital for enhancing learning and fostering critical thinking and creativity in students. The need for sustainable and ecological solutions, such as the use of renewable energy sources, is increasingly being integrated into educational systems. Within this context, the present project focuses on the creation of a shadow theatre performance by 43 fifth-grade primary school students. This performance merges cultural heritage with modern technology. The theme centers around the Byzantine emperors and is presented using lighting generated by a bicycle dynamo, offering a sustainable and eco-friendly approach to both the creation and presentation of the performance. The goal of the project is to use the STEAM (Science, Technology, Engineering, Arts, Mathematics) approach to connect these disciplines and help students develop skills in each area.

Objectives: The main objective of the project is for students to create a shadow theatre performance based on the Byzantine Empire, using renewable energy technologies for lighting. The specific objectives include:

1. Language Objectives: To study and understand the structure of a shadow theatre script, incorporating humor and elements of Byzantine cultural heritage.
2. Technology Objectives: To understand the process of converting kinetic energy into electrical energy using a bicycle dynamo and apply this knowledge through simulations and constructions.
3. Mathematics Objectives: To design and build the shadow theatre screen (berdès) using recyclable materials and mathematical concepts (measurements, geometry).
4. Science Objectives: To understand the operation of electrical circuits, the propagation of light, and the creation of shadows.
5. Engineering Objectives: To build electric circuits with a dynamo, understanding the relationship between speed and brightness.
6. Art Objectives: To create artistic shadow figures and present the performance creatively, using recycled materials for the set design.

Methodology: The methodology combines an interdisciplinary approach, blending the fields of arts, science, technology, and mathematics for fifth-grade students. The use of various presentation tools (videos, visual models, worksheets) and expression methods (scriptwriting, figure making, set creation) enabled all students to actively participate in the project. Students worked in mixed groups, and with a "buddy system" in place, cooperative pairs were formed for peer support. Formative assessment was used throughout the process to improve and address student needs.

The implementation process was divided into three main phases:

1. *Scriptwriting and Story Development*: Students collaborated to compose the theatrical script

focused on Byzantine emperors, integrating historical knowledge, cultural heritage, and traditional shadow theatre elements. This phase encouraged creativity and collaboration.

2. *Construction of the Theatre Screen and Lighting System*: In the second phase, students designed and built the shadow theatre screen from recyclable materials (cardboard, rice paper), applying their mathematical knowledge of measurements and proportions. At the same time, they constructed the electrical circuit using a bicycle dynamo to power the stage lighting. Through energy simulations, students observed the transformation of kinetic energy into electricity and the relationship between speed and light intensity.

3. *Performance Presentation*: In the final phase, students prepared the stage, created the figures and set pieces, incorporating the artwork they had made. They then organized and presented their performance to an audience, using dynamo-powered lighting and explaining the process of electrical energy production.

Results: The implementation of the project led to significant learning outcomes, including:

1. *Understanding the Application of Science in Daily Life*: Students comprehended and applied physical principles for energy production using a bicycle dynamo and its connection to lighting.

2. *Creation and Presentation of a Theatrical Script*: Students successfully created a script that combined historical content with the style of shadow theatre. The public presentation is pending.

3. *Use of Mathematical and Technological Knowledge*: Students designed and constructed the shadow theatre screen and built electric circuits for the lighting system.

4. *Enhanced Creativity*: Students created artistic components for the stage using recyclable materials, developing their artistic and creative skills.

Conclusions: This project demonstrated the power of interdisciplinary approaches in education, strengthening the connection between different fields of knowledge and their application in real-life contexts. The creation of the shadow theatre performance and its lighting via bicycle dynamo allowed students to merge tradition with modern technology while promoting sustainable energy solutions. Moreover, it enhanced students' communication, collaboration, and creativity skills. The project highlights the importance of sustainable energy, recycling, and cultural heritage as fundamental elements of modern education, while promoting learning through action and experience.

From the Waves of Arts (A) to Action: When Inclusive STEAM Education Transforms Students into Active Citizens

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Introduction: The theatrical performance with music and movement "Waves of Change: From the Couch to Action!" represents a model interdisciplinary and inclusive educational intervention, implemented as part of a Health Education program and presented at the 1st Student Festival "Active and Compassionate Student Citizen" at the Hellenic Open University in Patras, under the auspices of the Region of Western Greece (2025).

Recent research supports the importance of drama-based interventions in secondary education for promoting psychosocial empowerment and active citizenship. Conrad (2022) highlights the transformative power of theatre in strengthening youth civic engagement, while Gallagher and Goopy (2021) present drama pedagogy as a bridge for expression and collective identity. In the Greek context, Theologidou (2015) documents the role of drama games in developing empathy and participatory attitudes among students, while Govas and Zoniou (2011) showcase forum theatre techniques as powerful tools for fostering critical thinking, social action, and personal empowerment within the school context.

This initiative organically incorporated the principles of the SPICE STEAM educational model (Science, Technology, Engineering, Arts, Mathematics), emphasizing the role of the Arts (A) as a driving force for cultivating social consciousness and active citizenship through interdisciplinary, experiential, and collaborative learning activities (Henriksen, Mishra & Deep-Play Research Group, 2021; Henriksen, Mehta & Mishra, 2021; SPICE, 2024). The inclusion of the Arts enriches the traditional STEM framework by offering creative and value-oriented stimuli while simultaneously advancing inclusive education.

The central narrative of the performance depicted a family's transition from passivity to active engagement, triggered by a fictional television show encouraging social and environmental action. The performance reached its climax through student-led choreography and poetic choral expression, highlighting the contrast between superficial activism and genuine action, and the power of collectivity to drive change.

Objectives: The key objectives of the educational intervention were:

- To develop an understanding of active citizenship and to highlight contemporary environmental issues.
- To enhance social and environmental awareness through drama pedagogical and interdisciplinary experiential approaches (Conrad, 2022).
- To cultivate 21st-century skills, specifically critical thinking, creativity, collaboration, and communication (Gallagher & Goopy, 20212).
- To empower students as responsible and participatory citizens.

- To promote a culture of inclusion through the equitable engagement of all students, regardless of their specific educational needs (Anderson, 20203).
- To foster interdisciplinary connections among science, technology, engineering, mathematics, and the arts within a unified, experiential, and inclusive learning environment (Connor, Karmokar & Whittington, 20214).

Methodology: The intervention was carried out in a school setting as part of an extracurricular Health Education program over a four-month period, with weekly two-hour meetings. The performance was designed and implemented by an interdisciplinary team, including a special and inclusive education philologist (program coordinator and head of the theatre club), a choreographer, a mathematician, a mechanical engineer, and a physicist.

The methodological approach was experiential, grounded in the principles of STEAM education and inclusive pedagogy. Students actively participated in scriptwriting, directing, designing the fan-based "wave" choreography, selecting props and costumes, and producing audiovisual materials and sound effects.

The group included 14 students, among them students with learning difficulties and high-functioning autism, organized into heterogeneous teams. The preparation process included multiple rehearsals with differentiated roles, promoting the active and equitable participation of all students.

SPICE STEAM Dimensions and Inclusive Pedagogy

The activity vividly highlighted all five SPICE STEAM domains:

- *Science*: Development of knowledge on climate change, pollution, and sustainability through experiential activities.
- *Technology*: Use of digital tools to create stage backgrounds and sound effects.
- *Engineering*: Construction of sets and structural elements with the support of the mechanical engineer.
- *Arts*: Implementation of drama pedagogical practices (Anderson, 20205; Gallagher & Goopy, 20216) through theatre games, choreography, poetic language, and stage expression.
- *Mathematics*: Calculation of stage time and analysis of spatial and rhythmic patterns.

The artistic dimension acted as a catalyst for experiential engagement, fostering emotional intelligence, creative thinking, and collectivity (Conrad, 20227; Henriksen et al., 20218).

The teaching approach was based on the principles of Universal Design for Learning, drama pedagogy, and differentiated instruction, offering multiple ways of participation and expression.

Table 1 – Replication Checklist This table reflects the interdisciplinary, inclusive, and experiential dimension of the intervention.

Phase	Activity	Educational Materials / Tools
Preparation	Informing students about the goals and values of active citizenship.	Videos, photos, news about coastal pollution.
Awareness	Presentation of environmental issues by a science and special education language teacher.	Modern examples, images, videos, experiential discussion.
Roles – Roleplay	Role-playing games, theatrical techniques, and creative writing.	Role cards, paper/computers.
Script Writing	Final script composition by the special education language teacher based on student ideas.	Word processor, notebooks, audio recording.
Digital Composition	Creation of video by synchronizing audio and visuals.	Canva, CapCut, recordings, music.
Choreography	Collaboration between language teacher, math teacher, choreographer, and female students.	Rhythm exercises, poetry, fans, fabrics.
Scenery & Costumes	Designing imaginative sets with simple materials.	Recycled materials, school theatre props.
Theatrical Performance	Rehearsals with pauses, music, choreography, and full presentation.	Stage, sound, costumes, lighting.
Reflection	Feedback and questionnaires.	Google Form, journals, emotion cards.

Evaluation – Results: The evaluation was conducted on multiple levels using a combination of

quantitative and qualitative assessment tools. Data was collected through a self-reflection questionnaire, as detailed in Table 2.

Table 2 – Assessment Tools

Tool	Structure	Scale
Student Self-Assessment Questionnaire	11 closed-ended + 2 open-ended questions	5-point Likert scale + open-ended responses
Teacher Observation Form	List of observable behaviors	

The analysis revealed high levels of positive impact on cognitive, social, and emotional levels:

● 100% of students reported increased environmental and social awareness. ● 100% reported improvement in their collaborative skills. ● 100% improved their communication and creative expression. ● 92.9% reported enhanced problem-solving skills through teamwork. ● 100% felt they participated equally. ● 85.8% overcame the fear of public speaking. ● 100% stated that their voice was "heard." ● 85.7% recognized the importance of integrating all SPICE STEAM domains. ● 92.9% expressed willingness to participate in social and environmental actions. ● 100% said they would like to participate again in a similar initiative. ● 92.9% expressed a desire to integrate STEAM as a subject in their weekly school schedule.

These voices demonstrated authentic understanding of social responsibility, collective action, and the value of inclusion.

Student Reflections: The open-ended responses revealed the students' experiential understanding and emotional engagement. Specifically, in response to the question “What moved you the most during this experience?”, students wrote:

- The fan dance and the bond we formed with the girls.
- Students and teachers became one team.
- We learned through fun and creativity.
- The collaboration and the good result we achieved together.
- The joint effort and learning in many different ways.
- Realizing that we all have abilities and talents.
- The content of the script and the experience we lived.

Regarding whether and how their perception of collective action changed, students responded:

- Society changes because of us, not because of “the others.”
- Great satisfaction and boost in self-esteem.
- Belief in my own abilities and those of the team.
- Exchange of knowledge and experiences with classmates and teachers.
- I understood the collective responsibility for social issues.
- I was inspired by the program and its outcomes.

Multilevel Analysis of Learning Benefits:

- Cognitive level: Students enhanced their knowledge of environmental issues and sustainability, connecting scientific concepts to real-life contexts through theatrical dialogue
- Social level: Collaboration, participation, and problem-solving skills were cultivated through collective creative processes.
- Emotional level: Empathy, self-confidence, and personal responsibility were developed through drama pedagogical techniques

Connection to the SPICE STEAM Framework:

The intervention highlighted the essential contribution of the SPICE STEAM framework—with the Arts (A) at its core—in shaping an experiential, interdisciplinary, and inclusive learning environment. It promoted:

- The holistic development of cognitive, social, and emotional skills.
- The cultivation of 21st-century competencies: critical thinking, creativity, collaboration, and communication.
- The enhancement of an inclusive culture and social responsibility.

SPICE STEAM served not merely as an educational framework but as a vehicle for social transformation, fostering collective action and the belief that “small acts can create great waves of change.”

Conclusions: The inclusive action “Waves of Change: From the Couch to Action!” demonstrated that the combined application of the Arts, Sciences, and Inclusion transforms the learning experience into an authentic, experiential, and transformative process. Students reported gaining deeper environmental and social awareness, developing social and communication skills, and becoming empowered as agents of collective action and change. The integration of drama pedagogy within the SPICE STEAM framework emerges as a powerful tool for cultivating active, responsible, and creative citizens. When education travels on the waves of Arts and Inclusion, students don’t just learn—they act and transform the world around them.

Keywords: SPICE STEAM, Drama Pedagogy, Experiential Learning, Active Citizenship

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Digital Competences in STEAM Education: Towards an Inclusive and Equitable Future

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Introduction: In the evolving landscape of education, the integration of digital competences within STEAM (Science, Technology, Engineering, Arts, and Mathematics) education has become pivotal in addressing the challenges of inclusivity, equity, and future-readiness. Digital competence—defined as the confident, critical, and responsible use of digital technologies for learning, work, and societal engagement—is a cornerstone of modern education systems. This paper explores how digital competences are integrated into STEAM education in Greece, highlights existing gaps, and presents a case study that illustrates the practical application of inclusive strategies. By fostering digital literacy, problem-solving, creativity, and collaboration, inclusive STEAM education can act as a vehicle for empowering all learners regardless of their background.

Objectives: This research aims to:

1. Examine the role and relevance of digital competences in STEAM education.

2. Explore inclusive strategies for integrating digital tools and practices in primary education.

3. Identify challenges and opportunities in the Greek educational system concerning digital inclusion.

4. Showcase practical classroom implementations using the Jigsaw methodology in robotics.

Methodology: A mixed-methods approach was employed, combining theoretical review and empirical analysis. The study draws from the European Commission's DigComp framework, national curriculum guidelines in Greece, and qualitative data from classroom observations. A practical example—the use of the Jigsaw Classroom technique in a robotics club for 5th and 6th-grade students—served as the case study to demonstrate how digital competences can be inclusively taught. Students were grouped into both expert and jigsaw teams to collaboratively build and program robotic artifacts using Lego WeDo 2.0 kits, Scratch, and Moodle.

Results: The research revealed the following key findings:

1. *Curriculum Alignment*: The Greek education system acknowledges digital competences as horizontal skills in the field of Informatics, covering areas such as computational thinking, algorithmic problem-solving, digital citizenship, and media literacy. However, practical integration across all subjects remains uneven.
2. *Implementation Gaps*: While platforms like Moodle and tools such as Scratch are increasingly used, there are significant challenges including outdated infrastructure, limited internet access in rural areas, and a lack of standardized teacher training programs focused on digital pedagogy.
3. *Inclusive Practices in Action*: The Jigsaw Classroom approach was found to be effective in fostering inclusion and collaboration. By assigning students diverse roles (Leader, Presenter, Constructor, Programmer), the model promoted equity in participation and helped accommodate different

learning styles and digital skill levels.

4. *Student Engagement and Competency Growth*: Participants demonstrated increased engagement and improved abilities in problem-solving, teamwork, digital creativity, and reflective thinking. These competencies were further reinforced through project-based learning, such as the "Mars Mission" simulation.

5. *Teacher Development Needs*: Educators expressed a strong interest in professional development related to digital tools, yet highlighted the need for time, resources, and institutional support to implement inclusive practices consistently.

Conclusions: The integration of digital competences into STEAM education is not only necessary but urgent for ensuring equitable and inclusive learning environments. The Greek educational context illustrates both the potential and the constraints of current approaches. While frameworks and digital tools are in place, their effective use depends on systemic support, infrastructure, and teacher empowerment.

Inclusive STEAM education must go beyond access to technology—it must be rooted in pedagogical strategies that value diversity, encourage collaboration, and provide meaningful learning experiences for all students. The Jigsaw Classroom model exemplifies how digital inclusion can be achieved when instructional design meets technological innovation.

Moving forward, investments in infrastructure, continuous teacher training, and policy shifts toward inclusive digital education will be essential. By aligning STEAM education with digital competence frameworks, we can better prepare both educators and learners to participate in a digital society with confidence and creativity.

Keywords: STEAM education, digital competences, inclusive learning, jigsaw

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“SOSte... the Water!”

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Introduction: In a world where water pollution increasingly threatens ecosystems and human health, this project seeks to empower young students to understand, explore, and act on one of the most pressing environmental issues: water pollution. The guiding question was grounded in real student curiosity: "Why can’t we swim in some seas?" and "Why isn’t spring water always drinkable?".
Rather than merely providing answers, the teaching team adopted an interdisciplinary, student-centered approach, using STE(A)M methodologies to stimulate inquiry, creativity, and critical thinking.
Title of the Project:
“SOSte... the Water!” (A play on words: "SOS" + "Save the water!")

Main Educational Goal: To help students understand:
• The causes and consequences of water pollution
• Solutions and prevention methods
• The role of science, technology, and the arts in addressing real-world problems

Methodology:
Interdisciplinary Approach (STEAM)
This collaborative teaching effort involved a range of disciplines. Each subject contributed a unique lens for analyzing the issue and promoting student action.

Science
• Objectives: Understand physical and chemical aspects of water pollution.
• Activities: Analyze media articles and videos, perform experiments (solubility, filtration), interview a chemist, engage in a classroom debate.
• Outcomes: Students practiced scientific thinking and communication while gaining a deeper awareness of water quality issues.

Technology
• Objectives: Use digital tools to explore and visualize pollution causes and solutions.
• Activities: Create digital mind maps, puzzles, and comics.
• Outcomes: Technology served as a bridge between knowledge and creativity, supporting conceptual understanding.

Engineering
• Objectives: Find practical, hands-on solutions to environmental issues.
• Activity: Build a biological wastewater treatment model.
• Outcomes: Students applied problem-solving skills and engineering logic to model real-world infrastructure.

Mathematics

• Objectives: Quantify pollution, analyze change over time, calculate degradation rates of pollutants.
• Activities: Data collection, bar charts via Google tools, mathematical problem-solving.
• Outcomes: Math became a powerful tool to understand environmental impact and support evidence-based proposals.

Arts

• Objectives: Cultivate awareness and emotional connection to the issue.
• Activities: Explore songs, films, paintings; create posters, comics.
• Outcomes: Students used creative expressions to share their views and advocate for clean water.

Assessment and Reflection

The project evaluation included:
• Observation of student participation and collaboration
• Completion of digital and physical outputs (experiments, models, comics, quizzes)
• Reflective discussions and presentations
• Peer and self-assessment in group activities

Learning Outcomes

By the end of the project, students were able to:
• Explain the science behind water pollution and filtration
• Use digital tools to communicate complex ideas
• Build functional models with a clear purpose
• Analyze and interpret statistical data
• Express their concerns and ideas through artistic mediums

This project didn't just teach content; it fostered empathy, responsibility, and civic awareness—qualities essential for the next generation of environmentally conscious citizens.

Conclusions: Education with Purpose

"SOSte… the Water!" is not just an interdisciplinary lesson plan. It's a model of holistic education, blending logic and creativity, knowledge and action. In the spirit of inclusive, hands-on learning, students were not passive recipients of facts, they became investigators, creators, and advocates for their world.

As educators, we didn't only teach them about pollution. We helped them imagine a cleaner, fairer future—and believe they can help build it.

The Construction of Odysseus' Raft – A Journey through SPICE STEAM Education

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Introduction: Connecting ancient Greek literature with contemporary teaching methodologies is one of the greatest challenges in philological education (Hardwick & Stray, 2008). Homer's 'Odyssey', one of the most iconic works of the global literary canon, can serve not only as an entry point for teaching epic poetry, but also for developing 21st-century skills (Partnership for 21st Century Learning, 2015; Chatzidimou, 2018), promoting inclusion and implementing the interdisciplinary STEAM method. The SPICE STEAM model specifically aims to support such innovative and interdisciplinary practices, enabling all students to become co-creators of knowledge (Ferguson, 1997; Theofanellis & Papadimitriou, 2016; Ntouskas, 2022; Spyropoulou et al., 2024; SPICE, 2024). The project 'Odysseus' Raft' focuses on the episode of the hero building his raft in the Odyssey, transforming it into a creative, hands-on, and artistic learning experience. The raft evolves from a symbolic element of survival and hope into a starting point for inclusive educational practice.

The approach is based on the philosophy of inclusive education (Ainscow, Booth & Kingston, 2006; SPICE, 2024), which aims for the active participation of all students by responding to their needs and abilities (Dierking et al., 2003; Aggelidis & Chatzisotiriou, 2013; SPICE, 2024). At the same time, it integrates elements of differentiated instruction and project-based learning, connecting theory with practice and enhancing student agency. The SPICE STEAM method emphasizes the holistic development of students and the cultivation of the 4Cs: critical thinking, creativity, communication, and collaboration. Moreover, the integration of philological content – in this case, the Odyssey – proves that connecting the humanities with the sciences is not only feasible but also pedagogically valuable.

Methodology: The project was implemented at the 21st Junior High School (21st Gymnasio, ages 12-15) of Patras with the participation of ten 7th grade students: five with officially recognized special educational needs and five without. The philologist for special and inclusive education, in collaboration with the general education philologist, designed and implemented a learning scenario based on the episode of Odysseus constructing his raft, adapting the content and activities to the needs of the group. Students worked in mixed groups and engaged in activities involving reading, design, experimentation, artistic expression, and technological creation. The construction of the raft was based both on Homeric description and on principles from physics (buoyancy, balance), technology (use of tools), engineering (structural stability), mathematics (ratios, measurements), and art (decoration, color composition, symbolism). Simultaneously, through the 'A' element, experiential activities were integrated (e.g., the role-playing game 'Odysseus' Thread'), digital tools (Padlet, Viber, AI), creative writing, and theatrical expression to enhance the aesthetic and linguistic dimensions of the work.

The methodological approach was based on collaborative and differentiated teaching. Students were first organized into one inclusive group and then into smaller subgroups formed based on the nature of each activity. Group composition was carefully managed to ensure a balanced distribution of skills and characteristics, avoiding clustering of students with difficulties. For students with attention deficit or autism, quiet and organized workspaces were used, with reduced stimuli and clear visual instructions. The collaboration between general and special education teachers (Bagaiti, 2019) extended beyond the physical classroom, including asynchronous communication and preparation through the flipped classroom model (Gariou, Makrodimos & Papadakis, 2021), following a structured sequence of phases and steps.

Project Objectives:

General Educational Objectives:

- To recognize the timeless value of the Homeric excerpt.
- To approach epic poetry as a source of interdisciplinary inspiration.
- To cultivate 21st-century skills: creativity, collaboration, critical thinking, and communication.
- To enhance problem-solving skills through experiential and creative processes.
- To function effectively in inclusive, mixed-ability groups.

Specific STEAM Objectives:

Science

- Understand principles of buoyancy and balance in floating objects.
- Investigate the relationship between density, weight, and floating.

Technology

- Become familiar with basic construction tools.
- Understand the application of technological solutions in creative projects.

Engineering

- Reinforce understanding of structural stability.
- Develop design thinking for placement and assembly of materials.

Arts

- Foster aesthetic sensitivity through decoration and symbolism.
- Encourage artistic and linguistic expression.

Mathematics

- Use geometric concepts and measurements for design and proportions.
- Calculate area, weight, and proportions of the raft.

Differentiation and Inclusion: Differentiation was implemented in content, process, and product. Students with special educational needs were supported through:

- Visual material (picture cards, role cards, images)

- Tiered activities with alternative difficulty levels

- Predefined roles based on their interests

- Adapted workspace and timing

- Co-teaching support (Panteliadou, 2008; Tzivinikou, 2015; Xanthopoulou, 2017) and emotional encouragement.

The goal was to create a safe, well-structured learning environment where all students participated equally, felt accepted, and empowered.

Implementation steps:

- Reading and analyzing Book V of the Odyssey (lines 257–289).

- Forming a group of 10 students (5 with SEN, 5 without); informing parents and coordinating with teachers.

- Preliminary study of the student profiles with SEN and planning personalized methodology.

- Experiential game 'Odysseus' Thread' to build group cohesion.

- Brainstorming and formulation of the project's central question.

- Use of flipped classroom with digital tools (Padlet, Viber).

- Raft design: sketches, materials list.

- Procurement and organization of materials with school support.

- Construction of the raft (frame, deck, mast, sail).

- Decoration with symbols of hope, return, and resilience.

- Creative writing, theatrical scenes, poems, monologues.

- Buoyancy tests in water, revisions, and feedback.

- Reflection and journaling of experiences.

- Final presentation and digital documentation of the project.

Evaluation: Evaluation was based on rubrics with qualitative and quantitative criteria:

Criteria:

- Fidelity to the Homeric description
- Structural stability and buoyancy
- Creativity in construction and language
- Team collaboration and role fulfillment
- Application of scientific principles
- Active engagement and student satisfaction

Methods of evaluation:

- Observation
- Self- and peer-assessment
- Video/photo documentation
- Reflective journaling

Results: The project yielded significant pedagogical and educational outcomes:

Educational Outcomes: - Successful construction of a functional raft model - Understanding scientific concepts through experiential learning - Enhanced creativity and emotional connection with the subject and epic - Development of critical and visual thinking

Inclusive Outcomes: - Students with SEN felt secure, accepted, and empowered. - Students without SEN cultivated empathy, adaptability, self-regulation, and teamwork. - The group as a whole operated with respect, equality, and creative synergy.

Teacher Observations: - Role-playing enhanced cohesion and interaction. - Activity variation promoted focus and active engagement. - Theatrical, artistic, and poetic expression provided psychosocial benefits.

Conclusions: The construction of Odysseus' raft showcased how ancient Greek literature can be creatively linked with principles of modern teaching and inclusion. The project served as a model of holistic and experiential education within the SPICE STEAM framework. Just as Odysseus built his raft to return to Ithaca, students built their own journey of knowledge and self-awareness. The pedagogical value lies not only in the final product but in the process: in collaboration, imagination, acceptance, and discovery. Myth meets science, theory becomes practice, and the school becomes a 'raft' of exploration, inspiration, knowledge, creativity, and equal participation.

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Mirroring Emotions: Empathy through Painting in Primary School – an Inclusive STEAM Approach

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Introduction: This presentation presents an innovative teaching plan that focuses on cultivating empathy through the use of art and specifically painting in primary school. The plan is applied to general education students with an emphasis on the inclusion of students with mild learning difficulties. The teaching proposal is part of the STEAM education framework, with the Arts operating as the main axis, strengthening both the socio-emotional skills and the creative expression of students. Through the analysis of visual works, discussion and artistic creation, students are trained in the observation, expression and understanding of the emotions of the Other, thus strengthening inclusion and emotional literacy in school. The plan utilizes differentiated teaching techniques and supportive tools for the accessibility of all students. The educational experience combines aesthetic education, empathy and active participation, promoting a holistic, human-centered learning model.

Objectives: The main objective of the project is to cultivate emotional awareness and empathy by engaging students in the observation, interpretation, and artistic reproduction of emotional states as depicted in paintings. A secondary objective is to promote inclusion and active participation of all learners in the classroom through differentiated and multimodal activities.

Methodology: The intervention was implemented over two instructional hours in a general education setting with students aged 10–12. Students examined emotionally charged artworks (e.g., The Scream by Edvard Munch, The Kiss by Gustav Klimt, and works by Mary Cassatt) and participated in group discussions using visual emotion cards and guiding questions. They then created their own emotional self-portraits using mixed media. The activities were designed based on differentiated instruction principles and included supports for students with learning difficulties (e.g., structured worksheets, peer collaboration, visual aids).

Results: Preliminary classroom feedback indicates that students were able to recognize and articulate emotions with increased confidence. Students with learning difficulties showed higher engagement levels, especially during the artistic creation phase. The group reflection circle revealed enhanced understanding of others' feelings and personal emotional experiences.

Conclusions: The integration of visual arts into emotional education within a STEAM framework can foster empathy, promote inclusion, and empower students with diverse learning needs. Art-based strategies, when designed with inclusive principles, can serve as powerful tools for emotional literacy in primary education.

Keywords: Arts, Empathy, Students with MLD

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STEAM education, environmental studies and computational thinking: Action research in primary education

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Introduction: Between October 2024 and May 2025, this action research was conducted with 17 third-grade students at the 1st Experimental Primary School of Portaria, in Greece. The study integrates STEAM (Science, Technology, Engineering, Arts, Mathematics) methodologies into the Environmental Studies curriculum (IEP, 2022). Two teaching hours per week were dedicated to this innovative action. Group-based activities designed to address diverse interests, needs and prior knowledge. Through inquiry-based learning, students engaged in creative expression, conduction of experiments, engineering constructions, and computational thinking (Wing, 2006) activities, using platforms like Scratch Jr, Scratch, EdBlocks. This approach emphasizes inclusion by offering various representations of content to ensure accessibility for all students. This study is rooted in Project-Based Learning (PBL), with a focus on socio-emotional and metacognitive development, aligned with social constructivism (Fessakis, 2019). The instructional design adhered to the principles of Universal Design for Learning (UDL), integrating differentiated strategies to promote equal access to information for all learners (McGuire et al., 2006). The project also connects with Sustainable Development Goals (SDGs), promoting global citizenship and environmental responsibility. Furthermore, an eTwinning STEAM project enhanced intercultural awareness, providing students with additional opportunities to apply the 4Cs (collaboration, creativity, critical thinking, and communication) in real-world contexts.

Objectives: This action research aims to improve student engagement, attitudes toward STEM careers, computational thinking and 21st-century skills, by integrating STEAM-based learning activities into the 3rd-grade Environmental Studies curriculum. To address the research aim, this study sets the following objectives:

1. To design and implement interdisciplinary, inclusive STEAM-based teaching materials aligned with the thematic units of the 3rd-grade Environmental Studies curriculum.
2. To enhance student engagement and collaborative problem-solving through experiential, inclusive, and differentiated learning activities.
3. To promote positive attitudes toward STEM-related fields and careers, particularly among girls.
4. To foster algorithmic thinking and digital literacy through the use of coding tools and inquiry-based tasks that support 21st-century skills.

Methodology: This study follows a cyclical action research model (Kemmis & McTaggart, 2000), consisting of planning, acting, observing, and reflecting phases. During the planning phase, STEAM challenges were developed to promote inquiry, experimentation, and creative problem-solving (Lavicza et al., 2022) and the activities were designed around environmental themes, such as ecosystems, water cycle, materials, citizenship, sound, heat, SDGs.

Universal Design for Learning (UDL) principles were applied through the use of multiple means of representation, action/expression, and engagement (Meyer et al., 2014). In addition, differentiation strategies included a focus on essential concepts, visual aids, graphic organizers, leveraging students' interests and strengths, clear instructions, varied content delivery methods, choice in the format of student products (e.g., think-tac-toe), peer teaching, and flexible time for task completion. The use of an interactive whiteboard, tablets and science kits facilitated active engagement. Data collection included questionnaires, reflective journals, semi-structured student interviews, portfolios, and feedback from parents. Informal observations and co-teacher discussions were held weekly, while a digital wall (blogspot) allowed families to monitor student progress and provide input. For data analysis, mixed-methods approach was applied. Quantitative data from pre- and post-intervention questionnaires—collected via Google Forms—were analyzed using descriptive statistics in Microsoft Excel to identify trends in student engagement and attitudes. Qualitative data from interviews, reflective journals, and observations were coded and analyzed thematically using structured frameworks developed in Google Sheets to identify recurring patterns related to collaboration, problem-solving, emotional involvement, and student perceptions of the STEAM experience. Student work and portfolios were assessed for evidence of progress in computational thinking and creativity. This triangulation of quantitative and qualitative data sources enhanced the study's validity.

Results: The study's results reveal significant improvements in:

- *Student Engagement*: Before the study 82% of the students didn't like the traditional instruction in environmental studies. By the end, 18% enjoyed the STEAM activities "very much," and 76% enjoyed them "extremely." Students' participation in group discussions and tasks increased. Teachers' reflective journals confirmed that students became more active in STEAM challenges.

- *Inclusive Learning*: The study ensured all students, including those with mild disabilities, could engage with the activities. Differentiation strategies like visual aids, simplified instructions, and multiple response formats ensured meaningful participation for all students. Teachers' reflective journals confirmed that students with mild disabilities became more active and interested in STEAM activities, especially in coding tasks and art projects.

- *Collaborative Learning*: Through group work, students developed greater collaboration, communication, and creativity. The eTwinning project further promoted these skills and enhanced intercultural awareness.

- *Attitudes Toward STEM careers*: Pre-study surveys indicated that only 20% of girls expressed interest in science careers, but by the end, 71% showed increased interest in STEM fields. They reported that the hands-on nature of the activities increased their curiosity about careers in STEM.

- *Computational Thinking and Problem-Solving*: Portfolios and student work samples demonstrated that students grasped basic computational concepts such as sequencing, loops, and conditionals. In group tasks also, students used problem-solving skills to overcome challenges, reinforcing their computational thinking.

Conclusions: This research demonstrates the significant impact of integrating STEAM education and computational thinking into the Environmental Studies curriculum for 3rd-grade students. The project-based, differentiated approach increased student engagement and 4Cs skills. Also, girls showed greater interest in STEM careers. Computational thinking tools like Scratch Jr/EdBlocks supported the development of problem-solving skills.

The study highlights the need for more inclusive STEAM resources and curriculum integration at the primary education level. Despite challenges such as time and resource constraints, the positive feedback from students, parents, and colleagues advocates for the expansion of STEAM in early education. As such, this study calls for continued efforts to advocate for the integration of inclusive STEAM education into national curricula, fostering the development of critical skills, which are necessary in an increasingly technology-driven world.

Keywords: STEAM, computational thinking, primary education, environmental studies, student engagement

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Creative contribution of the 'A' in the SPICE STEAM Project “Odysseus’ Raft”

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Introduction: Inclusive pedagogy in the modern school must transcend its theoretical dimension and be transformed into educational experiences that offer voice and role to every student. Within this framework, art (Arts), as an integral component of the SPICE STEAM model, contributes to cultivating the creative, expressive, and emotional dimensions of learning (Ewing, 2020). The project “Odysseus’ Raft,” implemented in a mainstream Junior High School in Patras (Greece) with a mixed group of ten first-grade students (five with and five without special educational needs), constitutes an innovative application of inclusive education. Interweaving epic poetry, creative expression, and aesthetic education as aspects of the 'A' component (Arts), along with the other STEAM disciplines, the project promotes a holistic approach to knowledge, grounded in the 21st-century 4Cs skills: critical thinking, communication, collaboration, and creativity (Partnership for 21st Century Learning, 2015; Chatzidimou, 2018). This interdisciplinary approach fosters empathy, group identity, and aesthetic expression, while offering new meanings to Homer’s Odyssey (Book V, lines 257–2894) through an experiential, playful, and collaborative process. This article presents three philological activities designed and implemented by a philologist in special and inclusive education, showcasing the contribution of the 'A' component: an experiential role-playing activity titled “Odysseus’ Thread,” a symbolic artistic representation of the raft’s sail, and a final activity in creative writing and theatrical expression. Each activity promotes aesthetic experience, critical thinking, expression, collaboration, creativity, and problem-solving, following a multimodal and philological approach aligned with the philosophy of SPICE STEAM.

Activity 1: Odysseus’ Thread – The Raft That Unites

Objectives: This is an experiential role-playing activity – involving both verbal and non-verbal communication – adapted to the inclusive group of first-grade junior high school students. Its purpose was to strengthen the group and enhance communication, interaction, and a sense of belonging (Booth, 2021; Rudduck & Flutter, 2004), through a symbolic and playful framework inspired by the Odyssey. The objectives included cultivating a positive climate and collaborative spirit, enabling personal expression based on students’ abilities and interests, observation, self-awareness, emotional engagement in the project, and reflection.

Methodology: Students sat in a circle with the teacher, passing a blue ball of yarn while stating their name and choosing a role they would assume as a member of Odysseus’ raft, using 12 illustrated role cards created by the teacher via the DALL·E AI tool. A symbolic ‘net’ was created to visualize the group’s interconnection. The activity concluded with a brief reflective dialogue.

Information Gathering – Evaluation: The role cards were designed to reflect various forms of contribution to the group and to spark students’ imagination and willingness to engage. They served

as tools for self-identification, free from evaluative pressure, allowing students to express preferences and personal strengths. The responses were used to organize groups and assign roles. During final reflection, students reassessed their initial roles through self- and peer-evaluation, determining how well each role matched them and what they discovered about themselves.

Results – Observations: All students participated actively and spontaneously. Even those with learning difficulties or low self-esteem embraced roles with enthusiasm and satisfaction. The visual representation of interconnection through the yarn served as a powerful emotional anchor throughout the project. During the final reflection, most students (8 out of 10) – equally divided between those with and without SEN – confirmed the suitability of their chosen roles. All students (10 out of 10) stated that they could relate to other roles as well, demonstrating self-awareness and adaptability.

Conclusions – Educational Value: The activity proved to be an especially effective tool for fostering inclusion, revealing the power of aesthetic symbolism and literary metaphor in developing group identity and a positive learning climate (Chatzidimou, 2018; Koutselini, 2022; UNESCO, 2023).

Activity 2: The Raft's Sail – Symbolic Artistic Depiction

Objectives: The aim of this activity was to encourage students to express abstract and symbolic ideas through art, develop collaborative and argumentative skills, enhance digital and visual literacy, and create a shared artistic symbol for the group (Craft, 2013; Ewing, 2020).

Methodology: The students worked in plenary, brainstorming symbols for Odysseus' raft sail. An argumentative discussion followed, culminating in a vote where the symbol of the sun was selected. The symbol was created digitally using the DALL·E AI platform and printed to be placed on the raft model’s sail.

Evaluation – Outcome: Evaluation was qualitative, based on observations of student participation, argumentative discourse, and decision-making processes. Particular emphasis was placed on including a student with special educational needs, whose proposal was selected and realized by the group.

Conclusions – Educational Value: Aesthetic involvement strengthened students' personal sense of meaning and group identity. The 'A' component functioned as a medium of symbolic thinking, digital creativity, and collective empowerment (Domingo & Garganté, 2016; Mishra & Henriksen, 2020).

Activity 3: The Art of Reflection – Closure with Creative Expression

Objectives: This activity aimed to help students document their learning experience through creative writing, develop skills in theatrical and poetic expression, enhance reflection and emotional connection to the project, and express their voice with freedom and aesthetic completeness (Ewing, 2020).

Methodology: Students worked in mixed pairs, writing poems and monologues inspired by their participation in 'Odysseus’ Raft', using keywords and brainstorming techniques. These monologues were then dramatized, with students giving voice to Odysseus and his Raft.

Evaluation: Evaluation was based on the authenticity of student participation and the quality of their creative expression. The poems were integrated into the raft using fabric strips or wooden plaques, and the monologues were presented during the final showcase of the project.

Conclusions – Educational Value: This activity showcased the power of the 'A' (Arts) component as a mirror of internal meaning-making. The integration of art, language, and emotion contributed to a deeply inclusive and aesthetically enriched learning environment.

Art as a Catalyst for Inclusion and Learning: The implementation of the project highlighted the value of aesthetic experience and active participation as foundations of a pedagogical practice that fosters inclusion and the acceptance of diversity. In this context, the 'A' component (Arts) was not only a tool for creative expression but also a core driver of identity formation and active engagement in the learning environment, enriching the educational content. This experience underscores the need for inclusive and multimodal approaches, inspired by differentiated pedagogy (Panteliadou, 2022; IEP, 2022, 2024), creative learning (Kapsalis, 2013), and the arts as a vehicle for cultivating cultural awareness (Kassotakis, 2019). The project embraces a contemporary educational perspective that transcends the traditional curriculum, advocating for a school culture of inclusion and experiential, culturally enriched learning, aligned with the interdisciplinary principles of SPICE STEAM education.

Keywords: inclusion, Odyssey, arts, experiential playful learning, AI, SPICE STEAM

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Mathematics and Art in STEAM education

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Introduction: Being a mathematician with 36 years of teaching experience I have realised that mathematics can be taught and learnt in different ways and contexts than those traditionally followed or technologically introduced. Namely, Theatre and Drama in Education activities, innovative experiential learning methods such as embodiment, the use of appropriate literature and hands-on low-cost easy-to-find materials facilitate children to become aware of their inner world and make meaningful connections with the curriculum. All these methods can enhance teaching and learning mathematics by providing teachers and students with a context where they could engage in meaningful activities based on the significance and beauty of Mathematics in a fruitful multidisciplinary collaboration.

Objectives: Still standing critical towards the true intentions behind the inclusion of the Arts in STEM education I will present evidence that support the efficacy of using artistic interactive methods in teaching and learning Mathematics in a multidisciplinary approach in formal and informal education contexts. In the presentation original activities will be presented; these were applied during a whole decade of teaching in the primary and secondary education levels, in class or in extracurricular activities in which people with disabilities fully participated. These designed activities were based either on mathematical notions and identities or on appropriate literature books; they led to various outcomes – from joyful meaningful lessons in the classroom to theatrical plays targeting a wider audience.

Methodology: In our approach we used Drama in Education experiential method, invented by the pioneer drama practitioner Dorothy Heathcote, introduced to teach the curriculum in UK primary education schools in the 1960's. The method is totally experiential. It uses theatrical techniques and has an educational target; it offers a helpful structure but at the same time provides flexibility. It was initially based on the theories of 'Zone of Proximal Development' by Lev Vygotsky and 'Scaffolding' by Jerome Bruner; largely evolved since then it is nowadays widely applied in many professional sectors for skills development. Drama means 'action in a certain context here and now'. It addresses participants as whole personalities with mind, heart, and body. In a drama workshop individual and group activities take place; through improvisation participants express the point of view of the roles they take on while interacting with the rest of the group and the changing environment conditions. The workshop is usually based on a fictional or real story. On their way to reach their goals the hero or heroes face obstacles such as problems or dilemmas; they need to make informed decisions, take action, act, react, and interact with their environment. Learning takes place through embodiment, teamwork, experimentation, reflection, social interaction, peer collaboration, by asking the right questions, making connections, creating own examples and genuine implementations, and investigating alternatives in an inclusive emotionally safe environment which is guaranteed by the fundamental principles of the method.

Results: During the last decade scientific evidence has accumulated supporting the cognitive, emotional, social, and other key skills development of students participating in drama workshops. In addition, a recently published mixed-methods PhD research about the Drama in Education impact on teenagers' career self-efficacy and career decision-making skills development proved that the experimental group teenagers who used drama in their scenarios significantly developed important career skills such as self-appraisal, critical thinking, decision making, goal setting, career scheduling, and problem solving. These results allow strong optimism for introducing drama in STEAM education.

Conclusions: In Drama in Education workshops social issues are being tackled together with scientific questions. All sciences can be involved in a drama scenario depending on the goals of the workshop – and this will be obvious in the examples to be presented. Various drama techniques such as 'Mantle of the Expert' can facilitate a multidisciplinary approach enhancing students' engagement and active involvement, allowing time for experimentation at each one's own pace, self-expression, initiative taking, growth of creativity and imagination, battling fear for making mistakes or choosing a different alternative or innovative path. STEAM education can find in Theatre/Drama in Education a useful context to question one's assumptions, set conditions, and prerequisites; through trial and error, embodiment, improvisation, peer collaboration and peer evaluation, it can lead to student growth, teacher professional development and meaning making through reflection within a safe and inclusive environment.

Keywords: mathematics, Drama in Education experiential method, inclusive educational environment, multidisciplinary approach

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Session: Presentations by educators - IV

Integrating Entrepreneurship into Inclusive STEAM Education for Workforce Readiness Among Students in Public Universities in Anambra State, Nigeria

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Introduction: In the ever-evolving global economy, the intersection of STEAM (Science, Technology, Engineering, Arts, and Mathematics) education and entrepreneurship presents a powerful approach to equip graduates with practical, future-relevant skills (Beers, 2011). STEAM-based instruction fosters critical thinking, creativity, innovation, and collaboration, competencies vital for entrepreneurial success and workforce adaptability. However, in many parts of the world, and particularly in public universities in Anambra State, Nigeria, challenges persist in achieving inclusive access to STEAM education and effectively integrating entrepreneurial training within existing curricula.

The concept of inclusion in education is rooted in equity, emphasizing not only physical access but also full participation, engagement, and academic achievement for all learners, including those with mild learning disabilities (UNESCO, 2009). Despite Nigeria's policies promoting entrepreneurship education and inclusive practices, implementation gaps remain evident in tertiary institutions. Students with diverse learning needs often face barriers in traditional lecture-driven classrooms, especially in STEAM fields perceived to be rigid or highly technical. At the same time, the demand for graduates who are not only academically sound but also job creators and innovators continue to rise (World Economic Forum, 2020).

This paper proposes the Inclusive "STEAMpreneurship" Framework (ISF), a contextualized model that blends entrepreneurship education with inclusive STEAM learning in a manner responsive to students' diverse needs. The framework envisions an educational ecosystem that cultivates creativity, technical acumen, and business sense, enabling students to transition confidently into the workforce or entrepreneurial ventures.

Objectives: The main objectives of this study are to:

1. Examine the extent to which entrepreneurship is embedded in current STEAM-related curricula in public universities in Anambra State.

2. Propose a framework for integrating inclusive, entrepreneurship-based learning in STEAM education.

Methodology: The study adopts a qualitative case study approach. Two public universities - Nnamdi Azikiwe University and Chukwuemeka Odumegwu Ojukwu University were selected due to their diverse student populations and commitment to entrepreneurship education. Data were collected through a semi-structured interviews with 21 students, including 6 with documented mild learning disabilities. Thematic analysis was used to extract patterns related to inclusion, entrepreneurship, and

pedagogical strategies within the STEAM landscape.

Results (Anticipated): Preliminary findings indicate limited synergy between STEAM and entrepreneurship curricula. While entrepreneurship courses are offered, they are often stand-alone and disconnected from STEAM-specific learning outcomes. Moreover, inclusive pedagogical strategies such as differentiated instruction, assistive technologies, and alternative assessments are inconsistently applied or lacking. Students with learning difficulties reported that group projects in STEAM subjects often sidelined them, and few opportunities existed for them to contribute creatively or practically.

In a recent project, students from various departments including a visually impaired computer science major and a student with mild dyslexia, collaborated to design a low-cost water filtration system for rural communities. With support from a faculty mentor, the team integrated both scientific knowledge and entrepreneurial planning, developing a pitch for a local grant. Their participation was enabled by digital tools such as text-to-speech software and visual collaboration platforms like Miro. The experience highlighted how structured collaboration, accessible tools, and real-world challenges can help bridge inclusion and innovation.

Despite these gaps, there is strong institutional interest in entrepreneurship and growing recognition of its relevance for all students. Informal innovation hubs, student-led startups, and community-based projects are emerging across campuses, providing fertile ground for structured integration.

The Inclusive “STEAMpreneurship” Framework (ISF) model proposed by this paper aims to:

i. Foster interdisciplinary project-based learning

ii. Promote peer mentorship and inclusive collaboration

iii. Leverage adaptive technologies

iv. Adopt flexible assessment practices

Conclusions: The integration of entrepreneurship into inclusive STEAM education presents an opportunity for public universities in Anambra State, Nigeria. It not only addresses systemic gaps in access and engagement for students with disabilities but also prepares all learners for a volatile job market. The proposed ISF model holds promise in aligning curriculum design with workforce realities while upholding educational equity. However, for this vision to materialize, universities must commit to institutionalizing inclusive teaching practices through policy and training, revising curricula to reflect interdisciplinary and entrepreneurial competencies, providing resources for adaptive learning environments and strengthening partnerships with the private sector, NGOs, and community stakeholders.

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Breaking Barriers with Code: Robotics and Coding for Inclusive STE(A)M Education

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The integration of robotics and coding into inclusive classrooms has gained momentum as a pedagogical strategy that fosters equity, engagement, and learner empowerment, particularly for students with special educational needs. Among these, learners with Down Syndrome often encounter challenges in cognitive processing, fine motor coordination, and social communication. Purposefully designed STE(A)M-based interventions can offer these learners meaningful opportunities for active participation, differentiated instruction, and skill development.

In alignment with the STEM Discovery Campaign 2025 and under the framework of the Scientix Inclusive Creators Award, the initiative “Kodlarla Engel Tanımıyoruz!” (Breaking Barriers with Code) was developed to coincide with World Down Syndrome Day (March 21). The project was implemented at İldem Borsa İstanbul Middle School’s Special Education Classroom in Türkiye with the primary aim of supporting inclusive learner agency through the use of robotics kits and visual programming tools such as Scratch and Open Roberta.

The instructional design of the initiative was grounded in inclusive education principles (Florian & Black-Hawkins, 2011) and informed by the constructivist approach, emphasizing inquiry-based learning, peer collaboration, and hands-on exploration. By incorporating block-based coding and tangible robotics, the program provided a multisensory learning environment that aligned with the diverse learning profiles of neurodiverse students. This environment encouraged students to engage in meaningful problem-solving, supported fine motor development, and fostered emotional expression and self-confidence.

The implementation involved a scaffolded sequence of sessions, beginning with baseline assessments and progressing toward increasing learner autonomy. Students participated in activities that integrated physical construction, digital programming, and collaborative tasks, all within a nurturing and responsive learning environment. Teachers recorded observations through qualitative field notes, while caregivers provided additional insights through informal feedback mechanisms.

Key outcomes of the initiative included:

• Enhanced attention span and task persistence during structured activities

• Improved fine motor skills through assembling and programming robotic components

• Strengthened communication and teamwork, including peer-assisted learning moments

• Evident gains in self-expression, with students displaying pride, curiosity, and joy during project tasks

These findings align with international research suggesting that educational robotics fosters executive

functioning, creativity, and emotional well-being among learners (Bers, 2020; Alimisis, 2013; Hourcade et al., 2017).

Ultimately, “Kodlarla Engel Tanımıyoruz!” demonstrates how pedagogically sound and learner-centered STE(A)M education can transcend barriers and contribute to inclusive school cultures. The initiative presents a replicable and scalable model for educators aiming to cultivate socially just, adaptive, and future-ready learning environments. By integrating computational thinking with social-emotional learning, the project advances a compelling vision of inclusion—where every learner is supported not only to participate, but to thrive.

Keywords: Inclusive Education, Robotics, Coding, Down Syndrome, STE(A)M

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Smart Classrooms, Smarter Inclusion: STEAM for Equitable Education

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Introduction: The quantum leap from STEM to STEAM was initiated by the innate urge of STEM to incorporate Arts into its multiverse. While digging the grave, it was observed that the lacuna was nothing else, but the sense of abstraction in the psyche of the people. Inclusiveness, being ambiguous in its structure, canonically, did not just limit itself to the socio-economic strata, rather it carved its way through the entire universe of Education. STEAM, stands on five pillars, namely, Science, Technology, Engineering, Arts and Mathematics, which changed its course from STEM after it incorporated "Arts" as another pillar into the mainstream. Arts as a discipline was deprived of its share, in the previous STEM-based curricula as it focused more on the skillsets prescribed by various market forces to compete globally. While transitioning into the advanced curricula, it was identified that the role of arts and humanities plays a pivotal role in almost all the domains of the world and especially in the field of Education. The 'A' in STEAM has incorporated rituals such as modeling, developing reasons with argumentative logic and critical evaluation are undermined while teaching Mathematics and Science. The integration of "Arts" is all about applying creativity and abstractness in real-time problems However, due to the changing dynamics of the world and Education, STEAM educationalists are trying to integrate technologies such as Augmented Reality (AR), Mixed Reality (MR), Virtual Reality (VR) by merging the digital reality with the real-world knowledge. A dedicated field of science is aiming to inculcate the computational literacy in learners' cognitive domain known as Educational Robotics. Researchers are trying to develop a novel learning strategy which may incorporate learners from different fields, to collaborate in a project, to solve a problem with dedicated mathematical algorithm. Therefore, it is necessary to provide a dedicated methodology which can motivate the learners through practical applications of the computational methods. It will not only introduce the learners to algorithms and codes, helping them in enriching their computational as well as mathematical intellect, but also help them in developing themselves in the field of robotics for knowledge acquisition and skills relevant to learn STEAM disciplines. Several research studies have proposed the importance of robots in formal and informal educational ecosystem of STEAM. Algorithm Coding and Robotics are emerging as the most efficient technology when it is integrated with any form of arts. The results observed were remarkable when the collaboration between STEM subjects and the arts was successful not theoretically rather practically.

Research Questions:

1. What are the key elements of a STEAM-based pedagogical framework that facilitate inclusive education in technologically advanced learning environments?

2. How much do STEAM-based pedagogical the paths augment smart classroom accessibility, engagement, and engagement for diverse learners in smart classrooms?

Objective: The study aims to develop a conceptual construct of pedagogical pathways based on STEAM and to examine its viability for inclusion.

Methodology: In this paper, we have developed a third eye vision through review analysis of the existing literature was performed to make STEAM, a platform of education aiming to stimulate an eternal love for the field of Arts and Science amongst learners since their infancy. All the pillars of STEAM have some collinearity in their structure of learning as all of them incorporate innovation and none of them use a particular method for analysis and research. Therefore, Opposing the conventional methods of knowledge dissemination, educationalists are trying to establish equilibrium by making all the pillars of STEAM resonate with same frequency. A thematic review analysis was conducted to synthesize findings from various studies related to education, inclusive pedagogy, and STEM in technology-enhanced environments. The goal of this review was to identify patterns, gaps, and key elements of STEM pedagogy that facilitate effective inclusion. The thematic analysis adhered to specific steps to establish inclusion and exclusion criteria for the literature: only studies published between 2015 and 2025 were considered, and only those available in Scopus literature, incorporating keywords such as STEM, Smart Class, Inclusion, and Assistive Technology, were included.

Consequently, a conceptual framework of STEM-oriented inclusive pedagogy for smart classrooms has been developed based on the data that was extracted and analysed to determine recurrent educational elements and outcomes. This framework was based on the findings of the data analysis procedure. The stem-based Pedagogical pathways (For Smart class and Smart Inclusion) consisted with the core elements including; Interdisciplinary Integration, Universal Design for Learning (UDL), Experiential learning, Project based learning, Collaborative and peer-assisted learning, Creative and critical thinking Focus, Culturally and Linguistically Responsive Teaching, Technology-Enabled Personalization (Use of Assistive technology) that enable technologically enriched educational environments that foster inclusive education.

Conclusion: As a result, fostering and teaching the necessary and important abilities ensures that students develop an innovative attitude from an early age, making them a valuable asset to the country and to themselves. STEAM fosters a friendly and inclusive educational atmosphere that enables diverse student participation, prompting educators to use heuristic teaching approaches that correspond with its foundational pillars.

The results of the literature review demonstrated that varied student motivation and engagement are enhanced via the use of access and equity strategies in STEAM education. Technologies that enhance learning for all students (augmented reality, artificial intelligence, simulations, gamification), models for collaborative or multidisciplinary planning framework, Co-teaching and ongoing professional development for educators in inclusive ed-tech can be a couple possible best practice for smart classrooms. From review analysis, it was found that there are some gapes in Inclusive STEM paradigms that fail to adequately incorporate arts and culture and showed inadequate representation of neurodiverse students in STEM fields.

Keywords: STEAM, Inclusion, Technology, Education

Through Technology Towards Equal Opportunities in History Education

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The integration of digital tools, such as virtual reality (VR), into education enables inclusive approaches to learning, especially when working with students of diverse abilities. Although commonly associated with STEM, VR is increasingly enriching the humanities, such as history, contributing to the development of STE(A)M education.

This abstract presents a history lesson in which students explored the life of Anne Frank using VR technology. The activity was carefully designed to include all students, including those who attend regular classes but follow what in the Croatian education system are known as individualized or adapted educational programs— educational approaches for students with developmental difficulties. The individualized program modifies teaching and assessment methods without altering core content, while the adapted program also simplifies the curriculum according to the student's abilities.

The International Holocaust Remembrance Alliance (IHRA) recommends introducing Holocaust education to students through personal stories. Such narratives help students understand that the victims were not merely statistics, but real individuals with names, families, and lives before the war.

The lesson aimed to approach the topic in a 21st century way—using digital tools. Through VR, students “visited” the Secret Annex in Amsterdam, which is otherwise inaccessible. One of the key objectives was to develop 21st century competencies such as communication, collaboration, creativity, and critical thinking, along with the inclusion of all students through technology adapted to their individual needs. Students with lower digital literacy received technical assistance. Those in adapted or individualized programs were given simplified tasks while gifted students accessed additional content.

After the experience, students completed a survey and wrote a reflective essay on whether VR is appropriate for teaching tragic historical events. Survey results showed a high level of student engagement and a positive perception of VR technology: 85% of students reported a better understanding of the historical context, 78% felt more motivated to explore the topic, and 90% believed the experience would stay with them longer than content delivered through traditional classroom teaching. In their essays, students emphasized the importance of honoring Holocaust victims while recognizing VR as a valuable educational tool, demonstrating critical thinking.

Although VR provides immersive and experiential learning, placing students in "realistic" situations, such methods are generally not recommended for sensitive topics like the Holocaust. For this reason, the classroom discussion was carefully moderated, avoiding any questions that might lead students to imagine themselves personally experiencing trauma, thereby maintaining an ethically respectful approach.

Students from all learning profiles participated equally, confirming that this approach allows every student to engage meaningfully with complex and emotionally demanding content.

Integrating VR into history education not only modernizes teaching methods but also creates opportunities for inclusive learning, helping bridge gaps between students of different learning profiles.

By integrating history and technology, this lesson represents a strong example of effective STE(A)M practice where “A” stands for All, reflecting the inclusion of every student and subject within STEM-based education.

Keywords: digital technology, inclusion, Holocaust, virtual reality

The Power of Inclusive STEAM Education in Nigerian Tertiary Education

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Problem and Context: Inclusion of Science, Technology, Engineering, Arts and Maths (STEAM) education has now become revolutionary in educational systems worldwide. STEAM education in Nigerian universities and colleges is predominantly exclusionary for mildly disabled persons who have significant impediments to their full inclusion. Not only does their exclusion curtail their academic job prospects but it also denies Nigeria's labour market access to a pool of talents and ideas that are vital to innovation and development.

Key Outcomes Summary: A two-year intervention across six Nigerian institutions demonstrated substantial gains with 43% improved student STEAM course enrolment with mild disabilities, 37% reduced course withdrawal rates and an average 0.87-point gain in academic performance. Faculty belief in their ability to implement inclusive instructional practices was notably increased ($p<0.001$), with 83% reporting "moderate" to "high" ability compared to 24% at baseline.

Study Design and Methods: This study examines the revolutionary potential of inclusive STEAM education in Nigeria's universities and colleges, reporting findings from a large-scale two-year intervention program implemented in six institutions. A mixed-methods design was implemented that involved quantitative and qualitative collection of data from six participating institutions that represent Nigeria's geopolitical zones. Data collection was carried out in three phases over 24 months with baseline data collected from institutional accessibility audit; 187 questionnaire surveys of faculty members; interview of 43 disability support service staff; focus group discussion with 76 students with mild disabilities.

Results: Baseline survey revealed significant gaps in inclusive practices among STEAM subjects with maths and engineering departments showing lowest levels of accessibility (mean score 2.3/10 and 2.8/10 respectively). Surveys of staff revealed poor knowledge of inclusive teaching strategies (76% gave "no" or "minimal" knowledge), but institutional audit revealed significant physical and technological exclusion. Student interviews revealed exclusionary experiences, in particular from laboratory-based modules, with little if any provision of different modes of access.

Post-intervention institutional accessibility scores by all disciplines were bettered, with greatest gains made in engineering (2.3 to 6.8/10), then by computer science (3.1 to 7.2/10). Student self-efficacy scales were boosted appreciably ($p<0.01$), especially for lab and field-based courses with systematic accommodations. Qualitative findings identified four determinants of outstanding success in inclusive STEAM education promotion: (1) leadership buy-in for policy development and resource commitment; (2) empowering faculty through ongoing professional development and communities of practice; (3) contextualizing integration of technology to local contexts and available resources; and (4) intersectoral collaboration between disability services, academic staff, and industry partners.

Implications and Recommendations: This research demonstrates that inclusive STEAM education is possible and justifiable in Nigerian tertiary education if carried out by context-aware, multi-facetted intervention. The findings counter prevalent deficit discourses on dis/ability in Nigerian tertiary education by showcasing academic potential in applicants with minor disabilities if reserved support is given. Key recommendations are: to establish institutional policy that focuses specifically on STEAM access; to restructure faculty reward systems such that inclusive excellence in instructional practices is rewarded; to prepare resource-informed lab adaptation strategies; and to embed student voice mechanisms in institutional decision-making for accessibility.

Keywords: Disability, STEAM education, inclusive education, Nigerian higher education, educational equity

Exploring the impact of absentism rate on academic performance in inclusive STEM classrooms: causes, consequences and implications for global education

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Introduction: Students' attendance at school and their classes plays a decisive role in achieving the desired result from education and training activities. For policies and reforms in education to succeed, students must attend school first. Among the main areas of work for education managers is determining and eliminating the factors that lead to absenteeism and their effects on educational environments. Student absenteeism defined as the persistent, habitual, or unexcused absence from school by learners of compulsory age (Magwa & Ngara, 2016) represents a critical challenge to educational systems worldwide. In inclusive classrooms, where students with diverse cognitive, physical, and socio-emotional needs learn alongside their peers, the consequences of absenteeism are particularly pronounced. Absenteeism can be either “excused absenteeism” or “unexcused absenteeism.” (MoNE, 2015)

For STEAM education, which is inherently participatory and inquiry-driven, consistent attendance is indispensable for effective learning, especially in subjects such as English Language and Mathematics that underpin 21st-century skills development. The term “STEAM” and its variations have been widely used across educational settings (Aldemir, Kermani 2017, Kumtepe, Genc-Kumtepe 2015). In the classroom, STEAM activities incorporate science, technology, engineering, and math concepts. STEAM has demonstrated effectiveness in promoting engagement, persistence, problem-solving skills, and active learning through exploration, observation, and discovery. STEAM also promotes development in areas of language acquisition, comprehension, and communication skills (Miller, 2016). Additionally, research supports the idea that engagement in the arts enhances children’s learning skills, including creative and strategic thinking skills, and allows children to explore patterns, use measurement tools, and perform calculations (Butera et al, 2016). Therefore, art has since been incorporated into traditional STEAM pedagogy, and the acronym STEM has evolved into STEAM. Considering the benefits of STEAM, it is important that educators embed this pedagogy across early childhood settings by designing the environment, intentionally planning learning experiences, and providing necessary materials for STEAM activities.

In Nigeria and many developing countries, socioeconomic disparities exacerbate the issue of absenteeism. Learners from disadvantaged backgrounds are often unable to access school regularly due to health concerns, financial barriers, or adverse learning environments. In inclusive settings, these challenges are compounded for students with disabilities, who may face additional structural and attitudinal obstacles.

This study focuses on secondary school learners in Awka South, Anambra State, Nigeria a region characterized by a mix of urban and semi-urban schools, with diverse student populations. It

investigates the multifaceted causes of absenteeism and their direct and indirect impacts on academic performance in inclusive STEAM classrooms. Notably, it emphasizes the perspectives of learners themselves, using empirical data to inform policy recommendations.

Recent global research highlights the link between absenteeism and declining educational outcomes, particularly in STEAM disciplines where cumulative learning is critical (UNESCO, 2023). By bridging local data with global educational concerns, this study contributes to a broader understanding of equity and access in STEAM education.

Specific objectives: The study is guided by the following specific objectives:

i. To examine the perceived causes of absenteeism among secondary school learners in inclusive STEAM classrooms.

ii. To determine the relationship between absenteeism rates and academic performance, particularly in English Language and Mathematics.

iii. To identify the academic consequences of absenteeism for learners with varying educational needs, including those with disabilities, in STEAM subjects.

Methodology: A mixed-methods research design was adopted to capture the complexity of absenteeism and its implications. The quantitative component involved the administration of structured questionnaires to secondary school students across schools in Awka South Local Government Area. The instrument assessed both the perceived causes of absenteeism and its perceived effects on academic performance.

Descriptive statistics were used to determine the most common causes of absenteeism, while inferential statistics including Pearson correlation and multiple regression analyses were employed to explore relationships between absenteeism and academic performance in core STEAM subjects.

The target population comprised students enrolled in inclusive secondary classrooms, ensuring representation of both students with and without disabilities. Ethical considerations, including informed consent and data confidentiality, were rigorously observed throughout the study.

Results: The analysis revealed that health and financial constraints are the most significant factors influencing absenteeism. Specifically, responses showed high mean scores for "Sickness prevents students from going to school" (mean = 2.94) and "Lack of money for educational needs" (mean = 2.92), indicating that these were widely recognized as primary causes of school non-attendance.

Correlation analysis revealed a statistically significant negative relationship between lack of financial resources and academic performance ($r = -0.35$, $p < 0.01$). This suggests that as financial barriers increase, student achievement in STEAM subjects declines. Similarly, regression analysis showed that both "Lack of money" and "Harshness of teachers" were significant predictors of academic underperformance ($R^2 = 0.15$, $p < 0.01$), underlining the influence of the school environment on student's learning outcomes.

The perceived consequences of absenteeism were striking: respondents strongly agreed that

absenteeism results in lower grades in assignments, tests, and exams (mean = 3.47), indicating widespread recognition of its detrimental impact.

These findings align with global literature on absenteeism, which identifies a consistent link between attendance and academic performance, especially in resource-constrained and inclusive educational settings (Sekiwu et al., 2020).

Conclusion and Implications: This study highlights the significant and multifaceted impact of absenteeism on student academic performance in inclusive STEAM classrooms. Socioeconomic challenges—particularly financial hardship—and negative school climate factors, such as teacher harshness, contribute substantially to student absenteeism. The compounded effect of these issues is particularly severe for learners with disabilities, who already navigate multiple layers of educational disadvantage.

Addressing these issues requires multi-tiered, evidence-based interventions, including:

i. Provision of financial support and educational materials for underprivileged students.

ii. Training for teachers to foster inclusive and empathetic classroom environments.

iii. Health programs to minimize absenteeism due to illness.

iv. Inclusive policy frameworks that ensure learners with disabilities are not disproportionately affected.

These recommendations have global implications for STEAM education, especially in similar socio-economic contexts. Reducing absenteeism is not merely a matter of increasing attendance rates—it is a vital strategy for achieving equity, inclusion, and excellence in education.

An Assessment of the Relationship Between Teachers' Retraining Strategies and Job Effectiveness in Special Needs Schools in Cross River State, Nigeria

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Over the years, the integration of Science, Technology, Engineering, Arts, and Mathematics (STEAM) education in developing countries such as Nigeria has emerged as a viable strategy for promoting inclusive, equitable, and quality education, as well as lifelong learning opportunities for all. This approach aligns with the objectives of Sustainable Development Goal 4 (SDG 4), which seeks to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all," thereby contributing significantly to the realization of the broader 2030 Sustainable Development Agenda.

STEAM education—an interdisciplinary framework that incorporates Science, Technology, Engineering, Arts, and Mathematics—can be effectively implemented across all educational levels, from early childhood to tertiary institutions, provided that supportive and conducive learning environments are established. The integration of the Arts into the traditional STEM paradigm enriches the educational experience by fostering creativity, enhancing innovation, and promoting critical thinking and problem-solving skills through the application of appropriate instructional methodologies and tools.

Recent initiatives in Nigeria underscore the relevance of STEAM in advancing the goals of SDG 4. For instance, the Universal Basic Education Commission (UBEC) has developed curricular modules that integrate STEAM components into basic education, emphasizing the development of technical skills, creativity, and entrepreneurial competencies from an early age. These efforts aim to prepare Nigerian learners to thrive in a dynamic and competitive global environment by equipping them with the requisite skills to address complex real-world challenges. Globally, STEM education has been recognized as a vital reform strategy aimed at preparing students for participation in the 21st-century knowledge economy.

The successful attainment of sustainable development goals hinges not only on access to quality education but also on the effectiveness and performance of teachers. Teachers play a pivotal role in shaping the educational experience of all learners, including those with special needs. Their influence is particularly significant for students with diverse abilities, interests, and learning needs. These students enrich the educational landscape with their unique perspectives and contributions, reinforcing the principles of inclusive education—a pedagogical approach that fosters empathy, mutual respect, and appreciation for individual differences among all learners.

Ensuring quality education for special needs students requires that teachers possess mastery of the

curriculum and the capacity to manage classrooms that address diverse learning profiles. However, meeting these expectations often presents considerable challenges. Observational evidence indicates that several teachers in special education schools across the study area frequently arrive late to work or are absent from teaching duties altogether. In addition to staffing challenges, there is a critical need to enhance the quality of Science, Technology, and Mathematics (STM) education, particularly within the affective domain, which encompasses students' interests, motivation, and self-efficacy. Field observations suggest that students in these schools often demonstrate low engagement and limited confidence in science-related subjects, pointing to a broader systemic issue that requires targeted intervention.

Given these challenges, it is imperative that teachers are continuously retrained and updated with relevant knowledge, skills, methodologies, and resources. In response to this need, the present study assessed the relationship between teachers' retraining strategies and job effectiveness in special needs schools in Cross River State, Nigeria. Specifically, it examined how retraining strategies—such as seminars and mentorship programs—enhance the delivery of quality education to learners with special needs.

To guide the investigation, two research questions were posed, and two null hypotheses were formulated. The study adopted a correlational research design and involved 191 teachers from 27 special education centers across Cross River State's 18 Local Government Areas. A purposive sampling technique was used to select the schools, while a census method included all teachers from the identified schools in the study. Data were collected using an 18-item instrument titled the Retraining Strategies and Teachers' Job Effectiveness Questionnaire (RSTJEQ). This questionnaire was subjected to face and content validation by three experts from the Department of Educational Management and the Measurement and Evaluation Unit at the Faculty of Educational Foundation Studies, University of Calabar. The reliability of the instrument was confirmed using Cronbach's alpha, yielding coefficients ranging from .82 to .85.

Descriptive statistics using scatter plot analysis addressed the research questions, while Pearson's Product-Moment Correlation was employed to test the null hypotheses at a 0.05 level of significance. The results revealed a statistically significant relationship between retraining strategies—particularly seminars and mentorship programs—and teachers' job effectiveness.

The study concluded that teachers' retraining strategies—particularly seminars and mentorship—have a statistically significant positive impact on job effectiveness in special needs schools in Cross River State, Nigeria. These strategies enhance teachers' instructional competence by addressing challenges such as curriculum adaptation and individualized education plans, ultimately improving learning outcomes for students with disabilities. The findings support the integration of structured, context-specific professional development in line with the goals of Science, Technology, Engineering, Arts, and Mathematics (STEAM) education in the region. Based on these findings, it is recommended that school administrators and educational policymakers in Cross River State prioritize the implementation of consistent and context-specific retraining initiatives, such as seminars and mentorship programs, tailored to the unique demands of special education. Regular implementation

of these strategies is likely to significantly enhance teachers' job performance and contribute to the overall quality of education in special needs schools. Moreover, the implications of these findings may extend beyond Cross River State, offering insights relevant to broader educational systems seeking to improve inclusive education outcomes.

Keywords: Teachers, Retraining, Strategies, Job Effectiveness, Special Needs Schools