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ABSTRACT OF DOCTORAL THESIS

DEVELOPMENT OF COMPETENCES IN SCIENCE AND TECHNOLOGY IN MIDDLE SCHOOL THROUGH EXTRACURRICULAR ACTIVITIES CARRIED OUT IN CHILDREN'S PALACE AND CLUBS

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INTRODUCTION

Education systems in Europe take on the idea that formal education is no longer able to respond to all the challenges of the knowledge society using only its own strengths and values, but needs to be strengthened through the contribution of non-formal and informal education (COM 2001-681). This requires a permanent complementarity between non-formal education and formal education. We also believe that non-formal education needs to become an innovative, systematic educational activity, the content of which is adapted to the needs of students and the demands of contemporary society, in order to maximize learning and knowledge and minimize the problems faced by the student in formal education system. Children's Palaces and Clubs are educational institutions, which, according to the law, have the role of organizing extracurricular activities, part of non-formal education, complementary to formal education.

The topic of this thesis is in the context of concerns about the role of extracurricular technical and scientific activities carried out within the Children's Palace and Clubs in Covasna County in the formation of competences in science and technology in middle school students.

Starting from the idea that extracurricular activities are complementary to formal education (OMNE[1] no. 4624/2015), we developed an extracurricular educational program "Science and technology in Your life", which capitalizes, in an interdisciplinary manner, the content elements of the Curriculum subjects like physics and technological education and practical applications (6th grade), which we implemented in the circles of the Children's Palace and Clubs in Covasna County. Through this program, a bridge was made between the teaching efforts of teachers in school and extracurricular activities in the Children's Palace and Clubs.

The extracurricular activities presented in the research involve a new approach to learning through interactive, motivating, engaging and fun activities. Its multiple advantages include checking all the skills specific to the traditional education system, with an additional contribution of skills gained in terms of freedom of expression, giving students the pleasure of knowing and developing, in an environment conducive to practicing and cultivating different inclinations, skills and abilities. Creative activities are related to knowledge, to competences and must be developed, help to form independent thinking, capitalize on intellectual potential and discourage mechanical storage of information (I. Albulescu, 2008).

[1] abbr. for Order of Ministry of National Education

Thus, the curricular integration of the “Science and technology in Your life” intervention program was achieved, establishing the targeted competences and complementary contents from the Curriculum of the two mentioned school disciplines.

The structure of the doctoral thesis

The thesis is structured in two parts: a first part containing the theoretical substantiation of the research, and the second containing the empirical research. In Chapter I, we made an analysis of the concepts: competence, Curriculum focused on competences, key competences and their interaction, the development of competences in science and technology through the school Curriculum in middle school education. In Chapter II we addressed the specifics of non-formal education and extracurricular activities within the Children’s Palace and Clubs in Covasna County, the relationship between formal education and non-formal education, the complementarity of these forms of education, insisting on extracurricular activities that contribute to the development of competences in science and technology. Based on these concepts, we developed the “Science and technology in Your life” intervention program, designed for the development of competences in science and technology in middle school students (6^{th} grade).

In the second part of the thesis the experimental pedagogical research is presented, in which we aimed to identify, in a scientific way, what is the formative potential of the intervention program applied in the Children’s Palace and Clubs for the development of competences in science and technology at middle school students (6^{th} grade).

In research, we aimed, through the implementation of the “Science and technology in Your life” intervention program, to determine the formative values of extracurricular activities in the Children’s Palace and Clubs, in terms of developing science and technology competences in middle school students. In this sense, we started from the general hypothesis that the activities of the “Science and technology in Your life” intervention program, carried out within the Children’s Palace and Clubs in Covasna County, contribute to a better development of specific competences in science and technology, competences that are also provided in the school curricula for the subjects physics and technological education practical lessons for middle school students (6^{th} grade).

The “Science and technology in Your life” intervention program integrates the fields of knowledge/development (science and technology) in a coherent learning perspective, based on practical applications. Students are much more motivated if the topics are taught from different perspectives and if they are based on facts from everyday life.

The intervention program was designed in such a way as to be based on the use of solid, active-participatory, student-centred pedagogical practices, based on investigation, experimentation, practical applications, and elaboration of projects. Extracurricular activities must be complementary to those in school and must relate to the curricular standards of the subjects studied. It must be the result of the optimal assembly of concepts, processes and approaches in science and technology, reflecting the standards and educational content corresponding to each discipline (physics and technological education and practical applications), enhancing the integrative utility of knowledge.

Part I: Theoretical substantiation

I. COMPETENCE-CENTERED CURRICULUM

I.1. The Significance of the Concept of Competence

The modern student-centred education system required the reconsideration of the educational process, by promoting teaching-learning-assessment activities that meet the development needs of students according to the requirements of society. The efficiency of the educational process in school can be obtained by using active-participatory teaching methods, correlating contents and competences, shifting the emphasis on acquiring, processing and applying information, so as to facilitate the integration of students in social and professional life. School must be a formative institution in the knowledge society, in which knowledge, information, theoretical and practical understanding must have an important and determined role. Student-centred education means activating them, so that the student asserts himself as a personality, able to find a successful path in life. It requires a creative, innovative school model based on a competence-centred Curriculum.

The competence-based Curriculum causes a reconstruction of education in terms of purposes, organization, and content designed for long-term development (S. Cristea, 2017). Modern education promotes learning based on direct investigation of reality, the elaboration of knowledge through own effort and the active participation of the student in the process of producing new knowledge (I. Albulescu, 2008).

Both the new approaches to the aims of education and the eight key competences set out in the 2006 Recommendation of the European Parliament and of the Council of the European Union require a broader approach to translating theoretical knowledge into practical knowledge, developing creativity, logical thinking, solving problems (Recommendation of the European Parliament and of the Council on key competences for lifelong learning, 2006/962 / EC1, in Official Journal of the European Union, L 394/10, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006H0962&from=EN).

Modern pedagogy views the student as an axis around which everything revolves and takes into account a number of important coordinates:

1. lifelong learning, as an educational project and principle of global organization of an educational system;
2. promoting in-depth learning (V. Chiş, 2005);
3. acquisition of competences;
4. the constructivist approach at "micro" level (M. Bocoş, 2017);
5. concrete facilitation of access to initial, continuing and permanent education (V. Flueraş, 2014).

School has made the transition from a pedagogy for knowledge to a pedagogy for competences, through the formation of disciplinary competences and transversal competences, which involve interdisciplinary transfers (V. Chiş, 2005). The introduction of competences in the School Curriculum and in the National Education Law (2011) determined the transformation of the previous finalities (educational objectives) into a new frame of reference, with a particularly important regulatory role in the new context of pre-university education development.

The concept of competence does not benefit from a unanimously accepted definition, there is no consensus on this; it is a polysemantic and dynamic concept (M. E. Dulamă, 2010). Professional literature gives us an impressive list of definitions and for this reason it is probably one of the vaguest concepts.

The term was introduced in the educational system to eliminate the gaps between "academic knowledge and those used spontaneously" (trans. V. Flueraş, 2014, pp. 12). The use of the concept of "competence" in education is the result of research in the field of psychology and pedagogy and a response to the challenges posed by the development of society.

Due to the complexity resulting from the interaction man-technology-society-globalization, competence is defined, according to the European Council Recommendation, as the interaction of knowledge, skills, attitudes, through which what is learned is put into practice to generate new ideas, new products, new knowledge, to solve problems and develop critical thinking, ability to cooperate, and creativity. Competence is defined as: knowledge (theory, information) + skills (practice, methods) + attitudes (how to approach what you have to do, behaviour) (Official Journal of the European Union, 2018/C 189/01, https://eur-lex.europa.eu/legal-content/ RO/TXT/PDF/?uri=OJ:C:2018:189:FULL&from=DE). Another definition emphasizes the interaction of "3C": competence means functional knowledge ("knowing how to do") + competences in the form of skills, abilities, habits + constructive comportment of positive behaviours and attitudes (V. Copilu, 2002, pp. 154).

In the UNESCO Glossary Curriculum of Terminology, competence is defined as an ability to apply learning outcomes in a defined context; it cannot be limited to cognitive elements, involving the use of tacit theory, concepts or knowledge, but must include practical skills as well as social, organizational skills and ethical values (IBE-UNESCO, 2013).

Competence indicates the ability to apply learning outcomes adequately in another defined context, such as personal development. It is not limited to cognitive elements, to theoretical knowledge (concepts), but includes technical skills and interpersonal attributes, social, organizational skills and ethical values (S. Cristea, 2017).

I.2. Key Competences

Learning is a specific human activity, carried out continuously, during schooling and after completing formal studies. In knowledge society, due to the change that is happening with an accelerated dynamic, learning is one of the ways to adapt.

Lifelong learning programs were designed to provide people with learning opportunities at all stages of life. In order to implement lifelong learning, in 2006 the European Parliament and the Council of the European Union adopted a Recommendation on the establishment of key competences for lifelong learning, essential for the individual to adapt to a world that is rapidly evolving and having a high level of interconnection. Key competences are needed for any citizen for personal training and development, active citizenship, work and social inclusion.

On the recommendation of the European Parliament and the Council of the European Union, the National Curriculum, according to the National Education Law no. 1/2011, is focused on the training, development and diversification of key competences, which outline the training, forming profile of the student. The training profile of the pre-university graduate is structured based on the eight key competences and represents a set of knowledge, skills and attitudes necessary for any person, throughout life. The eight competences must be seen as a whole, being a complex construct, with multiple relationships and overlapping with the society of which the citizen is part.

Romania has adopted a Curriculum focused on competences, as a central organizing element of the curricula specific to the different disciplines and which involves all the components of the Curriculum, not only the knowledge obtained by going through the contents. The Curriculum, through competences, transfers and mobilizes knowledge and skills in various life contexts. The aim is to develop students' competences, in order to obtain a job and personal well-being, in a modern economy (ISE, 2015).

In 2006, the European Parliament and the Council of the European Union adopted the Recommendation on Key Competences for Lifelong Learning (Recommendation of the European Parliament and of the Council on Key Competences for Lifelong Learning, 2006/962 / EC1, in Official Journal of the European Union, L 394/10, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32006H0962&from=EN). Through this recommendation, Member States were invited to "develop the provision of key competences for all as part of their lifelong learning strategies, including their universal literacy strategies" and to use "key competences for lifelong learning" – A European framework of reference" (COM, 2017, 673 final). Since its adoption, the Recommendation has been an essential reference document for the development of competence-based education, training and learning for all Member States.

According to the National Education Law no. 1/2011, Art. 68 (1), "The national Curriculum for primary and middle level education focuses on 8 areas of key competences that determine the training profile of the student:

a) communication competences in Romanian language and in the mother tongue, in the case of national minorities;

b) communication competences in foreign languages;

c) *basic competences in mathematics, science and technology*;

d) digital competences to use information technology as a tool for learning and knowledge;

e) social and civic competences;

f) entrepreneurial competences;

g) awareness and cultural expression competences;

h) the competence to learn to learn".

The National Curriculum for primary and middle school education is focused on the training and development/diversification of key competences, which outlines the training profile of the student.

Key competences are a multifunctional, transferable, structured set of knowledge, skills and attitudes. They must be developed by the end of compulsory education and must act as a foundation for lifelong learning. They overlap or intersect, the component elements can be reconfigured into a mosaic, being crossed by a number of themes, which are applied transversally: critical thinking, creativity, problem solving, risk assessment, decision making, constructive management of emotions (D. Nistor, 2016).

The development of key competences is achieved through the implementation of the National Curriculum. School curricula focus on the training and development of general and specific competences. General competences are defined for a subject of study (or a group of subjects) and are formed over several school years. Specific competences are formed during a school year and are derived from general competences (M. Bocoș, 2017). OMNE no. 393/28.02.2017 on the approval of school curricula for middle school education indicates the specific competences for each year of study, but also the contents to be achieved.

There is a close correlation between key competences, globalization, the European economy and lifelong learning. In an increasingly globalized world, people need a wide range of competences to adapt and thrive in a rapidly changing environment. The knowledge, competences and attitudes acquired during childhood, in school, in the family, during extracurricular activities, vocational training or university will not last a lifetime. The knowledge gained, the competences developed in one country must be capitalized in another country, and this can only be achieved if the educational aims are uniform at European or global level.

Education does not stop at the moment of obtaining a diploma and a job. Lifelong learning is a continuous process of flexible learning opportunities, correlating learning and competences acquired in formal institutions with the development of competences in non-formal and informal contexts, especially in the workplace. This involves uninterrupted learning, anytime, anywhere (F. Erickson, 2016).

I.3. The Interaction of Key Competences

The key competences are characterized by transversality and by the fact that they do not belong to a specific school discipline, hence their interaction. They are built over a long period of time, through a variety of content, contexts and learning situations. School curricula are focused on competences, but there is a shift to the area of knowledge, to the detriment of skills and attitudes, highlighted by the results of international assessments PISA and TIMSS, which show an increase in functional illiteracy.

Key competences are acquisitions of learning in several areas and will allow a flexible and rapid adaptation of the student to a given situation or in solving problem situations. The acquired knowledge, abilities, skills are structured in such a way as to overlap and intersect in the form of a spider's web. These key competences are crossed by a number of topics, which are applied transversally in the frame of reference: critical thinking, creativity, problem solving, risk assessment, decision making, constructive management of emotions, etc. These dimensions are found at the level of each key competence and in their transfer into everyday life. The interrelation of key competences requires an interdisciplinary approach, which involves developing the ability to transfer quickly and efficiently, to synthesize and apply knowledge, skills, competences acquired through the study of various disciplines, the ability to make connections that lead to effective achievement of concrete problems in order to solve some problem situations (L. Ciolan 2008).

Crossing the boundaries between disciplines and transversality are key features of the training and development of key competences. To achieve their interaction, the transfer process is very important to perform in a new situation. The quality of the interaction of key competences consists in the ability of graduates to solve problems in everyday life (D. Rycher, L. Salganik, 2001).

The interdisciplinary approach of the Curriculum is the way to organize the learning contents and to carry out the didactic activities, so as to offer a unitary image on the phenomena and processes studied within the different educational disciplines and that allows the contextualization and application of the acquired knowledge. The integration of the competence-centred Curriculum can be achieved through a logical linear or concentric organization. The concentric organization in terms of the development and interaction of key competences structures knowledge in such a way that it is later revised, enriched or deepened, at different levels of education. By combining the two modes of organization, the linear and the concentric, we reach a spiral development of the educational process.

Promoting interdisciplinarity, transdisciplinarity and multidisciplinarity is a defining element of the progress of knowledge and the formation of key competences. In everyday life we do not use knowledge accumulated only in a certain discipline and we do not capitalize on specific skills of a subject. Key competences can be developed through an interdisciplinary approach, looking for themes common to several disciplines, which can lead to the achievement of high-level learning objectives, transversal competences, such as decision-making, problem-solving, mastering techniques and effective learning methods, competences that, regardless of discipline, involve the same principles. Through interdisciplinarity, the connection between competences or interdependent contents from two or more disciplines is achieved, which involves the overlapping of disciplines, in order to develop integrated competences, transversal, key competences, through horizontal transfers of knowledge from one discipline to another, on a methodological and conceptual level (B. Nicolescu, 2008).

I.4. The Specifics of the Competence-Centred Curriculum

The Curriculum focused on competences meets the demands of the labour market, as it better ensures the preparation of graduates for socio-professional life. It’s about the transition from “knowing” to “knowing how to do”. In the educational process, the learner must accumulate knowledge, skills and attitudes for personal development. The teacher becomes rather a facilitator, who motivates, guides, orients, supports the student (D. Potolea, E. Păun, 2002). Everything must be related to the external and internal influences that are exerted on the child.

The multidimensional approach of the Curriculum involves three plans of analysis:

1. „Structure plan – aims at the component elements of the Curriculum (pentagonal model: finalities, contents, strategies, evaluation/regulation, time).
2. Procedural plan – indicates the following fundamental processes: research, design, implementation, evaluation, regulation.
3. Product plan - refers to the set of results of Curriculum design: main (curricula, programs, textbooks) and auxiliary curricula (methodological guides, methodologies, multimedia sets, educational software)”. (D. Potolea, 2002, p. 69).

Postmodern pedagogy advocates an integrated approach to content and a competence-based Curriculum. Through an interdisciplinary approach, the competences necessary for professional achievement and social integration can be better formed (A. P. Borzea, 2017).

The competence-centred Curriculum is “the educational offer of the school and represents the system of direct and indirect learning and training experiences, offered to educated and lived by them in formal, informal and even informal contexts” (trans. M. Bocoș, 2017, p. 73). Its realization is a complex process and includes, in addition to the mentioned components, also the learning situations (experiences). Integrated Curriculum is a planning and organization of the educational process, which produces an interrelation of disciplines or objects of study, which meets the developmental needs of students and helps to create connections between what students learn and their present and past experiences (A.P. Borzea, 2017).

The Curriculum focuses on the construction of knowledge, skills and attitudes of the learner, taking into account all internal and external factors, training time, forms of training, educational policies, to create learning situations in which children are engaged. The induced learning experiences they will go through must correspond to the requirements of modern pedagogy, to be interesting and stimulating and to develop those competences that will help the transposition of theoretical knowledge into practical ones (M. Bocoș, 2017). The competence-based Curriculum is based on a constructivist approach. This is necessary because the training and development of competences is achieved by actively acquiring information, based on those previously existing (M. Bocoș, V. Chiș, 2013).

The National Curriculum for middle school education developed in 2015 was designed according to a constructivist vision, focused on the student, by shifting the emphasis from teaching to learning, adapting learning to the interests and developmental needs of students. The focus on competences, as an organizing element of the school curricula specific to the different study disciplines, emphasizes all the components of the competence in an equal manner. According to Annex no. 2 to the OMNE no. 3393/28.02.2017, the National Curriculum for middle school focuses on the formation of key competences, and the graduate training profile is structured based on the eight key competences, representing a set of knowledge, skills and attitudes necessary for each person throughout life. The eight key competences must be seen as a whole, as a complex construct with multiple relationships and overlapping, they being transversal, because they represent value and attitudinal acquisitions, which go beyond a certain field, a study program, which implies transdisciplinarity (www.ise.ro, 2015).

The competence-centred Curriculum offers the freedom to manifest and capitalize on different learning styles, makes interdisciplinarity possible, and facilitates the contextualization and application of the knowledge acquired in performing different tasks. In conclusion, competences are related to certain social practices, being a response to the concrete needs of the community in which the school operates, which must prepare students to successfully solve life's problems.

I.5. The Applicative Character of the Curriculum

The Curriculum can be treated as a pedagogical project, in which the components interrelate with each other, in order to achieve the proposed finality, namely the development of students' competences. The fundamental structural components of the Curriculum are the educational finalities, the instructive-educational contents, the training strategies in formal, non-formal, informal context and the evaluation strategies (M. Bocoș, D. Jucan, 2017). "The Curriculum exists through the three processes – design, implementation and evaluation – none can be suspended, and consequently, are to be integrated into a comprehensive concept of the Curriculum" (trans. D. Potolea, 2002, p. 81). The enumerated concepts, the adaptation of the learning experiences in such a way as to produce favourable change through the assumed finalities, require their integration in a Curriculum management. Curriculum management helps to optimize and streamline the instructional-educational process (M. Bocoș, V. Chiș, 2013).

The applicative role of the Curriculum can be derived from the synthesis made by M. Bocoș and D. Jucan (2017):

1. Learning experiences: “The Curriculum is considered as the set of learning experiences that a student has under the auspices of the school” (trans. R. Doll, 1988).
2. Educational objectives: “… is the most concrete goal of the finalities and designates the type of changes that the educational process or the one from another educational system always expects and/or represents, the educational objectives refer to acquisitions to be incorporated, rendered in terms of concrete, visible, measurable and expressible behaviours. Educational objectives are deduced from the purposes of education” (trans. C. Cucoș, 1996, p. 48).
3. Content: “The Curriculum indicates the list of contents of the school subjects” (G. Mailaret, 1979).
4. Its prescriptive and axiological dimension: “The Curriculum is to be considered a wide range of models of thinking about human experience, not conclusions, but models from which these conclusions derive, and also contextual, in relation to these conclusions, called truths that are substantiated and validated “(M. Beth, 1965).
5. Project character: “The Curriculum is considered a project that defines the goals, aims and objectives of an educational action, the ways, means and activities used to achieve these goals, methods and tools necessary to evaluate the results obtained” (trans. L. D. Hainaut, 1981).
6. The character of the project and the need for its implementation: “In a broad sense, the Curriculum designates all the educational processes and learning experiences that the student goes through during his/her schooling. In a narrow sense, the Curriculum includes all these regulatory school documents in which the essential data on the educational processes and learning experiences that the school offers to the student are recorded. This set of documents is usually called a formal or official Curriculum” (trans. Al. Crișan, 1994).

The process of implementing the Curriculum is done, with the teacher’s contribution, at class level. The transposition into reality of what the formal Curriculum mentions is conditioned by an important variable, namely by the competence profile necessary to fulfil the multiple roles of the teacher (O. Popa, 2015). The teacher’s decisions are constantly challenged and adjusted by the interrelationship with the students, by the feedbacks regarding the content and the strategies applied in the educational process. The Curriculum is a response to the progress of human knowledge, to the interaction between culture, science, technology, education and society.

The Curriculum must provide, through the teacher, procedural knowledge that will contribute effectively to the forming of competences. The competences of each discipline highlight the vector of progress from one year to another. The current school curricula "define in general terms the information necessary for intellectual training, without specifying the (unique) time necessary for the assimilation of each content unit" (trans. C. Cucoş, 2014, p. 276). The transposition, the transformation of the prescriptions of the formal Curriculum into a concrete reality, the particularization on disciplines, is directly proportional to the teacher's competence. The teacher is the key to translating the Curriculum into reality; without a teacher, any educational intention remains only declared, not realized (E. Stan, 2004).

I.6. Development of Competences in Science and Technology Through the School Curriculum in Middle School Education

One of the areas recommended by the European Parliament for key competences is represented by the acquisition of competence learning in mathematics, science and technology (European Commission, 2005, https://eur-lex.europa.eu). The Organization for Economic Co-operation and Development (OECD) introduced in 2003, in the PISA assessments, the field of natural sciences and technology, at the same time drawing attention to their contribution to the education of students.

Competences in science and technology should contribute to science literacy. Scientific literacy means the totality of knowledge, skills and attitudes acquired by the student, which creates the possibility for him to identify questions and problems in real life, to formulate explanations and draw conclusions, to understand the need for technological and scientific education (W.R. Bybee, 2013).

Competences in science and technology are formed through systematic practice in certain significant learning situations. Their formation presupposes activities carried out with the purpose of not only "knowing", but also of knowing how to "apply" theoretically and "to do" practically, and through this "to be" and "to become". The emphasis shifts from what to learn to for what reason and with what results (M. Bocoş, 2002).

Students' lives are influenced by technology, an integral part of society's development in the 21st century. Science and technology education is trying to keep up with the knowledge society. Technology can no longer be conceived only as an instrument, it must be seen as an environment: "Technology becomes, practically, an environment of human existence" (trans. J. Ellul, 1980, p. 38).

The requirements for science and technology education are formulated almost identically in the National Curriculum and in European educational policy documents. According to Recommendation 2006/962 EC of the European Parliament, of the European

Council of 18 December 2006, but also to the National Education Law no.1/2011, through such an education students acquire:

1. Knowledge – basic principles of the natural world, concepts, fundamental scientific principles and methods, technology and products, technological processes, understanding the impact of science and technology on the natural world, understanding the progress, limitations and risks of scientific theories, applications and technology in society as a whole (in connection with decision making, value issues, morals, culture, etc.).
2. Skills – the ability to use and handle technological tools and equipment, scientific data, to achieve a goal or to reach a fundamental decision or conclusion; recognition of the characteristics of scientific investigation, the ability to communicate conclusions and the reasoning that led to them.
3. Attitudes – critical appreciation and curiosity, interest in ethical issues and respect for safety and sustainable development, in particular in terms of scientific and technological progress, in relation to the self, family, community and global issues (2006/962/EC, Official Journal of the European Union, L 394/10).

The training and development of science and technology competences require an interdisciplinary approach to basic concepts and their application in different contexts. Today's children are more motivated if the subjects taught are based on real facts from everyday life. "The strongest argument for interdisciplinarity is the very fact that life is not divided into disciplines," said Jean Moffat (R. Harris, J. Moffat, 2011). The content must be related to the educational objectives pursued and the pedagogical values assumed: "The pedagogical value represents the axiological benchmarks (moral, technological, aesthetic, psychophysical) that support the fundamental contents of education, designed according to objectives of maximum generality and epistemic stability, materialized in the activities organized at the level of the education system and process" (trans. S. Cristea, 2017, p. 43).

The development of competences in science and technology is a complex process, the main goal is not only to enrich the student's knowledge, but also to develop skills, to help him address problems in science and technology, to arouse his/her curiosity and need to learn, to explore and discover. "School defined by attributes such as accessibility, creativity, flexibility and continuity is the main factor that contributes, through the ability of teachers, to stimulate cognitive processes" (trans. V. Chiş, 2002, p. 36). The process is influenced by the applied teaching strategy. The teacher-student relationship is the main factor in stimulating cognitive processes.

An important aspect in the development of competences in science and technology is constituted by that theoretical knowledge without which the understanding of the phenomena and laws of nature cannot be transformed into practical knowledge, experiments, models, simulations, etc. Competences in science and technology represent structured sets of knowledge and skills, which can be acquired by practicing, repeating schemes, by experience and problem solving, etc.

The didactic strategies used must overcome the tendency towards encyclopaedism, towards exhaustive knowledge, still promoted by some teachers. The memorization of the contents must be balanced by an active participation of the students. The transition from an education focused on transmitting information to one that promotes thinking, creativity and the development of the ability to cope with situations in learning and in life must be made (C. Cucoș, 2014). Focusing on the student means that students are no longer seen as passive recipients of content. The passive student only receives what is transmitted to him by teaching. Unfortunately, many teachers and students are convinced that learning is a process through which knowledge is received and not an active process of acquiring it (L. Sparrow, H. Sparrow, P. Swan, 2000). Active learning must include approaches to processing new informational content, their correlation with what the student already knows their integration into their own cognitive structures.

The experiment is the effective method of teaching-learning science and technology, because by using it you can get a reflection of the knowledge, skills and abilities of students, giving them an applicative character. It is a multisensory method, which allows the successful achievement of cognitive, affective and motor objectives (J.R. Davids, S. Ball, 1991). From a methodological perspective, experimentation and observation of natural reality transforms the student from a simple spectator into an actor of the scientific-technical activity, facilitating the development of intellectual and practical work skills. Experimenting means putting students in a position to conceive and practice a certain kind of operation themselves, in order to observe, study, prove, verify, and measure the results under the guidance of the teacher. The experiment involves activities to challenge, reconstruct and modify some phenomena and processes, in order to study them.

Chapter II. DEVELOPING COMPETENCES IN SCIENCE AND TECHNOLOGY THROUGH NON-FORMAL EDUCATIONAL ACTIVITIES

II.1. The Specifics of Non-Formal Education

Non-formal education brings together all actions and influences structured and organized in an institutionalized framework, but located outside the education system. It is about the multiple extracurricular instructive-educational actions, which offer a better possibility to fold on the particular interests, abilities and options of the students (Ph. H. Coombs, 1986).

Non-formal education allows the widening of the cultural horizon, the enrichment of knowledge, the development of special skills and interests of students, etc. This education has the advantage of an instructive-educational space much more flexible than the school one, thus offering the individual a greater freedom of action. On the other hand, it may present some disadvantages: the risk that the activities carried out under the signs of the non-formal to cultivate ridicule, to convey a minor, obsolete culture, a popularization of science, art, culture.

One of the characteristics of the content of extracurricular education, an integral part of non-formal education, as a structural component of the educational system, is the following: it can be correlated with the content of formal educational activities (M. Bocoș, D. Jucan, 2017). At the level of Children's Palaces and Clubs, the scientific-technical circles, and others, carry out their activity on the basis of a non-formal, extracurricular Curriculum, complementary to the school one. According to article 10 of the Regulation of the units that offer extracurricular activities approved by Order no. 4624/2015 of MESR[2] the following fields are targeted: cultural, artistic, civic, technical, scientific, applicative, sports and tourism. Within the circles, the activity is structured on groups of beginners, advanced and highly advanced, depending on the level of training of students and the competences to be trained. When developing non-formal education programs organized in Children's Palaces and Clubs, the leader of the circle is the one who makes a selection, organization, structuring of the contents. According to the Regulation, parallelism and thematic overlaps with formal education programs should be avoided.

There is a relationship of complementarity between formal and non-formal education, both in terms of content and in terms of ways and forms of achievement or purposes. The two forms must be combined in such a way as to contribute to the integral, complex and harmonious development of the personality. Non-formal education can be influenced by pedagogical theory, laws and strategies, which ensure an effective scientific orientation.

[2] abbr. for Ministry of Education and Scientific Research

However, the interaction between the two forms must avoid unnecessary repetitions and information overload, while taking into account the interests and options of individuals.

The extracurricular activities that take place in the Children's Palaces and Clubs are focused on students, their real learning needs, skills, inclinations and individual passions. The Curriculum of non-formal activities, of development programs is structured according to the interests of students and not to academic disciplines. The contents are flexible and the satisfaction is higher among the participants. Diversification, expanding learning contexts, making learning space and time more flexible are aspects that the leader of the circle in the Children's Palace and Clubs must take into account. These activities complement formal education in terms of development of competences, helping children's personal development. Changing the place of educational activities can reduce the monotony, routine – laboratories, workshops, scientific-technical circles organized in the Children's Palace and Clubs offering dynamic, attractive, stimulating learning contexts.

Extracurricular activities have a formative value in the perspective of personal and social development of the child. The general benchmarks in their design and organization are identical to those for formal activities: setting goals, choosing the experiences needed to achieve educational goals, choosing the contents through which the learning experience will be realized, organizing and integrating experiences and contents in specific activities and evaluation (R.S. Rubin, W.H. Bommer, T.T. Baldwin, 2002).

According to Feldhusen (1998), Maoz (1993), Puskáné (2002), it should be noted that extracurricular activities are self-selective, due to the fact that they are chosen voluntarily by children, which often gives additional motivation to curricular ones.

Education through extracurricular activities emphasizes the development of "practical skills, interests, desires" (trans. S. Cristea, 2008, p. 196). Some of these activities are regulated by law, within "Sports Clubs, Children's Palaces and Clubs, school camps, sports, tourist and leisure facilities or other units accredited for this purpose" (art. 81 of NEL[3] no. 1/2011 par. 1), and the instructive-educational activities are organized in such a way as to be complementary to formal activities, to help "deepen and diversify knowledge, to train and develop vocation-specific competences and to capitalize on children's free time through their involvement in educational projects" (MESR Order no. 4624/2015 – Regulation on the organization and functioning of the units that offer extracurricular activities -art. 1-par. 1).

The need for flexibility and diversification determines the concern for a continuous updating of the contents and methodological approaches. The requirements of the society based on knowledge towards education require the rethinking of extracurricular activities

[3] abbr. for National Education Law

within Children's Palaces and Clubs, in this sense is the implementation of the new Regulation of units offering extracurricular activities (MERYS[4] Order no. 4624/2015) carried out. The Regulation regulates the development of extracurricular educational activities, in order to deepen and diversify knowledge, to form, develop, and exercise competences according to vocation and to capitalize on children's free time through educational projects (art. 1 of the Regulation, Annex to MESR Order no. 4624/2015). It reflects the intention to raise the quality standards and to achieve a balance between traditional and modern pedagogical methods, to motivate and create an atmosphere conducive to the formation of children's personality.

II.2. The Relationship Between Formal Education – Non-Formal Education – Informal Education

The educational field cannot be limited to the activities carried out in school (formal education), educational alternatives are needed. In addition to the actions and influences exerted in school on the child, many others are exerted coming from a multitude of educogenic factors. Formal education has to gain if it manages to creatively integrate all these influences.

There must be continuous, permanent and interdependent relations between the three forms of education. Ultimately, it is formal education that organizes and structures the cognitive, aptitude and attitudinal system of the individual in a way that allows for later receptivity to information and values conveyed through non-formal or informal education. Formal education ensures favourable conditions for non-formal and informal education, the latter in turn offering the necessary acquisitions for a good development of the school activity.

Each of the mentioned forms has its reason to be its own field of action in the whole education process. There are relations of interdependence and complementarity between them. Formal education, which, nevertheless, occupies a privileged place, has to gain from the interaction with other forms. School cannot ignore the rich information and experiences accumulated by students outside its space. At the same time, formal education guides and corrects the acquisitions obtained through non-formal or occasional education.

The quality of coordination and integration of informal or non-formal influences depends on the scope and depth of formal education. Of course, there is a risk that the influences coming from the social (informal) space will give another direction to the modelling of the child's personality, opposite to the will of the school; then, the activities of this institution would suffer, encounter many difficulties and fail. Only an integration and

[4] abbr. for Ministry of Education, Research, Youth and Sports

mutual enhancement of these three forms of leadership education leads to achieve efficiency in the education activity as a whole.

These activities, whether cultural-artistic, technical-scientific or sports, had a positive impact on students: greater involvement in school life, better learning outcomes and a low dropout rate (A.F. Feldman, J.L. Matjasko, 2005).

II.3. Improving Students' School Performance Through Non-Formal Education Activities

Mathematics, science and technology are key competences, which require a broader approach. The reports in the European Commission's documents show a low interest of students in the STEM study subjects (science, technology, engineering and mathematics). It is important to increase students' motivation to study the respective subjects, including through non-formal activities.

The president of the Romanian Physics Society and member of the Romanian Academy, N. Zamfir, shows us the reality of the Romanian education system: "The big problem of Romanian education is that the student does not understand the usefulness of the subject s/he has to learn. Thus, "functional illiterates" are the result of an education system in which theory has never been linked to practice "(C. Ducu, N. V. Zamfir, 2018). The only international reports that reveal functional illiteracy are those of the OECD (Organization for Economic Co-operation and Development), these were made following the PISA (Program for International Student Assessment) tests. According to the study, students often cannot make the connection between theory and practice; do not show creativity or logical thinking also because a more coherent interdisciplinarity is not achieved. Another essential condition for developing competences in science and technology is the interaction with competences in mathematics and digital, desirable in the modern world.

II.4. Development of Competences in Science and Technology Through Non-Formal activities – Customizations at the Level of Children's Palaces and Clubs

Children's Palaces and Clubs are institutions empowered to provide non-formal education. The purpose of the activities is to complete knowledge and support the development of competences in certain areas provided in school curricula, by conducting research and rediscovery of phenomena through practical experiments, cultivating inclinations towards science and technology, developing talents in technology and natural sciences, knowledge transposition in practical knowledge, applicable in everyday life.

The activities organized within the technical-scientific circles must be complementary to the education in science and technology carried out in school and contribute to the development of key competences. The activities of the technical-scientific circles, include the characteristics of formal training, plus those specific to extracurricular education (S. Cristea, 2017):

1. They are organized, planned and carried out in an open, flexible context, depending on the options of students, parents, community, and teacher training.
2. They are designed on the basis of specific objectives, for deepening and expanding knowledge, developing skills and a positive attitude.
3. The specific objectives can be achieved through activities designed in an open system with teachers, leaders of circles within the institution or collaborating teachers who carry out extracurricular activities in schools, but outside school curricula;
4. Interdisciplinary and transdisciplinary cognitive bridges can be achieved.
5. It is based on: integration, specific character, coordination, attractive character, variety.
6. Positive educational values create a closer, closer teacher-student relationship.
7. They are designed on the basis of direct or indirect requests from children, the school, the family, the community, with the purpose of deepening knowledge or developing competences in that field.
8. They are student-centred, demanding the educable differently.
9. They have attractive activities, diversified according to the requirements of the learner or the group.
10. They have a small number of participants at group level, between 10 and 15 children, depending on the degree of performance.
11. The activities are performed in specialized rooms, laboratories and outdoor activities.
12. Avoids the parallelism with formal activities, respectively with the disciplines included in the Curriculum and CSD[5].
13. The evaluation is “optional, informal, with psychological accents, primarily stimulating, without grades or qualifications” (trans. V. Chiş, M. Ionescu, 2010, p. 126).

Possible disadvantages of the activities of technical-scientific circles:

1. There is often a formal pragmatism and they are realized only in the niche that is the strong point of the leader of the circle/activity.

[5] abbr. for Curriculum at the School’s Decision

2. Systematic observation by the leader of the circle and self-evaluation of one's own activity are not enough to evaluate the activity, they can create lags and gaps in personality development.
3. Sometimes they do not adapt to individual requirements or the potential of the learner.
4. The lack of communication between school teachers and non-formal activities affects the complementarity regarding the development of competences.
5. The lack of funds and pedagogical tools, together with teaching methods, lead to the abandonment of circles by participants.

Natural sciences and technology can be learned more easily by correlating school and extracurricular activities.

The activities of scientific-technical circles have an interdisciplinary specificity and a dual, theoretical and practical character. The objectives pursued in the scientific-technical activities must be in a report of complementarity with the objectives of the school curricula. The content of the development programs is focused on practical experiments (layout, circuits, models that highlight the applied value of knowledge), develops the ability to observe and analyze physical laws, etc. Increasing creative capacity, invention and innovation is a priority goal. Knowledge of raw materials, auxiliary materials, the ability to read a technical drawing, making sketches and technical drawings, the use of tools, the equipment are some important benchmarks, which must be included in development programs. Understanding the relationship between technology and the environment, cultivating an ecological attitude and behaviour are, in turn, important objectives. An important formative dimension of each circle in the technical-scientific field should be the assimilation of values and ethical principles, which would define the relationship between man-society-nature-technology (M. Mircescu, 2019).

II.5.2. Teaching Strategies Used in Non-Formal Activities in the Children's Palace and Clubs

The methodological system within non-formal activities must represent the coherent totality of teaching methods and procedures with relations of influence, complementarity and mutual support (M. Ionescu, M. Bocoș, 2017). In order to make his/her activities more efficient, the leader of the circle cannot use a single method, because the children will get bored and abandon those activities. The pedagogy of the extracurricular activity is student-centred, it must be differentiated, and the methodological system must respect the multifunctional character of the instructive-educational process. The realization of multidirectional information transmission and reception and the development of activities in optimal conditions, the reduction of abandonment of circles of non-formal activities are conditioned by the use of a methodology that stimulates and motivates participation. The teaching aids must be selected, adapted, used according to the methods and procedures used, but also to the content and objectives of those activities.

The non-formal education system within Children's Palaces and Clubs needs effective teaching strategies in order to achieve its training objectives.

The methods used in scientific-technical circle activities must be active-participatory and interactive, the circle leader maintaining a differentiated dialogue with each student, taking into account his/her options and his/her intellectual abilities (I. Albulescu, M. Albulescu, 1999). This is the way to help students develop their intellectual abilities, talents, skills, abilities. The circle leader develops a student-centred development program in order to achieve the proposed goals. In its implementation, s/he opts for the teaching strategies that s/he considers to be the most effective. They "... outline the range of practical ways to achieve the intended target and have the value of working tools" (trans. I. Cergit, 2002, p. 273).

Interactive and active-participatory teaching strategies support an active and conscious learning, students have the opportunity to investigate, discover, develop, etc. In these activities, the degree of involvement of students must be high. The methods used in such activities must have transformative qualities, due to which the teacher can lead the students to find their own path to follow in order to solve problems.

The active-participatory and interactive methods (problematization, discovery learning, collaboration, case study, mutual learning, project, etc.) used in the activities in the technical-scientific circles require from the circle leader an effort to design and correlate resources, for keeping students' interest at a high level.

Within the activities in the field of science and technology education, in school or in the Children's Palace and Clubs, the most appropriate is the training by action (Learning by doing), proposed by J. Dewey, A. Ferriere and O. Declory. Teaching-learning methods must also correspond to the specifics of the digital native generation. Children receive informal information with the help of High tech technology, through smartphones, television, etc., and circle leaders have to apply visual and interactive training methods.

Interactivity, activism and student participation play a key role in extracurricular activities in Children's Palaces and Clubs. Each stage of business planning, monitoring of work tasks, evaluation of results and reflection on the whole process must be designed in this regard. In learning through action, students face problems they want to solve, with useful and meaningful results. In the research we used, for example, the problem solving method. Its elements are, in fact, the steps that characterize any process of scientific investigation: a) the creation of an empirical situation; b) the formulation of the problem; c) updating the previous experience; d) formulating the hypothesis and verifying its validity (J. Dewey, 2008).

Researching, searching, asking, combining and recombining, processing information, assigning personal meanings and significance to the information with which they operate are key elements in extracurricular activities and characterize the teaching methodology used. In search of solutions to problem-solving situations, students must restructure, adapt, and transform the knowledge stored in memory.

Also, play plays an important role in non-formal activity in "the intellectual, emotional and social development, especially in early childhood and could be defined as a voluntary activity, intrinsically motivated, involving a certain level of productive activity in the plan of personal development" (trans. H. Catalano, I. Albulescu, coord., 2018, p. 35). It is a method that combines the instructive-educational elements with the fun ones. The didactic game ensures variety, diversity, emotional involvement, dynamism, good mood, training, restoring the psycho-physical balance, providing stimulating motivations, strengthening the physical and intellectual energies of the students. Knowing the age and individual peculiarities of the students, as well as their level of preparation, the didactic game can be introduced in key moments of the extracurricular activity in order to keep their attention awake, to arouse their curiosity, to stimulate their interest in learning. We must not forget, however, that the role of the didactic game is to optimize the didactic act, to provoke, to maintain, to stimulate the attention and interest for the ongoing activities. However, if it is used in excess, the quality of the didactic act can be diminished (H. Catalano, I. Albulescu, coord., 2019).

II.5.3. Evaluation in the Activities of Children's Palaces and Clubs

The development of students' competences through activities in scientific and technical circles organized by the Children's Palace and Clubs can be assessed in forms and strategies specific to school activities, but also through an informal assessment, such as participation in competitions or symposia. Evaluations must be designed not only to assess that development, but also to improve development programs (contents, types of activities, strategies used, relationships, etc.). An approach that reflects the specificity of evaluation in such activities is described in L'Educateur et l'approche systemique (UNESCO, 1981): "the objective of evaluation is not to relate an educational action to a set of values, more or less absolute, to refuse or accept, but to arrive at a sufficiently systematic description to be able to perceive the links between different elements and, if necessary, to act on some of them in order to modify others" (UNESCO, 1981, pp. 137). The evaluations are performed to ascertain the performance of the students who attend the scientific-technical circles, but also for the purpose of their self-regulation. Thus, real feedback can be provided to both teachers, students and even parents, regarding the results of extracurricular activities.

The evaluation strategy is a complex pedagogical act "to establish the relevance and value of some processes, performances, behaviours, etc., by relating them to a system of performance indicators, respectively pre-established criteria and standards" (trans. M. Bocoș, M. Ionescu, 2017, pp. 383). It is not only evaluated what and how much the student knows, but also how s/he can apply this knowledge in practice, what new behaviours s/he has formed. Performance is a concrete competence; success must be assessed differently, depending on each student, it is circumstantial.

There must be a reporting framework, a comparison, included in the evaluation strategy: reporting the student's results to the objectives pursued. Each result can also be reported to the results of the group. In the activities organized in the Children's Palace and Clubs, the evaluation must aim at the level of development of students' competences and ends with the elaboration of an individual portfolio. The evaluation of the teaching staff in these institutions is carried out annually, according to the job description and the self-evaluation form prepared on the basis of a methodology, which provides the necessary framework for a unitary, objective and transparent evaluation.

Part II: Experimental Research

Development of competences in science and technology in middle school students through extracurricular education activities carried out in the Children's Palace and Clubs

Chapter III. EXPERIMENTAL RESEARCH DESIGN

III.1. The Premises and the Context of the Research

Through the experimental research, we aimed to highlight the potential of activities organized within the Children's Palace, through the development program "Science and technology in Your life", in the formation of competences in science and technology in middle school students and thus the complementarity of scientific activities proposed by disciplines in the curricular areas of mathematics and natural sciences, respectively Technologies. Through rigorously formulated and scientifically based conclusions, we intend to propose other directions of pedagogical research, as well as examples of good practice.

Our research started from the premise that extracurricular activities within Children's Palaces and Clubs can influence school results and can be complementary to formal education, in terms of competence training. The research is limited to the formation of basic competences in science and technology. The competences specific to physics and technological education and practical applications discipline (6th grade) were targeted, through an interdisciplinary approach. Through the development program “Science and technology in Your life”, applied to sixth graders who participated in extracurricular activities in the Children’s Palace and Clubs of Covasna County, we aimed at the following competences in science and technology (School programs for technological education and practical applications and physics, 6th grade, included in Annex 2 to OMNE No. 3393/28/02/2017, http://programe.ise.ro/Portals/1/Curriculum/2017-progr/):

1. Practical realization of useful products and/or creative works for current activities and their capitalization (technological education and practical applications);
2. Solving problems and problem situations with theoretical and applied character, through specific methods (physics);
3. Structured scientific investigation, mainly experimental, of simple, perceptible physical phenomena (physics);

In order for a student to develop certain specific competences in science and technology, it is necessary for him to master a set of fundamental knowledge in the respective fields, to develop skills to use them in concrete situations. The student solves various tasks, including practical ones, using the knowledge acquired in various learning, school and extracurricular contexts.

Research carried out through the application of the program “Science and technology in Your life” involves, in addition to competence training and creating contexts that promote the formation of responsible attitudes towards health, environment, work, by applying occupational safety measures, fire prevention and extinguishing, reduction energy consumption, rational use of material resources necessary to make products, supporting students in decision-making processes regarding the continuation of studies.

The extracurricular program “Science and technology in Your life” aims, first of all, to enrich, deepen and consolidate the knowledge acquired in and out of school, the application in practice of some of this knowledge and the involvement of students in multiple activities of observation, application and experimentation. Thus, students’ experience is capitalized and thus develops their ability to integrate new information into their own explanatory models, to apply the acquired knowledge, to find solutions to new problems.

Extracurricular activities are planned, they have a dynamic action model, through which knowledge, ideas and ways are systematically reconstructed and developed in which we can substantiate, examine and validate truths.

With the help of the development program “Science and technology in Your life” we want to involve as many middle school students as possible and improve their motivation and interest in participating in extracurricular activities in science and technology, by combining traditional methods, activities with modern, student-centred ones (I. Albulescu, 2003).

III.2. The Purpose and the Objectives of the Research

Research questions

1. What is the potential of extracurricular activities carried out in the Children’s Palace and Clubs, through the “Science and technology in Your life” intervention program, in the development of science and technology competences in middle school students, reflected in the development of products, devices, layouts and simple algorithms for calculating speed and density?
2. To what extent do the knowledge and practical skills acquired in the “Science and technology in Your life” intervention program contribute to the development of the ability of middle school students to solve problem situations?
3. Do the activities organized within the “Science and technology in Your life” intervention program, carried out in the Children’s Palace and Clubs, contribute to the development of students’ ability to conduct structured scientific investigations, mainly experimental, of simple, perceptible physical phenomena?
4. How does the participation of middle school students in the development program “Science and technology in Your life” within the Children’s Palace and Clubs influence the students’ school results, including national assessments?

The purpose of the research

The purpose of our research was to develop competences in science and technology in middle school students (6^{th} grade), by applying the “Science and technology in Your life” intervention program in the Children’s Palace and Clubs in Covasna County and thus, increasing their school performance.

Research objectives

1. Exploitation of the formative values of the program “Science and technology in Your life” in order to develop specific competences in science and technology in middle school students (6^{th} grade), participants in the scientific-technical circles of the Children’s Palace and Clubs during the school year.
2. Identifying the complementarity of the extracurricular activities program “Science and technology in Your life” with the school teaching-learning activities of the subjects in the curricular area of mathematics and natural sciences and the curricular area of

Technologies, in the development of science and technology competences in middle school students (6^{th} grade).

3. Valorisation of the interdisciplinary character and the practical-applicative character of the program “Science and technology in Your life” carried out in the Children’s Palace and Clubs in the development of science and technology competences in middle school students (6^{th} grade).
4. Stimulating the students from middle school education (6^{th} grade) to participate in scientific-technical extracurricular activities in the Children’s Palace and Clubs.
5. Providing models of good practice scientifically validated to middle school teachers.

III.3. The Research Hypotheses

The starting point in formulating the general hypothesis of the research was the decreasing presence of students in scientific and technical circles, the decrease of their interest in extracurricular activities of this kind, highlighted in national and international studies (E.A. Hanushek, L. Woessmann, 2015), perhaps also due to the gaps in the teaching strategies used in extracurricular activities in the Children’s Palace and Clubs.

General hypothesis

The activities of the “Science and technology in Your life” intervention program organized in the Children’s Palace and Clubs of Covasna County, contribute to a better development of specific competences in science and technology, also provided in school curricula for physics and technological education and practical applications for middle school students (6^{th} grade).

Depending on the general hypothesis, we formulated the following specific hypotheses:

1. The extracurricular activities carried out in the Children’s Palace and Clubs, through the “Science and technology in Your life” intervention program contribute to the development of students’ competence to make useful products and/or creative works for current activities and their capitalization.
2. The extracurricular activities carried out in the Children’s Palace and Clubs, through the “Science and technology in Your life” intervention program, contribute to the development of students’ competence to solve problems and problem situations of a theoretical and applied nature, in the field of science and technology.
3. The extracurricular activities carried out in the Children’s Palace and Clubs, through the “Science and technology in Your life” intervention program, contribute to the development of students’ competence of structured scientific investigation, mainly experimental, of simple, perceptible physical phenomena.

4. The extracurricular activities carried out in the Children's Palace and Clubs, through the "Science and technology in Your life" intervention program, determine an improvement of school results of 6th grade students at the national assessments in mathematics and Sciences.

III.4. The Research Variables

A. The independent variable

The independent variable: the development of the "Science and technology in Your life" intervention program within the scientific-technical circles of the Children's Palace and Clubs, Covasna County, for 6th grade students.

B. Dependent variables

VD1. The ability to make practical products and/or creative works for current activities and their capitalization means:

a) the ability to execute simple products/models/maps based on a technological file, selecting the appropriate raw materials, materials, tools/utensils/devices/equipment, performing operations (measuring, tracing, cutting, joining), carrying out projects ;
b) the ability to systematically analyze data, quantities, relationships, processes and phenomena specific to science and technology in making a product;
c) the ability to use the basic acquisitions in mathematics and science to make a product (measurements, calculations, elaboration of sketches, schemes, plans, etc.);
d) the ability to analyze and appreciate the products based on criteria established by mutual agreement.

VD2. Ability to solve problems and problem situations of a theoretical and applied nature, meaning:

a) the ability to solve problems through modelling and algorithmization to answer questions/problems that require factual knowledge;
b) the ability to generate ideas, concepts, solutions by using simple models in solving problems.

VD3. The ability of structured scientific investigation, mainly experimental, of simple, perceptible technological and scientific phenomena, meaning:

a) the ability to explore physical properties and phenomena in simple investigations;
b) the ability to use some methods of recording and representing the experimental data;
c) the ability to formulate simple conclusions based on the experimental data obtained within the technical-scientific investigations;

d) the ability to interpret the effects of technology development and awareness of the consequences that inappropriate exploitation may have on environmental protection.

V.D.4. The level of results obtained in national assessments in the 6^{th} grade, in mathematics and natural sciences.

III.5. The Intervention Program

The program included 34 interactive activities and initial and final evaluation tests. At each activity, 5 exercises were designed, through which the connection between the theoretical and the practical component of the contents of physics and technological education and practical applications discipline for 6th grade was realized. We specify that the content sample was established by reference to the contents of the curricula for the subjects of physics and technological education and practical applications. The materials needed to carry out the experimental intervention were of their own design.

The characteristics of the intervention program are: complementarity with school activities, interdisciplinarity, interactivity, immediate feedback, full presentation of experimental techniques and equipment for understanding phenomena, diverse types of exercises/experiences/practical applications for understanding theoretical content, information provided in short sequences respecting the learning progression depending on the degree of difficulty of the notions. We have also created educational contexts for problem-solving learning. The intervention program (training experiment) took place between September 2018 and June 2019, by carrying out training activities with the experimental group of subjects, while the activity of the control group took place normally in the classroom, without being influenced by the expected experimental variables. They, not being participants in extracurricular activities in the Children's Palace and Clubs, participated only in the teaching activities in the school.

The program is structured modularly, for one year of study, with an activity of 100 minutes. The contents of the program were organized in 34 educational activities. The students even had the freedom to choose the contents, according to their interests and desires.
Within the carting, aero-modelling and applied electronics circles, two activities were organized per week, a 100-minute activity for the specific activities of the respective circles and a 100-minute activity for the application of the intervention program (with advanced groups). During the school year, but especially in winter when outdoor activities, like carting and aero-modelling are not possible, 34 extracurricular activities were carried out, which gave students greater independence to cultivate attitudes of investigation, research.

III.6. The Place and the Period of the Research

The research took place at the Sf. Gheorghe Children's Palace and at the Children's Club from Întorsura Buzăului, because in the respective localities there are technical-scientific circles of experimental chemistry, applied electronics, aero-modelling and carting. The activities within the mentioned circles were attended by children from both rural and urban areas, from Sf. Gheorghe, Întorsura Buzăului, Sita Buzăului, Barcani, Brăduț, Valea Crișului, Ilieni.

III.7. Sample of subjects

The experimental group and the control group consisted of 6th grade students, who began school in the 2012-2013 school year, being the first students to attend the preparatory class, with curricula that emphasize the importance of students' learning in training and focus on competences, which allows for the phrase "student-centred" not to remain a slogan without content. The first generation of students were prepared based on the school programs approved by OMNE no. 3418/03.19.2013. The respective students are educated in the middle school level on the basis of a National Curriculum, which assumes a design of the school curricula based on the new curricular conception for the pre-university education, which operates with the notion of "competence".

The experimental group consisted of 75 middle school students, 6th graders, who attended the circles of experimental chemistry, applied electronics, carting, aero-modelling organized in the Children's Palace and Clubs in Covasna County.

The students in the control group were selected to correspond structurally to the experimental group – 59 students from an urban and 16 students from a rural school. The number of girls in the 6th grade (38 students) was higher than in the experimental group (26 students), which, in a way, is natural, because we are talking about normal classes. The control group also included students from a Waldorf class (8 students and 6 students), in order to make a comparison between extracurricular activities and the educational process based on the Waldorf Curriculum.

Chapter IV. RESEARCH RESULTS

IV.1. The Results of the Research Obtained in the Pre-Experimental Stage

IV.1.1. The Results Obtained After Piloting the Intervention Program

The administration of the initial test in the piloting stage and the quantification of its results represented, in the ascertaining stage, a main objective due to the following aspects: integration of the "Science and technology in Your life" intervention program in extracurricular activities in the Children's Palace and Clubs, the validation of the program contents, testing the efficiency of the activities in terms of student performance, didactic training of circle coordinators.

Two groups were selected (a total of 24 students) equivalent in terms of the values of the calculated statistical quantities (mean, median, module) and with an almost normal statistical distribution of the results obtained in the pre-test, in the piloting stage. The 24 students in the 6^{th} grade were the only group of subjects. The selection of the contents in order to pilot the intervention program, the validation of the test, were made after studying the curricular products (school curricula and framework plans, alternative school textbooks, AeL educational resources) for physics and technological education and practical applications.

When analyzing the items in the first stage, we made a comparison of the averages for each item to see if the application of the development program found a variation of dependent variables and competences in science and technology, or no significant changes. Based on the answers and the processing of the data obtained after the test, it was found that the students in the pilot group obtained better results in each item, except for the first question, which required more mathematical calculations and it seems, from the discussions we had with the students after the test, the math affected their results.

The increase of the average of the dependent variable that expresses the capacity of practical realization of useful products and/or creative works for current activities and their capitalization (V.D.1), is significant, because it increased from 9.8 to 18.8. The dependent variable (VD2), which expresses the ability to solve problems and problem situations of a theoretical and applied nature, increased from 4.5 to 14.4, and the average of the dependent variable (VD3) the ability for structured scientific investigation, mainly experimental, of some simple and perceptible technological and scientific phenomena, increased from 8.7 to 18.1, progresses due to the activities carried out within the program.

IV.2. The Results of the Research Obtained in the Post-Experimental Stage

The pre-test was applied to the 150 students included in the pedagogical research (experimental group and control group) and the following competences in science and technology were taken into account:

1. Practical realization of useful products and/or creative works for current activities and their capitalization (C_1);
2. Solving problems and problem situations with theoretical and applied character, with specific methods (C_2);

3. Structured scientific investigation, mainly experimental, of simple, perceptible physical phenomena (C_3);

For the evaluation of the three competences, the test with the 19 items was administered, which targets the three dependent variables (VD_{1-3}). The fourth dependent variable aims at the results from the 6th grade National Assessment, at mathematics and sciences.

Scientific-technical extracurricular activities are learning activities in which students learn differently than in lessons. They train or develop their competences in science and technology. In the extracurricular activity we can assess the competences developed, especially since these activities are not mainly aimed at accumulating new knowledge. Learning in science and technology circles aims at developing competences and as a natural consequence, the assessment of learning must aim at assessing competences. For a better evaluation we will analyze the dependent variables $V.D._{1-3}$ after data processing with the program SPSS26, and with the help of histograms we will illustrate the comparison of the dependent variables in the experimental and control group.

As a summary, we further compare the variations of the three dependent variables in the two groups in order to have a clearer perception of the importance of the "Science and technology in Your life" development program.

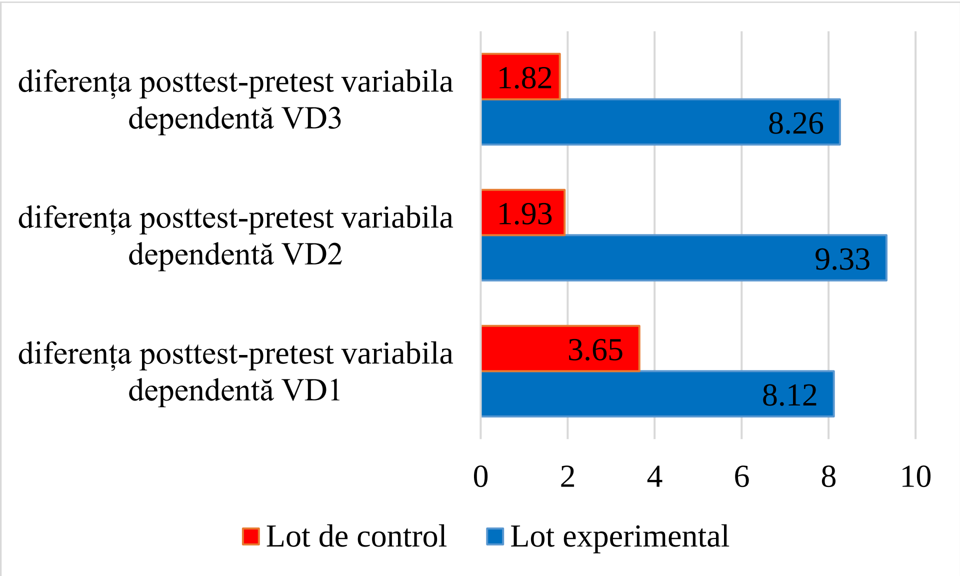

Figure no. 51. Comparison of the results of the dependent variables $V.D._{1-3}$, the experimental group and the control group

It can be observed, with the help of fig. no. 51, the differences resulting from the application of the "Science and technology in Your life" intervention program, activities that were complementary to formal education and contributed to the development of competences in science and technology.

The results are very real, because the curricula for the subjects of physics and technological education and practical applications (6th grade) were introduced in the 2017-2018 school year, programs that aimed at scientific investigation competences, which have a decisive role in the technological education of students. The "Science and technology in Your life" development program came with complementary activities which help form the competences of investigating phenomena, interpreting data, solving problems and problem situations, namely those competences that will be needed for the student's socio-professional integration into daily life.

Comparative analysis of the results obtained in pre-test - post-test from the experimental group and the control group

We will further analyze the results (R_{ETF}, R_{CTF}) obtained by the students of the experimental group and of the control group at the two tests: pre-test and post-test. To compare the results, we will also analyze the results of the pre-test in both groups.

The final results (Figure no. 52) reflect the theoretical and practical knowledge, as well as the scientific-technical competences of the students in the two groups. What differs and probably influences students' results are the materials, equipment, methods used, but also the level of knowledge of students.

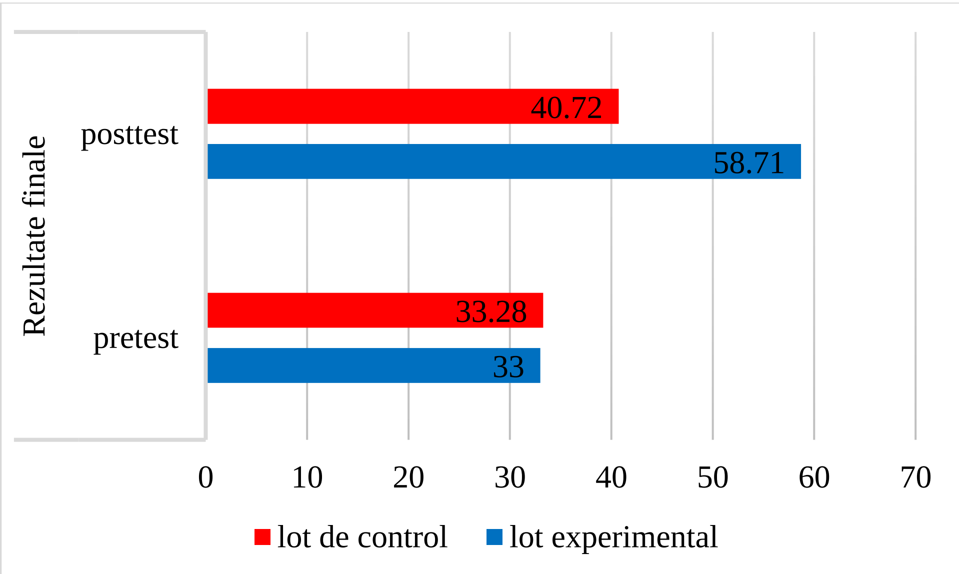

Figure no. 52. Comparison of students' results, experiment group and control group

In order to consider that the statistical difference between the two results is primarily due to the independent variable (the "Science and technology in Your life" program), but also to school programs, we will use the data obtained by applying the t test for independent samples, for which we formulated assumptions:

H_0-null hypothesis: following the curricula (control group and experimental group) and the "Science and technology in Your life" intervention program by the students of the experiment group, there is no significant difference between test results ($R_{ETF} \approx R_{CTF}$), in the pre-test - post-test stages, between the experimental group and the control group.

H_1-research hypothesis: following the school programs (control group and experimental group) and the "Science and technology in Your life" intervention program by the students of the experiment group, there will be a significant difference between the test results ($R_{ETF} \neq R_{CTF}$) applied to the experimental group and the control group.

	Lot grupe	N	Media	Diferența mediei	Diferența erorii standard
rezultat R_{ETF}	Lot experimental	75	33,00	13,987	1,615
	Lot control	75	33,28	11,052	1,276
rezultat R_{CTF}	Lot experimental	75	58,71	9,712	1,121
	Lot control	75	40,72	11,979	1,383

Table no. 62. Comparison of final post-test results (R_{ETF}, R_{CTF}), experimental group and control group

Rezultat R_{ETF} pre-test	Levene's Testul Levene -pentru egalitatea varianțelor		Testul t-pentru egalitatea mediilor						
	F	Sig.	t	Df	Sig. (2-tailed)	Diferența mediei	Diferența erorii standard	95% Intervalul de încredere pentru diferențe	
								Scăzut	Crescut
Equal variances assume	3,713	,056	-,136	148	,892	-,280	2,058	-4,348	3,788

d									
Equal variances not assumed			-,136	140,486	,892	-,280	2,058	-4,350	3,790
Equal variances assumed	4,158	,043	10,101	148	,000	17,987	1,781	14,468	21,506
Equal variances not assumed			10,101	141,930	,000	17,987	1,781	14,467	21,507

F=4,158, p_F=0,043, t(141,930)=10,101, p=0,000

Table no. 63. Data collected following the application of the t test, comparing the final post-test results (R_{ETF} , R_{CTF}), the experimental group and the control group

The statistical results of the t test for independent samples show a significant increase in the average of the post-test results for the experimental group. Mean difference $M=M_{RETF}-M_{RCTF}=17.987$, result obtained by the experimental group compared to the post-test control group (Table no. 62).

Because the Levene test is significant (Table no. 63) (F=4.158, p=0.043), p less than the theoretical significance of 0.05, the variants of the two groups are different and the null hypothesis can be rejected. From the Levene test result we will extract the results of the t test and the significance from the Equal Variances Not Assumed row with the values t(141.930)=10.101, p=0.000 indicates the rejection of the null hypothesis, because the significance threshold is zero, which indicates that in the pedagogical experiment, the increase in the average of the post-test results was mainly due to the independent variable (the “Science and technology in Your life” program).

Comparative analysis of the results of national assessments in mathematics and natural sciences for 6th grades, the experimental group and the control group

For 6th graders there is an annual evaluation of the fundamental competences acquired in the lower cycle of middle school (grades 5-6). According to the National Education Law no. 1/2011, with subsequent amendments and completions, the ENVI results aim to develop individualized learning plans for students.

The students of the experimental group went through a program of extracurricular activities (intervention program), which aimed at developing competences in science and technology (specific competences). Technical-scientific extracurricular education allows a systematized assimilation of knowledge and facilitates the development of abilities, skills, aptitudes, and attitudes necessary for the insertion of the individual in society. The respective activities are in complementary relationship with physics and technological education and practical applications, but also Biology and mathematics, in order to develop the respective competences.

The national assessments in mathematics and natural sciences for 6th grade aim at the 6 competences, partially found in the "Science and technology in Your life" intervention program.

The analyzes performed within the ENVI 2019 National Report, at item level, highlight the percentages of students at county level, to which they were assigned, for the answer given to each item, one of the corresponding codes (Annex no. 9). The data regarding this aspect, the average percentages of solving the requirements of each competence are presented with the help of Figure no. 53.

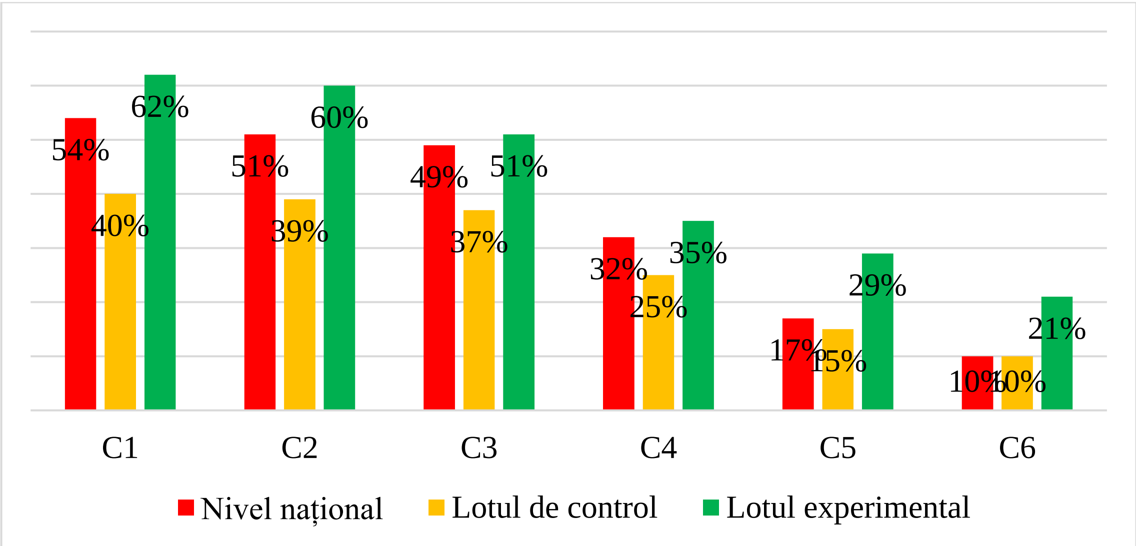

Figure no. 53. Comparison of the results of the experimental and control group with the national results at the National Assessments at the end of the 6th grade, mathematics and natural sciences test (school year 2018-2019)

IV.3. The Research Results Obtained in the Retesting Stage

The retest is important to follow the degree of assimilation, consolidation, longer-term retention of knowledge and competences, in the two groups of subjects. The extracurricular activities were organized in such a way that the students researched in more depth a problem they face, which generates ideas, searches, investigations, applications. Their work continues on websites, by email, on the teacher's blog or in activities with parents.

National and international studies show that during the long summer break, students lose a significant part of the knowledge gained during the school year. Forgetting is a natural phenomenon and is part of the educational process. Thematic camps, competitions, parents have an important role. The holiday is for resting, but also for another type of learning, such as lessons in nature or educational games, which consolidates what they learned at school, which reduces the level of loss of knowledge (T. Ionescu, 2014).

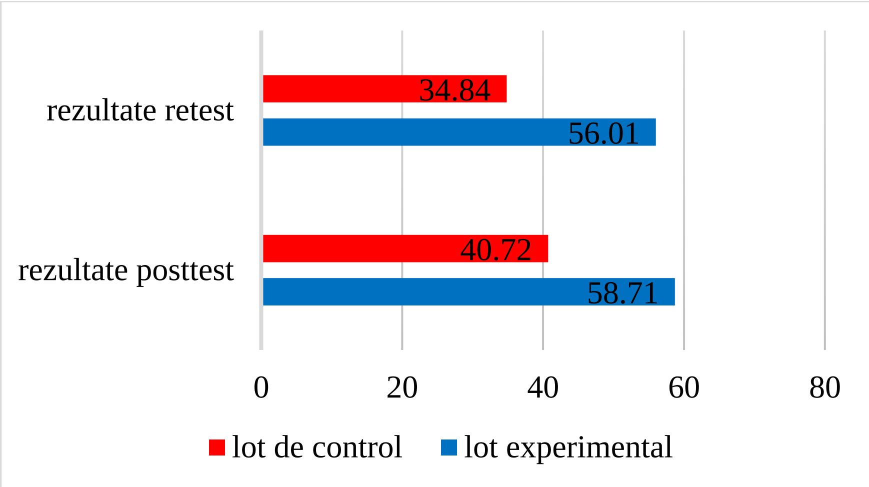

Figure no. 54. Comparison of post-test - retest results in the experimental group and the control group, in the retest stage

Figure no. 54 shows us that the acquisitions acquired within the extracurricular activities (intervention program), based on curiosity, the desire to observe and explain, to experiment, to build, to explore and discover, to create, were more sustainable in the case of the students from the experimental group. They had the opportunity to investigate, to research, to find knowledge on their own, to develop their own solutions to problems, to process knowledge, to systematize it, emphasizing learning through action. This fact also materialized through the results of the post-test. The students of the experimental group obtained better results, 56.01 compared to the 34.84 in the case of the students of the control group. Although both groups had poorer results in the retest than in the post-test (a decrease of 4.45% compared to 14.14% in the control group), it can be stated that the students who managed to translate the theoretical knowledge into practical knowledge registered a lower difference in the two tests. Basic competences in science and technology can be acquired by practicing, repeating schemes, by experience and problem solving, according to the pyramid of competence development (M. Mákádi, 2015), as can be seen in Figure no. 16.

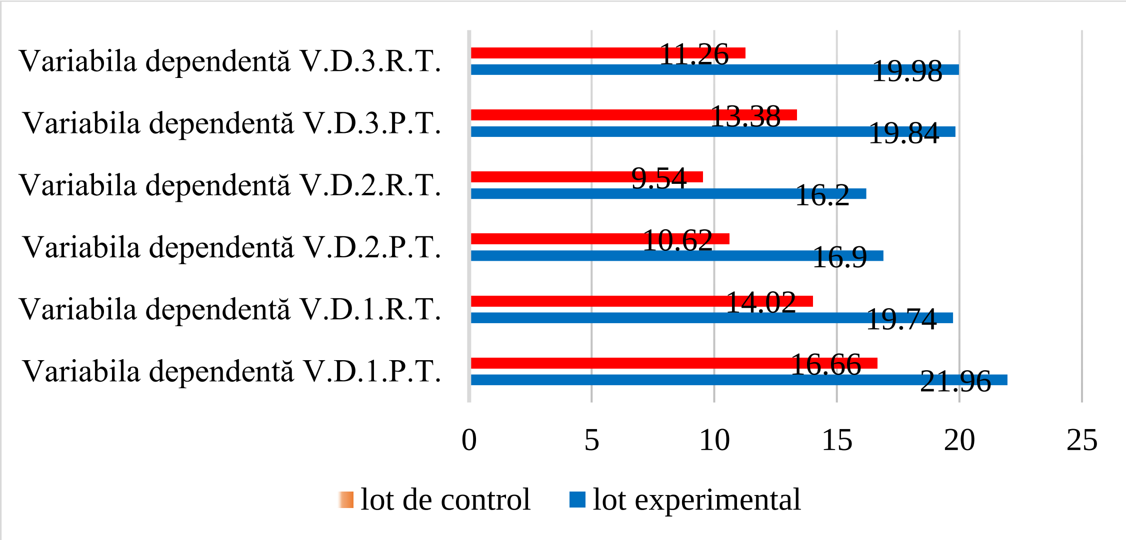

Figure no. 55. Comparison of results for dependent variables $V.D._{1-3}$ (post-test - retest), in the experimental group and in the control group, in the retest stage

Dependent variables are measured ($V.D._{1-3}$), to see the possible effects over time of the independent variable: the "Science and technology in Your life" intervention program on the development of competences in science and technology. The criterion for a good development of variables is stability. If an experiment is repeated, then the dependent variable should have the same score as before (M. Popa, 2010). In order to correlate the scores obtained at the post-test and at the retest (the same test applied after 4 months) and to observe the stability and durability of the scores over time, the retest was applied in the second week of the 2019-2020 school year to the students of the experimental and control groups.

The results show a slight decrease in the scores in the retesting stage (Figure no. 55). Dependent variable: the ability for practical realization of useful products and/or creative works for current activities and their capitalization ($V.D._{1}$.) registered a normal decrease in both groups (Figure no. 55) -2.22 compared to -2.64 in the case of the control group, that is -10.1% of the experimental group and -15.8% of the control group (a difference of 5.7% compared to the control group).

Dependent variable: the ability to solve problems and problem situations of a theoretical and applicative nature ($V.D._{2}$) experienced, in the case of the experimental group, a decrease of -0.7 compared to -1.08, that is -4.14% compared to -10.16%, representing a percentage of 6.02% in favour of the experimental group.

Research, investigation very often used in extracurricular activities, offers students the opportunity to be actively involved in the learning process, achieving permanent integration and restructuring in their own knowledge system, which gives knowledge a strong operational character. Regarding V.D.3., the results show an increase in the degree of assimilation of knowledge in the case of the control group of +0.14 compared to -2.06 in the control group, that is + 0.7% increase compared to -15.46 %, a significant difference of 16.16% in the experimental group compared to the control group.

CONCLUSIONS

The research was about, first of all, the science and art of teaching others, of teaching them to learn, but especially of stimulating the love for knowledge. At the same time, the evolution of extracurricular activities in the technical-scientific field towards complementarity with formal education was taken into account, using interactive teaching strategies, with emphasis on how assimilated information is processed, structured, interpreted and used in various situations. During the research, activities were designed and implemented through which students developed solid competences in science and technology, but also the confidence that these will prove operational and will serve them, authentically, in various life contexts.

The works consulted and referred to in the chapters of the thesis support the implementation of extracurricular technical-scientific activities of teaching strategies focused on the learner. In order to ensure the development and capitalization of the cognitive, affective and action resources of learners, in order to adapt and optimally integrate into the formal school environment (physics and technological education and practical applications), it was essential to build teaching strategies based on action, application, research, investigation, experimentation, these being found in the "Science and technology in Your life" intervention program. Thus, students were given the opportunity to participate in quality extracurricular activities, to make sustainable acquisitions, likely to be used and transferred in various instructional contexts, to have a positive attitude towards learning, to enjoy higher academic performance, to develop diversified practical skills, but also good problem-solving strategies. The interactive teaching strategies used promoted active learning, involved a sustained collaboration between students who, organized in micro groups, worked together to achieve predetermined goals. In these extracurricular activities complementary to the school ones, the teacher emphasizes not the role of the loudspeaker of informational messages, but the roles of organizer, facilitator and mediator of practical learning activities. Through these activities, the teacher organizes a learning environment adapted to the particularities and needs of students, facilitating the learning process and the development of skills in science and technology, offers students multiple opportunities to get involved in their own training, to freely express their ideas, opinions and to confront them with those of their colleagues, to develop their own competences.

We applied an extracurricular intervention program with the Children's Palace and Clubs of Covasna County as the framework. Having as starting points the specific competences from the school curricula for the subjects of physics and technological education and practical applications, we followed the extent to which these activities, through their specificity, contribute to the development of competences in science and technology in 6th grade students.

The hypotheses from which we started in conducting the research aimed at the contribution of technical-scientific extracurricular activities carried out in the circles of the Children's Palace and Clubs to the development of science and technology competences in middle school students (6th grade), and the improvement of school learning outcomes assessed through national tests. In this regard, in order to measure the relevant results of the implementation of the intervention program, we formulated the dependent variables. Participating in the intervention program, the students from the experimental group made, for a year, simple technical products, simple electrical circuits based on a sheet, measured, performed calculations, developed sketches, analyzed the results and capitalized on the results through a project, which they presented in front of the class or at competitions. Their ability to make products practical, make transfers and integrate knowledge and working methods specific to scientific and technical activity in order to apply them, proved to be much better developed after completing the intervention program, compared to students in the control group. Students in the experimental group obtained in the post-experimental stage results with 58.6% better in terms of competence established as VD_1, compared to the pre-experimental stage, while students in the control group recorded an increase of only 28.05%. We consider that these results were due, first of all, to the participation in the activities in the Children's Palace and Clubs.

The activities in the intervention program gave the students the opportunity to develop their competence of solving problems/problem situations. Students learned to focus on processes rather than results, to discover different ways in which problems/problem situations can be solved. Thus, the students in the experimental group obtained results with 123.2% higher in the post-experimental test compared to the pre-experimental one, compared to the students in the control group, which obtained an increase of 22.06%. Thus, the data confirm the significant development of the dependent variable VD_2, in the sense that students who participated in extracurricular activities in the intervention program have better developed their competence of solving problems/problem situations.

During the activities in the intervention program, the students from the experimental group were put in the situation to ask questions, to use experimental procedures, through which to investigate certain physical phenomena. This competence has been designated as the dependent variable VD_3. After experimentation and investigation, students must correctly interpret the data and evidence, assess the validity and relevance of the conclusions and formulate valid explanations, explain to their colleagues the results obtained, all at their level of development. The students of the experimental group had, in almost every activity, experiments or investigations and this fact was also noticed at the level of the obtained results, regarding the development of the respective competence. The students in the experimental group obtained results with 71.26% better in the post-test compared to the pre-test, compared to the students in the control group who registered an increase of only 15.05%.

Overall, the "Science and Technology in Your Life" intervention program provides an increase in data comparison for the dependent variables $V.D._{1-3}$ (science and technology competences), indicating significant differences: students in the experimental group scored better with 56.8% compared to the students of the control group for the items aimed at developing competences in science and technology. Another aspect pursued with the help of the dependent variable VD_4, was the achievement of better results by 15% by the students of the experimental group at the National Assessments for 6th grade in mathematics and natural sciences compared to the students from the control group,

These empirical results prove the effectiveness of the intervention program proposed by us and confirm the general hypothesis of the research, as well as each secondary hypothesis. The research, in line with specialized studies, claims that these extracurricular activities help students to form a positive attitude towards learning (they have higher school performance), diversified practical skills, and appropriate problem-solving strategies as well.

An important aspect that we managed to highlight was the complementary role of extracurricular activities with school activities. The complementarity of the intervention program, of a real importance, is constituted especially by the practical character of the extracurricular activities. The application of the knowledge acquired by students in school or outside it (including in extracurricular activities) has the value of an exercise in developing competences in science and technology. Important in carrying out these activities is the fact that students can be trained both in initiating and organizing, and in how they are conducted.

Extracurricular activities within Children's Palaces and Clubs are also a priority element in educational policies, as they have a positive impact on the development of students' personality, on school performance and social integration. They are also a way of training competences, disciplining their actions and expanding their technical-scientific horizon. Extracurricular activities are a means of training students' skills, an opportunity for them to use their free time rationally, they are propitious to the manifestation of the spirit of independence and initiative.

Although this thesis makes significant contributions to identifying ways to improve and diversify the development of competences in science and technology in middle school students, it also has a number of limitations, due to the complexity of developing and using extracurricular programs complementary to formal education. From an empirical point of view, a first important limit derives from the small number of students who participated in the research due to, first of all, the equipment with modern technological means of the scientific-technical circles. Circles need modern teaching aids and interactive educational softwares, which would also increase students' motivation to participate and learn. Another limitation was the lack of students' free time or their overload with a lot of school and extracurricular activities, which prevents students from dedicating themselves to such activities. Another limitation was the lack of interest from schools to get involved in collaboration with the Children's Palace and Clubs, for a good development, in our case, of students' competences in science and technology.

Taking into account the wide range of extracurricular activities in the field of science and technology, in particular those carried out in the Children's Palace and Clubs, we have proposed the following future research directions:

- Combining the elements and characteristics in the field of STEM with the technical-scientific extracurricular activities, in an integrated approach, and their use in the formation of competences in science and technology, at all levels of education.
- Facilitating contexts of exploring problems in everyday life, involving students in authentic, meaningful learning situations, using design, investigation, experimentation, testing, reflection and documentation.
- Stimulating students and teachers to use modern technology as a problem-solving tool.
- Application of extracurricular intervention programs aimed at complementarity with other disciplines, with a content that represents the result of optimal assembly of concepts, processes and approaches in science and technology, taking into account the standards and educational content corresponding to each level.
- Expanding activities in science and technology to middle school students in rural areas, their involvement in complementary activities that balance the lack of non-

formal education in villages and contribute to reducing school dropout and functional illiteracy.

Exploring the formative values of the “Science and technology in Your life” intervention program in the development of competences in science and technology is far from exhausted by this paper. We believe that used in the context of collaboration projects with other technical-scientific circles in other counties, this intervention proves extremely useful in supporting the acquisition of independence in student learning, in the transmission of content and in their evaluation, as well as in student accountability for the process of learning.

Slightly approached in the specialized literature – although their number is growing – extracurricular activities are an important resource of educational practices, being models for streamlining extracurricular teaching, providing original and valuable insights, contexts for testing new teaching strategies to contribute to motivating the student to learn and to increase his/her performance.

The research managed to highlight the contribution of technical and scientific extracurricular activities carried out in the Children’s Palace and Clubs to the development of competence in science and technology, developed in school through physics and technological education and practical applications, 6^{th} grade, and to improve students’ results in national assessments for 6^{th} grade, mathematics and natural sciences. The complementarity of the technical-scientific extracurricular activities within the Children’s Palace and Clubs, which emphasize interdisciplinarity, with those achieved in the teaching of school subjects is obvious.

We consider that through this research we have made a significant contribution to the progress of knowledge in the field of education and, at the same time, we offer solid benchmarks for both school instructional and educational practices, and for extracurricular ones, in particular those made in the Children’s Palace and Clubs. Formal education institutions should cooperate with Children’s Palaces and Clubs in carrying out extracurricular activities that combine knowledge and methodologies specific to both types of education, for the benefit of students. In this context, the continuous professional training of teachers, including in terms of enhancing learning in extracurricular contexts, is becoming a necessity.

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