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FACULTY OF PSYCHOLOGY AND EDUCATIONAL SCIENCES

DOCTORAL SCHOOL "EDUCATION, REFLECTION, DEVELOPMENT"

ABSTRACT OF DOCTORAL THESIS

DEVELOPMENT OF S.T.E.A.M SKILLS FOR PRESCHOOLERS THROUGH APPLICATIONS IN eTWINNING/ERASMUS+ PROJECTS

Scientific leader,

Prof. Univ. Dr. BOCOŞ MUŞATA-DACIA

PhD student,

PUICA (GĂZDAC) VASILICA AUGUSTA

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PART A. THEORETICAL CONSIDERATIONS

ARGUMENT

Recent research has focused on finding the most appropriate didactic model applicable in education, to create an effective training framework for the development of skills and processes that underlie key competencies and transversal competencies.

S.T.E.A.M education is one of the topics discussed for which we notice an increase in interest from researchers, preschool teachers, but also from European Union countries, companies or institutions due to socio-economic developments in recent years and the acceleration of the technological revolution, in especially the massive presence of Artificial Intelligence.

The S.T.E.A.M had an evolution based on the STEM educational concept which over time was not considered perfect by researchers, being centered only on the fields of: Sciences, Technologies, Engineering, Mathematics.

S.T.E.A.M education is based in education on a series of principles: the principle of active and applied learning, the principle of integrated content research, the principle of generating creative ideas in solving problems and on a series of methods: the method of project-based learning, the method of experiential learning, the method design thinking, the question-based learning method.

So, through the eTwinning/Erasmus+ projects, opportunities were offered for the development of S.T.E.A.M skills in preschoolers (observation, communication, collaboration, mathematical and digital), and the 12 practical applications implemented capitalized and validated, at an international level, the teaching model S.T.E.A.M.

The approach of the STEM didactic model includes only the four thematic areas (Sciences, Technology, Engineering and Mathematics) while the S.T.E.A.M concept is defined as follows:

"a didactic model that departed from the STEM model, in which the Arts and the design" (Baciu at al., 2022, p. 180)

S.T.E.A.M education is a topic of increased interest among researchers, preschool teachers and various European entities due to socio-economic and technological changes. This concept is based on the STEM model, but also adds Arts and Design. The principles of S.T.E.A.M education include active learning, integrated content inquiry, and creative idea generation.

Within the Erasmus program, emphasis is placed on the development of S.T.E.A.M skills in education, and eTwinning/Erasmus projects have demonstrated the success of this teaching model in developing the skills of preschoolers. It is important that the S.T.E.A.M model be integrated into the curriculum for early education in Romania, as well as to develop the collaboration and exchange of good practices between European countries.

CHAPTER I

S.T.E.A.M EDUCATION – INNOVATIVE APPROACH TO THE DEVELOPMENT OF SKILLS IN PRESCHOOLERS

I.1. Concepts of S.T.E.M and S.T.E.A.M

I.1.1. Terminological delimitations

The accelerated development of technologies and society in recent years has contributed to important changes in the field of education leading to the identification of the closest educational concepts to help new generations acquire key skills, and the most used concepts are STEM and S.T.E.A.M.

STEM has been defined as: "a teaching model that promotes interdisciplinary, applied, real-world educational approaches using the disciplines of Science, Technology, Engineering and Mathematics." (Baciu et al., 2022a, p. 180) S.T.E.A.M was defined as: "a teaching model that departed from the STEM model, in which Arts and design were integrated" (Baciu et al., 2022b, p. 180). The primary difference between the two concepts consisted in the integration of Arts and Design in the S.T.E.A.M didactic model, but if we carefully study the purposes of the two didactic models, slight differentiations and key features for each appear.

The S.T.E.A.M didactic model (Science, Technology, Engineering, Mathematics and Arts) was focused in kindergarten on the integrated and interdisciplinary approach to the contents of the previously mentioned thematic areas and the inclusion of artistic and humanistic elements in the structure of a preschool activity in order to develop S.T.E.A.M skills in preschoolers.

I.1.2. S.T.E.M didactic model

The acronym STEM appeared in the 90s and referred to the educational approach that promoted the interdisciplinary learning of the four fields: Science, Technology, Engineering and Mathematics for the understanding and technological development of today's society. As part of

our research, we have analyzed each domain/thematic area specifying the disciplines that make it up as follows:

- Science, this field deals with the living and non-living world, the study of physical and chemical processes, the study of natural phenomena. The disciplines integrated in this field are: Biology, Chemistry, Physics, Astronomy, Geography, etc.
- Technologies (Technology), this field refers to tools, equipment, processes that help man to solve problems and improve his life. The disciplines integrated in this field are: Information and communication technology, Robotics
- Engineering, this field refers to the design, development of solutions and products that solve the current problems of human society. The integrated disciplines are: Technological Education, Social Education, Electrical Engineering, Mechanical Engineering, etc.
- Mathematics (Mathematics), this field refers to the study of structures, models, relationships and calculations. The integrated disciplines are: Algebra, Geometry, Trigonometry, Mathematical Analysis, Statistics, etc.

Children are much more capable and attracted to integrated STEM learning, according to several scientific research conducted in recent years.

I.1.3. S.T.E.A.M educational approach

This new conceptual framework, interdisciplinary didactic model is considered a new and integrated approach that responds to the needs identified at the level of education systems, but also on the formation of the set of skills, behaviors necessary for a future graduate for the labor market.

The American researcher highlighted the interconnections between the five areas of the S.T.E.A.M approach with emphasis on the idea that STEM disciplines and those in the field of Arts should not be separated but have a common approach because they influence each other and lead to a deep understanding of concepts. Design and Arts are important in the development of technological products such as web design, in the fashion industry but also in engineering or architecture.

The proposed model emphasizes the applicability of knowledge in real contexts, thus, students or preschoolers are encouraged to transfer the concepts and information acquired in school in solving problems, finding innovative solutions." (Lin et al., 2021, p. 114) The interdisciplinary approach to S.T.E.A.M education in preschoolers is based on projects that contain practical applications to develop preschoolers a series of skills integrating subject contents from all five areas: Sciences, Technologies, Engineering, Mathematics and Arts.

S.T.E.A.M education is a holistic concept, which is based on interdisciplinarity, pluridisciplinarity and transdisciplinarity from the point of view of basic concepts, but for its implementation we need principles, methods and tools.

This didactic model represents an innovative approach through which the teaching staff integrates the curricular contents from the five thematic areas: Science, Technology, Engineering, Arts and Mathematics, showing the preschooler the practical usefulness of the integrated contents.

The research and specialized literature related to the S.T.E.A.M didactic model for preschoolers are limited, therefore, we conclude that it is a promising field for analysis and research, which would capitalize on the already known data, at an international level.

The term S.T.E.A.M education refers to teaching and learning in the five thematic areas, including educational activities that can be carried out at all levels of education, starting with the preschool level and ending with the post-doctoral level, through S.T.E.A.M education developing skills basic necessary for children.

I.1.4.S.T.E.A.M, principles and methods

S.T.E.A.M education for preschoolers is based on certain principles and methods, which facilitate the development of skills in the fields of: sciences, technologies, engineering, arts and mathematics.

The principle of active and applied learning provides students and preschoolers with opportunities to perform experiments and put knowledge into practice. The participation of all students and preschoolers regardless of age, gender, ethnicity or race is encouraged.

The principle of generating creative ideas in problem solving encourages students or preschoolers to develop their critical thinking, creative thinking and problem solving ability,

regardless of the application context. The methods and tools applied in S.T.E.A.M education are varied and promote deep understanding of scientific concepts and development of basic skills. The most well-known approaches from a methodological point of view are:

The project-based learning method (Project-Based-Learning - PBL) - requires preschoolers to work in teams where they collaborate, in various learning contexts, to find solutions to real problems.

The experiential learning method is based on practical activities and concrete actions, such as experiments in the fields of physics, chemistry, biology, visits to science museums or science centers, visits to digital centers, nature trips, visits to farms, making practical constructions in the external and internal environment of the kindergarten or school

I.1.5. S.T.E.A.M activities planning

The steps to follow in planning S.T.E.A.M activities are structured as follows:

- ✓ Establishing the theme
- ✓ Establishing learning objectives
- ✓ Establishing the method and tools
- ✓ Establishing human resources, materials, time
- ✓ Establishing the evaluation forms and methods
- ✓ Planning activities
- ✓ Carrying out the activities, alternating individual learning, with that in pairs, in groups and face-to-face
- ✓ Product evaluation and presentation
- ✓ Identifying solutions
- ✓ Reflections and conclusions.

The planning activity in S.T.E.A.M education is based on achieving a balance between the ideas expressed by preschoolers or students and the scientific contents of the five thematic areas.

I.1.6. S.T.E.A.M. education, oportunities and obstacles

S.T.E.A.M education offers opportunities for preschoolers, teachers, schools, communities and contributes to the development of the child, as a whole, through the holistic approach of the didactic model, which ensures the formation of a future adult integrated in the society of the future.

Table no. 1. *Opportunities and obstacles in S.T.E.A.M education model*

Oportunities:	**Obstacles:**
Finding solutions to real problems;	Lack of material resources, poor financing;;
Development of S.T.E.A.M skills and cognitive processes such as critical thinking and creative thinking;	Qualification of teaching staff in the S.T.E.A.M didactic model;
Collaboration, teamwork and opportunities for future career path;	Students/preschoolers from minority groups or disadvantaged backgrounds may have limited access to S.T.E.A.M education
Promoting equality of gender, ethnicity, race;	School culture and resistance to change;
International cooperation through activities and projects;	National tests and assessments;
Innovation in the field of education;	Gender segregation, in the sense that boys gain in S.T.E.A.M fields to the detriment of girls;
Improving the quality of life	Frustration and poor motivation of preschoolers, due to the complexity of some activities.

We conclude that it is necessary to make efforts on the part of socio-political factors, interested institutions, communities, teachers and preschoolers, in order to find the most suitable solutions in order to implement this didactic model.

I.2. Skills and cognitive processes developed in preschoolers through S.T.E.A.M education

S.T.E.A.M education has the role of developing skills and cognitive processes in preschoolers. The set of skills and cognitive processes S.T.E.A.M, presented by us in figure no. 5.I., is composed of: research observation, communication, collaboration, autonomy, initiative, mathematical skills, scientific skills, digital skills, which lead to the development of cognitive processes, such as: problem solving, critical thinking and creative thinking, etc.

In the activities of the eTwinning/Erasmus+ projects, roles are played and actions analogous to those of the scientific researcher are used." (Bocoș et al., 2021c, p. 1448)

Through the Erasmus+ activities, through which: ,,interpersonal exchanges of messages, meanings, decisions are carried out, from kindergarten through the application of the S.T.E.A.M didactic model, preschoolers develop their observation skills actively, in particular, through the application of integrated activities from different fields experiential, by carrying out experiments and practical investigations.

I.2.1. Research observation

Research observation is defined as follows: "the most complex form of observation, which requires the student to exercise roles and carry out actions analogous to those of the scientific researcher." (Bocoș et al., 2021c, p. 1448)

Through the activities in the kindergarten carried out by applying the S.T.E.A.M didactic model, preschoolers develop their observation skills actively, in particular, by applying integrated activities from different experiential fields, by carrying out experiments and practical investigations.

I.2.2. Communication and collaboration

Communication in S.T.E.A.M education takes different forms, the most common in S.T.E.A.M education, through the prism of eTwinning/Erasmus+ projects, being: communication of new knowledge, educational communication, interpersonal communication, communication in small groups, within the S.T.E.A.M integrated activities, the communication of new knowledge defined as: "the transmission of new knowledge, messages, meanings and affective states, by a

transmitter (for example, the teaching staff) to a receiver/ receivers (of for example, the student/s)." (Bocoș et al., 2021d, p. 244)

Practical S.T.E.A.M applications facilitate group learning and, implicitly, communication in small groups at the level of the group and at the level of eTwinning partnerships, electronic communication within the ESEP platform, Twinspace and within video conferences between kindergarten groups and in other digital specific activities, through which: "interpersonal exchanges of messages, meanings, decisions, value judgments, affective states and influences are carried out, with the help of the components/elements of own communication repertoires, in online/virtual/electronic environments, through information and communication systems." (Bocoș et al., 2021h, p. 244)

Collaboration within S.T.E.A.M activities and within eTwinning/Erasmus+ projects is present at all stages of achievement and is defined as: "collaboration between individuals, institutions, organizations and even governments, working together to solve a problem or to achieve common goals and objectives." (Bocoș et al., 2021i, p. 220)

I.2.3. Autonomy and initiative

Through the S.TE.A.M educational model applied within the eTwinning/Erasmus+ projects, the educational autonomy of preschoolers gradually develops, defined as: "situation in which the institution or person is self-administered, self-directed with full freedom in taking decisions and their implementation. The acquisition of educational autonomy represents a gradual, step-by-step process of reaching a degree of maturity and gradually acquiring independence in educational actions." (Bocoș et al., 2021j, p. 125)

In today's society, acquiring the status of autonomous preschool is an urgent desideratum regarding Romanian education. In addition to educational autonomy, preschoolers develop their spirit of initiative, as an important part of critical thinking.

I.2.4. Mathematical, scientific and digital skills

Fundamental skills are developed starting from the preschool level, because in kindergartens children become familiar with mathematical concepts (counting, strings, operations, geometric figures, etc.), digital concepts (using tablets, using interactive whiteboards, using simple

digital applications, using Lego kits, the use of "Ozobot/Beebot" robots, etc.) and with scientific concepts (physical and chemical experiments, observations, etc.).

I.2.5. Problem solving process

S.T.E.A.M skills contribute to the development of cognitive processes and the solving of transversal problems, so necessary for the future society.

I.2.6. Critical and creative thinking

Creative thinking, as a cognitive process, is closely related to imagination, creativity, curiosity and the openness to find novel solutions to problems, and critical thinking is based on information processing, analysis, playing an important role in innovation.

These cognitive processes—critical thinking and creative thinking—are to prepare preschoolers for the real world, for the advancement of human society in the fields of science, technology, engineering, arts, and mathematics.

I.3. Innovative research in S.T.E.A.M education for preschoolers, worldwide - examples of good practice

The information was extracted from the analysis of public documents for the preschool level and from analyzing the results of these states in the international tests TIMSS 2019 and PISA 2022, from the following countries: Singapore, South Korea, USA, Finland, Estonia, Netherlands, Australia and Canada.

Several trends identified in the studied documents can be grouped, respectively:

- ✓ the use of technology in the education process;
- ✓ equipping educational institutions with S.T.E.A.M kits and materials;
- ✓ assessment of preschoolers' progress; use of experiential learning methods;
- ✓ training of preschool teachers for STEM/S.T.E.A.M educational approaches;
- ✓ inclusion and diversity strategies for preschoolers;
- ✓ partnerships with local, national and international communities and the IT industry;
- ✓ strategies for developing emotional and social skills;

- ✓ measuring the impact of STEM/S.T.E.A.M didactic models throughout the preschool cycle.

I.4. Conclusions

STEM and S.T.E.A.M approaches in education develop skills and cognitive processes, such as: research observation, communication, collaboration, autonomy, initiative, mathematical skills, scientific skills, digital skills, critical thinking, creative thinking and problem solving.

The S.T.E.A.M (Science, Technology, Engineering, Arts and Mathematics) educational model is an integrated approach to science content that aims to develop basic skills from an early age. Unlike traditional methods, which treat these subjects separately, the S.T.E.A.M educational approach integrates them, encouraging the development of cognitive skills and processes such as creativity, critical thinking, problem solving, communication, collaboration.

CHAPTER II

THE ERASMUS+ PROGRAM – TOOL IN THE DEVELOPMENT OF S.T.E.A.M SKILLS

II.1. Presentation of Erasmus+ program

The Erasmus+ program, coordinated by the European Commission, is the main axis of personal and professional development in education, vocational training, youth and sport that runs in the period 2021-2027. All three types of education, formal education, informal and non-formal education, provide participants in the Erasmus+ program with an increased level of skills, competences and qualifications necessary for involvement in society, for the promotion of multiculturalism and the successful integration of participants in the labor market.

The Erasmus+ program, coordinated by the European Commission, is based on European Union documents, namely: the European Education Area, the Digital Education Action Plan (2021-2027), the EU Youth Strategy and the European Union Work Plan for Sports (2021- 2024).

The Erasmus+ program is defined as: "the most important education and professional training program in the European Union, in terms of mobility and cooperation" (Răduț-Taciu et al., 2015, p. 308).

The member countries of the European Union, the 27 states participate in the Erasmus+ program with full rights: Belgium, Bulgaria, Czech Republic, Greece, Spain, France, Lithuania, Luxembourg, Hungary, Portugal, Romania, Slovenia Denmark, Germany, Estonia, Ireland, Croatia , Italy, Cyprus, Latvia, Malta, Netherlands, Austria, Poland, Slovakia, Finland, Sweden, and in addition there are 6 countries associated with the program: North Macedonia, Iceland, Norway, Serbia, Liechtenstein and Turkey.

In Romania, the National Agency for Community Programs in the Field of Education and Professional Training (ANPCDEFP, Erasmus+Ro) is the institution that manages the Erasmus+ program, and information about its actions can be found on the website: https://www.erasmusplus.ro/

The Erasmus+ program is based on three main actions: key action 1, KA1, called mobility of people for learning purposes, key action 2, KA2, called cooperation between organizations and institutions, key action 3, KA3, called support for policy development and cooperation, and, as

complementary shares, Jean Monnet and eTwinning which complements the educational activities carried out in the form of digital collaborations between different European partners.

II.2. Objectives, priorities and elements of Erasmus+ program

The specific objective of the Erasmus+ program presented in the Erasmus+ Program Guide, 2023, promotes, for educational institutions, the learning mobility of individuals and groups, with the aim of developing cooperation, communication, inclusion, innovation of organizations and educational policies of education systems, implicitly, the approach of good validated educational practices.

The Erasmus+ program, within the 2021-2027 funding cycle, pursues four main priorities, called European priorities, presented in figure no. 1.II.:

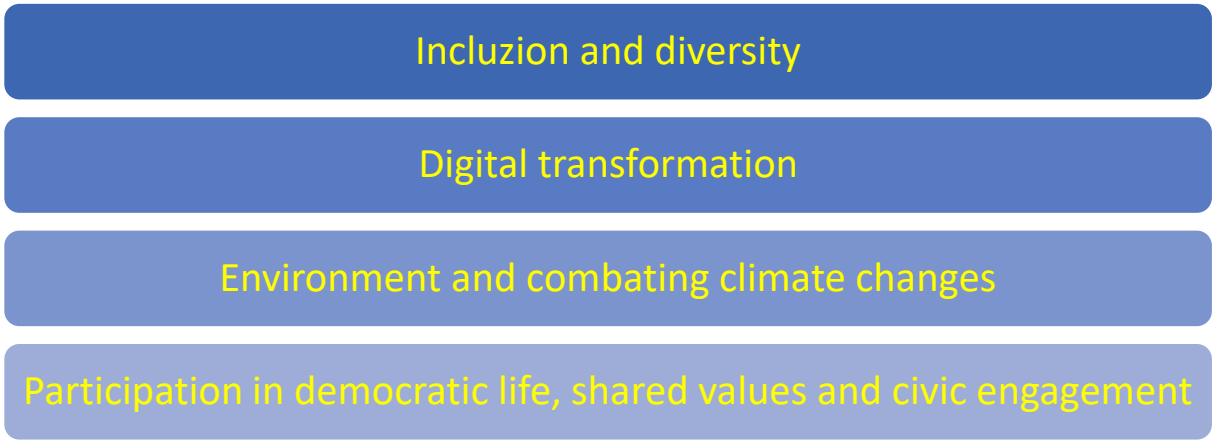


Figure no. 1.II.: *The main priorities of the Erasmus+ program, 2021-2027*

In addition to the European priorities, the Erasmus+ program pays more attention to the elements of the program specified in (Erasmus+ Program Guide, 2023, pp. 12-15) as follows:

a) "Respecting EU values;

b) Protection, health and safety of participants;

c) Multilingualism;

d) The international dimension;

e) Recognition and validation of skills and qualifications;

f) Communication of projects and their results, in order to maximize the impact;

g) The requirement regarding open access to teaching materials within the Erasmus+ program;

h) Open access for research and data within the Erasmus+ program;"

Knowing the objectives, priorities and defining elements of the Erasmus+ program brings added value in the writing, implementation and valorization of projects from different actions of the program, with applicability and impact on preschool children.

II.3. Key actions of the Erasmus+ program

The Erasmus+ program provides, for the financial cycle 2021-2027, the three main key actions, KA1 – Mobility of people for the purpose of learning, KA2 – Cooperation between organizations and institutions, KA3 – Support for policy development and for cooperation and complementary actions, Jean Monnet and eTwinning, are specified in figure no. 2.II., detailing each individual action, to highlight their specificity and applicability, at the level of preschool education.

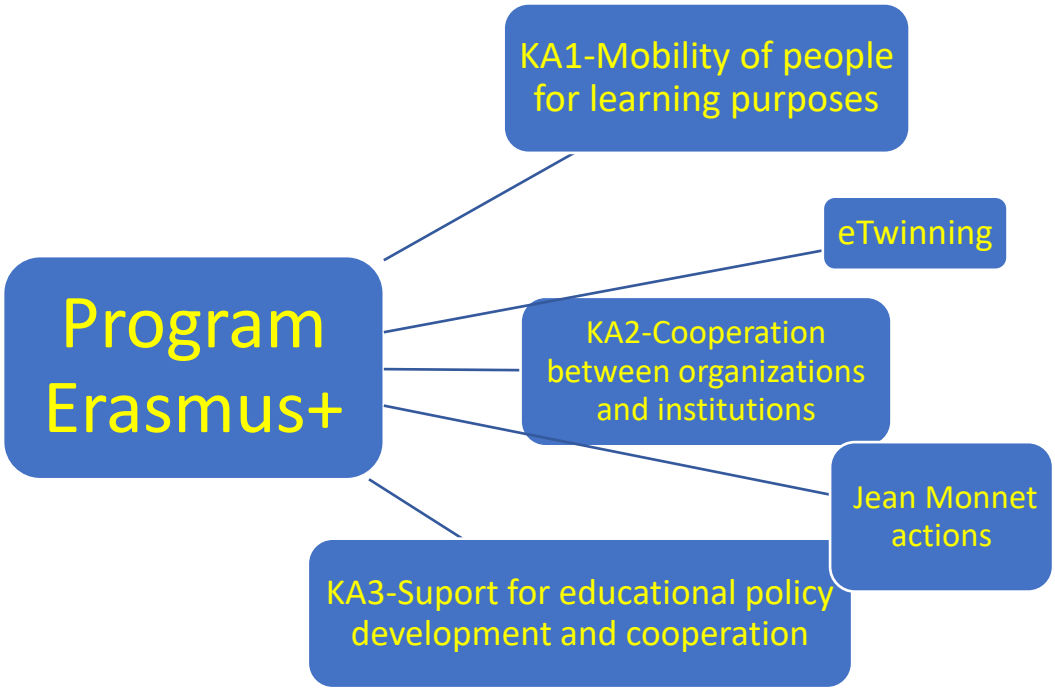


Figure no. 2.II.: *Structure of the Erasmus+ program*

II.3.1. Key action KA1- Mobility of people for learning purposes

Erasmus+ Key Action 1, known by the acronym KA1, aims to support the mobility of pupils, teachers, students, trainees, young people, university professors, trainers, youth workers, sports coaches, etc., to benefit from learning and training activities professional and personal in another country.

The projects within the KA1 action, recommended for the school education sector with a focus on the preschool education level, i.e. for preschoolers and teachers, are, in turn, divided into two categories:

- Accredited projects for student and staff mobility, (KA121);
- Short-term projects for student and staff mobility, (KA122).

II.3.2. Key action KA2-Cooperation between organizations and institutions

Key action 2 with the acronym KA2 aims to increase the relevance and quality of activities carried out in collaboration and cooperation with European partners, in order to align educational policies, exchange good practices, develop new educational practices, use digital methodologies, validate skills and competencies, addressing social, linguistic and cultural diversity.

Due to factors such as the size of the participating organizations, their specifics, project objectives, human and material resources, experience in the Erasmus+ program, partnerships for cooperation for the school education sector, focusing on preschool education, can be approached differently in two large categories:

1. Cooperative partnerships, KA220;
2. Small-scale partnerships, KA210.

II.3.3. Key action KA3-Support for educational policy development and cooperation

Key Action 3 or KA3, called Support for Education and Cooperation Policy Development aims to support partnerships between countries to experiment with European policies by gathering evidence and knowledge about European systems, approaches and policies, so that the learning paths of trainees to be aligned and Europe to be an attractive destination for studies and the research sector.

II.3.4. Jean Monnet actions

The Jean Monnet actions aim to contribute to the dissemination of knowledge about the formation and integration of the European Union states and to the strengthening of the European identity for young people, students, pupils and teaching staff. Within the Jean Monnet actions, two funding axes are eligible:

• a) Jean Monnet actions addressed to higher education;

• b) Jean Monnet actions in other sectors;

II.3.5. eTwinning

eTwinning is an action included in the Erasmus+ Program, promoted by the European Commission whose main objective is to create collaboration projects between European educational institutions aimed at preschoolers/students, promoting exchanges of good practices, communication and effective collaboration through the European platform, European School Education Platform (ESEP).

The countries participating in the eTwinning action are:

- ✓ □ 27 member states of the European Union;
- ✓ □ 8 countries associated with the action (Albania, Bosnia-Herzegovina, North Macedonia, Iceland, Liechtenstein, Norway, Serbia and Turkey);
- ✓ □ 7 neighboring countries of the European Union (Armenia, Azerbaijan, Georgia, Jordan, Moldova, Ukraine, Tunisia) within the eTwinning Plus action.

The activities of the eTwinning Romania agency can be consulted at this web address: https://etwinning.ro/. The European eTwinning action supports and encourages educational institutions for digital collaboration in all the actions of the Erasmus+ program presented above,

and the projects can be found on ESEP, the European platform for collaboration and communication in the field of education, made by the European Commission which can be consulted at the following link: https://school-education.ec.europa.eu/ro/etwinning

II.5. Erasmus+ projects with S.T.E.A.M theme implemented in Romanian preschool education, 2021-2024 – comparative analysis

From the results database of the national agency in Romania, ANPCDEFP (www.erasmusplus.ro) and from the information received from experts of the national agency, we extracted information on the number and type of Erasmus+ projects carried out or being implemented in kindergartens in Romania that have as S.T.E.A.M theme, for the period 2021-2024. These are increasing but there are limits to our analysis: incomplete data, kindergarten groups are included in school units with legal personality, lack of official statistics, etc.

II.6. Conclusions

The Erasmus+ program, through the key actions it carries out, creates favorable contexts for the development of S.T.E.A.M skills from the earliest ages, thus becoming the main tool at European level that facilitates the exchange of European best practices through formal, informal and non-formal learning.

The didactic strategies used within the S.T.E.A.M didactic model have the role of involving preschoolers in eTwinning/Erasmus+ projects, in collaborative projects with European kindergartens for the creation of common content, in sharing good practices in digital learning, in using applications and for awareness of one's own efforts to form their basic skills for a future course.

The development of S.T.E.A.M (observation, collaboration, communication, mathematical and digital) skills is important for the child's educational path, because the earlier the fundamental acquisitions are made, according to the objectives and priorities of the Erasmus+ program, the greater the chances of success of children to become active and engaged adults in a digital, green and inclusive society.

CHAPTER III

SPECIFIC APPROACHES TO S.T.E.A.M IN PRESCHOOL EDUCATION IN EUROPE AND ROMANIA

III.1. European policies in the field of education S.T.E.A.M

The European Union, especially after the COVID-19 pandemic, started to focus its efforts on climate change, sustainable activities, green transition and digitization. Future European citizens will possess basic S.T.E.A.M skills and competences and a combination of transversal competences, all of which are supported by sectoral education policies, transversal policies and general European policies.

European policies increasingly value the S.T.E.A.M didactic model, by promoting it in official documents, by encouraging European education systems to use it from the earliest ages, through formal, informal and non-formal training programs .

III.2. Approaches to S.T.E.A.M in European preschool education – comparative analysis (Bulgaria, Poland, Romania, Slovakia and Turkey)

The S.T.E.A.M model is defined as the transdisciplinary interaction between science, technology, engineering, mathematics, arts/humanities, in an integrated manner. Preschool children and teachers, to a small extent in our country, implement the S.T.E.A.M didactic model.

Comparisons between countries are difficult to make, so we decided to analyze the results of international TIMSS tests (Trends in International Mathematical and Scientific Studies) at the closest level of education to the preschool cycle, i.e. for 4th grade students, at the end of the primary cycle.

Table no. 1.III.: *Presentation of TIMSS test data from the countries investigated in Mathematics*

No.	Countries	2011	2015	2019
1	**Bulgaria**	-	524	515
2	**Poland**	481	535	520
3	**Slovakia**	507	498	510
4	**Turkyie**	469	483	496
5	**Romania**	482	-	479

Table no. 2.III.: *Presentation of TIMSS test data from the countries investigated in Science*

No.	Countries	*2011*	*2015*	*2019*
1	Bulgaria	-	536	521
2	Poland	505	547	531
3	Slovakia	532	520	521
4	Turkyie	463	483	526
5	Romania	505	-	470

The approaches to S.T.E.A.M education in the preschool education systems listed above have taken into account the needs and peculiarities of children and have taken into account that these approaches are flexible, fun, exploratory and creative.

III.3. Approaches to S.T.E.A.M education in Curriculum for Early Education in Romania

Preschool education was regulated in our country during the period we researched (2021-2024) by the National Education Law no. 1/2011, article 28, paragraphs (1) and (2), section 3, dedicated to this level of education, until the appearance of the new education law - Pre-university Education Law no. 198/2023.

The Curriculum for Early Education, 2019 was approved by the Ministry of Education with no. 4694/02.08.2019 and was inspired by national and European best practices. This document specifies the preschool level (3 months-3 years) and the preschool level (3-6 years).

This document is based on the Basic lines in Early Learning and Development (RFIDT) document.

For the preschool education level, the education plan provides:

• 7 activities on experiential fields for the normal program, to which 7 more are added for the extended and weekly program;

• 10 games and didactic activities chosen for the normal program, to which 5 more are added for the extended and weekly program;

• 5 personal development activities for the normal program, to which 10 more are added for the extended and weekly program.

The types of learning activities at preschool level provided for in the Curriculum for Early Education (2019), which we will detail, are presented in figure no. 1.III.:

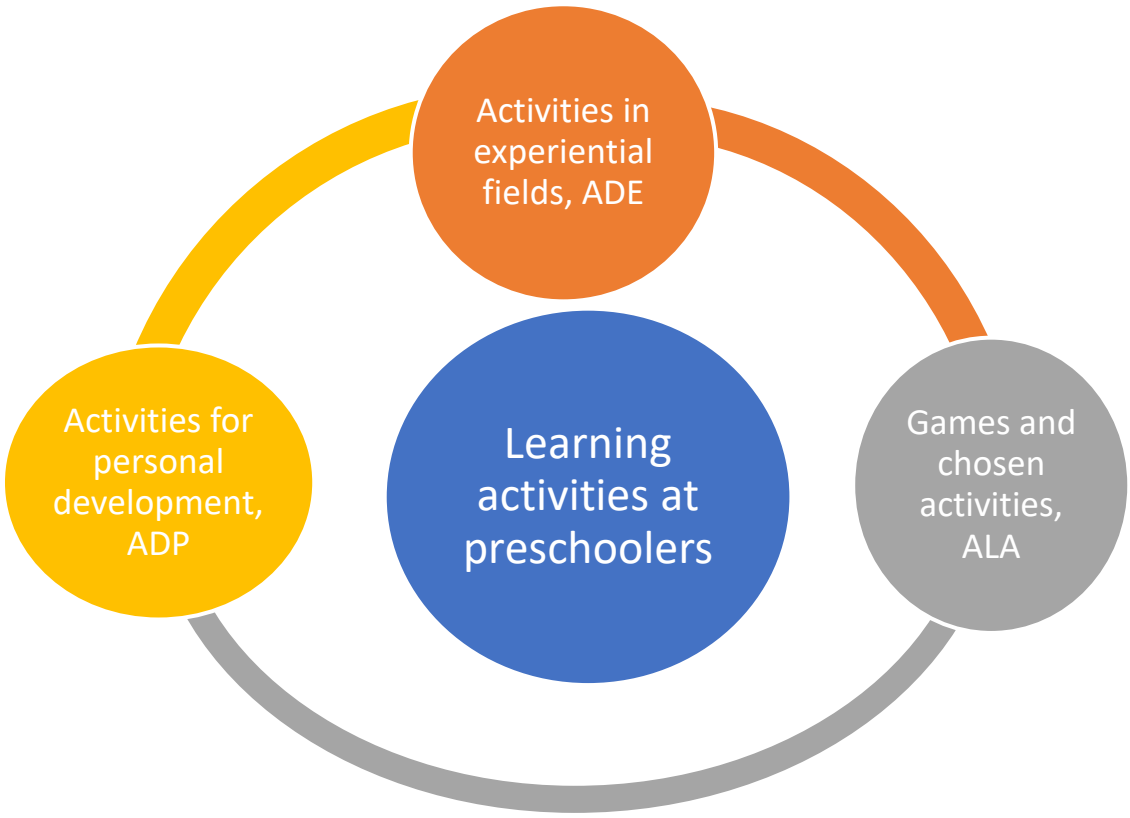


Figura nr. 1.III.: *Learning activities at preschoolers*

We find that, in the document Curriculum for Early Education (2019), the concepts of STEM/S.T.E.A.M. are not specified at all. The elements identified within these concepts can be achieved within the development domains, through activities within the experiential domains, within the annual study themes, in the design of STEM/S.T.E.A.M learning environments at the corners of interest, through freely chosen games and activities, through outdoor activities and reading moments.

III.4. S.T.E.A.M activities carried out in eTwinning/Erasmus+ project "n EURO NESTING 3.0" (2020-2023) in partnership with preschool educational institutions from Spain, Greece, Bulgaria, Portugal and Romania

The project was implemented for 36 months, through implementation, the creation of products, common outcomes and the development of S.T.E.A.M skills in preschoolers. The development of skills in the field of S.T.E.A.M was achieved through various joint activities with European partners, with a focus on bird protection within the strategic cooperation project, key action 2, KA2: "n'EURO Nest 3.0" (European Nest 3.0). The strategic partnership project within key action 2, KA2 with the title: "n'EURO NEST 3'0" (European Nest 3.0) was implemented over three years, 1.09.2020-31.08.2023 in the kindergarten groups within Professional School "Tiberiu Morariu" Salva, Bistrița-Năsăud county.

The project was implemented in collaboration with four European educational institutions:

- CEIP Bilingue Juan Palmireno, Alcaniz, Spain;
- Basic School. Integrated by Ribeira Grande, Portugal;
- Second Elementary School Elefteria-Kordelio, Thessaloniki, Greece;
- Zvanche Kindergarten, Burgas, Bulgaria.

The project was developed on the ESEP platform, within the eTwinning action, as a virtual collaboration between preschool groups and teachers from partner educational institutions.

The eTwinning/Erasmus+ project "n'EURO NEST 3'0" (European Nest 3.0) had as its objectives the development of S.T.E.A.M skills in preschool children, by carrying out joint activities on the theme of bird protection, creating digital products as open educational resources for early ages, increasing preschoolers' motivation regarding S.T.E.A.M. themed activities.

III.5. S.T.E.A.M activities carried out in eTwinning/Erasmus+ project "S.T.E.A.M ACADEMY" (2022-2023) in partnership with preschool educational institutions from Turkey, Poland, Slovakia and Romania

The project developed under key action 1, KA1, in School Education Accreditation, Erasmus+, with the name: "S.T.E.A.M ACADEMY" (S.T.E.A.M Academy) had as its objective the development of S.T.E.A.M skills at preschool age.

The project was implemented in the kindergarten groups from the Professional School "Tiberiu Morariu" Salva, Bistrița-Năsăud county, Romania for a period of 15 months (1.06.2022-31.08.2023), in collaboration with three educational institutions from Poland, Turkey and Slovakia.

The partner schools in the project were:

• Antalya Tobb Fen Lisesi. Antalya, Turkey;

• Zespol Szkol Publicznych Szewnie, Ostrowiec Sw, Poland;

• ZS s MS Pod Vinbargom v Bardejove, Bardejov, Slovakia.

The activities within the project were organized under the theme "S.T.E.A.M ACADEMY" (S.T.E.A.M Academy) and aimed to develop S.T.E.A.M skills through "green" activities, made using natural materials, recyclable materials, activities described extensively in the eTwinning space of the project, structured on four themes:

- Let's look for S.T.E.A.M in nature;
- Let's look for the S.T.E.A.M in the books;
- Let's look for S.T.E.A.M in construction;
- Let's look for S.T.E.A.M in the kitchen.

PART B. PRESENTATION OF EXPERIMENTAL RESEARCH

CHAPTER IV
DESCRIPTION OF THE EXPERIMENTAL RESEARCH ENTITLED "INVESTIGATION OF THE IMPACT OF THE PROGRAM «S.T.E.A.M IN KINDERGARTEN» FROM THE FRAMEWORK OF THE eTWINNING/ERASMUS+ PROJECT «S-TEAM IN KINDERGARTEN» ON S.T.E.A.M SKILLS ON PRESCHOOLERS"

IV.1. Context of experimental research

The research proposed and carried out by us with the theme: "Development of S.T.E.A.M skills in preschoolers through eTwinning/Erasmus+ projects" aimed at the impact of the S.T.E.A.M didactic model on observation, communication, collaboration, mathematical and digital skills in older preschoolers.

In this research, we set out to study how the application of the educational program "S.T.E.A.M in Kindergarten" from the eTwinning/Erasmus+ project "S-TEAM in Kindergarten" in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey contributes to the development basic skills of preschoolers.

IV.2. Applied research design

By carrying out the formative experiment, we investigated the impact of the "S.T.E.A.M in Kindergarten" program within the eTwinning/Erasmus+ "S-TEAM in Kindergarten" project on the level of observation, communication, collaboration, mathematical and digital skills of older preschoolers in Bulgaria, Poland , Romania, Slovakia and Turkey.

The research design is within subjects, the research technique is single-group. The research is experimental. Depending on the proposed purpose, the research was a developmental one, being directed longitudinally, and depending on the criterion of the number of subjects involved, the research is extensive

IV.2.1. Aim and objectives

The purpose of this research was to study the impact of the implementation of the educational program "S.T.E.A.M in kindergarten" within the eTwinning/Erasmus+ project "S-TEAM in kindergarten" in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey on the development of observation skills, of communication, collaboration, mathematics and digital in older preschoolers.

Research objectives:

 Investigating the opinions of urban and rural pre-school teachers from all counties of the country and from Bulgaria, Poland, Slovakia, Turkey, regarding the development of S.T.E.A.M skills in older preschoolers through practical applications within the eTwinning/Erasmus+ projects;

 Exploring the opinions of stakeholders in education, representatives of the national eTwinning agency, Romania, of ANPCDEFP, Romania, school inspectors for early education, school inspectors for educational projects, eTwinning and Erasmus+ ambassadors from Romania on the S.T.E.A.M didactic model, skills S.T.E.A.M and eTwinning/Erasmus+ projects in Romanian preschool education;

 Establishing the factors that facilitate and hinder the implementation of S.T.E.A.M practical applications through eTwinning/Erasmus+ projects in preschool education in Bulgaria, Poland, Romania, Slovakia and Turkey;

 Implementation of the educational program: "S.T.E.A.M in kindergarten" within the eTwinning/Erasmus+ project "S-TEAM in kindergarten" through practical applications based on: "Lego Education", "Ozobots", introductory elements of programming, chemical and physical experiments, elements of engineering, plastic language elements, etc.;

 Analysis of the level of development of observation, communication, collaboration, mathematical and digital skills through the educational program: "S.T.E.A.M in kindergarten" within the eTwinning/Erasmus+ project "S-TEAM in kindergarten";

 Elaboration of didactic and educational recommendations at national and European level regarding the implementation in optimal conditions of practical applications with the theme of S.T.E.A.M through eTwinning/Erasmus+ projects for large preschools.

IV.2.2. Research questions, hypothesis and variables

IV.2.2.1. Research questions

The research question guiding our research is:

S.T.E.A.M practical applications ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc.) from the "S.T.E.A.M in Kindergarten" educational program within the eTwinning/Erasmus+ project Does S-TEAM in kindergarten" in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey develop the observation, communication, collaboration, mathematical and digital skills of preschoolers?

IV.2.2.2. Hypothesis of research

The experimental approach aims to verify the following hypothesis:

Implementation of the educational program "S.T.E.A.M in Kindergarten" ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc.) within the eTwinning/Erasmus+ "S-TEAM" project in kindergarten" in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey, contributes significantly to the development of observation, communication, collaboration, mathematical and digital skills of preschoolers.

IV.2.2.3. Variables of research

The independent variable is represented by:

The practical applications ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc.) from the educational program "S.T.E.A.M in Kindergarten" in the eTwinning/Erasmus+ project "S-TEAM in kindergarten".

The **dependent variables** are:

- ***The level of development of observation skills;***
- ***The level of development of communication skills;***
- ***The level of development of the collaboration skill;***

• ***The level of development of the mathematical ability;***

• ***The level of development of the digital skill.***

Along with the previously stated variables, there are several moderator variables that influence the relationship between the independent variable and the dependent variables, which we list:

 Biological gender;

 Country of origin of preschoolers.

IV.2.3. Research strategy

IV.2.3.1 System of utilized research methods and tools

In our research, we used complementary investigative methods whose purpose is the correct collection of research data. The data used in this educational research was collected using the following methods:

 Pedagogical experiment;

 The investigation method;

 Observation method;

 Method of analysis of activity products;

 Research method of school and curriculum documents.

The psychopedagogical experiment represented the basic method used for testing the research hypothesis, a method whose purpose was to study the impact of the independent variable on the dependent variables. In the framework of the research proposed by us, through the educational program "S.T.E.A.M in kindergarten" within the eTwinning/Erasmus+ project "S-TEAM in kindergarten" we investigated the impact of practical applications ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, elements of engineering, elements of plastic language, etc.) on the level of development of observation, communication, collaboration, mathematical and digital skills at preschoolers. The working hypothesis was tested during the 2023-2024 school year, in 6 preschool education units in the country and abroad.

The survey method was one of the interactive and extensive research methods used,

the indirect survey, through which the respondents answered, in writing, the questionnaires in electronic format in Romanian and in English, made with the help of the Google Forms application and used as the main research tools for investigating the opinions of preschool teachers.

The self-designed questionnaires were intended for teachers from all counties of the country and from Bulgaria, Poland, Slovakia and Turkey, representatives of the national eTwinning agency, Romania, of ANPCEDFP, Romania, eTwinning ambassadors, Erasmus+ ambassadors, school inspectors for early education and school inspectors for educational projects, such as:

 Questionnaire regarding the development of S.T.E.A.M skills at preschool level, through the eTwinning/Erasmus+ projects, was applied to a number of 482 teachers for preschool education from rural and urban areas in all Romanian counties and to a number of 22 European teachers participating in the eTwinning/Erasmus+ project "S-TEAM in kindergarten".

 Questionnaire for experts of the national eTwinning agency, Romania, of ANPCDEFP, Romania, eTwinining ambassadors, Erasmus+ ambassadors and school inspectors was applied to a number of 82 representatives of the national eTwinning agency, Romania, of ANPCDEFP, Romania, eTwinning ambassadors, Erasmus+ ambassadors , school inspectors for early education, school inspectors for educational projects.

 Questionnaire addressed to teaching staff involved in the implementation of S.T.E.A.M practical applications ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc.) was applied to a number of 22 teachers participating in the educational program "S.T.E.A.M in kindergarten" in the eTwinning/Erasmus+ project "S-TEAM in kindergarten".

The observation method systematically investigated, with the help of research tools, natural observation situations, in order to obtain relevant information about the behavior and activity of older preschoolers in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey. Research tools that have been translated and applied to English using Google Forms, as follows:

 Scale Preschool-Teacher (The tool was developed by researchers, starting from the tools of researchers Hightower and Perkins, 2010).

 Observation grid of S.T.E.A.M activities. (The tool was developed by researchers, starting from the tools of researchers Morales et al., 2020)

 S.T.E.A.M teacher document (The tool was developed by the researchers, starting from the tools of the researchers Steam-H Teacher training module, Erasmus+, 2022)

IV.2.3.2. Research participants

In the framework of our research, 255 children of high preschool age (5-6 years) and 22 teachers from educational units participating in the educational program "S.T.E.A.M in Kindergarten" were involved in the eTwinning/Erasmus+ project "S- TEAM in kindergarten".

The questionnaire regarding the development of S.T.E.A.M skills at preschool level, through the eTwinning/Erasmus+ projects, was applied to 482 preschool teachers from all the counties of the country, the questionnaire was formulated in Romanian through the Google Forms application, during the pre-experimental stage.

I reproduced, in figure no. 1.IV., the distribution of the answers received, by county, and in the municipality of Bucharest:

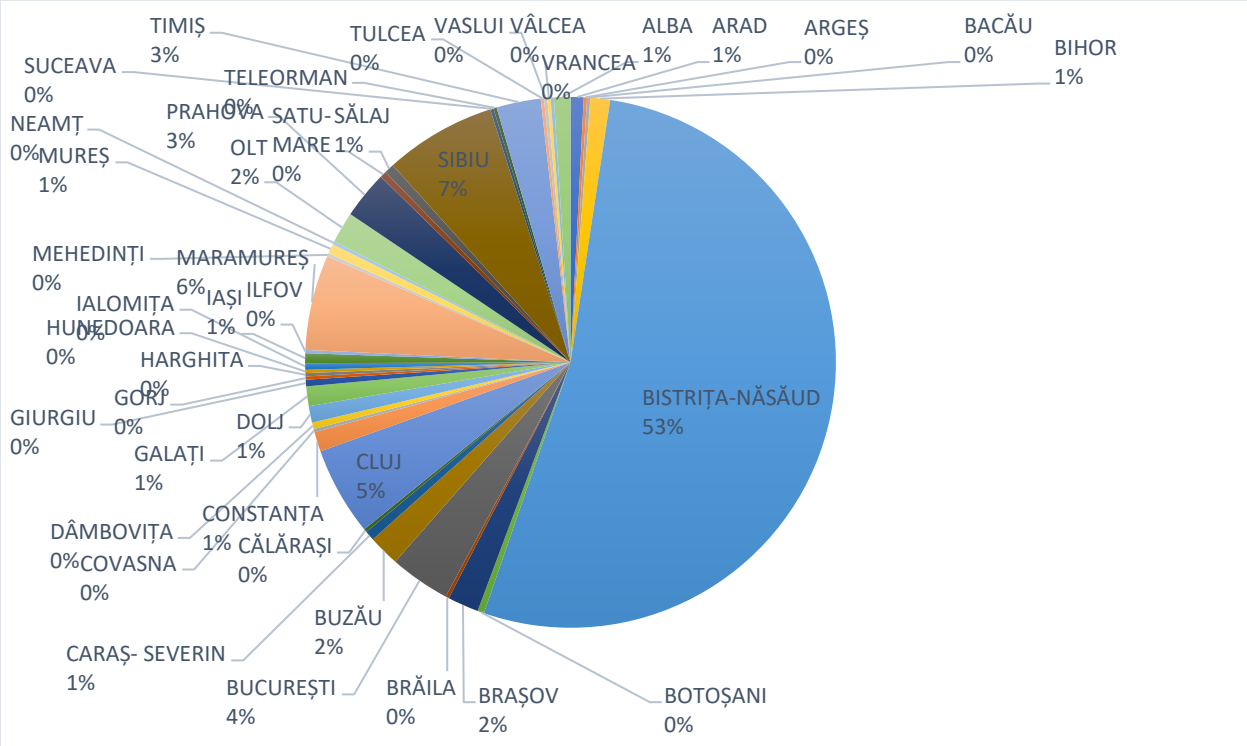


Figure no. 1.IV.: *Distribution of teaching staff by counties and in municipality of Bucharest*

Questionnaire for experts of the national eTwinning agency, Romania, ANPCDEFP, Romania, eTwinining ambassadors, Erasmus+ ambassadors and school inspectors had 82 respondents surveyed as associated parties, "stakeholders" in the educational process. The questionnaire was drafted in Romanian using the Google Forms application.

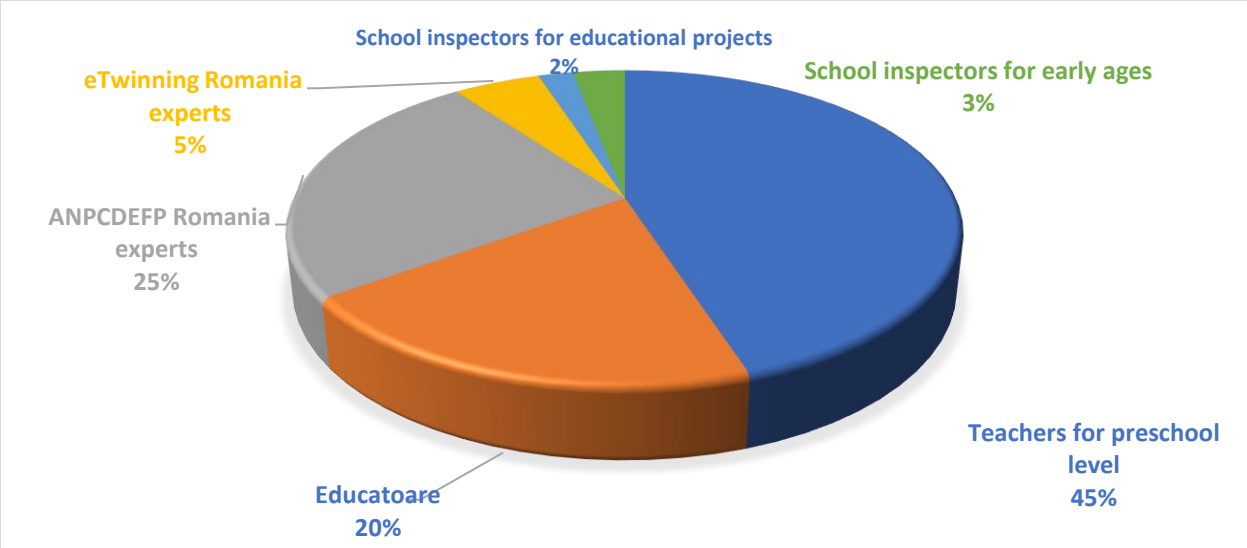


Figure no. 2.IV.: *Distribution of respondents corresponding to jobs*

We found that, among the people involved in our survey, the highest percentage (45%) is that of preschool teachers with the role of eTwinning Ambassador or Erasmus+ Ambassador. In second place are experts from various actions of the National Agency for Community Programs in the Field of Education and Vocational Training, Romania (ANPCDEFP), with a percentage of 25%, and close in percentage value, 20%, corresponding to the number of teaching staff with the position of educator.

We find lower percentages among experts from the eTwinning Romania Agency, respectively a percentage of 5%. The lowest percentages are found among school inspectors for early education from different counties, with a percentage of 3% and the lowest percentage, of 2 %, is registered with school inspectors for educational projects.

IV.2.3.3. Content of research

The content sample was enhanced by the formative experiment and consisted of 12 practical applications ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc.) , designed by teachers participating in the eTwinning/Erasmus+ "STEAM WITH GREEN" and "S.T.E.A.M ACADEMY" projects,

The proposed S.T.E.A.M practical applications took place between March and May 2024, a number of 12 practical applications, one per week being integrated into the daily program of preschool educational institutions in Bulgaria, Poland, Romania, Slovakia and Turkey.

The theme of S.T.E.A.M practical applications as well as the proposed period for their realization are further presented in table no. 3.IV.:

Table no. 3.IV.: *Themes of the proposed S.T.E.A.M practical applications*

Mounth	**Number of week**	**S.T.E.A.M practical application**
March	Week 1	Application no. 1: *"Ballerinas with motors"* (battery, magnets, crepe paper, copper wire, plush wire, glue, scissors, etc.) -Physical experiment, plastic language elements
	Week 2	Application no. 2: *"Shelters for domestic animals"* (cardboard straw, plasticine, dry leaves, twigs, gravel, watercolors, figurines of domestic animals, seeds, boxes made of recyclable materials, etc.) - Elements of engineering, elements of plastic language
	Week 3	Application no. 3: "*Balloons and rockets"* (balloons, paper and cardboard recyclables, watercolors, scissors, glue, plastic containers, vinegar, ammonia, fireworks, etc.) - Chemical experiment, physical experiment, plastic language elements
	Week 4	Application no. 4: "*The Volcano"* (plasticine, pebbles, watercolors, PET, vinegar, ammonia, food coloring, etc.) – Chemical experiment, engineering elements, plastic language elements
April	Week 5	Application no. 5: *"Rainbow*" (colored candies, plates, water, plastic cups, food coloring, etc.) - Chemical experiment, plastic language elements

	Week 6	Application no. 6: "*The Solar System*" (polystyrene balls, colored paper, watercolors, carios, ribbons, etc.) - plastic language elements
	Week 7	Application no. 7: "*Bird feeders*" (plastic bottles, bird seed, cardboard rolls, peanut butter, carioca, wooden spoons, string, tablets, etc.) - Engineering elements, mathematics, plastic language elements
	Week 8	Application no. 8: "Musical instruments" (seeds, rice, cardboard/plastic cups, plastic PETs, glue, carios, colored paper, etc.) – Engineering elements, plastic language elements, digital elements
May	Week 9	Application no. 9: "*Migratory and sedentary birds* - digital applications", "Worldwall" and "Jinsawplanet" - Mathematical elements, digital
	Week 10	Application no. 10: "*Lego Labyrinth*" - Engineering, mathematical elements
	Week 11	Application no. 11: "*My Green Village/City*" (recyclable paper and cardboard, natural elements, construction kits, etc.) - Elements of engineering, mathematics, elements of plastic language
	Week 12	Application no. 12: "*Ozobot/Beebot*" (tablets, coding, route markers, figurines, electric hubs, model, etc.) – Programming, coding, engineering elements.

CHAPTER V

PRE-EXPERIMENTAL STAGE

V.1. Objectives of the pre-experimental stage. Their subordination to the purpose and objectives of the research

Objectives of the pre-experimental stage:

 critical analysis of curricular legislative documents: Law on pre-university education, no. 198/2023, National Education Law no. 1/2011, Curriculum for early education, 2019 and various related school documents in order to identify:

the extent to which practical S.T.E.A.M applications, S.T.E.A.M skills and the S.T.E.A.M teaching model are encouraged in preschool education;

the extent to which eTwinning/Erasmus+ projects are encouraged in preschool education;

 defining and delimiting the content sample that will be used, respecting the considered criteria;

 obtaining parental consent and holding meetings with the directors of preschool units in the country and abroad, to identify the experimental sample and to sign partnership agreements with the Faculty of Psychology and Educational Sciences, Cluj-Napoca and with kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey (Annexes No. 7-12);

 constituting the experimental sample;

 the application, analysis and interpretation of the Questionnaire regarding S.T.E.A.M skills at preschool level, through the eTwinning/Erasmus+ projects to Romanian preschool teachers and European teachers participating in the eTwinning/Erasmus "S-TEAM in kindergarten" project;

 application, analysis and interpretation of the Questionnaire for experts of the national agency eTwinning Romania, ANPCDEFP Romania, eTwinning ambassadors, Erasmus+ ambassadors and school inspectors;

 receiving consent for the use of the Teacher-Child Rating Scale 2.1 (TEACHER-CHILD RATING SCALE (T-CRS)2.1) (Annex no. 3);

 the analysis and interpretation of the Teacher-Preschooler Evaluation Scale for preschoolers participating in the experiment from kindergartens in Bulgaria, Poland, Romania, Slovakia and

Turkey (The instrument is of our own design, it was developed by us, starting from the instruments of researchers Hightower and Perkins, 2010);

 receiving consent for the use of the S.T.E.A.M Activities Observation Grid (TPACK Observation Grid, Philippine Normal University, National Center for Teacher Education, Manila, 2020) (Appendix no. 4);

 analysis and interpretation of the S.T.E.A.M activity observation grid for the participating teachers from kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey (The tool is of our own design, it was developed by us, starting from the tools of researchers Morales et al., 2020);

 measuring and analyzing the performances of research participants, using the previously stated tools, in order to obtain relevant and valid data in order to meet the proposed objectives and measure the performances of research participants.

V.2. Research methodology used to collect initial data

V.2.1. The research method of curriculum documents and other school documents

In order to collect the initial data, we analyzed the curricular legislative documents: Law on pre-university education, no. 198/2023, Curriculum for early childhood education, 2019 and various related school documents: Key milestones in early learning and development of the child from birth to 7 years, Methodical letters, 2021-2023, Erasmus+ program guide, 2021-2023, Twinspaces projects: "S.T.E.A.M ACADEMY", "S.T.E.A.M WITH GREEN.

V.2.1.1. Analysis of concepts in curriculum documents

Pre-university education law no. 198/2023, p. 79, which was apply from2 September 2023, provides for the creation and operation of S.T.E.A.M/ȘTIAM clubs.

In addition to the education law, we analyzed the Curriculum for Early Education, 2019, which did not explicitly state the concepts stated above: the S.T.E.A.M didactic model and the eTwinning/Erasmus+ programs.

Respecting the recommendations provided in the Curriculum for Early Education, 2019, the practical applications of the educational program "S.T.E.A.M in kindergarten" were implemented within the eTwinning/Erasmus+ project "S-TEAM in kindergarten".

V.2.1.2. Analysis of concepts in school documents

Along with curriculum documents, we analyzed related school documents in this endeavor; thus, in order to plan the practical applications of S.T.E.A.M, we consulted: Fundamental bases in the learning and early development of the child from birth to 7 years

Along with the school documents presented above, we analyzed aspects related to the approach to the S.T.E.A.M didactic model for preschoolers, topics recommended for pedagogical circles and for the methodical activities highlighted in the Methodical Letters developed by the Ministry of Education in time of 2021-2023.

V.2.1.2. Analysis of the concepts in Erasmus+ program documents

We analyzed aspects related to the priorities, structure and specifics of eTwinning/Erasmus+ projects, according to the Erasmus+ Program Guide, 2023.

An eTwinning/Erasmus+ project comprises four stages, which start even before the project application is selected to receive funding, namely: planning, preparation, implementation and monitoring.

The previous experiences carried out within the eTwinning/Erasmus+ projects visible in the Twinspaces of the "S.T.E.A.M ACADEMY", "S.T.E.A.M WITH GREEN" projects contributed to the selection of the most suitable practical S.T.E.A.M applications for the realization of the "S.T.E.A.M in Kindergarten" educational program.

V.2.2. The observation method

To collect the initial data we used the observation method, having as research tools the Scale Preschool-Teacher for the preschoolers participating in the experiment and Observation Grid

of S.T.E.A.M activities (The tool is of our own design, it was developed by us, starting from the tools researchers Morales et al., 2020) for participating teachers.

In methodological complementarity with the Preschool Teacher Evaluation Scale, we used Observation Grid of S.T.E.A.M activities (The research tool was developed by us, for the preschool level, with the consent of the authors Morales et al., 2020).

V.2.3. The investigation method

The survey method had as research tools in our case, Questionnaire on the development of S.T.E.A.M skills at preschool level, through eTwinning/Erasmus+ projects and the Questionnaire for experts of the national eTwinning agency, Romania, of ANPCDEFP, Romania, eTwinning ambassadors, Erasmus+ ambassadors, school inspectors , addressed to teaching staff and associated parties in the educational process.

V.3. Application of the pretest

The pretest was applied to 255 older preschoolers from the 6 preschool education units in Bulgaria, Poland, Romania, Slovakia and Turkey, participating in the eTwinning/Erasmus+ project "S-TEAM in kindergarten", with the aim of identifying the levels of development of S.T.E.A.M skills (operationalized with the help of indicators: the level of observation skills, the level of communication skills, the level of collaboration skills, the level of mathematical skills and the level of digital skills).

V.4. Data processing and interpretation

The data obtained following the application of the questionnaires, the Preschool Teacher Evaluation Scale, the S.T.E.A.M activity observation grid were entered into the IBM SPSS Statistics 20 statistical program.

V.4.1. Analysis and interpretation of the questionnaire regarding the development of S.T.E.A.M skills at preschool level, through eTwinning/Erasmus+ projects, for teachers in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey

We applied to 482 teaching staff from all the counties of the country and from the city of Bucharest, the Questionnaire regarding the development of S.T.E.A.M skills at preschool level, through the eTwinning/Erasmus+ projects,

Most opinions focused on the importance of familiarizing preschoolers with the S.T.E.A.M didactic model, a fact that has a positive impact on the development of S.T.E.A.M (observation, communication, collaboration, mathematical and digital) skills. Also, most of the responding teaching staff highlighted the innovative character of the approach, motivating and attractive of the activities, applications carried out within this educational approach.

Analyzing the responses aimed at the profile of the teaching staff, we found that the instrument proposed by us was completed by teaching staff of all ages, with a harmonious professional development, from all counties of the country, both from urban and rural areas, which indicates the fact that, regardless of the place of origin, there is concern for the development of S.T.E.A.M skills in preschoolers through eTwinning/Erasmus+ projects.

V.4.2. Analysis and interpretation of the questionnaire for eTwinning ambassadors and Erasmus+ ambassadors, experts of the eTwinning Agency, Romania, of ANPCDEFP, Romania and school inspectors

We applied to 82 "stakeholders" - parties associated in the educational process, the Questionnaire for experts of the national eTwinning agency, Romania, of ANPCDEFP, Romania, eTwinning ambassadors, Erasmus+ ambassadors, school inspectors.

Regarding the opinions of Romanian and European teachers regarding the development of S.T.E.A.M skills through eTwinning/Erasmus+ projects, we noticed that there is confusion between S.T.E.A.M skills and the S.T.E.A.M didactic model.

We encountered the same personal opinions in the answers of the associated parties in education, regarding the level of training of teachers regarding the S.T.E.A.M teaching model and

regarding the eTwinning/Erasmus+ projects, therefore we consider it imperative to carry out continuous training courses for preschool teachers, on thematic S.T.E.A.M.

We found that regardless of the environment of origin or the institution where the respondents of the two questionnaires work, they recognize that practical S.T.E.A.M applications contribute to the development of S.T.E.A.M skills (observation skills, communication skills, collaboration skills, mathematical skills and digital skills).

V.4.3. Analysis and interpretation of the initial data regarding Evaluation Scale Teacher Prescholer

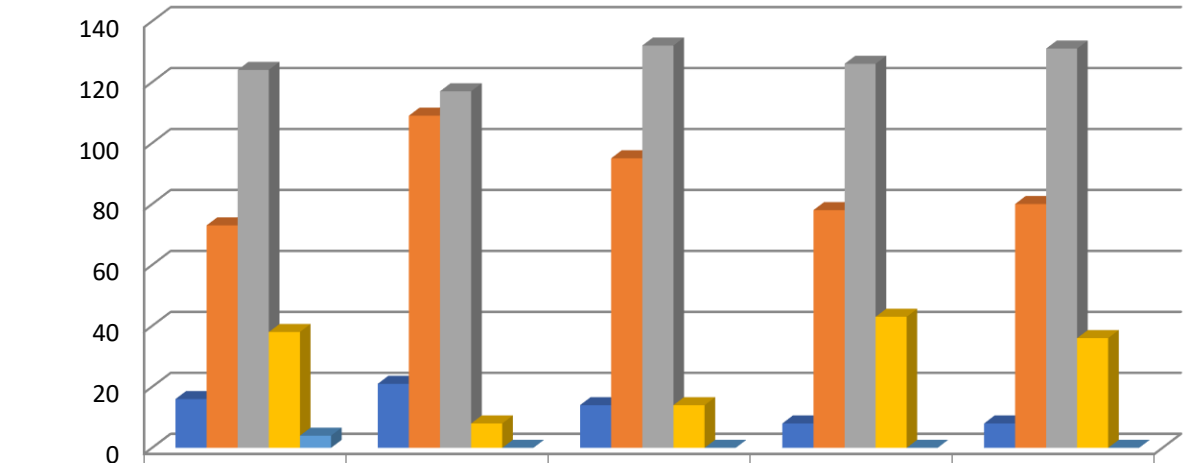
The data obtained following the application of the Evaluation Scale Preschool- Teacher (Appendix no. 3) to the 255 large preschoolers participating in the educational program "S.T.E.A.M in Kindergarten" within the eTwinning/Erasmus+ "S-TEAM in Kindergarten" project were entered in the statistical program IBM SPSS Statistics 20. We also present the level of development of observation, communication, collaboration, amteamtic and digital skills in older preschoolers, measured in the pre-experimental stage:

It was found that 6.3% of the children included in the study, respectively 16 children have a very poor level of development of observation skills, 28.6%), respectively 73 children have a poor level, 48.6%, respectively 124 of children have an average level, 14.9%, respectively 38 children have a good level and 1.6%, respectively 4 children have a very good level.

It was found that 8.2% of the children included in the study, respectively 21 children have a very low level of development of communication skills, 42.7%, respectively 109 children have a weak level, 45.9%, respectively 117 children they have an average level and 3.1%, respectively 8 children have a good level. No child achieved a very good level of development of communication skills.

It was found that 5.5% of the children included in the study, respectively 14 children have a very low level of development of collaboration skills, 37.3%, respectively 95 children have a weak level, 51.8%, respectively 132 children have an average level and 5.5%, respectively 14 children have a good level. No child achieved a very good level of development of collaborative skills.

It is found that 3.1% of the children included in the study, namely 8 children, have a very poor level of development of mathematical skills, 30.6%, respectively 78 children have a poor level, 49.4%, representing a number of 126 children have an average level, 16.9%, i.e. 43 children have a good level. No child achieved a very good level of development in mathematical skills.



	Level of observation skills	Level of communication skilss	Level of collaboration skills	Level of maths skills	Level of digital skills
very low	16	21	14	8	8
low	73	109	95	78	80
medium	124	117	132	126	131
good	38	8	14	43	36
very good	4	0	0	0	0

Figure no. 1.V.: *Distribution of the development levels of S.T.E.A.M (observation, communication, collaboration, mathematical and digital) skills of preschoolers, in the pre-experimental stage*

In table no. 2.V. the number of cases, mean, standard deviation, standard error and confidence interval are shown for each country:

Table no. 2.V.: *Descriptive statistics between countries*

S.T.E.A.M TOTAL	Nr	Media	Standard deviation	Standard error	95% interval		Minim	Maxim
					Low limit	Superior limit		
Romania	62	61.19	10.265	1.304	58.59	63.80	34	85
Bulgaria	73	74.16	11.992	1.404	71.37	76.96	25	100
Poland	75	64.51	15.910	1.837	60.85	68.17	25	100
Slovakia	25	72.96	10.573	2.115	68.60	77.32	50	90
Turkyie	20	75.15	12.902	2.885	69.11	81.19	50	100
Total	25	68.13	13.967	5.875	66.41	69.85	25	100

It can be seen that for the level of observation skills and for the level of mathematical skills, girls obtained higher averages than boys. For the other variables, the averages of girls and boys do not differ significantly from a statistical point of view.

Conclusion:

Following the results obtained, it was stated that the research instrument, represented by the Evaluation Scale Teacher-Preschooler, measured the levels of observation, collaborative communication, mathematical and digital skills of the 255 preschoolers from European kindergartens (Bulgaria, Romania , Poland, Slovakia, Turkey) participants in the educational program "S.T.E.A.M in Kindergarten".

Differences were identified between the level of S.T.E.A.M skills between the countries participating in the educational program, thus Romania recorded the lowest level, then in ascending order the levels are obtained by Bulgaria, Poland, Slovakia, and the highest level was recorded by Turkey. Higher averages were also recorded between the S.T.E.A.M skill levels of girls compared to boys.

V.4.4. Analysis and interpretation of the initial data regarding the Observation grid of ST.E.A.M activities

The data obtained following the initial evaluation by applying Observation grid of ST.E.A.M activities to the 22 teachers who implement the "S.T.E.A.M in Kindergarten"

educational program from the eTwinning/Erasmus+ "S-TEAM in Kindergarten" project were introduced into the IBM SPSS Statistics 2.0 statistics.

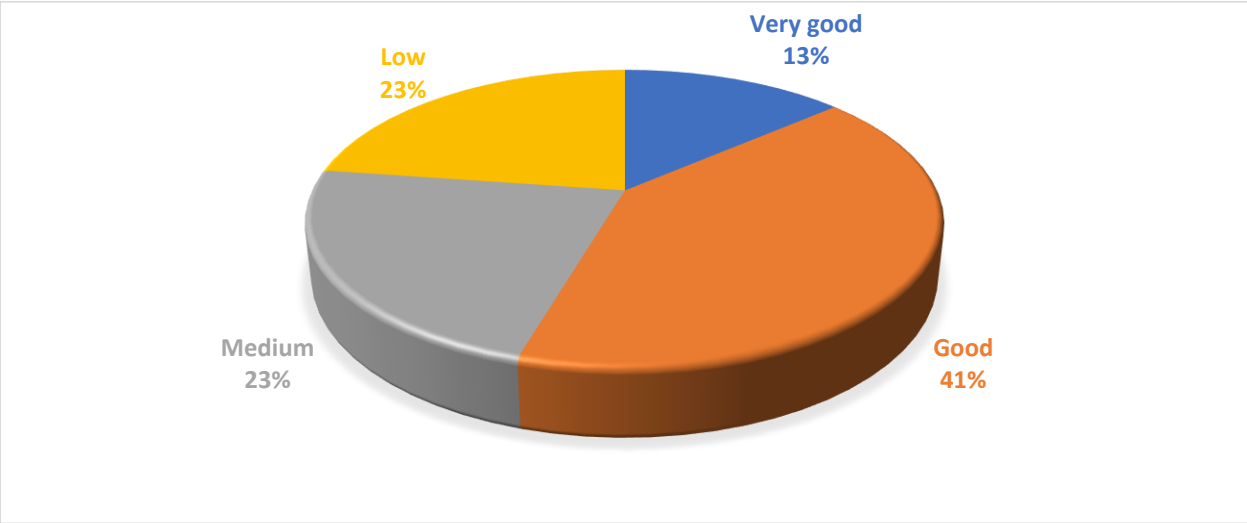


Figure no. 2.V.: *The distribution of the use of the S.T.E.A.M didactic model in content and didactic design among European teachers, in the pre-experimental stage*

It is found that 3 European teachers, representing 14%, have a very good level of using the S.T.E.A.M didactic model in content and didactic design, 9 teachers, representing the percentage of 41%, have a good level, 5 European teachers, representing 23%, have a average level, and 5 teachers representing 23% have a low level. No respondent with a very poor level was registered.

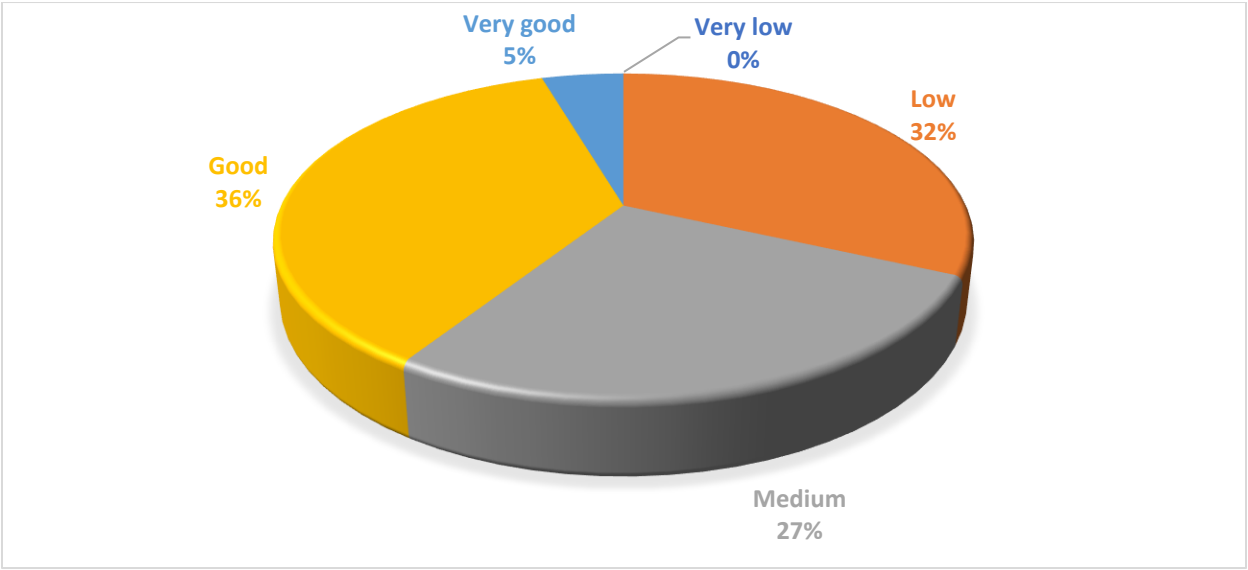


Figure no. 3.V.: *The distribution of the use of the S.T.E.A.M didactic model in the arrangement of the educational space among European teachers, in the pre-experimental stage*

Conclusions

Following the results obtained, it was found that the research tool, represented by the S.T.E.A.M activities observation grid, adapted for preschool level measured the level of use of the S.T.E.AM model in content and didactic design among European teachers, as well as in the use of the model didactic S.T.E.A.M for arranging the educational space of the 22 teachers from European kindergartens (Romania, Bulgaria, Poland, Slovakia, Turkey), participating in the educational program "S.T.E.A.M in kindergarten".

Regarding the use of the S.T.E.A.M didactic model in the arrangement of the educational space among the participating European teachers, a good and average level of use is found, of approximately 63%, and a poor level of 32% of the arrangement of the educational space, a much higher percentage than in the first concept.

CHAPTER VI

EXPERIMENTAL STAGE

VI.1. General description of the training experiment

The program of practical applications elaborated by us received the name "S.T.E.A.M in Kindergarten", it was implemented between March and May 2024 within the eTwinning project "S-TEAM in Kindergarten" on a sample of 255 large preschoolers.

The practical applications from the S.T.E.A.M area ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc.) within the program were implemented in the six preschool educational institutions in country and abroad in order to offer preschoolers the opportunity to develop the levels of observation, communication, collaboration, mathematical and digital skills, respecting their age characteristics and the methodical provisions regarding the instructional-educational activities in the kindergarten.

After completing each practical S.T.E.A.M application, European teachers completed the S.T.E.A.M Teacher's Document, made in English with the help of the Google Forms application through which the levels of S.T.E.A.M skills in older preschoolers were measured.

VI.2. Aims of the experimental stage

The objectives that were the basis of the experimental stage were:

- ✓ the development of the educational program "S.T.E.A.M in kindergarten" within the eTwinning/Erasmus+ project "S-TEAM in kindergarten", which included 12 practical S.T.E.A.M applications;
- ✓ the design, implementation and coordination of practical applications in the S.T.E.A.M area ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc.) to support the

development of the levels of observation skills, communication, collaboration, mathematical and digital skills of older preschoolers;

- ✓ the completion of the S.T.E.A.M teacher's sheet by the teaching staff after completing each application within the educational program "S.T.E.A.M in kindergarten";
- ✓ the analysis of the products made within the educational program "S.T.E.A.M in kindergarten" within the eTwinning/Erasmus+ project "S-TEAM in kindergarten" in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey located in the Twinspace of the project;
- ✓ analysis and interpretation of the S.T.E.A.M Teacher's Document.

VI.3. Educational program "S.T.E.A.M in kindergarten", within the eTwinning/Erasmus+ project "S-TEAM in kindergarten", in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey

The educational program, was developed and implemented during three months, March-May of the 2023-2024 school year, it consisted of 12 practical applications from the area of S.T.E.A.M.

Their planning was systematic like this, one practical application was made per week (with the exception of school holidays in Bulgaria, Poland, Romania, Slovakia and Turkey).

VI.4. Research methodology for data collection within the experimental stage

VI.4.1. Method of observation. S.T.E.A.M Teacher’s Document

The observation method had as a research tool in the experimental stage, S.T.E.A.M Teacher's Document, research tool addressed to the 22 teachers participating in the "S.T.E.A.M in Kindergarten" educational program, within the eTwinning/Erasmus+ project. S-TEAM in kindergarten", was completed at the end of each S.T.E.A.M practical application.

The research instrument aimed to assess the level of development of observation, communication, collaboration, mathematical and digital skills of older preschoolers.

VI.4.2. Method of analyzing the works/products of the activity, the Twinspace of the eTwinning/Erasmus+ project "S-TEAM in kindergarten"

The eTwinning program is an initiative of the European Commission since 2005 and aims to promote learning and collaboration between different European schools through a learning platform (ESEP) using information and communication technologies. The eTwinning program offers participants the opportunity to create joint educational projects based on similar learning needs where teachers and students/preschoolers learn, explore, collaborate and share learning experiences.

The eTwinning/Erasmus project "S-TEAM in kindergarten" represented a digital educational collaboration on the theme of S.T.E.A.M, lasting six calendar months (January-June 2024) between six preschool level institutions from Bulgaria, Poland, Romania, Slovakia and Turkey. The project was included in the Erasmus+ action, KA1, School Education Accreditation of the Romanian partner.

The European educational collaboration space, the Twinspace of our project "S-TEAM in kindergarten" is available at this link: https://school-education.ec.europa.eu/en/etwinning/projects/s-team-kindergarten/ twinspace

VI.5. Processing data and interpretation

VI.5.1. Analysis and interpretation of the S.T.E.A.M Teacher's Document in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey

We applied the S.T.E.A.M Teacher's Document, after each S.T.E.A.M practical application to preschoolers in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey, in the period March-May 2024, and then I reproduced the obtained results.

After analyzing the results obtained, it was found that the research tool, represented by the S.T.E.A.M Teacher's Document, measured the development levels of observation, communication, cooperation, mathematical and digital skills in the 255 preschoolers from European kindergartens (Bulgaria, Romania, Poland, Slovakia, Turkey) participants in the educational program "S.T.E.A.M in Kindergarten", after the implementation of each S.T.E.A.M

practical application. Advanced levels of observation, communication, cooperation, mathematical and digital skills were identified in over 60% of European preschoolers following the realization of S.T.E.A.M practical applications, then average percentages, between 24-28%, corresponding to the intermediate level of S.T.E.A.M skills and low value percentages, between 4-10%.

CHAPTER VII

POST-EXPERIMENTAL STAGE

VII.1. Aims of the post-experimental stage

The objectives that formed the basis of our research in the post-experimental stage were the following:

- □ Collecting and interpreting data by applying the Questionnaire addressed to teachers involved in the implementation of S.T.E.A.M practical applications ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc.), addressed to teachers participating in the "S.T.E.M. in kindergarten" program within the eTwinning/Erasmus+ project "S-TEAM in kindergarten";
- □ Completion of the Evaluation Scale Teacher-Preschoolerfor each preschooler participating in the "S.T.E.A.M in Kindergarten" program within the eTwinning/Erasmus+ "S-TEAM in Kindergarten" project;
- □ Completion of the Observation Grid of S.T.E.A.M activities by each teacher participating in the "S.T.E.A.M in Kindergarten" program within the eTwinning/Erasmus+ "S-TEAM in Kindergarten" project;
- □ Evaluation, with the help of the previously mentioned tools, of the performances of the research participants.

VII.2. Research methodology used to collect the final data

In this stage, we used the research methods and tools as in the pre-experimental stage, with the aim of measuring the level of S.T.E.A.M skills of preschoolers, as follows:

- ✓ □ For the survey method, the Questionnaire addressed to teaching staff involved in the implementation of S.T.E.A.M practical applications ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc.) (Annex no. 6), addressed to the 22 European

teachers participating in the "S.T.E.A.M in kindergarten" program within the eTwinning/Erasmus+ "S-TEAM in kindergarten" project;

- ✓ □ For the observation method, Evaluation Scale Teacher-Preschooler and the Observation grid of S.T.E.A.M activities

VII.3. Application of the posttest

The posttest was applied to 255 preschoolers from the 6 European educational units in Bulgaria, Poland, Romania, Slovakia and Turkey, participating in the program "S.T.E.A.M in kindergarten" in the eTwinning/Erasmus+ project "S-TEAM in kindergarten", with the aim to identify the levels of development of S.T.E.A.M skills (operationalized with the help of indicators: the level of observation skills, the level of communication skills, the level of collaboration skills, the level of mathematical skills and the level of digital skills).

In May 2024, the Questionnaire addressed to teaching staff involved in the implementation of S.T.E.A.M practical applications ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc.) was applied to the 22 teachers participating in the eTwinning/Erasmus+ project "S-TEAM in kindergarten".

Also in the same calendar period, namely the month of May 2024, Evaluation Scale Teacher-Preschooler and the Observation grid of S.T.E.A.M activities were applied to preschoolers and teaching staff in the kindergartens participating in the project eTwinning/Erasmus+ "S-TEAM in kindergarten".

VII.4. Processing and data interpretation

The data obtained from the application of the questionnaires, Evaluation Scale Teacher-Preschooler, Observation grid of S.T.E.A.M activities were entered into the IBM SPSS Statistics 20 statistical program. The results obtained from the statistical processing were presented, generally and individually, for each measured indicator .

Next, I presented the descriptive analysis of the research tools listed above, applied in chronological order.

VII.4.1. Analysis and interpretation of the Questionnaire addressed to teaching staff involved in the realization of S.T.E.A.M practical applications: ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc.), within the eTwining project /Erasmus+ "S-TEAM in kindergarten", in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey

Questionnaire addressed to the teaching staff involved in the implementation of S.T.E.A.M practical applications: ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc.) (Questionnaire addressed to the teaching staff involved in the implementation of the S.T.E.A.M. applications), were applied to the 22 European teachers (100%), of which 6 come from Bulgaria, 6 from Romania, 6 from Poland, 2 from Slovakia and 2 from Turkey.

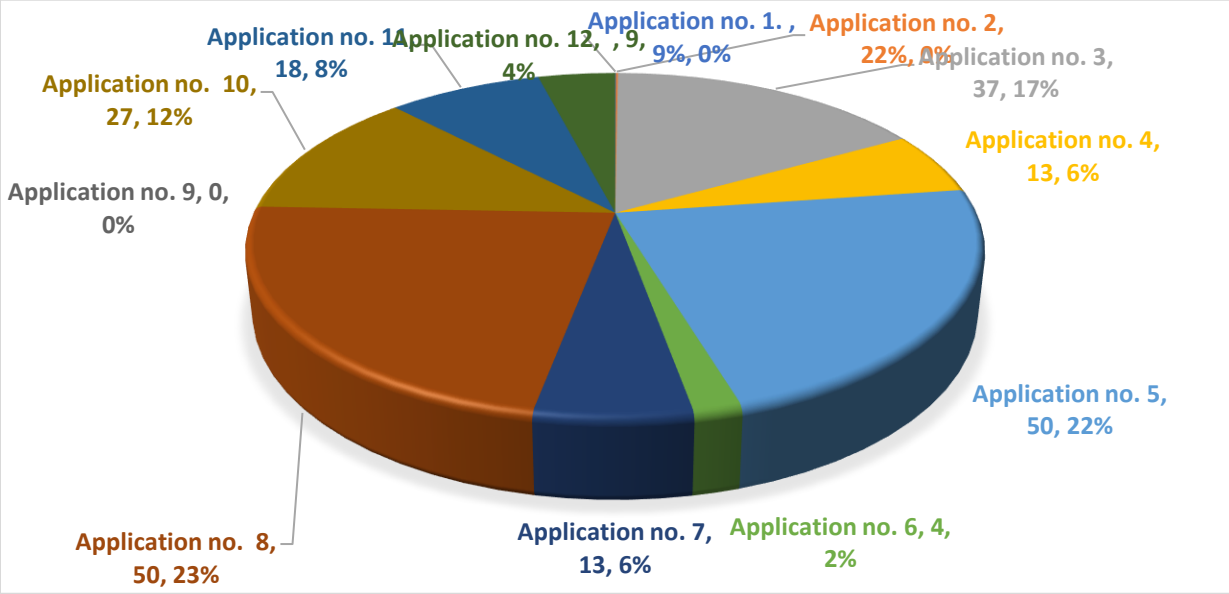


Figure no. 1.VII.: *The easiest S.T.E.A.M practical applications to achieve*

Lack of time, lack of financial resources for the purchase of expensive teaching materials (Neodymium magnets, Lego kits, Ozobots, etc.), the absence of professional training in S.T.E.A.M., the lack of information about the eTwinning/Erasmus+ program and its funded

actions from of national agencies, the young age of preschoolers to hold a conversation in English, the difficulty of using the ESEP-eTwinning platform, support from competent institutions were the main inhibiting factors extracted from the responses of European teachers.

VII.4.2. Analysis and interpretation of the final data on the Evaluation Scale Teacher-Preschooler

The data obtained following the final evaluation by applying the Evaluation Scale Teacher-Preschooler to the 255 large preschoolers participating in the educational program "S.T.E.A.M in kindergarten" within the eTwinning/Erasmus+ project "S-TEAM in kindergarten", at the end of May 2024 have were entered into the IBM SPSS Statistics 20 statistical program.

The presentation of the results obtained as a result of the statistical processing is carried out from general to particular, being presented comparatively, common, individually by country and according to biological sex.

Objectives:

 analysis of the level of development of observation, communication, collaboration, mathematical and digital skills in older preschoolers through the implementation of the educational program "S.T.E.A.M in Kindergarten" within the eTwinning/Erasmus+ "S-TEAM in Kindergarten" project;

 analysis of the level of development of observation, communication, collaboration, mathematical and digital skills in each of the countries of origin of older preschoolers and according to the biological gender of preschoolers.

- ✓ The mean of S.T.E.A.M skills for the group from Romania (M=100.50) was not statistically significantly different ($p>0.05$) compared to the mean of the group from Bulgaria (M=103.79) and the group from Poland (M=101.37), of the group from Slovakia (M=98.32) and the group from Turkey (M=103.60);
- ✓ The average S.T.E.A.M skills for the group from Bulgaria (M=103.79) was not statistically significantly different ($p>0.05$) compared to the average S.T.E.A.M skills of the Romanian group (M=100.50), the Polish group (M=101.37), of the group from Slovakia (M=98.32) and the group from Turkey (M=103.60);

- ✓ The mean S.T.E.A.M skills for the Polish group (M=101.37) was not statistically significantly different (p>0.05) compared to the mean S.T.E.A.M skills of the Romanian group (M=100.50), the Bulgarian group (M=103.79), of the group from Slovakia (M=98.32) and the group from Turkey (M=103.60);
- ✓ The mean S.T.E.A.M skills for the group from Slovakia (M=98.32) was not statistically significantly different (p>0.05) compared to the mean S.T.E.A.M skills of the Romanian group (M=100.50), the group from Bulgaria (M=103.79), of the group from Poland (M=101.37) and the group from Turkey (M=103.60);
- ✓ The mean S.T.E.A.M skills for the Turkish group (M=103.60) was not statistically significantly different (p>0.05) compared to the mean S.T.E.A.M skills of the Romanian group (M=100.50), the Bulgarian group (M=103.79), of the group from Poland (M=101.37) and the group from Slovakia (M=98.32);
- ✓ The average for the level of observation skills of boys, evaluated in the post-experimental stage (Mean=20.47, AS=2.658) does not differ significantly (t=-1.888, two-tailed p>0.05) from the average for the level of observation skills of girls (Mean=21.09, SD=2.542).
- ✓ The mean for the level of communication skills of the boys, evaluated in the post-experimental stage (Mean=19.75, AS=2.514) does not differ significantly (t=-0.005, two-tailed p>0.05) from the mean for the level of communication skills of girls (Mean=19.75, AS=2.831).
- ✓ The mean for the level of collaboration skills of the boys, evaluated in the post-experimental stage (Mean=19.93, AS=2.448) does not differ significantly (t=-0.151, two-tailed p<0.05) from the mean for the level of collaboration skills of girls (Mean=19.88, SD=2.697).
- ✓ The average for the level of mathematical abilities of boys, evaluated in the post-experimental stage (Mean=20.51, AS=2.509) does not differ significantly (t=-1.501, two-tailed p>0.05) from the average for the level of mathematical abilities of girls (Mean=21.02, SD=2.877).
- ✓ The average for the digital skills level of boys, evaluated in the post-experimental stage (Mean=20.39, AS=2.597) does not differ significantly (t=-1.224, two-tailed p>0.05) from the average for the digital skills level of girls (Mean=20.82, SD=3.018).

- ✓ It can be observed that, within the post-experimental stage, there were no statistically significant differences between the averages of girls and boys for the variables taken into account.
- ✓ Observation skills correlate positively with communication skills (r=466, df=253, p<0.01), with collaboration skills (r=423, df=253, p<0.01), with mathematical skills (r =671, df=253, p<0.01) and with digital skills (r=640, df=253, p<0.01);
- ✓ Communication skills correlate positively with observation skills (r=466, df=253, p<0.01), with collaboration skills (r=864, df=253, p<0.01), with mathematical skills (r=434, df=253, p<0.01) and with digital skills (r=402, df=253, p<0.01);
- ✓ Collaboration skills correlate positively with observation skills (r=423, df=253, p<0.01), with communication skills (r=864, df=253, p<0.01), with mathematical skills (r=530, df=253, p<0.01) and with digital skills (r=505, df=253, p<0.01);
- ✓ Mathematical skills correlate positively with observation skills (r=671, df=253, p<0.01), with communication skills (r=434, df=253, p<0.01), with collaboration skills (r=530, df=253, p<0.01) and with digital skills (r=936, df=253, p<0.01);
- ✓ Digital skills correlate positively with observation skills (r=640, df=253, p<0.01), with communication skills (r=402, df=253, p<0.01), collaboration skills (r =505, df=253, p<0.01) and with mathematical skills (r=936, df=253, p<0.01);

It can be seen that between all five variables there are statistically significant positive correlations, which means that preschoolers with high scores on one of the variables also have high scores on the other variables.

VII.4.3. Analysis and interpretation of the final data regarding the Observation Grid of S.T.E.A.M activities

The data obtained in the post-experimental stage by applying the Observation Grid of S.T.E.A.M activities to the 22 teachers who implemented the educational program "S.T.E.A.M in Kindergarten" in the eTwinning/Erasmus+ "S-TEAM in Kindergarten" project were introduced in the program of IBM SPSS Statistics 20 statistic.

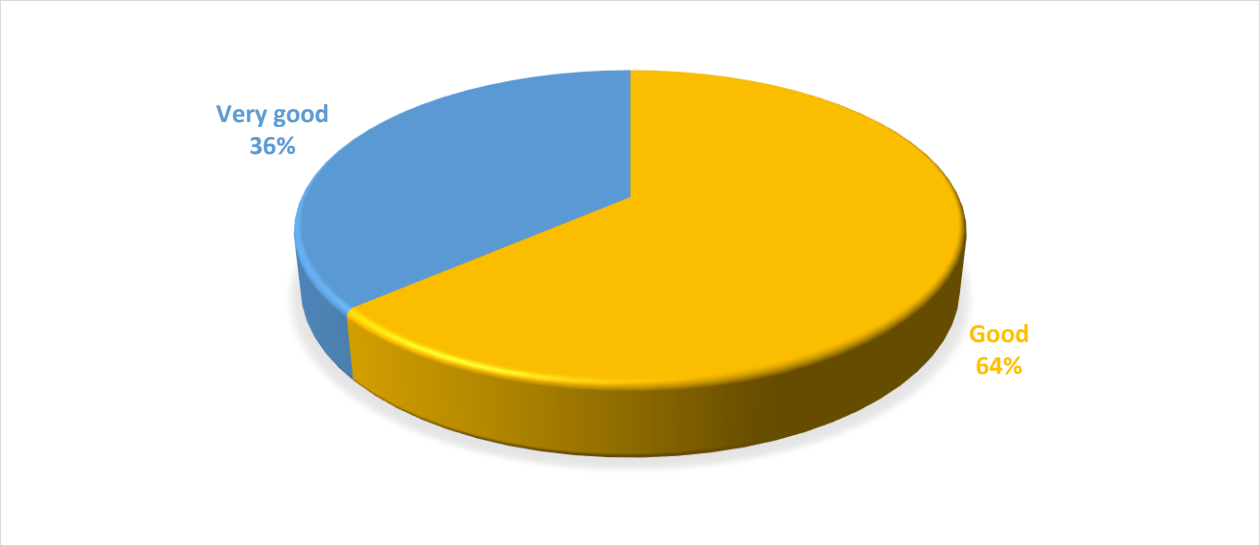


Figure no. 2.VII.: *Distribution of the level of use of the S.T.E.A.M model in content and didactic design among European teachers, in the post-experimental stage*

It can be seen in figure that 63.6%, respectively a number of 14 teaching staff among the European teachers included in the study have a good level and 36.4%, respectively a number of 8 teaching staff have a very good level of using the model S.T.E.A.M in contents and didactic design, in the post-experimental stage. No teacher obtained a medium level, a weak level and a very low level of using the S.T.E.A.M model in contents and didactic design, in the post-experimental stage.

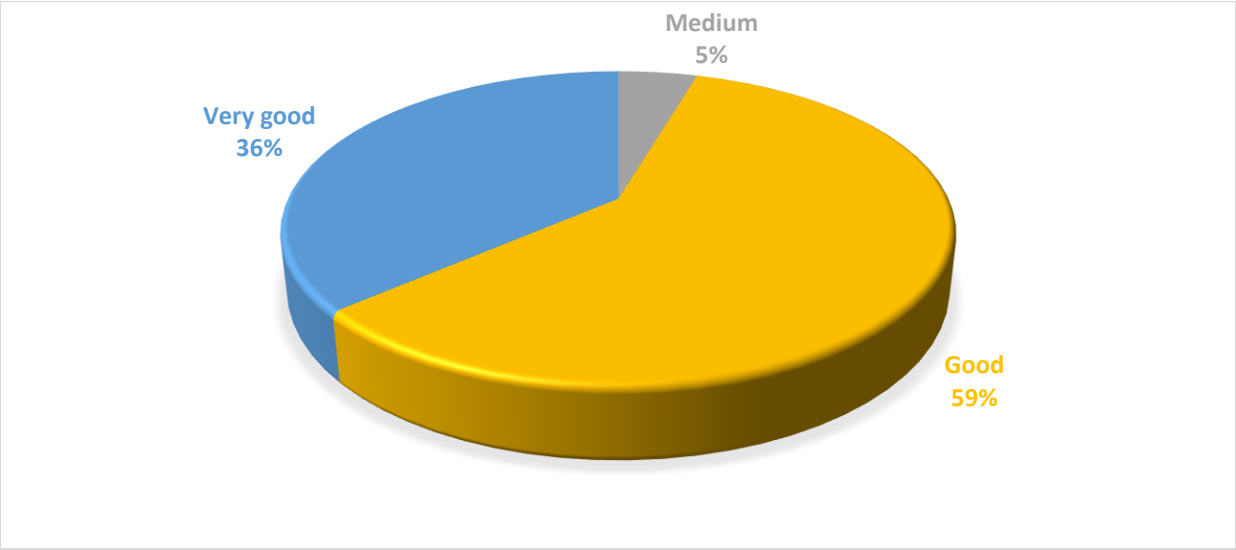


Figure no. 3.VII.: *The distribution of the level of use of the S.T.E.A.M model in the arrangement of the educational space among European teachers, in the post-experimental stage*

It can be seen in that 59.1%, i.e. 13 teachers have a good level and 36.4%, i.e. 8 teachers have a very good level, and 4.5%, i.e. 1 teacher, has an average level of educational environment in the S.T.E.A.M didactic model. No teacher achieved a poor or very poor level of setting up the educational environment in the S.T.E.A.M didactic model, in the post-experimental stage.

VII.5. Comparative analysis of the results obtained in the pre-experimental and post-experimental stages by applying the Evaluation Scale Teacher-Preschooler

The experimental study in preschoolers. The research design:

The research model used is based on the experiment strategy, uni-factorial model with a single group. The main condition for a research to meet the quality of an experiment is the selection or random assignment of subjects to the research group(s). Among the uni-factorial models with a single group, we chose the "before-after" model with a single group, in which the dependent variable is measured twice: on the experimental group, before and after the intervention.

The one-group unifactorial model. Experimental design

a) Independent variable: the educational program "S.T.E.A.M in kindergarten" in the eTwinning/Erasmus+ project "S-TEAM in kindergarten";

b) Dependent variables: the level of development of S.T.E.A.M skills in preschoolers operationalized by:

- observation skills;
- communication skills;
- collaboration skills;
- mathematical skills;
- digital skills.

The experimental group was composed of 255 preschoolers from 5 countries. Of these, 139 preschoolers were boys and 116 were girls. During the implementation of the educational program "S.T.E.A.M in kindergarten", in the eTwinning/Erasmus+ project "S-TEAM in kindergarten", there were no losses of subjects.

• Presentation and analysis of experimental study data

The hypothesis from which we started in the research was:

There are differences regarding the level of development of S.T.E.A.M skills in preschoolers from the experimental group in the pre-experimental and post-experimental stage, after the application of the intervention program, the educational program "S-TEAM in kindergarten" in the eTwinning/Erasmus+ project "S-TEAM in kindergarten".

In the case of comparing two averages obtained on paired samples, the null hypothesis (H0) can be stated as follows: We assume that the differences between the two averages are due to chance and that there are no differences between the level of development of S.T.E.A.M skills in preschoolers in the experimental group, in the post-experimental stage and in the pre-experimental stage.

• Paired-samples-total-subjects t-test

The averages from the pre-experimental stage and from the post-experimental stage were calculated, for the entire group that benefited from the intervention, and comparisons were made between the averages for the two variables taken into account, applying the t-test for paired samples. For the statistical analysis we used the IBM SPSS Statistics 20 application. The results obtained are presented, condensed, in the following table in terms of: the number of students (N), the mean (M), the standard deviation (AS), the t-test (t), the threshold of meaning (p).

The mean for the variable level of development of observation skills, in the post-experimental stage (Mean=20.75, AS=2.619), was significantly higher from a statistical point of view (t=-39.923, p<0.01), than mean from the pre-experimental stage (Mean=14.26, AS=3.754).

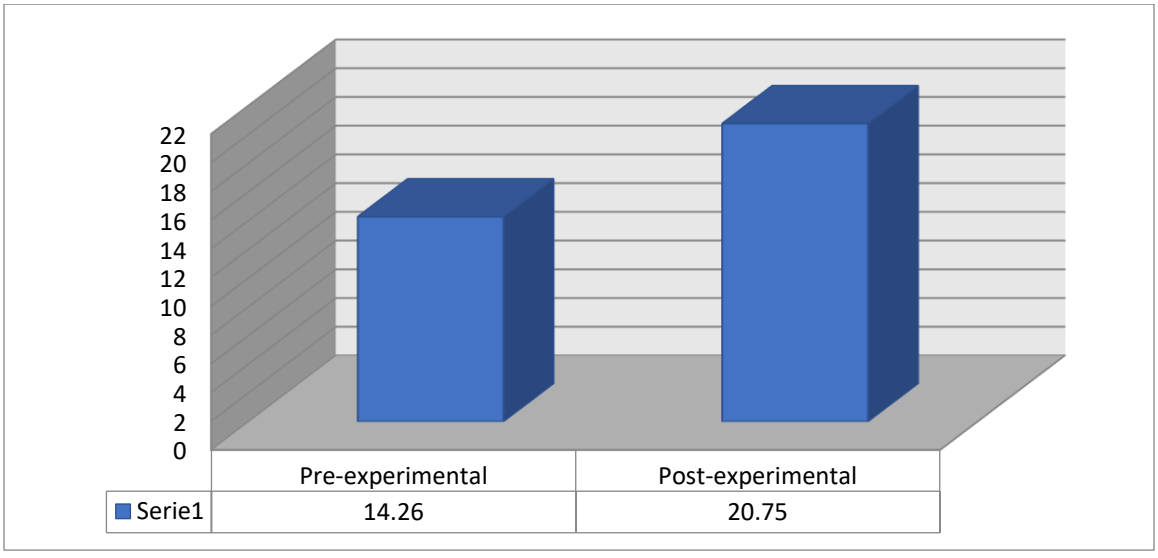


Figure no. 4.VII.: *Comparisons of pre-experimental-post-experimental stages for the dependent variable, the level of development of observation skills*

The mean for the variable level of development of communication skills, in the post-experimental stage (Mean=19.75, AS=2.658), was significantly higher from a statistical point of view (t=-39.787, p<0.01), than average from the pre-experimental stage (Mean=12.55, AS=3.196).

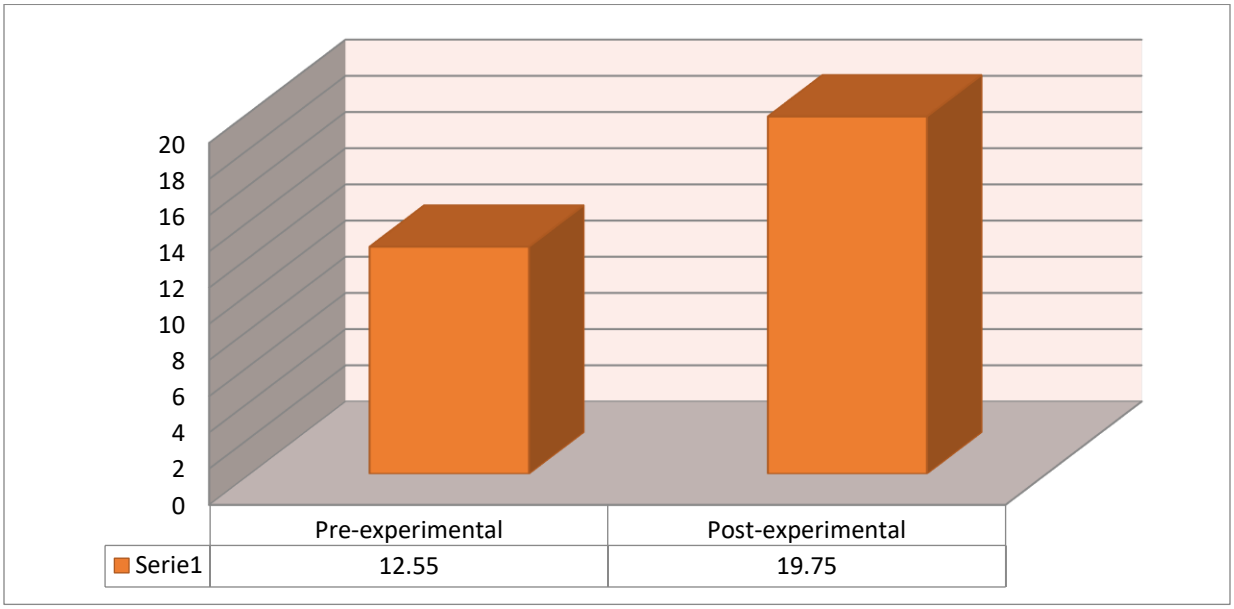


Figure no. 5.VII.: *Comparisons of pre-experimental-post-experimental stages for the dependent variable the level of development of communication skills*

The mean for the variable level of development of collaboration skills, in the post-experimental stage (Mean=19.91, AS=2.559), was significantly higher from a statistical point of view (t=-40.556, p<0.01), than mean from the pre-experimental stage (Mean=13.13, AS=3.183).

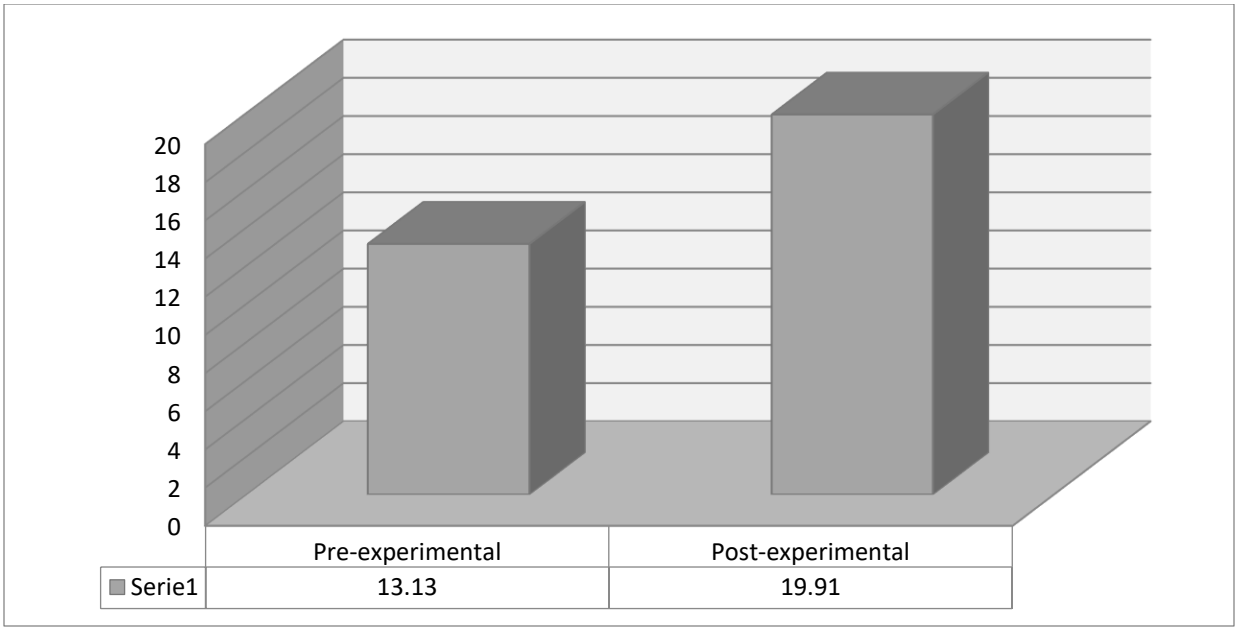


Figure no. 6.VII.: *Comparisons of pre-experimental-post-experimental stages for the dependent variable the level of development of collaboration skills*

The mean for the variable level of development of mathematical skills, in the post-experimental stage (Mean=20.74, AS=2.689), was statistically significantly higher (t=-40, 703, p<0.01), than the average from the pre-experimental stage (Mean=14.18, AS=3.546).

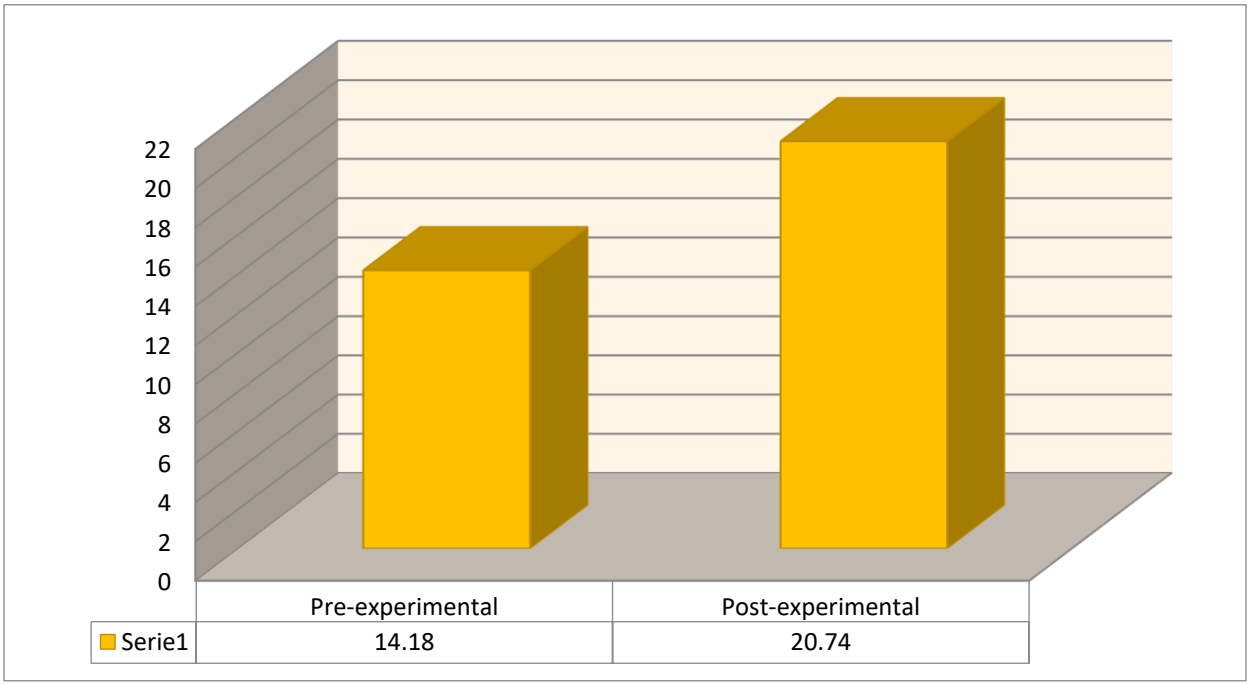


Figure no. 7.VII.: *Comparisons of pre-experimental-post-experimental stages for the dependent variable, the level of development of mathematical skills*

The mean for the variable level of digital skill development, in the post-experimental stage (Mean=20.58, AS=2.799), was statistically significantly higher (t=-37.678, p<0.01) than the mean from the pre-experimental stage (Mean=14.02, AS=3.458).

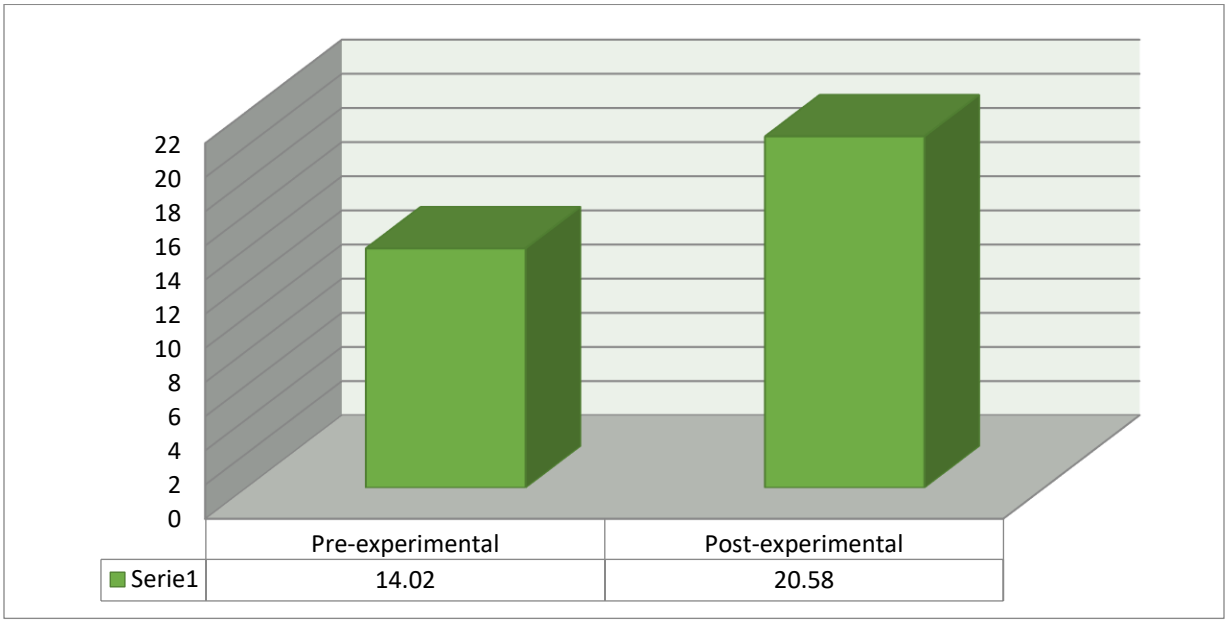
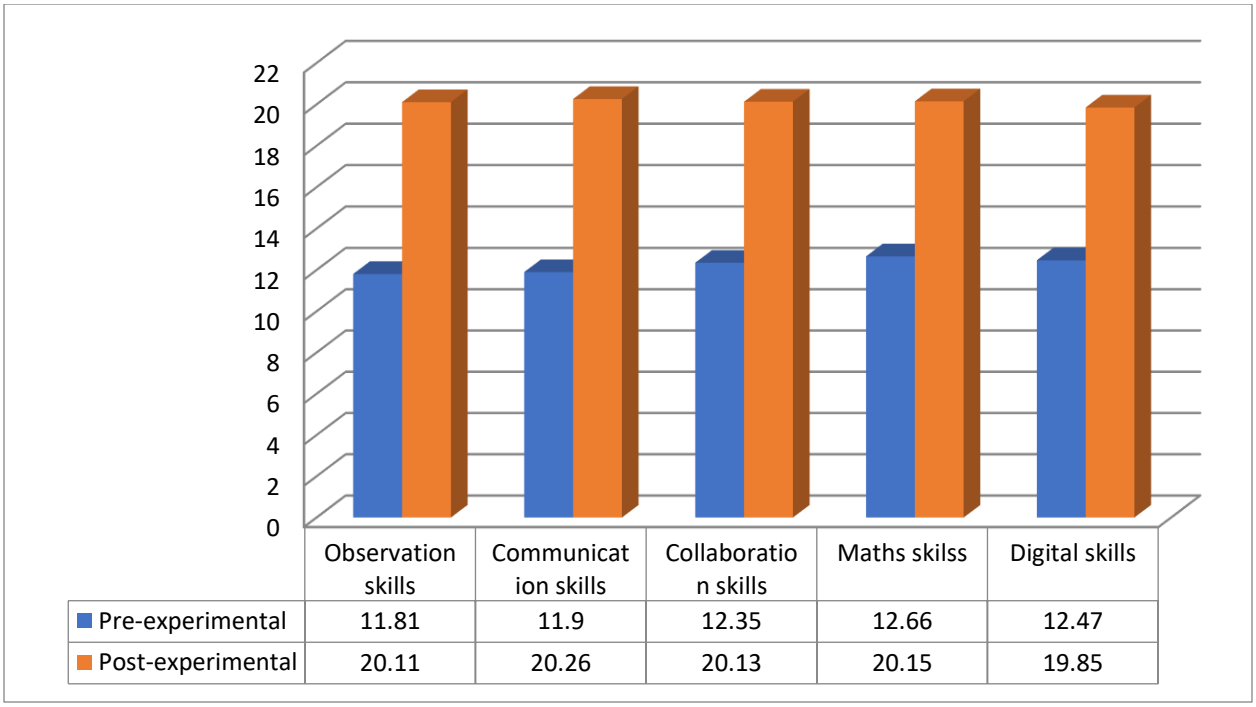


Figure no. 8.VII.: *Comparisons of pre-experimental-post-experimental stages for the dependent variable the level of development of digital skills*

We present below, the examination of the differences between the five countries (Bulgaria, Poland, Romania, Slovakia, Turkey), regarding the level of development of S.T.E.A.M (observation, communication, collaboration, mathematical and digital) skills, in the pre-experimental stage and in the post-experimental one.



	Observation skills	Communication skills	Collaboration skills	Maths skilss	Digital skills
Pre-experimental	11.81	11.9	12.35	12.66	12.47
Post-experimental	20.11	20.26	20.13	20.15	19.85

Figure no. 9.VII.: *Comparisons of pre-experimental-post-experimental stages for S.T.E.A.M skill levels for Romania*

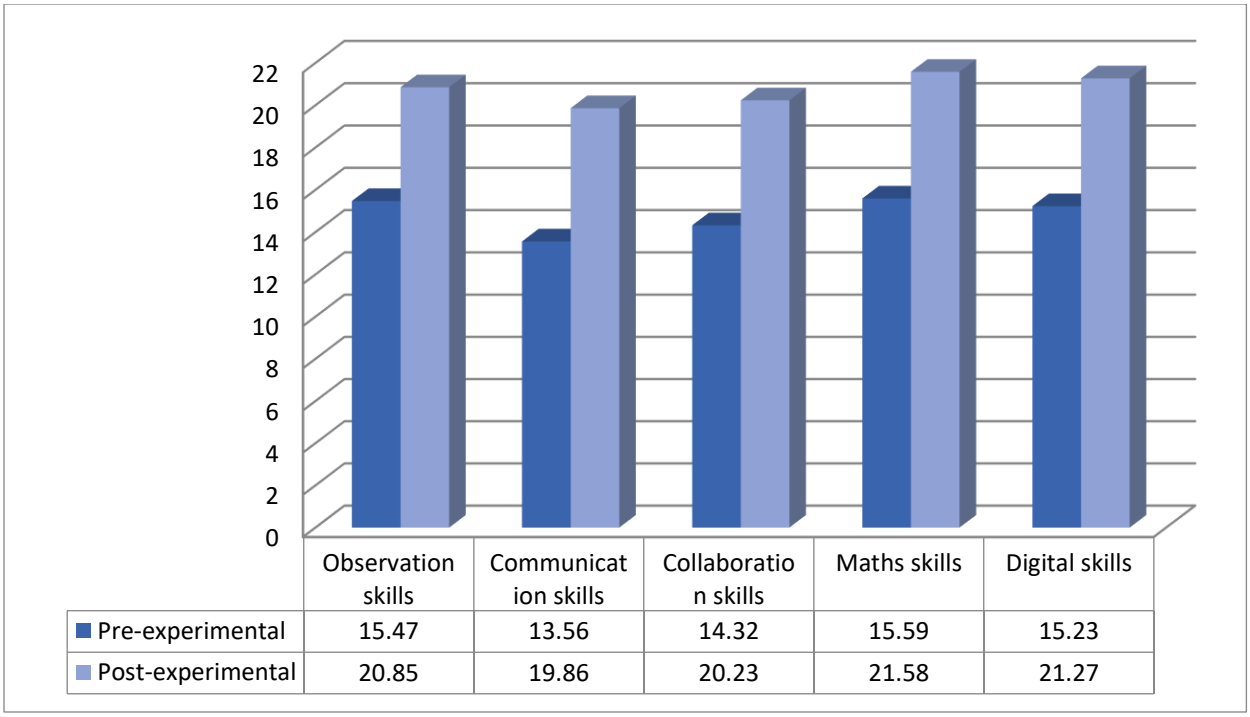
The mean for the variable level of development of observation skills, in the post-experimental stage (Mean=20.11, AS=2.592), was significantly higher from a statistical point of view (t=-24.103, p<0.01), than mean from the pre-experimental stage (Mean=11.81, AS=2.204).

The mean for the variable level of development of communication skills, in the post-experimental stage (Mean=20.26, AS= 2.579), was significantly higher from a statistical point of view (t=-19.307, p<0.01), than average from the pre-experimental stage (Mean=20.26, AS=2.579).

The mean for the variable level of development of collaboration skills, in the post-experimental stage (Mean=20.13, AS=2.405), was significantly higher from a statistical point of view (t=-19.872, p<0.01), than the mean in pre-experimental stage (Mean=12.35, AS=2.770).

The mean for the variable level of development of mathematical skills, in the post-experimental stage (Mean=20.15, AS=2.282), was significantly higher from a statistical point of view (t=-20.803, p<0.01), than the mean in the stage pre-experimental (Mean=12.66, SD=2.442).

The average for the variable level of development of digital skills, in the post-experimental stage (Mean=19.85, AS=2.534) was significantly higher from a statistical point of view (t=-37.678, p<0.01), than the average in the pre-experimental stage (Mean=12.47, SD=2.487).



	Observation skills	Communication skills	Collaboration skills	Maths skills	Digital skills
Pre-experimental	15.47	13.56	14.32	15.59	15.23
Post-experimental	20.85	19.86	20.23	21.58	21.27

Figure no. 10.VII.: *Pre-experimental-post-experimental stage comparisons for S.T.E.A.M skill levels for Bulgaria*

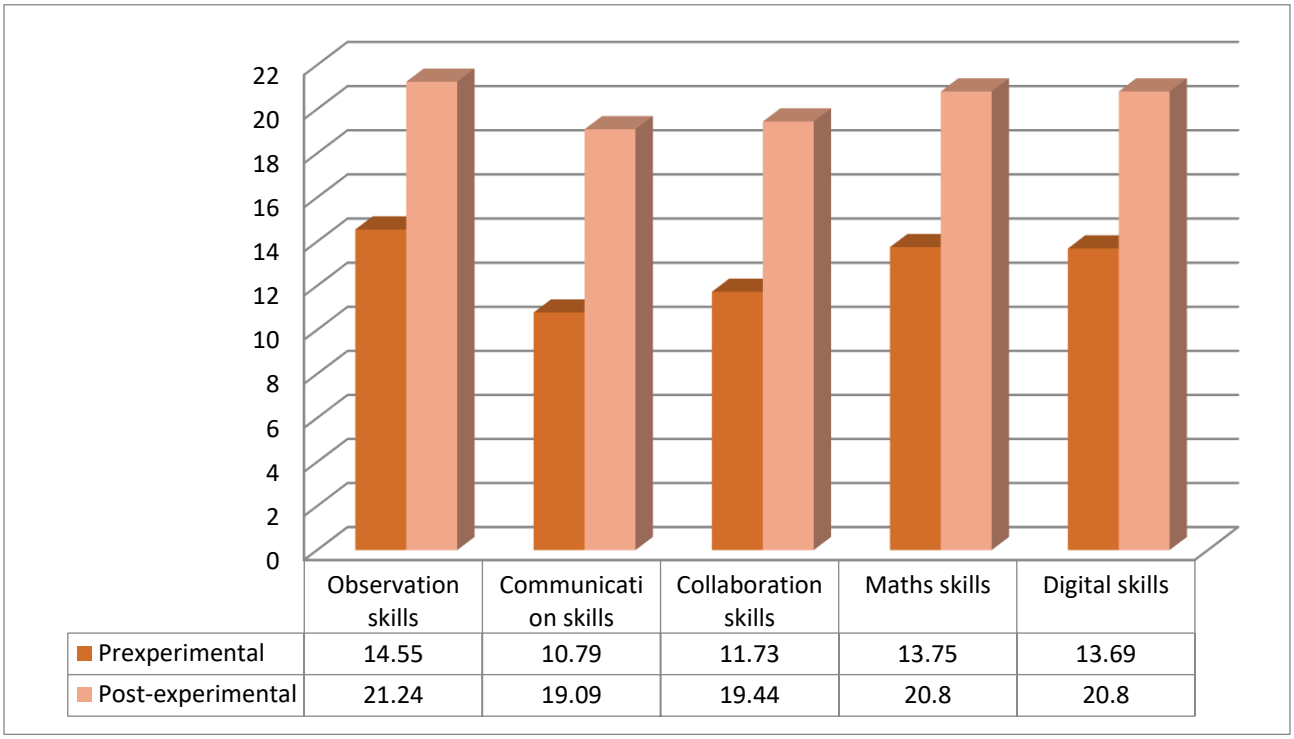
The mean for the variable level of development of observation skills, in the post-experimental stage (Mean=20.85, AS=2.569), was significantly higher from a statistical point of view (t=-24.147, p<0.01), than the mean in pre-experimental stage (Mean=15.47, AS=3.042).

The mean for the variable level of development of communication skills, in the post-experimental stage (Mean=19.86, AS=2.440), was significantly higher from a statistical point of view (t=-22.803, p<0.01), than the mean in pre-experimental stage (Mean=13.56, AS=2.478).

The mean for the variable level of development of collaboration skills, in the post-experimental stage (Mean=20.23, AS=2.492), was significantly higher from a statistical point of view (t=-26.134, p<0.01), than the mean in pre-experimental stage (Mean=14.32, AS=2.905).

The mean for the variable level of development of mathematical skills, in the post-experimental stage (Mean=21.58, AS=2.505), was significantly higher from a statistical point of view (t=-22.005, p<0.01), than the mean in the stage pre-experimental (Mean=15.59, SD=3.270).

The mean for the variable level of development of digital skills, in the post-experimental stage (Mean=21.27, AS=2.740), was significantly higher from a statistical point of view (t=-19.227, p<0.01), than the mean in the stage pre-experimental (Mean=15.23, AS=3.151).



	Observation skills	Communication skills	Collaboration skills	Maths skills	Digital skills
Prexperimental	14.55	10.79	11.73	13.75	13.69
Post-experimental	21.24	19.09	19.44	20.8	20.8

Figure no. 11.VII.: *Pre-experimental-post-experimental stage comparisons for S.T.E.A.M skill levels for Poland*

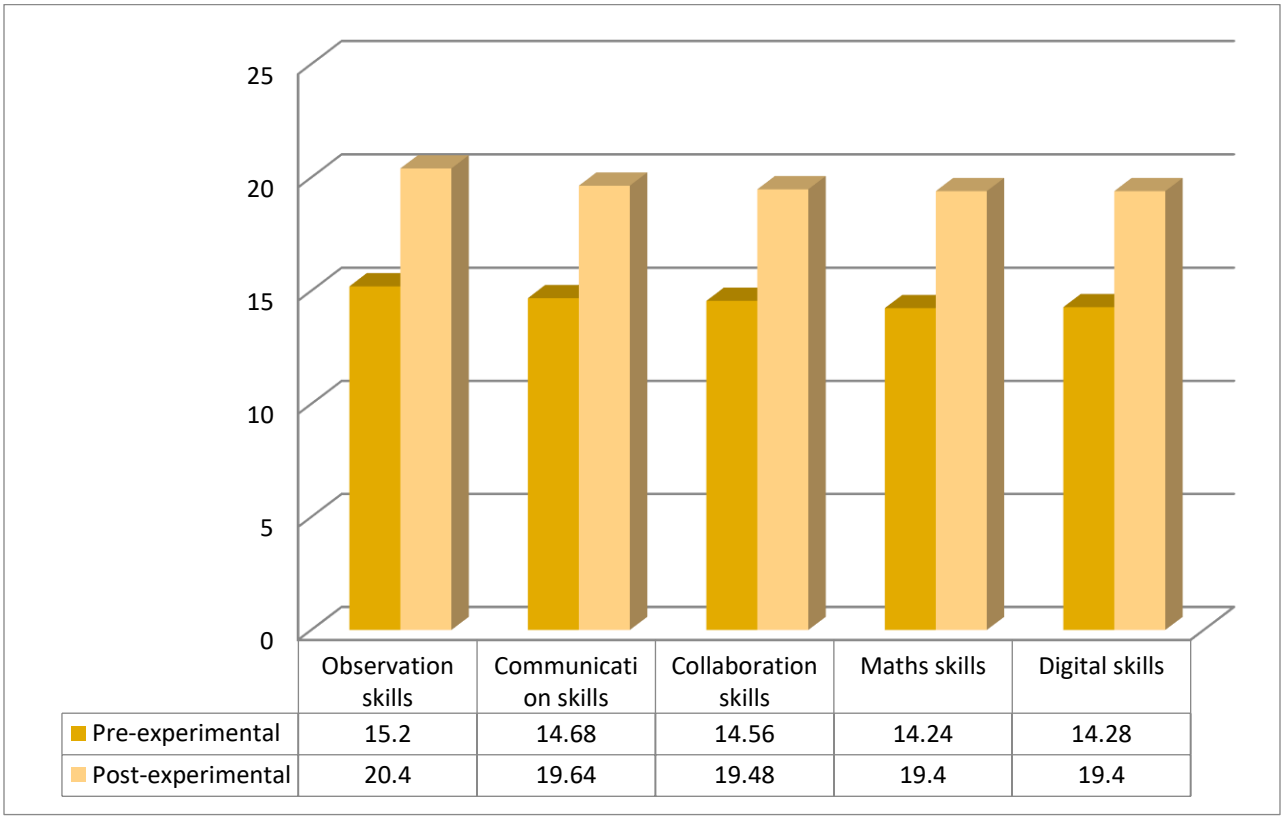
The mean for the variable level of development of observation skills, in the post-experimental stage (Mean=21.24, AS=3.053), was significantly higher from a statistical point of view (t=-20.778, p<0.01), than the mean in pre-experimental stage (Mean=14.55, AS=4.783).

The mean for the variable level of development of communication skills, in the post-experimental stage (Mean=19.09, AS=3.010), was significantly higher from a statistical point of view (t=-26.388, p<0.01), than the mean in pre-experimental stage (Mean=10.79, AS=3.430).

The mean for the variable level of development of collaboration skills, in the post-experimental stage (Mean=19.44, AS=2.834), was significantly higher from a statistical point of view (t=-23.331, p<0.01), than the mean in pre-experimental stage (Mean=11.73, AS=3.426).

The average for the variable level of development of mathematical skills, in the post-experimental stage (Mean=20.80, AS=2.968), was significantly higher from a statistical point of view (t=-23.092, p<0.01), than the average in the stage pre-experimental (Mean=13.75, SD=4.281).

The mean for the variable level of development of digital skills, in the post-experimental stage (Mean=20.58, AS=2.968), was statistically significantly higher (t=-20.748, p<0.01) than the mean from the post-experimental stage (Mean=13.69, AS=4.120).



	Observation skills	Communication skills	Collaboration skills	Maths skills	Digital skills
Pre-experimental	15.2	14.68	14.56	14.24	14.28
Post-experimental	20.4	19.64	19.48	19.4	19.4

Figure no. 12.VII.: *Pre-experimental-post-experimental stage comparisons for S.T.E.A.M skill levels for Slovakia*

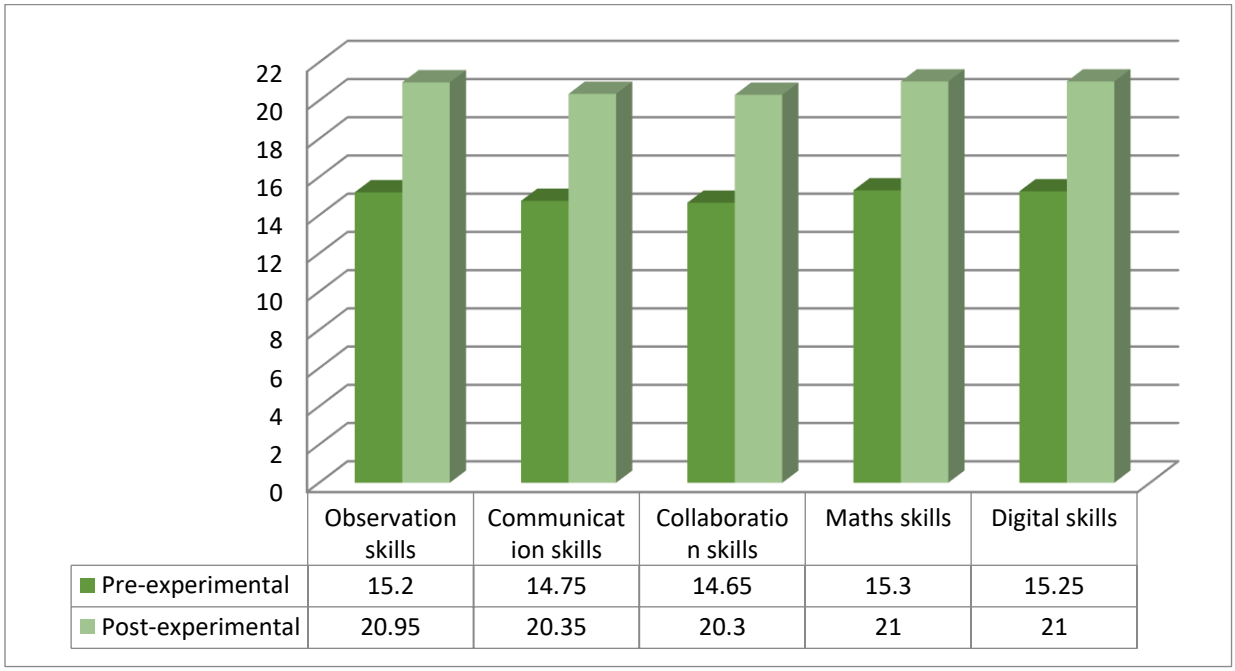
The mean for the variable level of development of observation skills, in the post-experimental stage (Mean=20.40, AS=2.327), was significantly higher from a statistical point of view (t=-24.071, p<0.01), than the mean in pre-experimental stage (Mean=15.20, AS=2.500).

The mean for the variable level of development of communication skills, in the post-experimental stage (Mean=19.64, AS=2.564), was significantly higher from a statistical point of view (t=-70.617, p<0.01), than the mean in pre-experimental stage (Mean=14.68, AS=2.577).

The mean for the variable the level of development of collaboration skills, in the post-experimental stage (Mean=19.48, AS=2.584), was significantly higher from a statistical point of view (t=-61.500, p<0.01), than the mean in pre-experimental stage (Mean=14.56, AS=2.534).

The mean for the variable level of development of mathematical skills, in the post-experimental stage (Mean=19.40, AS=2.630), was significantly higher from a statistical point of view (t=-14.962, p<0.01), than the mean in the stage pre-experimental (Mean=14.24, AS=2.603).

The mean for the variable level of development of digital skills, in the post-experimental stage (Mean=19.40, AS=2.630), was significantly higher from a statistical point of view (t=-15.363, p<0.01), than the mean in the stage pre-experimental (Mean=14.28, AS=2.654).



	Observation skills	Communication skills	Collaboration skills	Maths skills	Digital skills
Pre-experimental	15.2	14.75	14.65	15.3	15.25
Post-experimental	20.95	20.35	20.3	21	21

Figure no. 13.VII.: *Pre-experimental-post-experimental stage comparisons for S.T.E.A.M skill levels for Turkey*

The mean for the variable level of development of observation skills, in the post-experimental stage (Mean=20.95, AS=2.328), was significantly higher from a statistical point of

view (t=-16.221, p<0.01), than the mean in within the pre-experimental stage (Mean=15.20, AS=2.668).

The mean for the variable level of development of communication skills, in the post-experimental stage (Mean=20.35, AS=1.981), was significantly higher from a statistical point of view (t=-15.316, p<0.01), than the mean in within the pre-experimental stage (Mean=14.75, AS=2.221).

The mean for the variable level of development of collaboration skills, in the post-experimental stage (Mean=20.30, AS=1.976), was significantly higher from a statistical point of view (t=-14.394, p<0.01), than the mean in within the pre-experimental stage (Mean=14.65, AS=2.183).

The mean for the variable level of development of mathematical skills, in the post-experimental stage (Mean=21.00, AS=2.616), was significantly higher from a statistical point of view (t=-14.822, p<0.01), than the mean within pre-experimental stage (Mean=15.30, AS=3.358).

The mean for the variable level of development of digital skills, in the post-experimental stage (Mean=21.00, AS=2.616), was significantly higher from a statistical point of view (t=-14.038, p<0.01), than the mean within pre-experimental stage (Mean=15.25, AS=3.432).

VII.6. Comparative analysis of the results obtained in the pre-experimental and post-experimental stages by applying the Observation grid of S.T.E.A.M activities.

The research model used is based on the strategy of the experiment: the uni-factorial model with a single group. The main condition of a research, to meet the quality of an experiment, is the selection or random assignment of subjects to the research group(s). Among the uni-factorial models with a single group, we chose the "before-after" model with a single group, in which the dependent variable is measured twice: on the experimental group "before and after" the intervention.

The one-group unifactorial model

Independent variable:

• *The educational program "S.T.E.A.M in kindergarten" in the eTwinning/Erasmus+ project "S-TEAM in kindergarten".*

Dependent variables:

• The level of use of the S.T.E.A.M model in content and didactic design;
• The level of setting up the educational environment in the S.T.E.A.M didactic model.

Subjects: The experimental group was composed of 22 preschool teachers from 5 European countries. All teachers included in the study were female. During the implementation of the educational program "S.T.E.A.M in Kindergarten" there were no losses of subjects.

Presentation and analysis of experimental study data

The hypothesis from which we started in the research was:

There are differences regarding the level of use of the S.T.E.A.M model in contents and didactic design and the level of setting up the educational environment, in the S.T.E.A.M didactic model, among the teachers in the experimental group in the pre-experimental stage and in the post-experimental stage, after the application of the intervention program.

In the case of comparing two averages obtained on paired samples, the null hypothesis (H0) can be stated as follows: we assume that the differences between the two averages are due to chance and that there are no differences between the level of use of the S.T.E.A.M model in contents and didactic design and the level of setting up the educational environment in the S.T.E.A.M didactic model, for teachers from the experimental group in the pre-experimental and post-experimental stages.

The t-test for paired samples

The averages in the pre-experimental stage and the post-experimental stage were calculated, on the entire sample that benefited from the intervention, and comparisons were made between the averages for the two variables taken into account, applying the t-test for paired samples. The results obtained are presented, condensed, in terms of: number of participating European teachers (N), mean (M), standard deviation (AS), t-test (t), significance threshold (p).

The mean for the variable level of use of the S.T.E.A.M model, in the pre-experimental stage (Mean=41.68, AS=13.737) and the average in the post-experimental stage (Mean=66.77, AS=6.568) differ significantly (t-9.090, $p<0.01$).

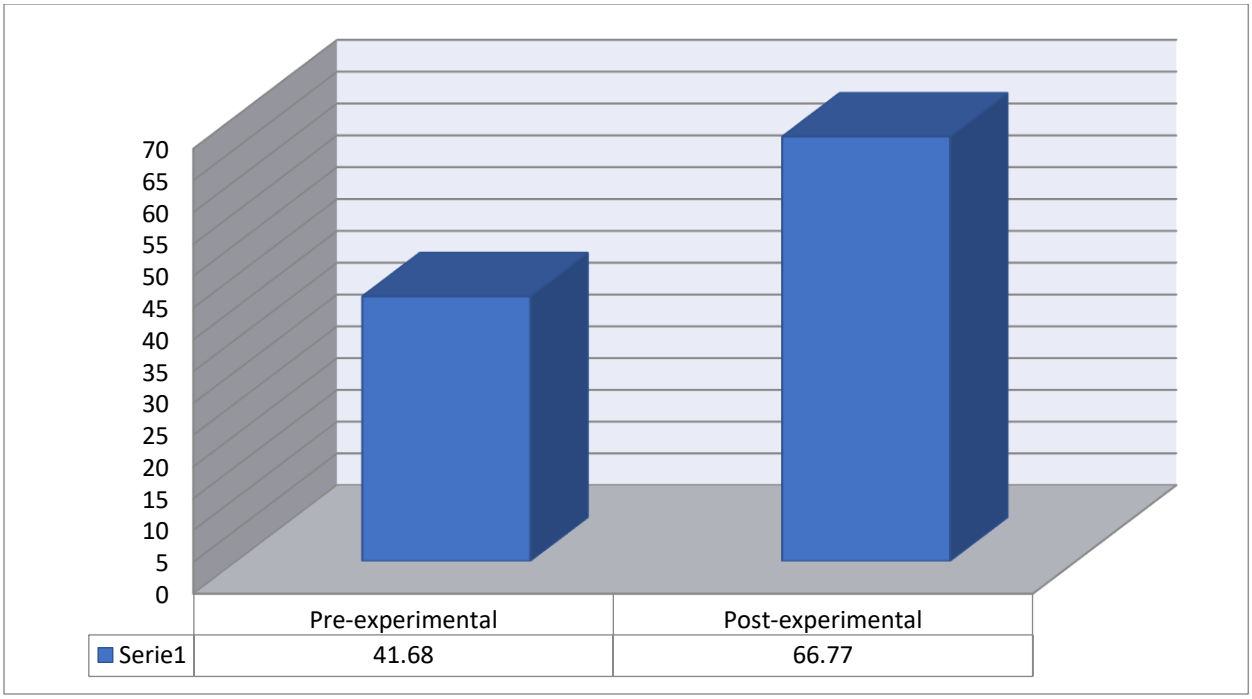


Figure no. 14.VII.: *Comparisons between the pre-experimental-post-experimental stages, for the dependent variable the level of use of the S.T.E.A.M model in contents and didactic design*

The mean for the variable the level of arrangement of the educational environment in the S.T.E.A.M didactic model, in the pre-experimental stage (Mean=29.45, AS=8.937) and the average in the post-experimental stage (Mean=43.64, AS=4.962) differ significantly (t=-6.973, p< 0.05).

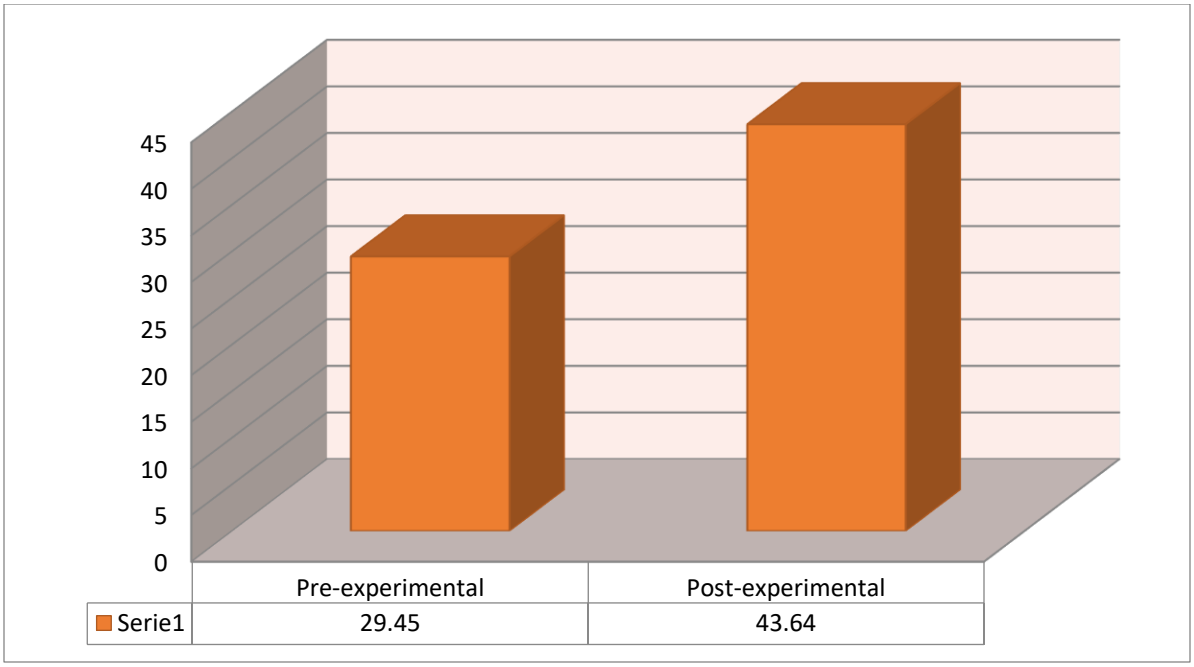


Figure no. 15.VII.: *Comparisons between the pre-experimental-post-experimental stages, for the dependent variable the level of use of the S.T.E.A.M model in content and didactic design, the level of setting up the educational environment in the S.T.E.A.M didactic model*

The null hypothesis is rejected if the value of p is lower than the fixed threshold, which, by default, is (0.05). In our case, the null hypothesis is rejected, accepting the research hypothesis, therefore the level of use of the S.T.E.A.M model in contents and didactic design and in the level of setting up the educational environment in the S.T.E.A.M didactic model increases after the application of the "S.T.E.A.M" intervention program in kindergarten" from the eTwinning/Erasmus+ project "S-TEAM in kindergarten", to the teachers in the experimental group.

CHAPTER VIII

CONCLUSIONS AND EDUCATIONAL RECOMMENDATIONS

VIII.1. Conclusions on personal contributions – theoretical and practical-applicative

In this paper, we analyzed the impact of the S.T.E.A.M didactic model on the S.T.E.A.M (observation, communication, collaboration, mathematical and digital) skills of older preschoolers, focusing on investigating the impact of the educational program "S.T.E.A.M in Kindergarten", from the eTwinning/Erasmus+ project "S- TEAM in kindergarten".

The present work analyzed the concepts and practices related to the S.T.EA.M didactic model and how this didactic model was integrated in the eTwinning/Erasmus+ projects at preschool level in the country, but also in the European kindergartens participating in the project. The work is structured and detailed in 8 chapters, providing a comprehensive perspective on S.T.E.A.M education through eTwinning/Erasmus+ projects and its influence on the development of observation, communication, collaboration, mathematical and digital skills of preschoolers.

In the first chapter, the paper addressed S.T.E.A.M education from the perspective of developing skills in preschoolers. The conceptual delimitations of S.T.E.M and S.T.E.A.M, the skills and cognitive processes developed by S.T.E.A.M education, good practices of the S.T.E.A.M didactic model in preschoolers developed worldwide were analyzed in depth, providing the reader with a complete theoretical foundation for understanding the subject.

The second chapter focused on the eTwinning/Erasmus+ program as a tool for developing S.T.E.A.M skills, by presenting the program and key actions of the Erasmus+ program, presenting the European priorities and S.T.E.A.M education, presenting the eTwinning action, presenting eTwinning/Erasmus+ projects with the S.T.E.A.M theme implemented at preschool level.

In the third chapter, the paper focused on the S.T.E.A.M education approach at preschool level, in Europe and in Romania. European policies recommended by the European Commission were presented, comparative approaches to S.T.E.A.M education in Bulgaria, Poland, Slovakia and Turkey, approaches to S.T.E.A.M education at preschool level in Romania and presentations of eTwinning/Erasmus+ projects "nEuro Nesting 3.0" (European Nest 3.0) and "S.T.E.A.M Academy" (Academia S.T.E.A.M).

The work presented, in the second part, structured in four chapters, the description of the experiment with all the stages and the learning interventions based on the S.T.E.A.M didactic model at preschool level. The practical S.T.E.A.M applications were detailed by presenting the objectives, the S.T.E.A.M areas, the didactic materials, the description of the implementation stages, the assessment methods. The S.T.E.A.M practical applications were carried out in the form of 12 weekly integrated learning activities aimed at developing observational, communication, collaboration, mathematical and digital skills in older preschoolers.

Through the experimental research, we followed, explored and described how to put into practice the S.T.E.A.M didactic model for preschoolers, through the eTwinning/Erasmus+ projects. We used an integrated approach, a common European learning approach through the 12 practical applications, combining theory with educational practice to shed light on the formative-educational and informative-didactic valences of the educational program proposed by us with the theme "S.T.E.A.M in Kindergarten".

Finally, the impact of the educational program "S.T.E.A.M in kindergarten", from the eTwinning/Erasmus+ project "S-TEAM in kindergarten", in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey was presented, identifying limitations, recommendations and future directions investigation of this approach, in the context of S.T.E.A.M.

Considered as a whole, the paper provided a complex and international perspective on the theory and practice in the field of S.T.E.A.M education for preschoolers.

Through this doctoral thesis, we believe that we are registering a significant contribution to the understanding of the S.T.E.A.M didactic model at preschool level, to be successfully implemented through practical applications developed within the eTwinning/Erasmus+ projects for the development of observation, communication, collaboration, math and digital.

We have validated the fact that the S.T.E.A.M didactic model in eTwinning/Erasmus+ projects is effective and has a major impact at preschool level in the country and abroad, and we have provided practical recommendations for educational specialists interested in the subject.

VIII.2. Conclusions of the experimental research

The experimental research that we proposed and carried out aimed to verify the hypothesis:

Implementation of the educational program "S.T.E.A.M in Kindergarten" ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc.) within the eTwinning/Erasmus+ "S-TEAM" project in kindergarten" in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey, contributes significantly to the development of observation, communication, collaboration, mathematical and digital skills in older preschoolers.

To test the hypothesis, we used the observation method, having as research tools the Evaluation Scale Teacher-Preschooler (The tool was developed by us, starting from the tools of the researchers Hightower and Perkins, 2010) for the preschoolers participating in the experiment, the S.T.E.A.M Teacher's Document (The tool of was developed by us, starting from the tools Steam-H Teacher training module, Erasmus+, 2022) and Observation Grid of S.T.E.A.M activities (The tool was developed by us, starting from the tools of researchers Morales et al., 2020) for the participating teachers . In this way, we followed, if the participation in the educational program "S.T.E.A.M in Kindergarten" in the eTwinning/Erasmus+ project "S-TEAM in Kindergarten" determines the development of observation, communication, collaboration, math and digital.

According to the statistical analysis for Evaluation Scale Teacher-Preschooler, it results that, in the post-experimental stage, compared to the pre-experimental stage, older preschoolers developed their observation, communication, collaboration, mathematical and digital skills thanks to the implementation of the 12 practical applications S.T.E.A.M. By carrying out the "before and after" t-test, it was established that there are significant differences between the levels obtained in the two stages.

According to the statistical analysis for the S.T.E.A.M teacher's sheet, it results that, in the experimental stage, increased levels of S.T.E.A.M skills were identified by the teachers who put into practice the practical applications, within the educational program "S.T.E.A.M in kindergarten" in the eTwinning/Erasmus+ project "S- TEAM in kindergarten".

Regarding the statistical analysis for the observation grid of S.T.E.A.M activities, it results that in the post-experimental stage compared to the pre-experimental stage, the level of use of the S.T.E.A.M model in contents and didactic design and in the level of setting up the educational environment in the S.T.E.A.M didactic model is significant grown up

In addition, we used the survey method with the research tool Questionnaire addressed to teaching staff involved in the realization of S.T.E.A.M practical applications ("Lego education",

"Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc. .).

Through the statistical analysis of the questionnaire addressed to the 22 teaching staff involved in the realization of the S.T.E.A.M practical applications ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc.), we found that European teachers identified increased levels of observational, communication, cooperative, mathematical and digital skills in European preschoolers

Analyzing the results of the research tools used, we can conclude that the hypothesis has been confirmed. Thus, it is obvious that the participation of older preschoolers in the educational program "S.T.E.A.M in kindergarten" in the eTwinning/Erasmus+ project "S-TEAM in kindergarten" in kindergartens in Bulgaria, Poland, Romania, Slovakia, Turkey, had a real positive impact on the growth development levels of observation, communication, collaboration, mathematical and digital skills.

To the research question: "S.T.E.A.M practical applications ("Lego Education", "Ozobots", introductory programming elements, chemical and physical experiments, engineering elements, plastic language elements, etc.) from the educational program "S.T.E.A.M in kindergarten", within the eTwinning/Erasmus+ project "S-TEAM in kindergarten" in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey develop observation, communication, collaboration, mathematical and digital skills of older preschoolers?, we conclude that the answer is affirmative, due to the statistical results of the applied research tools: Evaluation Scale Teacher-Preschooler the S.T.E.A.M Teacher's Document and Observation Grid of S.T.E.A.M activities.

The educational program "S.T.E.A.M in kindergarten" included 12 practical S.T.E.A.M applications: "Ballerinas with motors", "Shelters for domestic animals", "Balloons and rockets", "Volcano", "Rainbow", "The System Solar", "Bird feeders", "Musical instruments", "Migratory and sedentary birds - digital applications", "Lego maze", "My green village/town", "Ozobot/Beebot". Advanced levels were identified in the statistical analyzes of research tools of observation, communication, cooperation, mathematical and digital skills in European preschoolers following the realization of S.T.E.A.M practical applications, from the educational program "S.T.E.A.M in Kindergarten", within the eTwinning project /Erasmus+ "S-TEAM in kindergarten".

According to the statistical analysis for the moderator variable (countries of origin), by applying the Tukey Test and the ANOVA tests for Evaluation Scale Teacher-Preschool after the application of the educational program "S.T.E.A.M in kindergarten" in the eTwinning/Erasmus+ project "S-TEAM in kindergarten" found that there are no significant differences between the level of development of S.T.E.A.M skills in Romania compared to the other countries, in the post-experimental stage.

Consequently, there are no significant differences between the level of observation, communication, collaboration, mathematical and digital skills of older preschoolers in Romania and in Bulgaria, Poland, Slovakia and Turkey following the implementation of the "S.T.E.A.M in Kindergarten" educational program in the project eTwinning/Erasmus+ "S-TEAM in kindergarten".

Regarding the moderator variables, the t comparison test showed that there are no gender differences in the results of the preschoolers included in the study regarding the level of development of S.T.E.A.M skills (observation skills, communication skills, collaboration skills, mathematical skills and digital skills), more concretely significant differences between the averages of girls compared to the averages of boys.

We summarize by stating that the results obtained validated the research hypothesis and were in agreement with our initial expectations. It has been validated that the implementation of a system of S.T.E.A.M practical applications in the form of the "S.T.E.A.M in Kindergarten" educational program within the eTwinning/Erasmus+ "S-TEAM in Kindergarten" project had a major impact on the development of the levels of observation, communication, of collaboration, mathematics and digital in older preschoolers in Bulgaria, Poland, Romania, Slovakia and Turkey.

VIII.3. General conclusions

During the elaboration of the doctoral thesis, I started from studies and research that addressed S.T.E.A.M education and eTwining/Erasmus+ projects, generally addressable to other levels of schooling (primary level, secondary level, etc.). S.T.E.A.M education for preschoolers is a new approach and it has become imperative to study it, due to the fact that there are extremely few specialized studies on this topic in our country and few works at the European level addressed to the preschool level.

The aim of the present paper was to study the impact of the educational program "S.T.E.A.M in kindergarten" in the eTwinning/Erasmus+ project "S-TEAM in kindergarten" in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey on the levels of S.T.E.A.M skills (observation, communication , collaborative, mathematical and digital) in older preschoolers.

After the implementation of the "S.T.E.A.M in Kindergarten" educational program that capitalized on the S.T.E.A.M didactic model and the European eTwinning/Erasmus+ projects, significant increases in the levels of observation, communication, collaboration, mathematical and digital skills of older preschoolers were recorded, without significant differences between the countries involved in the project and without gender differences for preschoolers. The analysis of the data obtained and presented in tabular and graphic form in the content of the present paper shed light on the progress made by preschoolers in the development of S.T.E.A.M skills.

In addition, the implementation of the educational program "S.T.E.A.M in Kindergarten" led to an increase in the level of use of the S.T.E.A.M didactic model in content and didactic design, but also to an increase in the level of setting up the S.T.E.A.M educational environment by European teachers.

The virtual collaboration space of the eTwinning/Erasmus+ project (Twinspace) is on the ESEP platform which is an open educational resource for any European eTwinner or educational researcher interested in this topic.

In conclusion, the application of the educational program "S.T.E.A.M in kindergarten" in the eTwinning/Erasmus+ project "S-TEAM in kindergarten" in kindergartens in Bulgaria, Poland, Romania, Slovakia and Turkey, based on the didactic model S.T.E.A.M, brought significant increases in skill levels observational, communicative, collaborative, mathematical and digital in large European preschoolers.

VIII.4. Educational recommendations

In order to obtain more solid and significant results, it is recommended to extend the study period to monitor the long-term evolution of the impact of the educational program "S.T.E.A.M in Kindergarten". This action would allow us to evaluate the influence of the educational program on the development of S.T.E.A.M skill levels, as well as to establish possible changes and identify trends over a long time interval.

We recommend the inclusion, within the educational program, of a variety of practical S.T.E.A.M applications, with the introduction of different teaching-learning strategies, the use of non-polluting resources and materials, the use of S.T.E.A.M kits for digital applications, to support the motivation for learning of preschoolers.

To ensure the relevance and applicability of the results, it is imperative to increase the sample of participants in all countries participating in the eTwinning/Erasmus+ projects, to recruit a large number of preschoolers from different geographical, economic, socio-cultural environments, to analyze the effects of the program in a varied range of educational contexts.

Our recommendation would be to adopt a longitudinal research design in future research to track participants' progress and outcomes over time. This approach would facilitate a more detailed understanding of how S.T.E.A.M interventions and practical applications, through eTwinning/Erasmus+ projects, influence levels of S.T.E.A.M skill development.

In order to properly evaluate the effects of the educational program, we recommend the involvement of all actors interested in the educational act, parents and teachers in measurements, standardized tests to measure S.T.E.A.M skills, making series of behavioral observations of preschoolers, to provide a broad vision on the progress and on the advantages obtained.

Finally, suggestions for future research are designed to improve and complement our understanding of the impact of the educational program supporting the development of S.T.E.A.M skills in older preschoolers through the eTwinning/Erasmus+ program.

By applying the suggested recommendations, we will be able to contribute to the implementation of the S.T.E.A.M educational model at preschool level through eTwinning/Erasmus+ projects, and to the optimization of S.T.E.A.M practical applications aimed at developing observation, communication, collaboration, mathematical and digital skills.

VIII.5. Research limitations

In our research we have made efforts to carry out detailed, rigorous and complex research, but it is important to recognize that our research was affected by certain limitations:

- small size of the sample of participants;
- the limited duration of the research, to observe the long-term effects of the educational program "S.T.E.A.M in Kindergarten";

 the variability of the educational and socio-economic contexts of the study participants;
 absence of a control group;
 the absence of reference sources based on consistent practical-applicative research in the subject of S.T.E.A.M.

VIII.6. Future directions of investigation

This experimental research on the development of S.T.E.A.M skills in preschoolers through eTwinning/Erasmus+ projects can be enhanced by further studies and research exploring the same theme or related aspects developed from this topic.

For example:

 it is possible to follow the development of S.T.E.A.M skills in preschoolers, in the long term by capitalizing on the effectiveness of the program "S.T.E.A.M in Kindergarten";
 the effectiveness of the "S.T.E.A.M in Kindergarten" program can be followed outside of the eTwinning/Erasmus+ program;
 the effectiveness of the "S.T.E.A.M in Kindergarten" program can be followed in all countries participating in the eTwinning/Erasmus+ program by carrying out a European research included in the Erasmus+ key action, KA3, Support for educational policies.

Creating other perspectives of the educational program in different educational systems or in different learning contexts could provide a generalization of the results and the identification of factors that can influence the effectiveness of the educational program.

The analysis of interactions between the educational program "S.T.E.A.M in Kindergarten" and other European education systems, taking into account educational environment factors, socio-economic specificity, funding policies, could provide a deep understanding of the effectiveness of the program, regardless of the educational context in which it would be applied.

Another direction of future research is related to the use of an appropriate, well-chosen and properly managed control group to compare the results obtained, to perform complex analyzes of the educational program, identifying and eliminating the influences of variables and external factors, to increase the validity of the research and the possibility of disseminating its results, in order to support the conclusions related to the real impact of the educational program in different educational contexts.

BIBLIOGRAPHY:

Aguilera, D., & Ortiz-Revilla, J. (2021) STEM vs. STEAM Education and Student Creativity: A Systematic Literature Review. *Education Sciences*, *11*(7), 331. https://doi.org/10.3390/educsci11070331

Aldemir, J. & Kermani, H. (2017). Integrated STEM curriculum: improving educational outcomes for Head Start children. *Early Child Development and Care*, *187*(11), 1694–1706. https://doi.org/10.1080/03004430.2016.1185102

Andersson, K. & Gullberg, A. (2014). What is science in preschool and what do teachers have to know to empower children? *Cultural Studies of Science Education*. https://doi.org/10.1007/s11422-012-9439-6

Agenția Națională pentru Programe Comunitare în Domeniul Educației și Formării Profesionale România (2021). *Apelul Național la propuneri de proiecte 2021*. https://www.erasmusplus.ro/library/Apeluri/2021/Apel_national_2021_v4_feb%202021_1.pdf

Agenția Națională pentru Programe Comunitare în Domeniul Educației și Formării Profesionale România (2022). *Apelul Național la propuneri de proiecte 2022*. https://www.erasmusplus.ro/library/Apeluri/2022/Apel_national_2022_v4_feb%202022_1.pdf

Agenția Națională pentru Programe Comunitare în Domeniul Educației și Formării Profesionale România (2023). *Apelul Național la propuneri de proiecte 2023*. https://www.erasmusplus.ro/library/Apeluri/2023/Apel_national_2023_v4_feb%202023_1.pdf

Agenția Națională pentru Programe Comunitare în Domeniul Educației și Formării Profesionale România (2022). *Apelul Național pentru Acreditare, Educație Școlară, Educația Adulților, Formare profesională, Tineret.* https://www.erasmusplus.ro/library/Apeluri/2022/Apel%20National%20Acreditare_Oct_2022.pdf

Agenția Națională pentru Programe Comunitare în Domeniul Educației și Formării Profesionale România (2024). *Apelul Național la propuneri de proiecte 2024*. https://www.erasmusplus.ro/library/Apeluri/2024/Apel%20national%20v2_2024.pdf

Agenția Națională pentru Programe Comunitare în Domeniul Educației și Formării Profesionale România (2024). *eTwinning România*. https://etwinning.ro/

Agenția Națională pentru Programe Comunitare în Domeniul Educației și Formării Profesionale România (2024). *Ghid pentru scrierea unor proiecte de succes Parteneriate la scară mică Erasmus+*. https://www.erasmusplus.ro/library/Ghid%20candidatura%20succes%20Small-Scale%20v2_2023.pdf

Agenția Națională pentru Programe Comunitare în Domeniul Educației și Formării Profesionale România (2024). *Ghid pentru scrierea unor proiecte de succes Parteneriate de cooperare Erasmus+*. https://www.erasmusplus.ro/library/Ghid%20de%20completare%20candidatura%20KA2-2023_v2_finala.pdf

Ata Aktürk, A. Demircan, H. Ozlen, Şenyurt, E., & Çetin, M. (2017). Turkish early childhood education curriculum from the perspective of STEM education: A document analysis. *Journal of Turkish Science Education*, *14*(4), 16–34. https://doi.org/10.12973/tused.10210a

Avendano, L. Renteria, J., Kwon, S., & Hamdan, K. (2019). Bringing equity to underserved communities through STEM education: implications for leadership development. *Journal of Educational Administration and History,* 51(1), 66–82. https://doi.org/10.1080/00220620.2018.1532397

Baciu, C. (coord.), Bocoș, M.-D., & Magdaș, I.-C. (2022a). STEM În *Tehnologia Informației și a Comunicării în Educație (TICE). Dicționar de termeni Volumul II: L-Z* (p. 180). Editura CEEOL Press.

Baciu, C. (coord.), Bocoș, M.-D., & Magdaș, I.-C. (2022b). S.T.E.A.M În *Tehnologia Informației și a Comunicării în Educație (TICE). Dicționar de termeni Volumul II: L-Z* (p. 180). Editura CEEOL Press.

Baciu, C. (coord.), Bocoș, M.-D., & Magdaș, I.-C. (2022c). Finalitățile modelului didactic S.T.E.A.M În *Tehnologia Informației și a Comunicării în Educație (TICE). Dicționar de termeni Volumul II: L-Z* (p. 180). Editura CEEOL Press.

Baciu, C. (coord.), Bocoș, M.-D., & Magdaș, I.-C. (2022d). Finalitățile modelului didactic STEM În *Tehnologia Informației și a Comunicării în Educație (TICE). Dicționar de termeni Volumul II: L-Z* (p. 181). Editura CEEOL Press.

Baciu, C., & Bocoș, M.-D. (2022). *Evaluarea și utilizarea surselor și resurselor de documentare*. Editura Presa Universitară Clujeană

Bers, M. U., Seddighin, S., & Sullivan, A. (2013). Ready for robotics: Bringing together the T and E of STEM in early childhood teacher education. *Journal of Technology and Teacher Education*, *21*(3), 355–377. https://www.learntechlib.org/primary/p/41987/

Bertrand, M., Namaka, I.,(2017*).* STEAM education: student learning and transferable skills. *Journal of Research in InnovativeTeaching & Learning*, *13*(1), 43–56. https://www.emerald.com/insight/2397-7604.htm

Bourbour, M., (2020) *Digital tehnologies in preschool education*, Orebro Universty. Malmo.

Bocoș, M.-D., Stan, C., & Crișan, C.-A. (coord.) (2021). *Cercetarea educațională. Coordonate generale ale activităților de cercetare. Volumul I.* Editura Presa Universitară Clujeană.

Bocoș, M.-D., Stan, C., & Crișan, C.-A. (2021). *Cercetarea educațională. Repere metodologice și instrumentale*. *Volumul II.* Editura Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021a). Abilitate. În *Dicționar de pedagogie* (p. 14). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021b). Proces (psihic) cognitiv. În *Dicționar de pedagogie* (p. 1636). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021c). Observația de cercetare/Metoda observației (ca metodă didactică)> În *Dicționar de pedagogie* (p. 1448). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021d). Comunicarea de noi cunoștințe> În *Dicționar de pedagogie* (p. 244). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021e). Comunicarea educațională. În *Dicționar de pedagogie* (p. 244). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021f). Comunicare interpersonală. În *Dicționar de pedagogie* (p. 244). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021g). Comunicare în grupuri mici. În *Dicționar de pedagogie* (p. 245). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021h). Comunicare electronică. În *Dicționar de pedagogie* (p. 244). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021i). Colaborarea. În *Dicționar de pedagogie* (p. 220). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021j). Autonomie educativă (în sens general). În *Dicționar de pedagogie* (p. 125). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021k). Abilitatea practică. În *Dicționar de pedagogie* (p. 16). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021l). Rezolvarea de probleme (în sens general). În *Dicționar de pedagogie* (p. 1783). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021m). Experimentul. În *Dicționar de pedagogie* (p. 562). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021n). Ancheta directă. În *Dicționar de pedagogie* (p. 79). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021o). Metoda observației. În *Dicționar de pedagogie* (p. 1445). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021p). Metoda analizei lucrărilor/produselor activității. În *Dicționar de pedagogie* (p. 71). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021r). Metoda cercetării documentelor curriculare și a altor documente școlare. În *Dicționar de pedagogie* (p. 1213). Presa Universitară Clujeană.

Bocoș, M.-D. (coord.), Răduț-Taciu, R., & Stan, C. (2021s). Scrisoare metodică În *Dicționar de pedagogie* (p. 1816). Presa Universitară Clujeană.

Bureekhampun, S., & Mungmee, T., (2020). STEAM education for preschool students: Patterns, activity designs and effects. *Journal for the Education of Gifted Young Scientists, 8*(3), 1201–1212. http://dx.doi.org/10.17478/jegys.775835

Campbell, C., Speldewinde, C., Howitt, C., & MacDonald, A. (2018). STEM practice in the early years. *Creative Education, 9,* 11–25. https://www.scirp.org/pdf/CE_2018011815343334.pdf

Casey, T., Robertson, J., Abel, J., Cairns, M., Caldwell, L., Campbell, K., & Robertson, T. (2016). *Loose Parts Play*. 72. https://inspiringscotland.org.uk/wpcontent/uploads/2017/03/Loose-Parts-Play-web.pdf

Cazacioc, N. (2021). *Educația STEAM – o abordare inovativă în formarea profesională a elevilor și studenților*. Institutul de dezvoltare a societății informaționale. https://ibn.idsi.md/sites/default/files/imag_file/55-61_19.pdf

Chaldi, D., & Mantzanidou, G. (2021). Educational robotics and STEAM in early childhood education. *Advances in Mobile Learning Educational Research*, *1*(2), 72–81. https://doi.org/10.25082/AMLER.2021.02.003

Comisia Europeană (2020). *Agenda europeană 2020 privind competențele*. https://ec.europa.eu/social/main.jsp?catId=1223&langId=en

Comisia Europeană (2020). *Agenda reînnoită a UE pentru învățământul superior.* https://education.ec.europa.eu/ro/education-levels/higher-education/inclusive-and-connected-higher-education

Comisia Europeană (2023). *Anul competențelor*. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-year-skills-2023_ro

Comisia Europeană (2024). *Baza de date Erasmus+*. https://erasmus-plus.ec.europa.eu/ro

Comisia Europeană (2022). *Calea către deceniul digital*. https://www.consilium.europa.eu/ro/infographics/digital-decade/

Comisia Europeană (2017). *Comunicarea Comisiei către Parlamentul European, Consiliu, Comitetul Economic și Social European și Comitetul Regiunilor, denumită Dezvoltarea școlii și o predare excelentă pentru un start bun în viață*. https://eur-lex.europa.eu/legal-content/RO/TXT/?uri=CELEX%3A52022DC0230

Comisia Europeană (2021). *Ghidul Programului Erasmus+*. https://erasmus-plus.ec.europa.eu/ro/document/erasmus-programme-guide-2021-version-3

Comisia Europeană (2022). *Ghidul Programului Erasmus+*. https://erasmus-plus.ec.europa.eu/ro/document/erasmus-programme-guide-2022-version-2

Comisia Europeană (2023). *Ghidul Programului Eramus+*. https://www.erasmusplus.ro/library/Documente/GHIDURI%20generale/Ghid%202023/Erasmus%2BProgramme%20Guide2023_ro%20(1).pdf

Comisia Europeană (2024). *Ghidul Programului Eramus+*. https://www.erasmusplus.ro/library/Documente/GHIDURI%20generale/Ghid%202024/2024-Erasmus%2BProgramme-Guide_RO_v1.pdf

Comisia Europeană (2021). *O busolă pentru dimensiunea digitală*. https://ec.europa.eu/commission/presscorner/detail/en/IP_21_983

Comisia Europeană (2019). *Pactul ecologic european*. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

Comisia Europeană (2021). *Planul de acțiune privind educația digitală*. https://education.ec.europa.eu/focus-topics/digital-education/action-plan

Consiliul Europei (2018). *Recomandarea consiliului privind competențele-cheie pentru învățarea pe tot parcursul vieții*. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018H0604(01)&from=EN

Comisia Europeană (2021). *Summit-ul Digitalul pentru toți*. https://steamonedu.eu/news/steamonedu-final-conference-adsummit2021/

Comisia Europeană (2021). *Spațiul European al educației*. https://education.ec.europa.eu/

Davis, M. (2010). STEM Comes to Preschool. European Early Childhood, *Education Research Journal*. https://www.researchgate.net/publication/292035679_STEM_comes_to_preschool

DeJarnette, N. K. (2018*)*. Implementing STEAM in the Early Childhood Classroom. *European Journal of STEM Education*, *3*(3), 18. https://doi.org/10.20897/ejsteme/3878

Eco, U. (2006). *Cum se face o teză de licență*. Editura Polirom.

European Commission, Directorate-General for Education, Youth, Sport and Culture, (2023). *Erasmus+ annual report 2022 – Annexes*. Publications Office of the European Union. https://data.europa.eu/doi/10.2766/090374

European Commission, Directorate-General for Education, Youth, Sport and Culture (2023). *Erasmus+ annual report 2022*. Publications Office of the European Union. https://data.europa.eu/doi/10.2766/211791

European Commission, Directorate-General for Education, Youth, Sport and Culture (2024). *Guide for Experts on Quality Assessment*. Publications Office of the European Union. https://www.erasmusplus.ro/library/Documente/GHIDURI%20generale/Ghid%202024/I

V.1a%20%20E%2BGuide%20for%20experts%20on%20quality%20assessment_2024_v3.pdf

European Commission, Erasmus+ and European Solidarity Corps (2023). *Opportunities for Erasmus+*. https://webgate.ec.europa.eu/app-forms/af-ui-opportunities/#/erasmus-plus

Găzdac, V. A., & Bocoș, M. D.,(2022). Developing Steam Skills in Preschoolers. Presentation of Project Erasmus+" Act Green". *Education Facing Contemporary World Issues - EDU WORLD 2022*. 775–785. https://doi.org/10.15405/epes.23045.77

Găzdac, V. A., Cîmpean, M. E., & Bocoș, M. D.,(2022). Developing Digital Skills In Preschoolers. Presentation Of The Project Erasmus+ "Blend". *Educație, Reflection, Development-ERD 2022*. 235–246. https://doi.org/10.15405/epes.23056.22

Gonzales, H. & Kuenzi, J. (2012). Science, Technology, Engineering, and Mathematics (STEM) Education: A Primer. *CRS Report for Congress Specialist in Education Policy*, 34. https://www.researchgate.net/publication/292937643_Science_technology_engineering_and_mathematics_STEM_education_A_primer

Han, C. & Rosli, C. (2016). The Effect of Science Technology, Engineering and Mathematics (STEM) Project Based Learning (PBL) on students Achievement in four Mathematics topics. *Journal of Science Education and Technology.* https://www.researchgate.net/publication/311640045_The_effect_of_Science_technology_engineering_and_mathematics_STEM_project_based_learning_PBL_on_students'_Achievement_in_four_mathematics_topics

Haesen, S., & Van de Put, E. (2018). *STEAM education in Europe: A comparative analyse report.* Eurosteamproject. https://www.stemnetwork.eu/

Herro, D., Quiley, C., Andrews, J., & Delacruz, G., (2017). Co-Measure: developing an assessment for student collaboration in STEAM activities. *International Journal of STEM Education*. https://doi.org/10.1186/s40594-017-0094-z

Hunt, E. (2020). *STEM în 15 minute: exerciții creative de știință, tehnologie, inginerie și matematică pentru copii între 5 și 11 ani*. Editura Didactica Publishing House.

International Association for the Evaluation of Educational Achievement (IEA), *TIMSS.* https://timssandpirls.bc.edu/timss2011/international-results-mathematics.html

Ješková, Z., Lukáˇc, S., Šnajder, L., Guniš, J., Klein, D., Kireš, M., (2022). Active Learning in STEM Education with Regard to the Development of Inquiry Skills. *Educational Sciences.* 12, 686. https://doi.org/10.3390/educsci12100686

Kastriti, E, Kalogiannakis, M. Psycharis, S. Vavougios, D. (2022). The teaching of Natural Sciences in kindergarten based on the principles of STEM and STEAM approach. *Advances in Mobile Learning Educational Research*, *2*(1), 268–277. https://www.syncsci.com/journal/index.php/AMLER/article/view/AMLER.2022.01.011

Khine, M.-S., & Areepattamannil, S., (2019). *STEAM Education Theory and Practice*, Springer. https://doi.org/10.1007/978-3-030-04003-1

Kulaksız, T., & Toran, M. (2022) Development of pre-service early childhood teachers' technology integrations skills through a praxeological approach. *International Journal of Educational Tehnologies in Higher Education, 19,* 36(2022). https://doi.org/10.1186/s41239-022-00344-8

Land, M. H. (2013). Full STEAM ahead: The benefits of integrating the arts into STEM. *Procedia Computer Science*, 20, 547–552. https://doi.org/10.1016/j.procs.2013.09.317

Lin, C.-L., & Tsai, C.-Y. (2021) The Effect of a Pedagogical STEAM Model on Students' Project Competence and Learning Motivation. *Journal of Science Education and Technology*, 57–69. https://doi.org/10.1007/s10956-020-09885-x

Linder, S. M., Emerson, A. M., Heffron, B., Shevlin, E. & Vest, A. (2016). STEM use in early childhood education: Viewpoints from the field. *YC Young Children*, *71*(3), 87–91. https://www.researchgate.net/publication/318306860_STEM_use_in_early_childhood_education_Viewpoints_from_the_field

Martín-Páez, T., Aguilera, D., Perales-Palacios, F. J. & Vílchez-González, J. M. (2019). What are we talking about when we talk about STEM education? A review of literature. *Science Education*, *103*(4), 799–822. https://doi.org/10.1002/sce.21522

McClure, E. R., Guernsey, L., Clements, D. H., Bales, S. N., Nichols, J., Kendall-Taylor, N. & Levine, M. H. (2017). *STEM starts early: Grounding science, technology, engineering, and math education in early childhood*. http://joanganzcooneycenter.org/publication/stem-starts-early/

Ministerul Educației Naționale (2019). *Curriculum pentru Educația Timpurie*. *Anexă la Ordinul ministrului Educației Naționale nr. 4694/02.08.2019*. București.

Ministerul Educației, Cercetării și Tineretului (2008). *Ghid de bune practici pentru educația timpurie a copiilor între 3 și 6/7 ani.* București. https://www.isj.sv.edu.ro/images/Docs/Discipline/invatamnat_preprimar/2017/Documentatii_curriculare_si_metodice/Ghid_de_bune_practici_3-6-7_ani.pdf

Ministerul Educației (2024). *Educația timpurie (învățământ antepreșcolar+ învățământ preșcolar).* https://www.edu.ro/educatie_timpurie

Ministerul Educației (2011). *Legea Educației Naționale nr.1/ 05.01.2011.* București. https://www.edu.ro/sites/default/files/legea-educatiei_actualizata%20august%202018.pdf

Ministerul Educației (2023). *Legea Învățământului Preuniversitar nr. 198/05.07.2023*. București. https://edu.ro/sites/default/files/_fi%C8%99iere/Minister/2023/Legi_educatie_Romania_educata/legi_monitor/Legea_invatamantului_preuniversitar_nr_198.pdf

Ministerul Educației Naționale (2016). *Repere fundamentale în învățarea și dezvoltarea timpurie a copilului de la naștere la 7 ani.* Ordinul Ministrului Educației Naționale nr.203851/2010. https://www.edu.ro/sites/default/files/_fi%C8%99iere/InvatamantPreuniversitar/2016/prescolar/ORDIN%203851_2010_ANEXA_RFIDT.pdf

Ministerul Educației (2021). *Scrisoare metodică. 2021-2022, Anul comunităților profesionale de învățare.* Ordinul Ministrul Educației nr.33774/05.10.2021. https://www.isjbn.ro/sites/default/files/documente/2021-10/Scrisoare%20metodica-invatamant%20prescolar-2021-2022.pdf

Ministerul Educației (2022) *Scrisoare metodică, 2022-2023. Joc, respect și bucurie.* Ordinul Ministrul Educației nr.2389/30.09.2022. https://cdn.edupedu.ro/wp-content/uploads/2022/10/SCRISOARE-METODICA-2022-2023.pdf

Ministerul Educației (2023) *Scrisoare metodică. 2023-2024. Despre rost în educație...* Ordinul Ministrului Educației nr. 31.815/25.10.2023. https://www.edu.ro/sites/default/files/_fi%C8%99iere/InvatamantPreuniversitar/scrisori_metodice/educatie_timpurie/Scrisoare_metodica_educatie_timpurie_2023.pdf

Monkeviciene, O., Vildziuniene, J., & Valinciene, G. (2020). The Impact of Teacher-Initiated Activities on Identifying and Verbalizing Ways of Metacognitive Monitoring and Control in Six-Year-Old Children. *Research in Social Sciences and Technology*, *5*(2), 72–92. https://doi.org/10.46303/ressat.05.02.5

Morales, M. P. E., Abulon, E. R., Anito, J. C. Jr., Avila, R. A., Palisoc, C. P., Elipane, L. E., & Casilla, N. A. (2018). *TPACK in Philippine STEAM education: STEAM classroom observation protocol*. Philippines Normal University

Ng, A., Kewalramani, S., & Kidman, G., (2022). Integrating and navigating STEAM (in STEAM) in early childhood education: An integrative review and in STEAM conceptual framework. *EURASIA Journal of Mathematics, Science and Technology Education*, 2022, *18*(7), em2133, ISSN:1305-8223. https://doi.org/10.29333/ejmste/12174

Organizația pentru Cooperare și Dezvoltare Economică, (OECD), *PISSA*. https://www.oecd.org/en/about/programmes/pisa/pisa-test.html

Park, H., Byun, S., Sim, J., Han, H., & Baek, Y. S. *(2016*). Teachers' perceptions and practices of STEAM education in South Korea. *Eurasia Journal of Mathematics, Science & Technology Education*, *12*(7), 1739-1753. https://doi.org/10.12973/eurasia.2016.1531a

Purakom, A. & Soykeree, T. (n.d.). *Stem education: Innovation education for young generation in asean.* 9–12. https://www.researchgate.net/publication/343363945_STEAM_Learning_in_Early_Childhood_Education_A_Literature_Review

Răduț-Taciu, R., Bocoș, M.-D., Chiș, O. (2015). *Tratat de management educațional pentru învățământul primar și preșcolar*. Editura Paralela 45.

Nguyes, T. U. S., & Le, T. T. T. (2021). Organizing activities for children in the orientation of Steam education. *Turkish Journal of Computer and Mathematics Education (TURCOMAT), 12*(4), 1676–1680. https://doi.org/10.17762/turcomat.v12i4.1422

Simoncini, K., & Lasen, M. (2018). Ideas about STEM among Australian early childhood professionals: How important is STEM in early childhood education? *International Journal of Early Childhood*, 50, 353–369. https://doi.org/10.1007/s13158-018-0229-5

Spyropoulou, C., Wallace, M., Vassilakis, C., & Poulopoulos, V. (2020). Examining the use of STEAM Education in Preschool Education. *EJERS, European Journal of Engineering Research and Science, Special Issue: CIE.* https://www.ej-eng.org/index.php/ejeng/article/view/2309

Erasmus+ project (2022). *STEAM-H Teachers training module*. www.steamh.eu

Tippett, C. D., & Milford, T. M. (2017). Findings from a Pre-kindergarten Classroom: Making the Case for STEM in Early Childhood Education. *International Journal of Science and*

Mathematics Education, 15, 67–86. https://doi.org/https://doi.org/10.1007/s10763-017-9812-8

Tripon, C. (2023). *Dezvoltarea durabilă prin abordarea STEM a educației și a competențelor secolului XXI*. Editura Universitară.

Yakman, G. (2008). *What is the point of STE@M? – A Brief Overview.* https://www.researchgate.net/publication/327449281_What_is_the_point_of_STEAM-A_Brief_Overview

Twinspace-ul proiectului "*S-TEAM in kindergarten*", ESEP platform. https://school-education.ec.europa.eu/en/etwinning/projects/s-team-kindergarten/twinspace