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RESHAPING SCIENCE EDUCATION FOR YOUNGSTERS IN ROMANIA

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Abstract

This paper focuses on the importance of a relevant science education in the early years of schooling for the development of future STEM (science, technology, engineering and mathematics) professionals, considered crucial for the development of a nation. The paper investigates the possibilities to help pupils develop abilities like critical thinking, team work and creative assessment, needed by any STEM professional, by the stimulation of their natural curiosity and passion to experiment and play. The paper stresses out the need of an innovative learning from primary school, where the pupils should be more engaged into class and individual exploration. This research introduces an original pilot program developed by the author which is indented for pupils from a school from Romania placed at the begging of their road in science. The main results of the research might be translated into actual programs to be applied in every school from Romania at the science topic in order to stimulate hands-on activities, experiential learning and the foundation of the interest in STEM education. The findings of this paper contribute to increasing of the awareness of the need of an interesting and relevant content for science topic in schools and, at the same time, constitute an argument for a policy change in this regard.

Keywords: Quality, youngsters' science education, STEM, Romania.

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1. Introduction

A performing education system is a system that has in view the quality of education combined with the equity of education. Therefore, investment in the quality of education and creation of equal opportunities are essential, given the current demand for higher level skills (Organization for Economic Cooperation and Development, 2012). The relevant science education in the early years of schooling is very important for the development of the future skills, and STEM professionals (science, technology, engineering and mathematics) are considered crucial for the development of a nation (Momete, 2015a). The introduction of an innovative learning from primary school, where the pupils should be more engaged into class and individual exploration, is essential for creating the needed STEM skills (United States Environmental Protection Agency, 2018; Momete 2015b). The tackling of science from an early age should take into consideration the science definition: "*science is the aggregate of systematised and methodological knowledge concerning nature, developed by speculation, observation and experiment*" (Crump, 2002).

The paper investigates the possibilities to help youngsters develop skills like critical thinking, team work and creative assessment, needed by any STEM professional, by the stimulation of their natural curiosity and passion to experiment and play. This is to be achieved by a radical change in the school mentality, especially for the schools from Romania, and by implementing measures for pupils from early ages. Unfortunately, the school mentality changed very little over the years in Romania and this change was mainly based on very short programs developed at local levels or national initiatives, like one week of "*different schooling*". In this very brief national program, the pupils receive more information on cultural and entertainment aspects, while the science part is mainly left aside. However, regardless of their content, these initiatives should be included into the relevant curriculum of science topic and developed throughout the whole year, not only for a week, by the formal and informal involvement of the local community.

The paper stresses out the need for a new school where the innovative learning should be considered from primary school, where the pupils should be more engaged into class and individual active observation and experiment. Moreover, the design of this a new school, as a part of a community network, is considered as a must condition for the future development of a sound national economy. The school should be a part of a network that connects all the community, with the participation of local businesses, local authorities, local communities associations, and non-profit associations of educators and youth (Kozak & Eliott, 2015). This paper introduces an original pilot program developed by the author and intended for pupils from the IVth grade, from a school from Bucharest, Romania. As the local businesses, museums, community organizations, public libraries, local authorities should be more involved in each school activities, and the pilot program considered their support.

2. Problem Statement

This research aims to improve the quality in youngster's science education in Romania. After a brief investigation of the situation in science education for primary education, the paper presents as best option of improvement a science based program intended for pupils from a school from Bucharest, Romania. This option shows that there is a good potential to improve the quality in early science educating through innovative programs supported by community.

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3. Research Questions

The research focuses on Romania's situation and answers the next questions:

- Which is the actual situation of science education in primary school?
- What are the best ways to improve the quality in youngster's science education?
- What kind of a program should be developed with priority?

4. Purpose of the Study

This paper introduces an original pilot program developed by the author and intended for pupils from a school from Bucharest, Romania placed at the begging of their road in science. The pilot study aims to make pupils discover in a fun, but rigorous way how the world around them works. The program was designed having in mind Isaac Asimov's saying: "the most exciting phrase to hear in science, the one that heralds new discoveries, is not *Eureka!*, but *that's funny*!".

5. Research Methods

The method tackled by this research entails a step-by-step approach:

- Identification of the current situation of science education in primary school for pupils from Romania;
- Suggestion of the quality increase in youngster's science education in Romania by special community programs;
- Presentation of a pilot program for pupils from a school from Bucharest, Romania (IVth grade);
- Identification of the possible effects of the pilot program on the quality of the science education in Romania.

6. Findings

The main result of this research is the original pilot program which might be translated into actual programs to be applied in every school from Romania at the science topic in order to stimulate hands-on activities, experiential learning and the foundation of the interest in STEM education.

6.1. Brief investigation of the current situation of science education in primary school

In Romania, starting with 2004 the curriculum for *Natural Sciences* was revised for grades III and IV, given the fact the pupils failed to understand and apply the information from the area of natural sciences (Ministry of Education and Research, 2004). The new curriculum was based on one hour each week for IIIrd and IVth grades (Ministry of Education and Research, 2014) and provided a series of experiments to be developed at class, but unfortunately, most state schools from Romania, to the best author's knowledge, failed to apply them. The school teachers need to comprehend that the topic of *Natural Sciences* is essential for understanding daily life, but also for providing the children with scientific literacy. Despite the short time devoted each week to *Natural Sciences*, the topics should be correlated with other disciplines, like mathematics, and should involve also project-based activities. This paper further introduces a new, original pilot program, to assist the enthusiastic teachers to deliver scientific information in a fun way. This has the potential to increase the quality in youngster's science education in Romania.

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6.2. Brief description of the pilot study

The pilot program aims to stimulate pupils' interest in STEM education and to convince them that science is part of their lives. The project intends to initiate IVth grade pupils from a state school from Bucharest, Romania in the mysteries of science by organizing a series of hands-on activities, correlated with the curriculum of *Natural Sciences*, which all pupils from Romania are studying from the IIIrd grade. The target group has been selected so that the pupils can work both individually and in small teams (of 3 pupils), but also in plenary, and which can be safely coordinated by the teachers involved in the program (2 teachers). The number of children involved is 30, the pilot program considering important not the number of participants, but rather the formation of cognitive skills and scientific investigation as well as the stimulation of the development of ethical behavior. The teachers involved are the class teacher from primary education and the teacher of science from the secondary education. In such a way, the pupils involved in the target group will be initiated into scientific activity and will eventually be attracted to the topic of engineering and science, the one that has long been the engine of civilization and the crucible of great inventions that have pushed mankind on the current road. With this program, *Natural Sciences* time will become much more attractive, with pupils being able to practice useful activities in nature (in the schoolyard), but also in the classroom.

My students from the University Politehnica of Bucharest told me that throughout their entire pre-university education experience, they were not involved in practical activities and were rather stimulated to learn without understanding and to produce scientific reports through Internet documentation which was just copying, in many cases. This pilot program aims to change this mentality and hopefully will create an island of creativity, inclination towards knowledge through understanding and ethical and responsible behavior. So, when the actual IVth graders will grow up and will become university students, they will be the ones whom will pass forward the basic ideas of this program. I have the belief that if my family, my school, my streets, and then my neighbourhood and my city are doing well, this will spill over and will contribute to local, then regional and then national welfare.

6.3. Objectives of the pilot program

The general objective of the pilot program is to familiarize pupils with activities that bring them closer to science and its importance for building a future sustainable life. This program, designed especially for little explorers on the path of science, may create real bridges that bring together the interests of creative, discoverer and passionate pupils, university students as well as the local community, and hopefully national. The parents, science museums, local authorities and universities will be invited to support this pilot program.

The 30 children of the target group, of age 10, will be involved in four types of concrete activities, held within eight weeks that involve four modules and a final mission. The objectives set are meant to help pupils to obtain scientifically measurable results and to interpret them, with the aim to facilitate pupils acquire new skills that will lead them towards future scientific discoveries. All activities can be tackled by children of the IVth grade and are relevant in the context of acquiring knowledge about the natural sciences and the environment in which they live. Pupils will be directly involved in:

- Collection of samples from the schoolyard (individually and in teams);

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- Specific experiments performed by children, individual / in teams, using an individual experimental kit, water purification kit, electricity kit and electronic microscope;
- Individual reporting on paper (on the special experimental log) and electronic reporting for teams using a free on-line application for working in groups (Class Dojo). Reporting in the experimental logs will focus on the pupil's involvement in the specific activity (brief description of the experiment, the materials, the procedure to be followed, and their observations and explanation, as well as possible pupils' recommendations).

I know for a fact that the pupils from the target group really desire to experience and create something new and useful to mankind. In the first session held during *Nature Sciences* class, some pupils wrote that they would like to "experiment with substances," "analyze particles," but also want to be able to invent fast-moving devices such as "flying car", "flying boots", "teleporting machine" and "time machine". Some of these ideas might materialize in the future, but it is important that the pupils are stimulated to be creative by understanding the phenomena behind any invention, but also by their direct involvement, in accordance with their passions. This is exactly what this pilot program aims to achieve, and through innovative elements (such as hands-on sample collection, analysis and reporting, and presentation with electronic support) helps children better understand the phenomena around and develops skills useful to identify and solve everyday problems with the help of technology.

6.4. Activities in the pilot study

The activities will take place within the second term of school and will last for 6 months (January - June). The activities are designed in a logical sequence, with 2 months for preparing the scientific program, 2 months for hands-on activities and 2 months for completion and reporting. These activities were also correlated with the pupils' school curriculum during the second term. The program involves also visits to some objectives further mentioned, and will take place on the last Friday of each module.

Stage 1: Preparing the Pilot Program (January - February)

- Acquisition of materials necessary for carrying out the project;
- Completing the experiment books for each pupil;
- Completing the experiment logs for each pupil;
- Contacting all the persons for the visits and clear programming of visit and visit schedule;
- Communication on the project and its preparation at the school.

Stage 2: Hands-on activities and technical visits (March - April)

The experiments will be performed during *Natural Sciences* classes and on Fridays, on modules:

Module I: experiments aimed to scientifically initiate the pupils; activities using an individual experimental kit. Visit to the National Technical Museum from Bucharest.

Module II: experiments on water and its importance; activities using the water purifier kit for pupils. Visit to the University Politehnica of Bucharest (with the implication university students for experiments).

Module III: experiments on electrical phenomena; activities using the electricity kit for pupils. Visit to the University Politehnica of Bucharest (with the implication university students for experiments).

Module IV: observation of the surrounding nature through sample collection and microscope analysis; activities using the digital microscope. Visit to the University Politehnica of Bucharest (with the implication university students for experiments).

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Stage 3: Communication and Reporting Activities (May - June)

- Finalizing experiment logs;
- Preparing Pupils' digital reports (containing a digital portfolio made with Class Dojo);
- Preparing children's compositions: "*What I have learned and what I liked most in this program*";
- **Final mission**: Demonstrative works done by pupils aimed to involve them in protecting the environment; making presentations for parents and colleagues of other classes. This mission consists of building a wee-boy of recycled items that children will collect during this program.
- Collecting photos and inserting them into final reporting/presentation.
- Award of diplomas to participants and Power-Point presentation at a final event held for all supporters (parents, friends, local authority representatives, community association representatives, university students, etc).

During the 2-month period of the second phase of the project, within the *Natural Sciences* regular classes and on each Friday, pupils will be guided to discover the world through science and will be helped to understand how they can also get involved in protecting the environment (2 workshops / week). In addition, for the four visits scheduled on Fridays, the pupils will spend more time and will be transported by car (30 children and companions). The individual experimental training kit has only plastic instruments, safe for use by children over 8 years of age, and protection and goggles will also be provided for all pupils. The pilot project assumed that the collaborating professors and students will work on a voluntary basis and the parents and community stakeholders will cover the costs.

6.5. Anticipated results of the pilot study

The pilot program proposes a new approach of science learning through the direct involvement of pupils both in the collection of samples from nature and their analysis. The pilot program introduces the following innovative elements:

- The equipments used to understand the environment are modern and safe (educational kits, water and electricity purification kits, and the microscope).
- The laboratories that children will visit at University Politehnica of Bucharest contain state-of-the-art equipments.
- The mix of activities in the classroom, out of nature and at the university;
- Using experiment books and longs and also tablets to record and report results. The pupils will use their own equipments (tables/phones), encouraging children to write down what they are doing, design concept maps, synthesize information, and graphically present their own results.
- Familiarize students with mobile applications and their use in reporting and building of a digital portfolio (Class Dojo application).
- Introduce a concrete mission to save resources and protect the environment within the school. This mission consists of building a wee-boy of recycled items that children will collect during this project (batteries and other electronic products). The objective of this activity is to change their perception on waste.
- Introduce of a science program outcomes with parents and other stakeholders for the presentation of experiments logs and favorite experiments presented digitally by groups.
- Promote responsibility and ethics.

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- Initiate an informal group of initiative made up of pupils who will produce compositions / posters that they will exhibit in school to inform other pupils about how they can participate in "fabrication the future". Thus, children can become part of an informal initiative group aimed to promote the development of the passion for science and technology in school.

The pilot project contributes to the development of:

- Incipient scientific research skills by stimulating curiosity and challenging children to think creatively during experiments.
- Critical information analysis and solving complex problems, such as those generated by experiments and their reporting on paper and digital formats.
- Understanding and learning through experimentation.
- Children's initiative through the final mission.
- Communication and presentation skills acquired both by the teachers and the pupils. Presentation of each activity will be done by the teacher with the help of the laptop connected to the internet with projector projection (available in the classroom). Each child will have the experiment book and kit on the desk and will be able to proceed step-by-step after the sequential presentation of the experiments. The teacher will use an on-line application to build this real scientific community through which the 30 pupils, parents and friends can share the results of their work (Class Dojo). Thus, pupils will become more involved in scientific activities, will be rewarded with stars for correct and benevolent behavior, perseverance and active participation, thus creating a real positive culture among children.
- Experimental skills acquired both by the teachers and the pupils. The teachers, together with the pupils, will collect for the first time samples from nature that they will also analyze.
- Collaborative and teamwork skills.
- Accountability through reporting and ethics by observing the work of the team.

6.6. Management of risks for the pilot program

The following risks are indentified, but they will be minimized through creative risks management:

- Program delay due to events outside the project (weather conditions, programming of activities within the laboratories, special events, legal days off, etc.). To minimize this risk, the possibility of shifting the program with +/- two weeks was considered.
- Deterioration of equipment as pupils' work is involved. However, this risk is kept to a minimum by constant supervision of pupils and rigorous training.
- Re-planning visits and presentations to accommodate various possible issues in time (transport, weather conditions, availability of attendants / participants / parents, etc.).
- Possible problems when making visits within the University Politehnica of Bucharest during the desired period. To reduce the risks, the pilot program also includes a backup solution involving a number of similar activities in other laboratories / centers.
- Possible problems of availability of equipments, but these aspects have been considered and other similar equipments may be considered.

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- Failure of some anticipated experiments. That is why the activity was planned on only four modules and no additional number of experiments was indicated, so that all children could achieve the proposed objectives.
- Possible administrative problems from the administrative side of the institutions involved, but these will be minimized through good collaboration within the community network.

6.7. Effects on the quality of science education

The effects of the project will produce the increase of the quality of the education act meant for science and will impact the school environment on several medium and long-term dimensions:

Effects for participating school

- ***Dimension of pupils participating in the project***: by becoming aware of the importance of science and technology in their lives, pupils will continue to discover and understand the environment and the way in which human mentality and human behavior can be changed to have a sustainable planet.
- ***Dimension of pupils non-participating in the project***: observing the work of their peers, other pupils from the same school, through imitation, will desire to be more involved in scientific work and can even create a community within the school.
- ***Dimension of the teacher***: new skills of experiment and teaching for the teachers in the classroom will also be formed by engaging in classroom experiments, as well as using the modern technique of creating a school community through the use of Class Dojo.

Effects for quality in education

- ***Dimension of the quality in education for science***: the curriculum of science might be enriched with relevant experiments, becoming more comprehensible and attractive to pupils.
- ***Dimension of the STEM education***: the formation of STEM skills from an early age is essential for the development of an innovative society.
- ***Dimension of the community***: the realization of an authentic network that places the school in the centre and links local businesses, local authorities, local communities associations, non-profit associations of educators and youth, museums, public libraries and mentors.
- ***Dimension of the educational policy***: the revision of the educational policy in order to accommodate more time and extra-time in schools, a more relevant content and more activities devoted to science topic.

7. Conclusion

The paper investigated the possibilities to help youngsters develop scientific literacy, by the stimulation of their natural curiosity and passion to experiment and play. This is achieved by means of a program that was thought to create an island of scientific knowledge, which by merging with other initiatives of this kind, may lead to the increase of the scientific potential of the local community and then, maybe even national. By creating these real islands of scientific knowledge, the passion for STEM topics may be better disseminated and the children can be more oriented towards science, responsibility and ethics.

However, the approach of this paper cannot be followed unless there is a radical change in the school mentality from Romania, and this is to be implemented from primary school. The findings of this paper contribute to increasing the awareness of the need of an interesting and relevant content for science topic in schools and, at the same time, might constitute an argument for a policy change in this regard.

This research will be continued by identifying the key performance indicators for the quality of science education for primary school within the European Union member states.

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