

Research

International Collaborative STEM Learning in Early Childhood Education through eTwinning Projects within the Erasmus+ Framework

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Citation: Huștiuc N, Istileulova Y. International Collaborative STEM Learning in Early Childhood Education through eTwinning Projects within the Erasmus+ Framework. Proceedings of Socratic Lectures. 2026, 14, 96-100.
<https://doi.org/10.55295/PSL.14.2026.IV13>

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Abstract:

This paper presents a longitudinal educational research experience developed between 2020 and 2025 through four international eTwinning projects implemented annually with preschool children aged 4–6 years at Kindergarten with Extended Program Vinerea, Romania. The projects - *Coding STEAM and Stories*, *STEM Research in Kindergarten*, *Kindergarten from Home*, and *STEM with Pete is Really Great* - were carried out in collaboration with educational institutions from Romania, Greece, Turkey, Lithuania, and Poland within the eTwinning community, part of the Erasmus+ framework. Each project received both the National Quality Label and the European Quality Label, demonstrating educational quality, innovation, and international impact. The study explores the integration of STEM methodology, inquiry-based learning, coding activities, storytelling, collaborative digital learning, and intercultural communication in early childhood education. Findings indicate significant contributions to creativity, communication, collaboration, problem-solving, computational thinking, and intercultural awareness among preschool children.

Keywords: eTwinning; Erasmus+; STEM education; Preschool education; Inquiry-based learning; Coding

1. Introduction

1.1. *Introduction and Pedagogical Foundation*

The rapid transformation of contemporary education requires innovative pedagogical approaches capable of preparing children for the technological and interdisciplinary challenges of the twenty-first century. STEM education (Science, Technology, Engineering, and Mathematics) has gained increasing importance in early childhood education because it promotes curiosity, creativity, communication, critical thinking, and problem-solving through experiential and inquiry-based learning (Bybee, 2013). Research has also demonstrated that age-appropriate STEM activities can support the development of computational thinking and scientific reasoning from the preschool years (Papadakis, 2021).

Beginning in 2020, Kindergarten with Extended Programme Vinerea (Romania) implemented a series of annual international eTwinning projects focused on STEM education for preschool children aged 4–6 years. These projects were developed within the eTwinning framework, a European initiative supporting collaboration among educational institutions, and contributed to the broader objectives of the Erasmus+ programme related to innovation, digital education, inclusion, and intercultural cooperation (European Commission, 2023).

The projects involved educational institutions from Romania, Greece, Turkey, Lithuania, and Poland and promoted collaboration among teachers, children, and families through digital communication and joint educational activities. Four projects were implemented during the study period: STEM, Coding STEAM and Stories, STEM Research in Kindergarten, Kindergarten from Home, and STEM with PETE is Really Great. Each project addressed specific educational objectives while sharing a common focus on STEM-based learning.

The projects aimed to promote STEM education through inquiry-based and experiment-based learning, encouraging children to observe, explore, formulate questions, and discover scientific concepts through hands-on activities adapted to their developmental level. Another objective was to strengthen cooperation between kindergarten and families by actively involving parents in educational activities, including the continuation of classroom experiments and STEM tasks at home.

In addition, the projects integrated storytelling into STEM education by connecting narratives with experiments, engineering challenges, coding activities, and creative problem-solving tasks. This approach was intended to increase children's motivation and engagement while supporting the development of creativity, communication skills, collaboration, computational thinking, and critical thinking. Through international collaboration and the use of digital tools, the projects also sought to foster intercultural awareness and digital competences among both children and teachers.

This paper presents the pedagogical implementation of these international STEM projects and examines their contribution to children's learning experiences, family participation, and international educational collaboration in early childhood education.

2. Research Design and Methods

This study employed a qualitative research design based on longitudinal pedagogical observation conducted throughout the implementation of four annual international eTwinning STEM projects between 2020 and 2025. The educational activities were documented through continuous classroom observations, children's learning products, teachers' reflective notes, and records of family participation. The collected evidence was analysed qualitatively to identify patterns related to children's engagement, creativity, collaboration, communication, problem-solving, and early computational thinking.

The educational intervention was supported by a wide range of materials and digital resources that facilitated inquiry-based learning, experimentation, coding activities, storytelling, engineering challenges, and collaborative learning.

The materials included:

- STEM experiment kits adapted for preschool education;
- recyclable materials for engineering and construction activities;
- sensory materials for scientific observation and exploration;
- magnets, water containers, measuring cups, pipettes, balloons, plants, seeds, ice, colours, and other natural materials used in experiments;
- simple robotics and coding resources suitable for early childhood education;

- digital platforms and collaborative tools, including Padlet, Canva, Wordwall, LearningApps, and TwinSpace;
- tablets, interactive whiteboards, digital presentations, and online collaborative activities;
- storytelling resources and thematic educational games;
- complete sets of *Pete the Cat* books used in the project *STEM with PETE is Really Great*
- story cards, sequencing cards, emotion cards, and other visual supports;
- worksheets, posters, lapbooks, and collaborative classroom displays;
- art and craft materials, including markers, coloured paper, glue, cardboard, paint, and modelling materials;
- home-made experimental materials prepared by children together with their families;
- educational videos, digital quizzes, and collaborative online presentations.

These resources supported active, hands-on learning and enabled the integration of STEM concepts with creativity, digital technologies, and family participation throughout the educational process.

The project implemented an interdisciplinary STEM/STEAM approach by integrating children's literature with inquiry-based and hands-on learning activities. Using *Pete the Cat* as a narrative context, learners engaged in a variety of educational tasks, including scientific experiments, problem-solving activities, introductory coding, engineering design challenges, creative arts activities, and collaborative learning experiences. This pedagogical framework was designed to connect storytelling with authentic learning situations, thereby supporting the development of conceptual understanding across multiple STEAM disciplines (**Figure 1**).



Figure 1. STEM with *PETE is Really Great* project. Examples of educational activities integrating the *Pete the Cat* stories are centered on the character Pete, a blue cat, with inquiry-based STEM/STEAM learning, including scientific experiments, coding, engineering design, and collaborative problem-solving. These books are used in preschool and early primary education because they combine simple narratives with themes of resilience, problem-solving, emotions, creativity, friendship, and learning.

3. Results

The implementation of the four international eTwinning STEM projects generated complementary learning experiences across different areas of preschool education. The project *Coding STEAM and Stories* engaged children in coding games, interactive narratives, and collaborative problem-solving activities that incorporated computational thinking, sequencing, creativity, and digital storytelling. Children constructed logical sequences, followed coding paths, and expressed ideas through stories linked to STEM challenges.

STEM Research in Kindergarten introduced inquiry-based learning through hands-on experiments involving water, magnets, plants, colours, measurement, and natural phenomena. Children participated in activities involving observation, prediction, experimentation, and logical reasoning while exploring scientific concepts appropriate for early childhood education.

During the COVID-19 pandemic, *Kindergarten from Home* adapted STEM education to online and home-learning environments. Parents participated as educational partners by conducting experiments and STEM activities together with their children, thereby maintaining continuity of learning and strengthening collaboration between families and teachers.

The project *STEM with Pete is Really Great* (Figure 1) integrated the children's book series *Pete the Cat* with engineering, coding, mathematics, and collaborative problem-solving activities. Using stories as a narrative context, children participated in scientific experiments, introductory coding activities, engineering design challenges, creative arts activities, and collaborative learning experiences. The project was awarded both the National Quality Label and the European Quality Label within the eTwinning programme.

Across all four projects, qualitative pedagogical observations conducted by participating teachers indicated high levels of children's engagement, communication, collaboration, creativity, curiosity, critical thinking, and early computational thinking. International co-operation among partner institutions from Romania, Greece, Turkey, Lithuania, and Poland also promoted intercultural awareness, digital competences, and professional collaboration among educators.

4. Discussion

The findings suggest that interdisciplinary STEM education can be effectively implemented in preschool settings through the integration of inquiry-based learning, storytelling, coding, engineering design, and collaborative activities. These observations are consistent with previous studies reporting that integrated STEM approaches support children's creativity, problem-solving abilities, and scientific thinking (Bybee, 2013; Margot & Kettler, 2019).

The findings suggest that computational thinking can be introduced successfully at the preschool level through developmentally appropriate, play-based experiences. This finding supports previous research showing that coding activities enhance young children's logical reasoning and problem-solving skills (Papadakis, 2021).

Storytelling emerged as an important pedagogical strategy by providing meaningful contexts for scientific exploration and engineering challenges. Integrating literature into STEM activities increased children's motivation and emotional engagement while facilitating connections between scientific concepts and everyday experiences.

Another important outcome was the active involvement of families, particularly during the COVID-19 pandemic. Home-based STEM activities strengthened communication between teachers and parents and extended children's learning beyond the classroom. At the same time, international collaboration through eTwinning encouraged the exchange of teaching practices and educational resources among partner institutions, contributing to teachers' professional development and the implementation of innovative educational approaches.

Although the study is based on qualitative pedagogical observations rather than standardised assessment instruments, the findings indicate that international STEM projects can provide meaningful learning experiences and promote innovation in early childhood education.

The study has several limitations. It is based on qualitative pedagogical observations conducted in a single preschool setting and does not include standardized measures of children's learning outcomes or a comparison group. Consequently, the findings should be interpreted as evidence of educational practice rather than causal proof of effectiveness.

5. Conclusions

The implementation of four international eTwinning STEM projects between 2020 and 2025 demonstrates the educational value of interdisciplinary STEM learning in preschool education. The projects supported the development of children's creativity, communication, collaboration, curiosity, critical thinking, and early computational thinking while strengthening family involvement and international educational cooperation.

The study also highlights the benefits of combining inquiry-based learning, storytelling, coding, engineering design, and digital collaboration to create engaging learning experiences for young children. International eTwinning partnerships facilitated professional exchange among teachers and contributed to the dissemination of innovative educational practices across participating countries.

Future studies should complement qualitative pedagogical observations with systematic assessment methods and quantitative measures to provide stronger evidence of the educational impact of STEM-based international collaboration in early childhood education.

Acknowledgements: Pete the Cat characters and cover art are the property of James Dean, Kimberly Dean, and HarperCollins Publishers. All images and character references in this [presentation / paper] are used strictly for instructional, educational, and non-commercial purposes, falling under the fair use guidelines of U.S. Copyright Law. Figure 1 has been edited to protect the anonymity and privacy of the persons pictured.

Conflicts of Interest: The authors declares no conflict of interest.

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