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**INTERDISCIPLINARITY,
CREATIVITY AND
RESILIENCE THROUGH
COLLABORATIVE
PROJECTS**



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FOREWORD

This volume brings together the scholarly papers and best practices presented at the International Symposium entitled “*Cultural Passport: Interdisciplinarity, Creativity and Resilience through Collaborative Projects*,” an academic event organized by Colegiul Economic „Virgil Madgearu” Galați in partnership with Erasmus Centre Seville and Teacher Resource Center (Casa Corpului Didactic) Galați. This scientific gathering was conducted under the broader umbrella of the European Union’s Erasmus+ Programme, serving as a core dissemination and reflection platform within the framework of the Erasmus+ School Education Accreditation Project No. 2025-1-RO01-KA121-SCH-000339215.

In a contemporary educational landscape marked by unprecedented algorithmic acceleration and profound socio-cultural shifts, the upper secondary education system is called upon to move beyond traditional, linear, and fragmented models of knowledge transmission. The major challenge for twenty-first-century educators is no longer the simple delivery of curriculum content, but the cultivation of global, reflective, and highly adaptable citizens. To address this paradigm shift, this anthology serves as a vehicle for pedagogical innovation, providing the Romanian pre-university educational community with an authentic space for professional dialogue, knowledge exchange, and methodological validation designed to consolidate an educational system that is highly competitive within the European Education Area.

The dynamic structure and academic density of this volume closely reflect the two strategic focus areas of the symposium:

The first section, “Interdisciplinarity and Creativity in Teaching and Learning” explores a fundamental shift in instructional design: the blurring of rigid disciplinary boundaries and assimilation of digital tools not as decorative elements, but as core analytical assets. The included papers investigate structural mechanisms through which cultural and linguistic heritage can be pedagogically leveraged, proposing field-tested workflows for integrated curricular design. Ranging from the use of artificial intelligence and synchronous platforms in media literacy newsrooms to transdisciplinary ekphrasis, active learning methodologies, and innovative assessment tools, this track demonstrates that learning becomes profound and sustainable only when organically bound to the student's multi-dimensional reality.

The second section, dedicated to “ERASMUS+ Projects” functions as a European-scale dissemination platform, evaluating the direct impact of transnational mobility frameworks (Erasmus+, eTwinning) on the development of key competences and soft skills among high school students and staff. The cross-border experiences analyzed in these pages reveal how immersion in multicultural environments fosters diversity, reduces performance anxiety, and accelerates peer-to-peer social inclusion. Beyond its immediate formative value, this section proves that international educational cooperation acts as a powerful incubator for systemic resilience, equipping modern schools with the strategic mechanisms necessary to navigate uncertainties and build sustainable bridges of cross-cultural trust.

The studies compiled in this volume collectively validate a definitive conclusion: museum-based outdoor education, digital micro-fiction, volunteerism, experiential storytelling, and applied STEAM prototyping workshops are not supplementary, extracurricular activities; they rather represent essential and lived experience learning. They effectively transition twenty-first-century students from passive consumers to responsible, ethical prosumers of media, culture, and science.

We express our profound gratitude to the Scientific Reviewer of this volume, **Prof. Dominique Persano Adorno**, from The University of Palermo, Italy for her invaluable academic guidance and rigorous evaluation of the manuscripts. We also extend our deepest thanks to the authors, researchers, and European experts whose vision and scholarly dedication have breathed life into this volume. Furthermore, we appreciate the coordinating institutions and managerial teams who understand that a modern, inclusive school is built upon openness, flexibility, and rock-solid international partnerships.

We are confident that the pages of this anthology will provide a valuable source of inspiration and a benchmark methodological guide for all educational stakeholders who believe in the transformative potential of collaborative networks, and who embrace, day by day, the noble mission of turning education into an authentic passport to the future.

The Editorial and Organizing Committee

EMPOWERING SCHOOLS THROUGH AUGMENTED REALITY: LESSONS LEARNED FROM THE BIOS4YOU AR 2.0 ERASMUS+ EXPERIENCE

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Abstract

The rapid evolution of digital technologies is transforming educational practices, creating new opportunities to engage young students in Science, Technology, Engineering and Mathematics (STEM). Within this context, the Erasmus+ project “BioS4You AR 2.0 – *Bio-Inspired STEM Topics for Engaging Young Generations through Augmented Reality*” explored the potential of Augmented Reality (AR) and gamification to support innovative STEM teaching and learning. Building upon the successful outcomes of the previous BioS4You project, BioS4You AR 2.0 developed pedagogical methodologies, training materials, and interactive learning resources aimed at enhancing STEM education across Europe. This paper presents the project's objectives, methodology, and main outcomes, with particular attention to the role of the associated school partner, ICS Maredolce, and the impact generated on teachers and students through the Learning, Teaching and Training Activities (LTTAs), pilot studies, webinars, training courses, and multiplier events. The experience demonstrates how AR can foster student engagement, strengthen teachers’ digital competencies, and contribute to the creation of inclusive and innovative STEM learning environments.

Keywords: STEM Education, Augmented Reality, Erasmus+, Teacher Training, Bio-Inspired Learning, Gamification, Digital Competencies

Introduction

Contemporary societies increasingly require citizens who possess scientific literacy, critical thinking skills, and the ability to address complex challenges through interdisciplinary approaches. Among emerging educational technologies, Augmented Reality (AR) has attracted considerable attention due to its potential to enhance visualization, interactivity, and experiential learning (Azuma, 1997; Wu et al., 2013). Recent systematic reviews and meta-analyses have further highlighted the educational value of AR, demonstrating its capacity to improve learning outcomes, motivation, engagement, and conceptual understanding across a wide range of educational settings (Koumpourous, 2024; Sakr & Abdullah, 2024; Li et al., 2025). In particular, AR has shown significant benefits in STEM disciplines, where abstract and complex concepts often challenge learners, by providing immersive and interactive representations that support deeper understanding (Ibáñez & Delgado-Kloos, 2018; Li et al., 2025). At the same time, European and international educational policies emphasize the need to strengthen digital competencies, scientific literacy, and problem-solving skills in response to the demands of contemporary society and the digital transformation of education (OECD, 2019; UNESCO, 2023). Despite these priorities, many schools still struggle to effectively integrate innovative technologies into everyday teaching practices due to limitations in teacher training, pedagogical support, and access to suitable educational resources. The Erasmus+ project BioS4You AR 2.0 – *Bio-Inspired STEM Topics for Engaging Young Generations through Augmented Reality* was conceived to address these challenges. Building upon the successful outcomes of the

original BioS4You project (2019–2022), the initiative aimed to combine bio-inspired STEM education, gamification, and AR technologies to create innovative learning environments capable of increasing students' interest in science while supporting teachers' professional development (Persano Adorno et al, 2021).

This paper presents the educational framework developed within the project, describes the role played by the associated school partner, and discusses the impact generated on teachers and students through training activities, pilot implementations, and international cooperation.

The BioS4You AR 2.0 Methodology

The BioS4You AR 2.0 project adopted a design-based educational research approach involving iterative development, implementation, testing, and refinement of educational resources across different European educational contexts. The consortium included six organizations from five European countries: Karlsruhe Institute of Technology (Germany), University of Palermo and CEIPES (Italy), EDUACT (Greece), Tallinn Kesklinna Vene Gümnaasium (Estonia), and Kaunas University of Technology (Lithuania). The project activities were organized around three interconnected phases: (1) development of pedagogical methodologies and AR-enhanced STEM learning materials; (2) teacher training and capacity-building activities; and (3) pilot implementation and evaluation in participating schools. A central outcome of the project was the development of the 3E Framework (Explore, Execute, Enhance with AR), which structures learning activities into progressive stages. During the *Explore* phase, students investigate biological phenomena and identify real-world challenges inspired by nature. In the *Execute* phase, learners engage in collaborative experimentation, inquiry-based activities, and problem-solving tasks. Finally, the *Enhance* phase employs AR technologies to visualize concepts, support reflection, and enrich the assessment processes.

The project produced a comprehensive pedagogical methodology, teacher training materials, implementation guidelines, ten revised learning units from the original BioS4You project, and forty-two newly developed AR-enhanced STEM learning units. Evaluation data were collected through pilot activities, Learning, Teaching and Training Activities (LTTAs), webinars, classroom observations, and participant feedback questionnaires involving both teachers and students.

Results and Impact Assessment

The implementation phase of BioS4You AR 2.0 provided valuable evidence regarding the feasibility and educational potential of integrating Augmented Reality into STEM teaching practices across different European educational contexts. Pilot activities were conducted in all participating countries and involved a substantial number of educational stakeholders. Overall, each national pilot engaged at least 100 students and 20 teachers, resulting in the participation of more than 500 students and over 100 teachers across the consortium. These pilot studies allowed the project partners to test the effectiveness, usability, and pedagogical relevance of the AR-enhanced STEM learning units under authentic classroom conditions.

The five Learning, Teaching and Training Activities (LTTAs) represented another important component of the project. Each LTTA involved at least 10 students and 5 teachers from participating institutions, providing opportunities for international collaboration, exchange of practices, and direct experimentation with the educational resources developed during the project.

Teacher professional development was further supported through a series of international webinars organized by consortium partners. Each webinar attracted more than 100 participants from across Europe, including teachers, researchers, school leaders, and educational practitioners interested in innovative STEM methodologies and educational technologies. These online events contributed significantly to the dissemination of project results and the creation of professional learning communities beyond the formal project partnership.

Multiplier national Events also played a crucial role in disseminating project outcomes. Each event involved at least 30 participants and served as a platform for presenting the developed methodologies, AR resources, pilot experiences, and lessons learned. The positive feedback received during these events confirmed the relevance of the project outputs for the broader educational community.

Qualitative feedback collected during pilot implementations highlighted high levels of student engagement, increased motivation towards STEM subjects, and positive perceptions of AR-supported learning experiences. These findings are consistent with previous studies reporting positive effects of AR on learner engagement, conceptual understanding, and motivation (Billinghurst & Duenser, 2012; Wu et al., 2013; Ibáñez & Delgado-Kloos, 2018).

The Strategic Role of the Associated School Partner and the impact on teachers and students

One of the most valuable aspects of BioS4You AR 2.0 was the continuous and meaningful engagement of its associated school partner throughout the entire project lifecycle. Rather than serving merely as a testing site, the school acted as both a contributor to the development process and an evaluator of project outcomes. Within the contribution of the University of Palermo, ICS Mareddolce was the sole associated school partner and played a pivotal role from the project's inception to its completion. The school was involved in all major stages of the initiative, including the co-design, implementation, piloting, and assessment of the educational resources developed within BioS4You AR 2.0. Teachers from ICS Mareddolce took part in pilot activities, professional development programs, webinars, and dissemination events, offering ongoing feedback on curriculum integration, classroom relevance, and pedagogical value. Their contributions helped ensure that the materials remained closely aligned with authentic educational needs and teaching practices.

Students also played an important role by participating in the testing of AR-enhanced learning units and sharing insights on usability, engagement, and learning outcomes. This collaborative and participatory approach elevated the school's role beyond that of a traditional testing environment, establishing it as a key stakeholder in the project's innovation and development process.

The project generated significant benefits for teachers involved in the associated school. First of all, they acquired practical skills in using AR platforms and tools, including the creation of interactive learning content and AR-enhanced classroom activities. Moreover, the training activities encouraged educators to move beyond traditional lecture-based instruction toward more student-centred and inquiry-oriented approaches. Finally, the participation in LTTAs and webinars created concrete opportunities for collaboration with colleagues among different European countries, fostering the exchange of good practices and innovative methodologies. At the end of the project, teachers reported greater confidence in integrating AR technology into STEM education and appreciated the practical applicability of the educational resources, the flexibility of the 3E Framework, the possibilities offered by AR for visualizing complex scientific concepts and the opportunity to experiment with innovative teaching methods in a supportive international

environment. Similar findings have been reported in previous research emphasizing the importance of professional development and pedagogically grounded technology integration (Dunleavy et al., 2009; Santos et al., 2014). Therefore, the project contributed to the development of professional learning communities capable of sustaining innovation beyond the project duration.

The benefits for students extended beyond the acquisition of scientific knowledge. AR-enhanced activities transformed students from passive recipients of information into active participants in the learning process. The opportunity to interact with virtual models, simulations, and gamified activities increased curiosity and enthusiasm for STEM subjects. By visualizing scientific phenomena in three dimensions, students were able to develop deeper conceptual understanding of topics that are often perceived as abstract or difficult. Moreover, students strengthened important twenty-first-century skills, including: critical thinking; problem-solving; collaboration; communication; digital literacy.

Participation in the international project activities exposed the students to multicultural learning environments and strengthened their awareness of European cooperation in education and innovation.

The collaboration between the University of Palermo and ICS Maredolce represents a successful example of university-school partnership within the Erasmus+ framework, demonstrating how educational innovation can be strengthened when research institutions and schools jointly develop and validate teaching and learning solutions.

Conclusion

BioS4You AR 2.0 demonstrates how Augmented Reality can contribute to innovation in STEM education when supported by appropriate pedagogical frameworks and sustained teacher training. The project successfully combined educational research, technological innovation, and European cooperation to create engaging learning experiences for both teachers and students.

The BioS4You AR 2.0 experience confirms that the successful integration of emerging technologies in education depends primarily on pedagogical design rather than on technology itself. Consistent with the literature, the project demonstrated that AR is most effective when embedded within inquiry-based, collaborative, and student-centred learning environments (Dunleavy et al., 2009; Ibáñez & Delgado-Kloos, 2018).

Another key finding highlights the strategic role of schools as co-creators of innovation rather than passive recipients. The sustained engagement of teachers and students across the development and testing phases significantly enhanced the relevance, usability, and long-term sustainability of the project outcomes. The project also underscores the critical importance of teacher professional development. Participants in training activities reported greater confidence in adopting innovative teaching approaches, as well as an increased awareness of the pedagogical potential of immersive technologies. These results are consistent with current European priorities in digital competence development and innovative STEM education (OECD, 2019; UNESCO, 2023).

The experience suggests that future initiatives should continue exploring immersive technologies while maintaining a strong focus on accessibility, inclusion, and pedagogical quality. From a quantitative perspective, the project reached a considerable audience across Europe, involving more than 500 students and over 100 teachers in pilot activities, numerous participants in international mobility and training initiatives, over 100 attendees per webinar, and at least 30 participants in each multiplier event. These figures demonstrate the scalability of the proposed educational model and confirm the strong interest of the educational community in innovative AR-based approaches to

STEM education. Further research should investigate the long-term impact of AR-enhanced learning on student achievement, motivation, and STEM career aspirations.

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