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DEVELOPMENT OF RESEARCH/INVESTIGATION COMPETENCE IN PRIMARY SCHOOL STUDENTS: METHODOLOGICAL APPROACHES AND DIDACTIC STRATEGIES*

Marieta NEAGU[1] Viorel BOCANCEA[2]

Abstract

The article explores the importance of developing research/investigation competence in primary school students, highlighting the didactic strategies and methodological approaches essential for this process. It emphasizes the importance of practical activities and experiments for assessing research/investigation competence (CCI), proposing concrete examples of activities and taxonomies for evaluating the levels of this competence. It examines the didactic strategies and methodological approaches necessary for the development of research/investigation competence (DCCI) in primary school students within the context of pedagogical research for a doctoral thesis, particularly the pilot phase (PP), emphasizing the significance of education that integrates investigative and experimental activities.

Key words: *Research/investigation competence, Primary education, Didactic strategies.*

1. Introduction

Research/investigation competence is a fundamental pillar in the training of primary school students, combining specific skills from both the investigative process and the learning process. Reflecting on and classifying information in research significantly contributes to the development of conceptualization capacities and the enhancement of practical skills (Sclifos, 2009). In a knowledge-based society, cultivating strong research competence is becoming a priority in modern education.

Within the framework of pedagogical research, the pilot phase serves as a tool for testing and refining the proposed educational methodologies, tools, and

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[1]PhD student "Ion Creangă" State Pedagogical University of Chișinău, Republic of Moldova e-mail address: neagu.marieta2015@gmail.com, ORCID ID: https://orcid.org/0000-0001-6970-7117

[2]Associate Professor, PhD, „Ion Creangă” State Pedagogical University, Republic of Moldova, e-mail address: bocancea.viorel@gmail.com, corresponding author, ORCID ID: https://orcid.org/0000-0002-7055-678X

strategies. The purpose of the pilot phase (PP) is to test, in a controlled environment, the effectiveness and relevance of the educational project before its large-scale implementation. Through this program, potential difficulties can be identified, and the methodology can be adjusted to ensure it adequately meets student needs and pedagogical objectives.

The significance of the pilot phase in pedagogical research lies in its ability to provide valuable empirical data. These data enable researchers to validate working hypotheses, improve experimental design, and optimize pedagogical interventions. The data also help increase confidence in the final research results, ensuring they are robust and applicable in real educational contexts. The pilot phase not only minimizes implementation risks but also ensures better adaptation of the project to the specific needs of each class. It offers an initial evaluation of the efficiency and applicability of new pedagogical models. These data will be used to develop and adapt the didactic methodology of CCI in Natural Science in the primary level, ensuring that it effectively addresses the challenges and requirements identified in the study.

2. Didactic Strategies for the Development of CCI

In developing research/investigation competence, certain didactic strategies are crucial to facilitate this process.

In the current educational context, the emphasis is increasingly on the learning process and the understanding of knowledge, rather than merely the amount of knowledge acquired. It is important to recognize that new ideas are not only discovered through memorization but through the active search and critical processing of existing ideas, adapting them to one's own style or resolving cognitive conflicts arising from different experiences. The importance of a constructivist approach in education is highlighted, where learning becomes an active process of building knowledge and developing essential skills to adapt to contemporary challenges (Joita, 2006, p. 49).

The doctoral thesis deals with the development of research/investigation competence in primary school students in the Natural Sciences discipline. In the context of the lack of a unique and efficient methodological framework in Romania, this research required a solid theoretical foundation and a specific didactic methodology, based on a constructivist approach and a series of rigorous stages of elaboration and validation. The thesis development process included:

1. Reviewing of the specialized literature to identify relevant educational models and practices in the development of research/investigation competence at the primary school level.

2. Formulation of research hypotheses, aimed at exploring the impact of the proposed didactic methodology on the development of research/investigation competence.

3. Development of the pedagogical model and methodology to develop research/investigation competence in primary school students.

4. Piloting the pedagogical intervention program on a small sample of students, in order to evaluate its efficiency and applicability and subsequently to adjust and perfect the methodology.

5. The formative experiment that aimed to implement the DCCI methodology on a larger sample

6. Analysis and interpretation of the collected data finalized with methodological recommendations at the level of teachers.

Learning through discovery is an educational approach that emphasizes the active exploration of concepts by students, allowing them to uncover knowledge through their own efforts. Students actively interact with their learning environment by manipulating objects, conducting experiments, formulating questions, and engaging in discussions. This process helps students build self-confidence, enhances their problem-solving abilities, and supports the practical application of the knowledge they acquire (Jinga & Istrate, 2001).

This teaching strategy involves students in hands-on and experimental activities, stimulating their curiosity and creativity. By directly participating in the discovery process, students develop the ability to observe, experiment, and draw conclusions based on concrete experiences. This method of learning fosters a deep understanding of concepts and promotes long-term retention.

Inquiry-based learning, described as "the acquisition of skills necessary to conduct scientific research" (Bybee, 2000), plays a significant role in teaching Natural Science because it fosters the development of critical research skills and analytical thinking among students. This approach encourages them to develop concepts, ask questions, formulate hypotheses, and actively experiment, thereby facilitating a deep understanding of scientific principles (Pathway, 2011).

By engaging in such activities, students learn to construct and evaluate arguments based on evidence, recognize alternative explanations, and effectively communicate scientific conclusions (Tamir, 1985).

2.1. The use of open-ended questions and problems represents another effective strategy for developing research and investigation competencies

Teachers can stimulate critical thinking and exploration by presenting problems that do not have a single answer. This allows students to analyze various perspectives, develop their own solutions, and rationally argue their decisions. Through this method, students become more engaged in the learning process and develop their research and problem-solving skills (Dulamă, 2002).

Based on the literature reviewed we have selected a series of didactic strategies aimed at developing research/investigation competencies in primary school students within the Natural Science discipline. These strategies focused on:

- an integrated approach, which allows students to make connections between different concepts and disciplines;
- learning through discovery and investigation, providing students with opportunities to engage in practical activities, experiments, and research projects;
- the use of open-ended questions and real-world problems, which encourage students to think creatively and develop the ability to formulate and test hypotheses;

- the application of technology, by recording observations made during experiments or accessing additional information on the topics studied, all of which are integral to STE(A)M projects (Petrovschi, 2021).

Providing constructive feedback is essential in developing students' research skills (Rotari, 2017). Continuous evaluation of students' progress allows them to adjust their methods and refine their investigative abilities. Regular feedback helps reinforce knowledge, correct mistakes, and encourages perseverance and a desire to learn (Tiron, Stanciu, 2019).

Technology is playing an increasingly important role in the learning process (Istrate, 2020), including in the DCCI. The use of educational applications and online resources can support the research process by giving students access to a wide range of information and tools. Children can use tablets to document their observations during experiments or to access additional information about the topics studied. Integrating technology into the learning process contributes to creating an interactive and dynamic educational environment.

As part of the doctoral research, a pre-experimental PP was implemented to verify and improve the DCCI methodology in the Natural Sciences subject for primary school students. Initially, we administered a questionnaire entitled "Teaching Natural Sciences" to 198 teachers, with the aim of understanding their perceptions of DCCI for primary school students. The information obtained reflects how teachers plan their activities to support modeling and DCCI, using methods adapted to the Natural Sciences subject (Iordache Neagu, Bocancea, 2022).

We were also interested in their approach and interest in Natural Sciences classes. For teaching science in schools, especially at the primary level, where students encounter this subject for the first time, it is essential to find effective means, captivating ways to involve and interest children in the study of the subject. The questionnaire was structured in the following directions: interest and attitude towards science, experimentation, motivation and applicability, identified based on pedagogical, psychopedagogical literature and normative documents in force in Romania and the Republic of Moldova. It was administered to 18 third-grade students at Rachieri Junior High School - structure during the 2020/2021 school year, a period in which instruction switched entirely to online activities. This change required a significant change in teaching strategies and the conduct of educational activities. Direct contact with students in the classroom has been replaced by interactions mediated through online technology, which has affected the quality of feedback, making it more difficult to deliver and receive it effectively.

Given the low interest in the Natural Sciences discipline, we integrated research projects, case studies, experiments and STE(A)M activities in a pilot phase carried out during classes to maximize the educational benefits. Initially, the activities were tried out through group work, followed by short presentations and discussions in class. However, since not all students were able to complete their tasks within the established deadlines, the decision was made to carry out the activities at home, with the support of adults. As the pandemic forced a shift to online learning, technology became our ally, using platforms such as Edus.ro, Livework sheets, Wordwall and regular meetings on the WhatsApp group whenever necessary.

The aim of the pedagogical experiment carried out in the pilot phase was to explore and validate the applicability and efficiency of the methodology for developing students' research/investigation competence in the Natural Sciences discipline.

Specific objectives:

1. Implementing interactive methods and practical activities to develop students' scientific investigation knowledge and skills, emphasizing learning through discovery and experimentation. Thus, the following was pursued:

• Identifying vulnerabilities and difficulties that may disrupt the process of developing research/investigation competence in primary school students, as well as establishing strategies and work techniques that facilitate the development of DCCI in an integrated manner within the Natural Sciences discipline;

• Implementing and correlating specific techniques, methods and strategies in the activities of the pilot phase, in order to ensure an efficient transition from theory to practice;

• Stimulating students' interest and motivation to carry out research and investigation activities, by promoting collaboration and active involvement in the process of learning through investigation;

2. Analyzing and measuring the level of previously formed knowledge and investigative skills, in order to observe progress and adjust the methods applied.

3. Interpretation of the results obtained from the application of the proposed activities, in order to adjust and (re)think the methodological directions, as follows:

• adjusting the complexity of the exercises and the duration of the activities according to the age and needs of the students, respecting the time resources available in the natural sciences discipline.

• introducing various forms of assessment that allow for a better expression and application of the students' scientific investigation and research skills.

• aligning the curricular contents of Natural Sciences to support the development of the investigation skill, by integrating relevant themes and specific research activities.

The basic hypothesis was that, by implementing this methodology, third-grade students in the Natural Sciences discipline will significantly improve their research/investigation competence, reflected in the increase in scientific knowledge and the ability to approach complex problems.

Within this program, the “before and after” method was used, a research technique designed to minimize errors and evaluate students’ progress following the implementation of the program. This method allowed for constant monitoring and adjustment of activities and resources, so as to correct any deficiencies in the development of research and investigation competence.

The research stages within the PP were structured in such a way as to support the development of research/investigation competence and critical thinking in students. These include:

1. Investigating a specific problem: students were encouraged to explore a problem of interest in the field of Natural Sciences, identifying research questions and formulating relevant hypotheses.

2. Data collection: students were guided to collect empirical data through various observation and experimentation methods, applying appropriate measurement and documentation techniques.

3. Information analysis: the collected data were analyzed to identify patterns and verify the formulated hypotheses, students were encouraged to use logical reasoning and correctly interpret the results obtained.

4. Presentation of conclusions: students synthesized their conclusions, presenting the research results in a clear and structured format, demonstrating understanding of the investigation process and relevant conclusions.

5. Development of research and critical thinking skills: throughout the activities, the emphasis was placed on strengthening research and critical thinking skills, by promoting reflection on the results and the investigative process.

The strategies used in the applied activities subscribe to learning through discovery:

• learning strategies through discovery and investigation

• strategies for adapting the methodology to the particularities of age and level of knowledge

• strategies for diversifying the forms of assessment

• integration of relevant curricular themes in investigation activities

• development of the necessary resources and infrastructure

Example of a Research Project for Evaluating (CCI):

Impact of Pollution on Local Biodiversity

Description: Students investigate the effects of pollution on biodiversity in a local ecosystem (Teleajen River).

• They collect data about the number and types of species observed (by interviewing grandparents).

• They explore the influence of destructive human behaviors (by questioning adults about waste disposal practices).

• They analyze the correlations between pollution and species diversity.

Evaluation Focus: The evaluation targeted the students' ability to collect and analyze data, formulate hypotheses, apply knowledge of biology and ecology, conduct research, and present findings in a report.

Observation: We noted that students encountered difficulties in completing the project.

This structured approach in the PP allows for a comprehensive assessment of students' CCI, highlighting areas where further support and development are needed.

Challenges and Adjustments:

During the project, students struggled with dividing tasks and collaborating effectively. To address this, we dedicated time in Personal Development classes to discuss each student's strengths and how to form teams, emphasizing the value each student brings and how they can best contribute to the group.

Another area of focus was the formulation of questions and hypotheses. To improve this skill, we adapted our Romanian Language Communication classes by enhancing the "reading chain" activity. After one student reads a sentence, the next student asks a question based on that sentence, ensuring that the answer is derived directly from the text. The group moves on to the next sentence only after all possible questions have been exhausted.

3. Practical Experiments where students follow a set of instructions and record their observations, are invaluable for assessing their observation and analytical skills, which are fundamental in learning Natural Science.

Example of Practical Experiments for Evaluating Research and Investigation Competence:

Experiment no 1. Photosynthesis and Its Influencing Factors

Description: Students will explore how different factors (such as light, carbon dioxide, and water) affect the process of photosynthesis in plants.

- They will expose plants to various experimental conditions.
- They will measure the amount of oxygen produced using simple techniques, such as counting the bubbles released in water.

Evaluation Focus: This experiment was designed to assess the students' ability to plan and conduct an experiment, collect and interpret data, apply their knowledge of biology, and critically analyze the results.

Through these adjustments and practical activities, students were better equipped to engage in research and investigation, enhancing their competence in these areas.

Experiment no 2. Thermal Conductivity of Materials

Description: Students will investigate how different materials (such as metal, wood, and plastic) conduct heat.

- They will heat one end of the material.
- They will measure the time it takes for the heat to reach the other end using thermometers or temperature sensors.

Evaluation Focus: This activity aimed to assess the students' skills in experimentation and measurement, their ability to use technology for data collection, their understanding of physics concepts, and their ability to draw conclusions based on their observations.

Experiment no 3. Soil Acidity and Plant Growth

Description: Students will study the effect of soil pH on plant growth.

- They will plant seeds in soils with varying levels of acidity (adjusted with substances like vinegar or baking soda).
- They will observe and measure plant growth over time.

Evaluation Focus: This experiment was designed to evaluate students' ability to plan and conduct a controlled experiment, analyze results, apply their knowledge of chemistry and biology, make predictions, and verify hypotheses.

Students made predictions about which soil would promote the fastest plant growth and, with the guidance of both family members and the teacher, they formulated conclusions about the type of soil that was most conducive to plant growth.

Since the experiment spanned several weeks, students were eager for results, so we incorporated shorter activities to maintain their engagement while encouraging them to cultivate patience, emphasizing that the outcome would be rewarding.

Experiment no 4. Rate of Dissolution of Various Substances in Water

Description: Students will compare the rate at which different substances (sugar, salt, baking soda) dissolve in water at various temperatures.

They will record the time it takes for each substance to fully dissolve and analyze how the temperature of the water affects this process.

Evaluation Focus: This experiment aimed to assess students' ability to collect experimental data, observe and record changes, apply their knowledge of chemistry, and use reasoning to explain their observations.

As this was the first experiment conducted online, we realized that time management was challenging. To address this, we organized the session by preparing the necessary materials in advance and establishing clear rules: cameras on, only one microphone active at a time (for the speaker), adults maintaining silence in the student's workspace, and no interference in the activity.

The main drawback was the online setting, which limited our ability to observe each student's contributions directly. However, the students' critical thinking and creativity were remarkable. The involvement of adults had a positive impact, strengthening the student-parent-teacher relationship.

Students applied their understanding of substance properties and even made lemonade as a practical application.

Despite the established rules, not all students were able to present their results during the session, so we created a social media group where they could post their findings.

These practical experiments are designed to evaluate students' research/investigative competence, providing them with opportunities to apply theoretical knowledge in a hands-on way and to develop essential skills for understanding scientific processes.

4. Case Study: Direct Confrontation of Participants with a Real and Authentic Situation

Description: A case study involves the direct confrontation of participants with a real and authentic situation, using a typical and representative example of a set of similar problematic situations and events. Students analyze a real or hypothetical situation, applying the knowledge they have gained to solve the identified problems (Cerghit, 2006).

Examples of Case Studies for Assessing Research/investigative competence (CCI):

Energy Efficiency of School Buildings

- Description: Students will evaluate the energy efficiency of school buildings by investigating energy consumption and identifying areas where savings can be made.
- They will propose solutions to increase energy efficiency, such as thermal insulation or the use of alternative energy sources.
- Evaluation Focus: This case study aimed to assess students' ability to analyze and evaluate energy consumption, apply their knowledge of physics and technology, develop solutions to real-world problems, and create an action plan based on concrete data.
- Reflection: As we returned to school under new rules but with the ability to interact and collaborate in person, students contributed to creating "The School of My Dreams." They required less help from the teacher in formulating questions, hypotheses, testing them, and presenting conclusions.

Resolving an Environmental Conflict Between Habitats

- Description: Students will analyze a specific environmental conflict, such as the invasion of natural habitats through the construction of housing on village grazing lands or in forests.
- They will examine the interests of the involved parties (developers, local community, environmentalists) and propose solutions that balance urban development with nature conservation.
- Evaluation Focus: This case study focused on assessing students' ability to analyze complex conflicts, apply their knowledge of environmental law and urban planning, develop equitable and sustainable solutions, and demonstrate critical thinking and reasoning.
- Reflection: Technology was used more frequently, and students knew how to search for the necessary information. They progressed from discussing environmental conflicts to presenting well-reasoned arguments with minimal help from the teacher, bringing in examples of real-life conflicts.

As the students showed interest in the proposed topics, they continued to work on STE(A)M projects during the vacation, culminating in a school-wide exhibition.

These case studies are designed to evaluate students' competencies in research and investigation, providing them with opportunities to tackle complex problems and apply theoretical knowledge in a real-world context.

5. STEM Education is distinguished by its pedagogical quality, serving as both a specialized curricular area and an integrative pedagogical model that promotes complex scientific competencies of an experimental, applicative, and logical-mathematical nature. The primary function of STEM education is the pedagogical integration of theoretical and applicative knowledge from fields such as natural Science, technology, engineering, and mathematics, aligning scientific competence with the formation and development of theoretical and practical knowledge that adheres to the values of scientific truth and its utility (GRAS, ALÍ, 2023).

Examples of STE(A)M Activities for Assessing Research/investigative competence (CCI):

Green House

- Description: Students design a house that minimizes energy consumption by utilizing renewable energy sources (such as solar panels) and efficient insulating materials.
- They present a physical or digital model of the house and explain how each component functions.
- Evaluation Focus: This activity targeted research in renewable energy, application of knowledge in physics, engineering, mathematics, technology, and art, as well as the ability to create and present a sustainable model.
- Reflection: Following the activities conducted in the pilot phase, the STE(A)M projects brought together all the information and materialized them into products, effectively integrating the five domains. Interdisciplinarity was particularly evident in Natural Science.

Exploring the Solar System

- Description: Students are engaged in a project where they explore the characteristics of the planets in the solar system. Each group of students focuses on a specific planet and presents their findings in the form of a 3D model, along with a detailed report.
- Evaluation Focus: This activity focused on scientific research, the ability to synthesize information, and the visual and oral presentation of results.
- Reflection: As a result of the activities in the pilot phase, students successfully organized themselves, collaborated, and recognized their strengths. Each student contributed to the creation of the Solar System model, which was later gifted to the preparatory class students as a teaching tool.

These activities allow for the assessment of students' research/investigative competence within the context of the integrative application of STE(A)M knowledge. This pilot phase, structured around innovative didactic strategies and well-conceived educational activities, has the potential to stimulate students' scientific curiosity, enhance their analytical skills, and develop their ability to formulate and test hypotheses. Consequently, it is expected that students involved in this initiative will demonstrate a deeper understanding of scientific processes and a strong ability to approach and solve complex problems, thereby showing a significant increase in their research/investigative competence, in line with the taxonomy of competencies (Guţu, Bucun, Ghicov *et al.,* 2017).

Table 1. CCI Taxonomy

Level	Description	Examples
Level 1	The ability to identify and understand basic concepts and a simple formula.	They can identify the parts of a plant (root, stem, leaves). They can solve a simple addition or subtraction equation.
Level 2	The ability to generate hypotheses, design experiments,	They can make assumptions about what will happen if they plant a seed.

	and analyze data in a structured way.	They observe how it grows under different conditions, such as varying light or water amounts.
Level 3	Critical evaluation of results, identifying limitations, and applying knowledge in new contexts.	After observing how a plant grows, they can discuss how they might apply this knowledge in the school garden or at home. They think about what they might do differently to improve the plant's growth, such as changing the soil or watering more frequently.

The table helps clarify how different levels of competence manifest in the learning process of a third-grade student in Natural Science. The development of CCI is monitored through continuous assessments and adjustments to the program, ensuring that educational objectives are effectively achieved. This requires an integrated approach that includes a variety of teaching strategies, well-defined assessment methods, and the use of technology as support in the educational process.

The results obtained from the questionnaire applied to students reveal several important aspects that need to be addressed to increase interest and engagement in the Natural Science discipline:

- *Completion of Homework*: Only 11% of students consistently completed their homework. This indicates a lack of motivation and commitment to home assignments, which may suggest that the material is perceived as irrelevant or uninteresting.
- *Preferences for Activities*: 45% of students prefer group activities, while 39% prefer experiments. These figures suggest that students are more attracted to collaborative and practical activities than traditional lessons. Integrating these types of activities could increase motivation and engagement.
- *Level of Interest and Engagement*: 45% of students feel fairly interested and engaged, with only a small percentage of students not feeling involved. This balance shows that there is a clear division in students' perceptions of how Natural Science lessons are structured and delivered.

This summary provides a comprehensive understanding of the students' engagement and the challenges that need to be addressed to improve their interest and participation in the learning process.

- *Perception of the Importance of the Discipline*: Only 28% of students believe that Natural Science (ȘN) is important or very important for their future, while 72% do not share this view. This indicates a serious issue in how the importance and relevance of the discipline are communicated to students. The reasons why students perceive Natural Science as unimportant include lessons being too theoretical, the lack of practical activities, and the difficulty of the material. This highlights a clear need to transform the curriculum to include more practical activities and make the material more accessible and relevant.
- *Curiosity and Interest*: 45% of students state that Natural Science does not influence their curiosity, and 17% say it decreases their curiosity. These figures are

alarming and emphasize the urgent need to rethink the teaching approach to stimulate students' natural interest and curiosity.

In the *feedback questionnaire* applied at the end of the pilot phase, students' experience with the STE(A)M activities conducted during the pilot phase was very positive, with 67% of students reporting satisfaction. Investigation activities were the most popular, taking up 50% of the time, followed by group projects (28%) and experiments (22%). These activities were considered highly relevant for understanding concepts in the Natural Science discipline by 61% of the students.

This analysis suggests that while there is a foundation of interest in the subject, significant improvements are needed in how the subject is taught to make it more engaging and relevant to the students' lives.

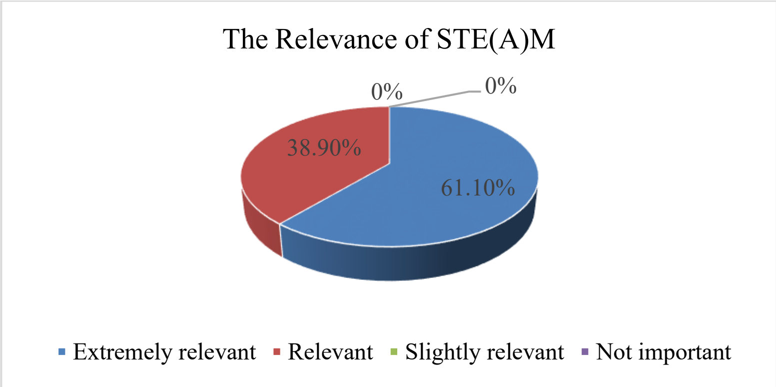

Figure 1. The Relevance of STE(A)M Activities for Understanding Concepts in the Science Discipline

The diagram illustrates how STE(A)M activities contribute to the understanding of essential concepts within the Science discipline, making it easier to comprehend the positive impact of STE(A)M activities on students' learning it. Additionally, 95% of students observed a significant or moderate improvement in their skills, while the difficulty level of the STE(A)M activities was deemed appropriate by 56% and slightly challenging by 39%. Students felt highly engaged and motivated, with 50% acknowledging this sentiment. The impact of STE(A)M activities on students' curiosity and desire to explore new topics in Natural Science was notable, with 89% of students reporting an increase in curiosity.

When asked, "Do you have any other suggestions for STE(A)M activities that would help you learn better and become more involved?" students responded that they would like lessons to always be conducted in this way, suggesting topics for projects. They expressed a desire for more playtime and for sharing STE(A)M activities with their peers, noting that these projects are interactive and educational. Students’ comments highlighted that, although additional effort is sometimes required, the activities are interesting and valuable for learning.

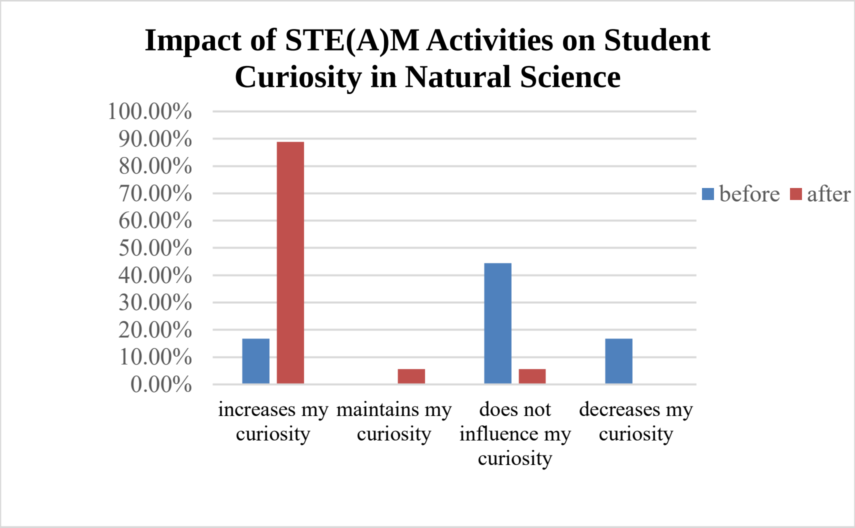

Figure 2. Results of the impact of STE(A)M activities on students' curiosity in Natural Sciences classes

The diagram presented in Figure 2 illustrates the results obtained using the before-and-after method, specifically highlighting the impact of the STE(A)M activities on students' curiosity. The table showcases a significant shift in students' attitudes towards learning after participating in the STE(A)M activities. Before the program, only 16.70% of students reported that their curiosity was increased by the activities, while 44.40% stated that the activities did not influence their curiosity, and 16.70% even felt that their curiosity was decreased. After the program, a remarkable 88.80% of students reported that the activities increased their curiosity. The percentage of students who felt that the activities maintained or did not influence their curiosity decreased significantly to 5.60% each, and no students reported a decrease in curiosity. This significant increase in curiosity following the implementation of STE(A)M activities suggests that these educational approaches effectively engage students and foster a more inquisitive and explorative mindset. The data supports the conclusion that integrating STE(A)M into the curriculum can have a profound impact on student motivation and interest in learning.

6. Conclusions

The implementation of STE(A)M activities within the pilot phase had a significant impact on the development of research/investigative competence among primary school students, contributing to an increase in their curiosity and motivation for exploring and learning about natural Science. This integrative approach, which combines science, technology, engineering, arts, and mathematics, has transformed educational activities into an interactive and engaging process, stimulating students' critical thinking and creativity.

The data collected from questionnaires and student feedback highlighted notable improvements in their ability to formulate hypotheses, design and conduct experiments, and analyze and interpret the results. Group projects and practical activities were particularly appreciated, becoming essential elements for increasing student engagement and interest.

The transition to online learning limited the ability to directly observe each student's contribution, yet creativity and critical thinking were especially prominent. Moreover, the involvement of adults had a positive impact on the relationship between students, parents, and teachers.

Integrating STE(A)M activities into the school curriculum not only improves students' academic performance but also develops their collaboration, communication, and problem-solving skills. These innovative educational methods have the potential to revolutionize the way students interact with science, providing them with an education that is relevant to contemporary realities and preparing them for a dynamic and ever-changing world. STEM education, with its integrated and applied nature, proves to be an effective model for developing scientific competencies, shaping informed, creative citizens capable of actively contributing to society.

Well-structured and guided activities enable third-grade students to develop skills in predicting and testing hypotheses through simple experiments. These activities contribute to the development of critical thinking and problem-solving abilities, giving students the confidence they need to explore and understand concepts in a practical and interactive manner.

REFERENCES

1. Adavidoaiei, M. (2015). *Consolidarea motivației elevilor prin metoda învățării bazate pe cercetare - investigare: ghid pentru profesori, învățători și educatori.* PIM.
2. Ardelean, A., Mândruț, O. (2012). *Didactica formării competențelor.* Universitatea de Vest „Vasile Goldiș” din Arad . https://www.uvvg.ro/docs/c-ercetare/cdep/Didactica-competente-final.pdf
3. Borzea, P. A. (2017). *Integrarea curriculară și dezvoltarea capacităților cognitive.* Iasi: Polirom Publishing House.
4. Boncea, A. G. (2016). Strategii didactice moderne: Metode interactive de predare - învățare - evaluare. *Analele Universităţii "Constantin Brâncuşi" din Târgu Jiu,* Seria Ştiinţe ale Educaţiei, *3*, 261-264.
5. Bybee, R. W. (2000). Teaching science as inquiry. In J. Minstrell & E. H. van Zee (Eds.), *Inquiring into inquiry learning and teaching in science.* AAAS, 20-46.
6. Cerghit, I. (2006). *Metode de învățământ* (4th revised edition). Iasi: Polirom Publishing House.
7. Gras, M. (Ed.) y Ali, C. (2023). *Educación STEM y su aplicación: Una estrategia inclusiva, sostenible y universal para la educación preescolar y primaria*. Movimiento STEM.

8. Guţu, V., Bucun, N., & Ghicov, A. (Eds.). (2017). *Cadrul de referință al curriculumului național*: Lyceum. Retrieved at: https://mecc.gov.md/sites/default/files/cadrul_de_referinta_final_rom_tipar.pdf.
9. Iordache (Neagu), M., Bocancea, V. (2022). Percepția profesorilor din învățământul primar asupra dezvoltării competențelor de cercetare / investigaționale în cadrul orelor de științe ale naturii. *Acta et commentationes (Ştiinţe ale Educaţiei)*, *4*(30), 141-151.
10. Istrate, O. (2020). Îmbunătățirea procesului educațional și a performanței școlare prin utilizarea instrumentelor și resurselor digitale. In: C. Ceobanu, C. Cucoș, O. Istrate, I.-O. Pânișoară. *Educația digitală.* Iasi: Polirom Publishing House, 107-127.
11. Jinga, I., & Istrate, E. (2001). *Manual de pedagogie*. Bucharest: All Publishing House.
12. Joița, E. (2006). *Instruirea constructivistă - O alternativă. Fundamente. Strategii*. Bucharest: Aramis Publishing House.
13. Pathway. (2011). *The features of inquiry learning: Theory, research, and practice*. European Commission: CSA-SA Support Actions. Retrieved at: http://www.pathwayuk.org.uk/what-is-ibse.html.
14. Petcu, I.-E., Cojocea, M., Milășan, A.-R., Bădescu, O., & Petcu, S. (Eds.). (2023). *Resurse STEM pentru profesori.* Asociația Europeană a Profesioniștilor în Educație EDUMI: Book For LIFE.
15. Petrovschi, N. (2021). *Tendințe moderne în didactica disciplinelor școlare. Suport de curs*. Garomont Studio.
16. Rotari, E. (2017). Utilizarea feedback-ului în instruirea adaptivă. *Tradiție și inovație în cercetarea științifică*, *6*(1). University „Alecu Russo" from Bălți, 99-103.
17. Sclifos, L. (2009). Dezvoltarea competenței de cercetare - Un model de educație intelectuală. *Revista Didactica Pro, 2-3*(55), 80-83.
18. Tiron, E., Stanciu, T. (2019). *Teoria și metodologia instruirii; Teoria și metodologia evaluării*. Bucharest: Didactică și Pedagogică Publishing House.
19. Tamir, P. (1985). Content analysis focusing on inquiry. *Journal of Curriculum Studies, 17*(1), 87-94.