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PRIMARY AND PRE-SCHOOL TEACHERS' VIEWS ON STEM BASED APPROACHES

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Abstract

At international level STEM education represents a still growing trend, its adoption as an important paradigm in education being determined by the need to adapt to nowadays society. STEM education has been imposed at the gymnasium, high school and university levels, where students possess disciplinary knowledge and skills that allow them to develop interdisciplinary and integrated approaches. Pre-school and primary school students have also to be initiated on STEM/STEAM or STREAM education by topics adapted to their interests and level of knowledge. This early openness towards STEM based approaches can support the future effort for the study of STEM disciplines, considered being difficult. The aim of this study was to investigate the opinion and practices of primary and pre-school teachers about STEM/STEAM subjects and their integrated approach. The research tools were a questionnaire, applied online to a sample of 97 respondents, teachers for primary and pre-school education and an analysis grid. The results show that respondents have favourable opinions about STEM/STEAM education, due to the knowledge, skills and behaviours developed by STEM based approaches to their students. As a result, even if integrated activities are time-consuming and need resources that are not provided by the school curriculum, textbooks, or infrastructure, respondents appreciate that they often do integrated STEM-based activities. The importance given to STEM education by respondents suggests the revision of the school curriculum and the development of a STEM culture at the level of school institutions.

Keywords: STEM, STEAM, STREAM, integrated approach, primary school, survey

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1. Introduction

As a concept, STEM education is relatively new in the Romanian educational system. The idea origins from the American continent and it is determined by a deeply technology-driven society and by the need to prepare the young generation for an active inclusion into the social life (Hasni & Potvin, 2015; Lamberg & Trzynadlowski, 2015).

International studies Pisa (OECD, 2019) and TIMSS (2015) raise concern over the pessimistic results and the low level of interest of the students in mathematics and sciences. A great majority of students find these fields / school subjects hard, challenging, full of useless knowledge and without connection with real life.

Research shows that the STEM study facilitates students' deeper understanding of the importance of exact disciplines, technology and engineering, of the interdependencies between them and of their role in real life (Roberts et al., 2018). For instance, mathematics enables the understanding of theoretical and practical problems, especially when combined with the other disciplines. The study of STEM school subjects helps students to cope with real-life problems/situations, motivates them and boosts their self-esteem (Baboș & Ciascai, 2020; Margot & Kettler, 2019). A significant aspect noted by the educators involved in STEM learning is that this approach develops students' critical thinking (Stein et al., 2007) and also sets the basis for STEM thinking (Li et al., 2019). For STEM based learning to improve the learning process and students' academic performances, it should be integrated in teaching and it should unfold in a context where the education focuses on students and the teacher acts as a mediator, respectively as a facilitator.

Many of the studies conducted in this area focus on teachers' perspective over STEM education (Park et al., 2016; Pimthong & Williams, 2018). Educational researches reveal a series of difficulties that prevent teachers from developing this kind of teaching approach: the monodisciplinary pre-service training, the poor material resources, educational establishments' lack of interest towards STEM, even the lack of an appropriate curriculum and respectively curricular overloading and its rigidity are part of these difficulties.

2. Problem Statement

In our country the attempts to implement STEM based education are sporadic (excepting a few proactive teachers, some training programs), although the results of international research encourage us to consider that this approach would bring clear value to the Romanian school system, especially to the primary education. The pre-school and primary school are the phases in which pupils are most receptive and need tangible learning models; these are the moments when their thinking must make a major leap in quality towards that critical thinking that will serve them for the rest of their lives (Piaget, 2017).

3. Research Questions

The present study aims at answering the following questions:

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1. How do pre-school and primary teachers perceive STEM/STEAM education, respectively school and curriculum openness towards this type of education?

2. What is the structure of an integrated STEM / STEAM / STREAM approach from the perspective of pre-school and primary teachers?

4. Purpose of the Study

The purpose of this study is to investigate the view that respondents, teachers for pre-school and primary education, have on STEM (with its branches STEAM and STREAM) and on integrated STEAM approach.

5. Research Methods

5.1. Research design

The research combined a survey on teachers' opinion on STEM/STEAM education and the analysis of teaching projects based on integrated STREAM approaches made by teachers for primary and preschool education.

5.2. The research tool

The survey was based on a questionnaire of 11 items revealing the teachers' opinions on STEM/STEAM training and the integrated approach of these disciplines in primary education. We selected this method since is the most common way of collecting data in the field and "serves the purpose of producing explicative data" (de Singly, 1998, p. 21). The survey was available online and was filled in voluntarily. The respondents were asked to rank on a scale from 1 to 5 (1-disagree, 5-totally agree) the statements that composed the body of the questionnaire. The data were processed through the calculation of average, standard deviation and sum of the percentages representing total and partial agree, respectively total and partial disagree. For the analysis of STREAM integrated activity projects we used a tool elaborated by researchers, focusing on three important aspects: (a) which is the main founding domain of the integrated STREAM approach; (b) which are the domains defectively or superficially integrated into a STREAM approach; (c) What integrating concepts are to be developed through STREAM approach and what abilities and transferable behaviors in life are being put forward by the authors of the projects. The integrated activity projects portfolio used in the second part of the research included 97 documents.

5.3. Demographic characteristics of the respondents

The written survey was completed by a sample of 97 teachers in both pre-school and primary education, 94 of whom were women and 3 men, whose participation was voluntary. The respondents' experience in teaching varies from 1 year to over 30 years, the most of them (39.13%) having a teaching experience of 20-29 years. Respondents' age is between 18 and 60 years old, most of them being 40-49 years old (50.51%). The respondents of this survey are teachers that work in Romanian public schools, both

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urban (43.36%) and rural (56.64%). 36.08% of them have superior studies and 32.99% have a masters' degree.

6. Findings

6.1. Respondents' opinion on STEM/STEAM subjects

In respondents' view, in order to be able to implement STEM/STEAM activities, the teachers need solid knowledge in the fields mentioned (78.35% agree) but also robust general knowledge (74.22%). Regarding the statement "students have in schools the facilities needed for developing STEM/STEAM skills" the opinions are shared almost equally (40.2% disagree and 44.33% agree). Over 82% of the respondents agree that students need special conditions (space, materials) to develop the necessary STEM/STEAM skills.

In a period in which labor market underwent drastic changes due to massive digitalization, developing skills in STEM/STEAM fields is vital for students and it should be set as a goal for the current educational system. Over 79.38% of the respondents agree with this statement.

6.2. Respondents' views on integrated STEM/STEAM approach

Promotion of STEM/STEAM integrated approaches is based on the premise that the world cannot be discovered and understood by students only in the light of a single discipline, respectively that of disciplinary approaches. Therefore, over 72% of the respondents agree that most situations encountered in life suppose knowledge of STEM/STEAM fields. Teachers must propose for students to solve problems that origin in life experience for highlighting the importance and the role of STEM/STEAM disciplines.

Respondents' opinions related to STEM/STEAM integrated approaches are presented in Table 01. 77.32% of the participants agree that students' interest in STEM/STEAM integrated approaches must be cultivated. The accomplishment of the integrated STEM based approaches represents a challenge that teachers must complete successfully although most of them (56.7%) agree that they are not familiar with the approach. Respondents make the difference between inter and trans-disciplinary approaches and the integrated approach, with a percentage of 17.45% of them in favour of the integrated approach. There is a significant/positive moderate correlation between the items "Knowledge and competencies in STEM/STEAM domains are not enough; one must be able to integrate them" and "For designing integrated STEM/STEA approaches teachers should be able to identify the key concepts and interdisciplinary competencies around which integrated STEM/STEAM approaches can be developed" (0.68, $p<0.05$).

Table 1. Respondents' perspective over STEM/STEAM integrated approach

Item	N	M	St. Dev.	Disagree	Agree
It is good to develop an integrating vision on STEM/STEAM disciplines/fields.	97	4.29	.98	6.18%	84.54 %
Teachers should bolster students' interest for STEM based integrated approaches.	97	4.13	1.11	8.24%	77.32 %
Teachers should be able to design integrated STEM/STEA activities.	97	4.29	1.11	8.24%	81.44 %

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Teachers are not familiar with the integrated STEM/STEAM approaches.	97	3.43	1.15	22.68%	56.7%
Knowledge and competencies in STEM/STEAM domains are not enough; one must be able to integrate them.	97	4.25	.95	5.15%	81.45 %
In order to develop students' skills in STEM/STEAM domains suffice it to achieve mono-, pluri-, -inter and -trans-disciplinary approaches.	97	3.71	1.05	15.46%	63.9%
For developing students' performances in STEM/STEAM domains integrated approaches are needed.	97	4.16	.95	5.15%	81.44 %
For designing integrated STEM/STEA approaches teachers should be able to identify the key concepts and interdisciplinary competencies around which integrated STEM/STEAM approaches can be developed.	97	4.38	.95	7.21%	87.63 %

6.3. Respondents' views on Curriculum and STEM/STEAM methodology

As it results from the data indicated in Table 02 school curriculum should be reshaped to include integrated STEM/STEAM activities (82,47% agree) since real life problems cannot be overcome otherwise than via the integration of STEM/STEAM competencies (80.21% agree). Roughly equal percentages of respondents agree/disagree with the statement that "School textbooks provide support to teachers who want to implement STEM/STEAM integrated activities.

Table 2. Curriculum and STEM/STEAM methodology

Item	N	M	St. Dev.	Disagree	Agree
Integrated STEM/STEAM approaches are often associated with solving problems.	97	3.79	1.17	16.5%	71.14%
Integrated STEM/STEAM approaches are often associated with the method of the project.	97	3.79	1.16	16.5%	54.17%
Integrated STEM/STEAM approaches are often associated with work group.	97	3.67	1.18	18.56%	63.92%
Dealing with real life problems requires integrated STEM/STEAM approaches.	97	4.10	1.12	12.5%	80.21%
School textbooks assist teachers to implement integrated STEM/STEAM activities.	97	2.93	1.21	40.2%	41.24%
School curriculum requests for integrated STEM/STEAM activities.	97	3.60	1.20	20.62%	58.82%

Designing integrated STEM/STEAM approaches is time consuming and over 87% of the respondents find that teachers must be able to identify key concepts and STEM/STEAM domains competencies around which integrated STEM/STEAM approaches can be developed. In the same line, the respondents broadly agree that STEM/STEAM knowledge and skills are not enough, but the ability to also use them in an integrated manner. What is more, the development of an integrating vision of STEM/STEAM disciplines is also vital.

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6.4. Teachers' opinion on integrated STEM/STEAM approaches in primary school

Table 03 reveals the way in which STEM/STEAM education fits in pre-school and primary education. There is little disagreement around the items “Primary school pupils are not ready to engage efficiently in integrated STEM/STEAM activities” (11.44%), “Primary school teachers are not interested in carrying out integrated STEM/STEAM activities” (10.29%). Nevertheless, integrated STEM/STEAM activities are considered interesting (85.57%). But for the rest of the items indicated in table 03 the discrepancies between agree and disagree are wide.

Table 3. Respondents’ perspective over STEM/STEAM and primary education

Item	N	M	St. Dev.	Disagree	Agree
Integrated STEM/STEAM approaches are hard to be implemented in primary education	97	2.91	1.30	41.24%	43.3%
Primary school students are not ready to engage efficiently in integrated STEM/STEAM activities	97	2.75	1.24	43.4%	31.96%
Primary school teachers are not interested in carrying out integrated STEM/STEAM activities	97	3.051	1.28	34.04%	44.33%
Integrated STEM/STEAM activities should be extra-curricular for primary education	97	2.49	1.29	52.58%	26.81%
Arts must be integrated in STEM activities for primary education	97	4.09	.99	10.31%	69.38%
School curriculum should include integrated STEM/STEAM activities for primary education	97	4.19	.99	10.31%	82.47%
Primary school teachers should benefit from dedicated training on integrated STEM/STEAM activities	97	4.38	1.05	8.24%	83.51%
Integrated STEM/STEAM activities implemented in primary education are interesting	97	4.40	1.05	9.28%	85.57%

The items "Integrated STEM/STEAM approaches are hard to be implemented in primary education" and "Primary school students are not ready to engage efficiently in integrated STEM/STEAM activities" are significantly and moderately correlated (0.649, $p<0.01$). Also, the items "Arts must be integrated in STEM activities for primary education" and "School curriculum should include integrated STEM/STEAM activities for primary education" (0.672, $p<0.01$). Furthermore, a significant / positive and moderate correlation has been found between the items "Arts must be integrated in STEM activities for primary education" and "School curriculum should include integrated STEM/STEAM activities for primary education" (0.672, $p<0.01$).

6.5. Analysis of integrate STEAM/STREAM projects' portfolio

The analysis of the portfolio of STEAM and STREAM projects proposed by respondents shows that 94.84% of them are based on sciences, focusing on topics such as: plants, wild and domestic animals, human body, prehistoric animals, solar system, Earth, atmospheric phenomena. 10 projects were focused on manufacturing hand made products such as: pinwheel (3), dioramas (3), libras (2), birds home (2). The fields whose integration raises difficulties for the respondents are engineering (90.72% projects), technology (85.56%) and mathematics (60.86%). In fact, the difficulties concern the confusion between

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engineering and technology (68%). What is more, regarding technology most project owners refer only to the instruments needed for observing and monitoring some phenomena. In what concerns engineering, they mention animal body and refer to the prostheses designed by engineers for remedying health problems, construction of aircrafts or protection against blows. Regarding the integration of mathematics, difficulties arise when identifying appropriate math topics (some are a bit forced) and developing problems that require interdisciplinary abilities and skills. Through the integrated activities that they implement, respondents have as a goal to shape in students the following integrating concepts: system (68.04%), causal links (56.70%), organisation (45.36%). The interdisciplinary skills mentioned in the projects are inquiry, analysis, synthesis, evaluation, group work, designing and building, critical analysis and communication. The most often mentioned transferable behaviour is environment protection (79.38%).

7. Conclusion

STEM/STEAM integration represents an innovative manner of rethinking teaching mathematics and sciences in primary school by valuing their connections with technology, engineering and arts.

Integrated STEM/STEAM approaches are perceived hard to conceive and implement in primary school. This fact is due to the increased workload required by the design of STEM/STEAM or STREAM activities. Teachers should benefit from trainings dedicated to integrated STEM based activities and general knowledge courses. Moreover, they should be encouraged by school management to keep up to date regarding this approach. In case of textbooks that serve this philosophy of learning are missing, teachers should benefit from financial support in order to have access to both digital and printed resources. Training institutions, as well as universities could provide support for pre-school and primary school teachers to enable them to develop the competencies needed for designing integrated STEM approaches. Also, to encourage teacher collaboration in projecting STEM education activities (Wang et al., 2020).

Integrated STEM approaches should be included in the curricula of bachelor's and master's degree for pre-school and primary education. We are confident that these approaches could build and strengthen a community of teachers that are both interested and competent in the area of integrated approaches based on STEM, respectively they could boost students' interest for the study of STEM disciplines. What is most important is that the STEM education skills prepare students for life and for their future careers.

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