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NGSS
Desk Research & Focus Groups

National Report

Bulgaria

NGSS
Next Generation Science Standards through STEAM

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Introduction

The Next Generation Science Standards (NGSS) project aims to promote the STEM + Arts (STEAM) subjects in the early education of children and pupils. The goal is to support pre-school and primary school teachers for teaching STEAM through novel educational methods that focus on Social and Emotional Learning (SEL) and inclusive education. To integrate and upscale the NGSS project outcomes into the Bulgarian educational context, it is required to assess the current level of development of STEAM in the country.

This report provides a summary overview of the current pre-school and primary school curriculum and investigates national, regional, and private initiatives that aim to promote STEAM among young learners in Bulgaria.

National Curriculum for Primary Education

In Bulgaria the primary education is with 4 years' duration and consists of grades 1 to 4. Most of the pupils are between 7 and 11 years old. The Bulgarian Ministry of Education and Science (BMES) requires all state schools to follow the same core curriculum as advised by the governmental regulation. Schools are allowed to expand the curriculum, but only if the core curriculum is fulfilled.

The key focus of the primary school education in Bulgaria according to BMES the is to develop the following competences in pupils *(the ones related to STEAM are in **bold**):*

1. Understanding and knowledge of the Bulgarian Language.
2. Ability to communicate in foreign languages.
3. **Core Mathematical knowledge and skills and basic competence in the field of Natural Science and Technology.**
4. **Digital skills.**
5. Self-study skills.
6. Knowledge of social and civil responsibilities.
7. **Innovation and Entrepreneurship.**
8. **Cultural knowledge and ability of expression through art.**
9. Skills for sustainable development, personal healthcare, and sports.

Table 1 (below) presents the different subjects covered in the primary school curriculum *(the subjects related to STEAM are in **bold**)*.

Subject	Grade I	Grade II	Grade III	Grade IV
Bulgarian Language & Literature	X	X	X	X
Mathematics	X	X	X	X
Surrounding Environment	X	X		
Music	X	X	X	X
Arts	X	X	X	X
Technology & Entrepreneurship	X	X	X	X
Sports	X	X	X	X
ICT	X	X	X	X
Foreign Language		X	X	X
Digital Modelling			X	X
Man and Nature (Natural Sciences)			X	X
Man and Society (Social Studies)			X	X

Table 1: Subjects in the Primary School Curriculum

BMES highlights that the curriculum develops links between different subjects and great effort has been put into evaluating the impact one subject has on another (e.g. Comprehension of *verbal mathematical problems* expands the ability of pupils to understand the *Bulgarian Language*).

1. Mathematics

The focus of primary level mathematics is for the pupils to develop an interest in the subject. This is done through learning the natural numbers, their comparison and the algorithms of addition, subtraction, multiplication, and division. pupils learn to distinguish between geometrical shapes, as well as how to measure their parameters and find lengths and areas. Furthermore, there is an introduction to practical application of mathematics to real life situations, thus the basic units of length, mass and time are also covered. Finally, the subject focuses on developing the ability of pupils to take a rational approach and logic when solving problems.

Throughout primary school Mathematics is the second most regular subject after Bulgarian Language and Literature, with around 20% of the curriculum being dedicated to it. The subject is expected to have a strong impact on all the core competences presented above, highlighting

the impact of Mathematics on cross-domain knowledge. Teachers are advised to spend approximately 50% of the lessons teaching new concepts, while 47% is used for revision and 3% for testing of the acquired knowledge.

2. Surrounding Environment

Surrounding Environment is an integrated subject that covers topics from both Natural Sciences and Social Studies, thus teaching pupils the relationship between those subject areas. It is part of the curriculum during the first two school grades and is further succeeded by another two integrated subjects: Man and Nature (Natural Sciences) and Man and Society (Social Studies).

The key focus of the subject is to familiarize pupils with their immediate surrounding environment. They are presented with information about the social and natural world, incl. climate change and develop skills on protecting the environment. The aim of this subject is to develop interest in science, nature and society; therefore, pupils are shown existing scientific phenomena. Finally, pupils are to be introduced to societal norms and personal healthcare.
Primary school pupils normally have 1 hour per week dedicated to this subject. It is 5% of the school curriculum but is still linked to other subjects and helps pupils develop many of the competences primary education is focused on. Teachers are advised to spend approximately 66% of the lessons teaching new concepts, while 31% is used for revision and 3% for testing of the acquired knowledge.

3. Man and Nature (Natural Sciences)

Natural Sciences is the integral subject, which covers considerable part of the STEM thematic at the primary school level. It encompasses topics from the areas of Physics, Chemistry and Biology. The subject is focused on familiarizing pupils with the key chemical elements, biological organisms, and physical phenomena. Pupils are encouraged to develop interest in the natural sciences and are taught practical skills for protecting the environment. Natural Sciences form basic skills for the observation and study of natural phenomena, as well as exposing pupils to the basic forms of scientific research (primary and secondary).

Despite the boldly declared aims of integrated education in the field of natural sciences, the topics are presented in separated thematic cores belonging to one or another natural science, which interchange every 2-3 months. Thus the introduction of the topics is separated and the links remain obscure for the pupils.

The subject is strongly linked to all core competences that primary education focuses on, particularly the ability of self-study. In the third grade pupils normally have 1 lesson per week (5% of the curriculum), while in the fourth grade they have 2 lessons per week (10% of the curriculum. Teachers are advised to spend approximately 47% of the lessons teaching new concepts, while 50% is used for revision and 3% for testing of the acquired knowledge. It is

important to note that the subject continues into the 5th and 6th grade and is split into separate subjects (Physics & Astronomy, Chemistry and Biology) in year 7.

4. Technology & Entrepreneurship

The aim of this subject is introduction to different types of technology and its role in people's life. Pupils are getting acquainted with different professions and their impact on society. The course focuses on economic awareness and teaches pupils basic financial skills. Finally, the course aims at inspiring pupils to be driven by innovation and entrepreneurship.
The subject which in previous decades had more hands-on elements gets more and more theoretical nowadays.

Normally pupils have 1 lesson of technology and entrepreneurship per week (5% of the curriculum). The subject is fundamental in developing the soft skills that are embedded in the primary education program. Teachers are advised to spend approximately 47% of the lessons teaching new concepts, while 50% is used for revision and 3% for testing of the acquired knowledge.

5. Information and Communication Technologies (ICT)

The focus of ICT at primary school is teaching pupils how a computer works and showing them what they can do with it. Pupils are introduced to the basics of electronic communication and gain basic skills in work with text processing applications like MS Office and the use of the Internet. The aim of the course is to build basic competences and computer literacy.

Normally pupils have 1 ICT lesson per week (5% of the curriculum). The subject is supposed to develop pupils into tech savvy youngsters. Teachers are advised to spend approximately 47% of the lessons teaching new concepts, while 50% is used for revision and 3% for testing of the acquired knowledge.

6. Digital Modelling

In line with current socio-economic trends the BMES has introduced a new subject that focuses on developing pupils' computational thinking from an early age. The scope of Digital Modelling covers types of digital devices and their safe use. Pupils are taught to work with data and files. In 4th grade Digital Modelling branches out into visual programming culminating in an animated project (video game) that pupils are supposed to create. Overall, it is supposed to be an entertaining and engaging process that encourages pupils to study computing.

Although in theory this subject is supposed to teach computational thinking (i.e. ability to recognize logical patterns, to break down complex problems into smaller size modules, to sequence long and complex processes in "steps", etc.), in fact the subject is heavily dominated by coding. This makes it difficult for some pupils to follow the curriculum.

The subject is one of the new additions to the primary school curriculum (introduced in 2018), showing the progress towards more exposure to STEAM subjects in primary education. Digital Modelling is introduced in third grade and pupils have 1.5-2hrs per week (8-10% of the curriculum). Teachers are advised to spend approximately 50% of the lessons teaching new concepts, 30% for project work, 14% for revision 6% for testing of the acquired knowledge.

7. Visual Arts

The main purpose of fine arts is to develop one's creativity. Pupils are exposed to different genres of fine arts, which should create a sense of aesthetics and understanding of different painting techniques. Furthermore, teachers should try to develop the interest of the pupil's and recognize their talent.

In primary school pupils have 1.5–2 hrs of arts per week (8%-10% of the curriculum). Arts is recognized as fundamental for developing soft skills. It is strongly linked to other subjects such as Surrounding Environment, Digital Modelling and Mathematics, as pupils are often tasked to draw physical phenomena, nature or use geometric shapes in their work. Teachers are advised to spend approximately 42% of the lessons teaching new concepts, while 50% is used for revision and 8% for testing of the acquired knowledge.

8. Class hour

The Bulgarian educational system includes one additional lesson per week for the so called "class hour". The curriculum for this hour is formed by the class teacher on the basis of the characteristics of the class and has some aims, related to safety and health education, character building and civic education. In years 1-3 the focus of those lessons is safety (incl. traffic, bullying, cyber-bullying, first aid in case of disasters and accidents, etc.) and the development of the patriotic spirit. In year 4 there is some allowance for media and digital literacy and for career development discussions. Based on the importance of such topics to one's development and given that a class consists of 25+ pupils such topics should be covered in more detail.

Summary

Figure 1 shows the distribution between STEAM and non-STEAM subjects during primary education. Less than 40% of the curriculum is focused on STEAM, 42% of which is Mathematics. The primary school focuses more on the pupil's verbal skills, as well as teaching them a foreign language. There is insufficient effort towards developing pupils' interest in STEAM. Most subjects (excl. Mathematics) have less than 2hrs per week, with less time for actual hands-on activities and observation of the exciting phenomena that could attract the attention of the young mind. In spite the tendency to increased exposure to technologies, the STEM / STEAM education is still fragmented and divided among different subjects into the curriculum.

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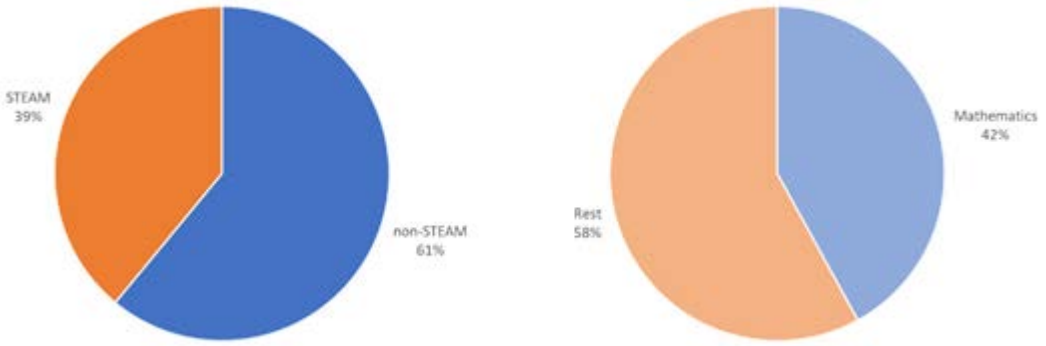


Figure 1: Distribution of STEAM and non-STEAM subjects in the Primary Curriculum

National Curriculum for pre-school education

In Bulgaria children may be enrolled into kindergarten when they turn 3 years. The focus there is child care, play and development of social skills. When children reach the age of 5 they are obliged to attend a pre-school program. According to BMES, pre-school should help children develop their physical, learning, language, social, emotional, and creative skills and enable them to adapt to primary school education. The pre-school curriculum consists of the following subjects (*STEAM in **bold***): Bulgarian Language & Literature, **Mathematics, Surrounding Environment, Arts, Music, Construction and Technology**, Sports. All those subjects are covered briefly, and the aim is to prepare children to study them in more detail once they enter primary education. Pupils are encouraged to study through various types of games and playing. The curriculum is flexible, all teachers can expand and develop their content outside of the minimum guidelines.

Overall, the curriculum focuses on the smooth introduction of children into the schooling system. The emphasis is making learning exciting and engaging. For this aim the learning activities at this stage often include music and singing, as well as physical activities and dance, which facilitate kids' learning.

The curriculum for the early years is very broad and gives freedom to the teachers. The obligatory pre-school education is supported by various didactic materials, which are ensured free of charge to the kids. However, most preschools have poor facilities for teaching STEM.

National Initiatives for STEAM

The Bulgarian Ministry of Education and Science realizes that most state schools lack facilities to encourage pupils to pursue a career in STEAM.

In 2020 the National Program for "Creating a STEM Environment at School" was kicked-off. It is aimed at creating new modern facilities that focus on the STEM subjects, integrating them into a single network across the state schools around the country. The STEM sector in the country is developing at a high-pace and the school system needs to follow suit. The goals of the initiative are:

· Motivate pupils to develop in the STEM field;
· Develop an environment for project-based learning;
· Increase pupils' practical skills;
· Encourage pupils to create new solutions in the fields of mechanics, programming, and AI;
· Develop automation and optimization skills;
· Increase the influx of STEM university applications and jobs – increase the GDP.

The expected outcomes are:

· Improved educational environment – better facilities;
· Improve the school curriculum;
· Improve the level of teaching;
· Provide better organization for the school system with regards to STEM.

At the primary school level, the aim is to create "Centers for young researchers". Those should be focused around developing pupils' interest in STEM, as well as giving them the skills necessary to expand their knowledge. The main priority is giving pupils access to practical STEM tasks and helping teachers enrich the curriculum with more STEM material.
The program does not mention the development of any STEM facilities at the pre-school level.

The program has a competitive character and distributed funding on a project-based principle – i.e. schools should prepare a concept, write an application, and apply for funding. During the first round of the program (2020–2021) in two phases had been funded approx. 250 school projects in 2 categories: big projects with approx. EUR 150.000 (BGN 300.000) and small projects with approx. EUR 25.000 (BGN 50.000).

In July 2021 the Bulgarian government published the Plan for recovery from the COVID crisis. BGN 1.8 billion is dedicated to education and science. Among main priorities of the spendings is the creation of a STEM environment in all schools for which will be dedicated approximately a third of the overall budget.

Finally, Bulgaria is renowned for its great traditions in international Olympiads in the STEM field, specifically Mathematics, Physics and Astronomy. However, most participants in such competitions are in secondary school or above.
Despite the evidence that the Bulgarian government is investing heavily into STEM subjects, it is evident that the importance of arts is not recognized in any of the national programs, thus showing the need for increased awareness on how arts help pupils develop their creative potential.

Regional and Private Initiatives for STEAM

Municipal authorities also have financial resources and run financial programs to support local educational initiatives. Although the priorities are determined by the municipal council and therefore may vary, many municipalities run programs for modernisation of the school environment (which often include provisions for hardware and equipment for STEM).

Among the local authorities that invest in education is the Municipality of Plovdiv (the second biggest city in Bulgaria). In 2021 it was awarded the prestigious American award "Smart50" by Smart Cities Connect Foundation and US Ignite, which annually distinguish the 50 most innovative and community-transforming projects in the world. The Municipality of Plovdiv was recognized for their support for introduction of cloud technologies in all municipal schools on its territory and for running experimental projects for introduction of 1:1 model of teaching (i.e. electronic device for every student and teacher).

Before the launch of the National Program for “Creating a STEM Environment at School” for more than a decade the America for Bulgaria foundation ran series of calls under the initiative "School of the future" aimed at transformation of the learning environment and the use of technologies in the teaching process. More than 6 million BGN had been spent in the course of 10 years and more than 50 school projects had been implemented.

In addition to the national and local public initiatives there are private organisations and individuals who try to encourage more pupils to be engaged in the STEM. The capital Sofia is renowned for its exciting IT industry, which has resulted in many schools focusing their effort on IT and computing. Some smaller cities (e.g. Kazanlak) are often gifted with individuals who are keen to develop the local education system towards STEM, giving a great foundation for the children living there. It is important to note, however, that the focus of such initiatives is high-school pupils.

There are succesfull private school concepts build on STEM innovations, but unfortunately private education is fairly inaccessible. A great example of teaching STEAM at the pre-school and primary school level is Izzi Science for Kids. This private school combines the Bulgarian education system with the Cambridge International system to create a unique primary school for children to develop firm interest in STEAM. It is one of the very few institutions in the country that recognizes the importance of Arts for STEM development.

Among the inspiring examples also is the Space Camp Turkey program, promoted by the Center for Creative Training, which offers to kids between 9 and 16 opportunity and scholarships to attend a 1-week STEAM program, build on NASA inspired curriculum aimed to motivate young people to pursue careers in science and technology.

Diversity in STEAM

In general Bulgaria faces less discrimination issues than other EU countries when it comes to gender or age, however there is still social discrimination towards some ethnic minorities (such as Roma), LGBTQ+ and disabled people. Despite the governmental programs for integration and inclusion, more effort in bridging this social gap is required. Furthermore, the **diverse.bg group** has carried out a study that indicates that 65% of the people in Bulgaria are not familiar with the concept of diversity. Unfortunately, there are few initiatives that focus on solving such issues. In the last few years there has been great improvement in diversity in Sofia and the other big cities in the country, however, there is no evidence of increase in awareness in other parts of the country. On the other hand, the STEM related industries are inversely proportional to the global perspective, with there being less gender and age diversity, but better diversity in terms of LGBTQ+ and disabilities.

In 2021 a new *National strategy for equality between men and women 2021–2030* had been adopted by the Bulgarian Council of ministers. One of the key focus areas of the strategy is that girls should not be discouraged to pursue STEM careers. The paper recognizes that the embedded stereotypes result in sexist behaviour among boys, which often results in mild forms of harassment. The paper highlights that such stereotypes are often developed at home and the schools are fundamental for their eradication. It is therefore essential to increase the awareness at pre-school and primary school level.

Ethnic discrimination is one of the biggest problems of Bulgarian society. Up to 2020 the EU framework towards the Roma population (biggest minority group in Bulgaria) was focused on socio-economic integration of marginalized Roma. The new framework requires equality, inclusion, and participation. Unfortunately, many Roma children are discouraged to study at a very young age or drop out of school prematurely. This is partially result from cultural traditions of early marriages, but also has deep roots in inadequate policies and measures for language education of the bilingual children.

Although research shows that the good knowledge of mother tongue supports the acquisition of second language, the strategies towards the minority languages in Bulgaria are rather assimilative. The poor knowledge of the official Bulgarian language makes it difficult for many minority kids to master the terminology and concepts in the field of STEM.

Having a nationwide primary school STEM system will engage pupils more, encouraging them to stay in school and pursue a rewarding career path.

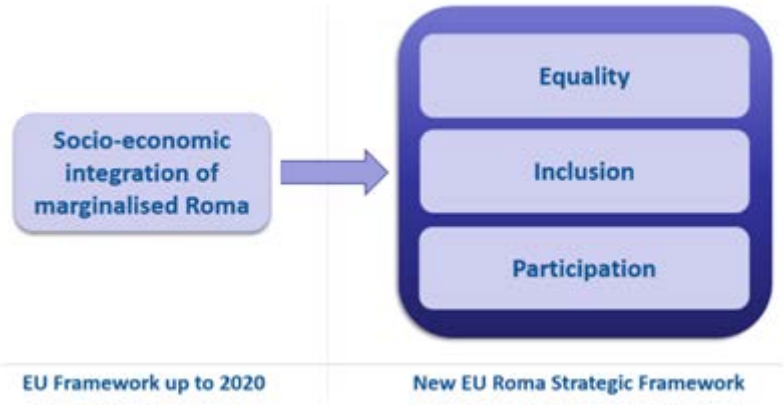


Figure 2: New EU Roma Strategic Framework

Conclusions

Despite the great development of the IT industry, other STEM fields and the success of pupils at international Olympiads, effort is required to improve the pre-school and primary school STEAM curriculum. First, there is little recognition of the impact arts have on STEM subjects and there is no national program for the development of STEAM at the primary school level. Secondly, the STEAM curriculum accounts for approximately 39% of the primary school curriculum and is mostly focused on mathematics. There is a need to develop the other STEAM subjects to attract more pupils towards science at an early age.

At pre-school level there is brief mention of STEAM related topics, but there is little guidance to teachers on how to approach those topics. This results in disparity based on local facilities and teaching abilities. Most national programs provide support to secondary and high school educational institutions. Fortunately, there are several successful private initiatives that employ foreign practices and give children early exposure to STEAM. Unfortunately, such initiatives are only accessible to few.

Finally, there is a need for more awareness of diversity. There is no evidence of institutional discrimination towards girls in the STEAM field, but there is a problem with the cultural sexism which has been embedded into the society.

II. Focus Groups' Meetings Report

Methodology

The contextual research of the NGSS project has been supported through facilitated groups' discussions, led by an interviewer who used the predefined questions designed by the PANEMISTIMIO KRITIS and VALAHIA UNIVERSITY of TARGOVISTE (See Annex I).

A written invitation had been prepared and spread through the facilitation of educational stakeholders. This invitation contained brief information about the purpose and the foreseen

contribution of the focus groups and a link to the NGSS project summary. The volunteers registered through an online registration form, which allowed collection of basic information for the purposes of the reporting, but was adjusted to the GDPR requirements. The registration form too contained brief explanation about the purpose of the interviews and how the information from the interviews will be handled – how it will be analysed, and what it will be used for. The necessary consent regarding the further use of the information from the interviews also had been collected through the registration form. The anonymity of the respondents whose opinion would be cited in the analytical report was guaranteed.

The interviews had been carried out online through Google Meet application. Prior to the interviews all participants received information regarding the online tool, rules of communication during the interview and short instructions how to connect.

All interviews had been recorded. The records had been used for preparation of this report.

Description of the groups

The focus group interviews in Bulgaria had been implemented in May and June 2021. The interviews had been carried out online in small groups of participants of 6 to 12 persons. It has been estimated that this group size will allow sufficient time for all participants to speak and express their opinion while at the same time the duration of the session will be limited to approximately one hour.

Structure of the meetings

The information about the project had been shared with the participants in advance in written and briefly reminded at the start of each online meeting. A brief presentation of the rules of communication during the meeting had been made before the start of the interviews. As all participants received written instructions and/or had previous experience with online meetings and voice communication in electronic environment, this was a mere formality.

Duration of the sessions

All interviews were approximately 1-hour long. Participants had been advised to keep their cameras switched off, as the opposite very often negatively affects the quality of the online connection. Furthermore, most of the participants joined the conversation from their homes and sharing personal information and details regarding their social or economic status is considered inappropriate.

Name and short profile of the Facilitators

The facilitator of the interviews was Reni Dimova – project manager at the Center for Creative Training Association (P2). Reni has pedagogical background and more than 20 years' experience in management and implementation of educational projects.

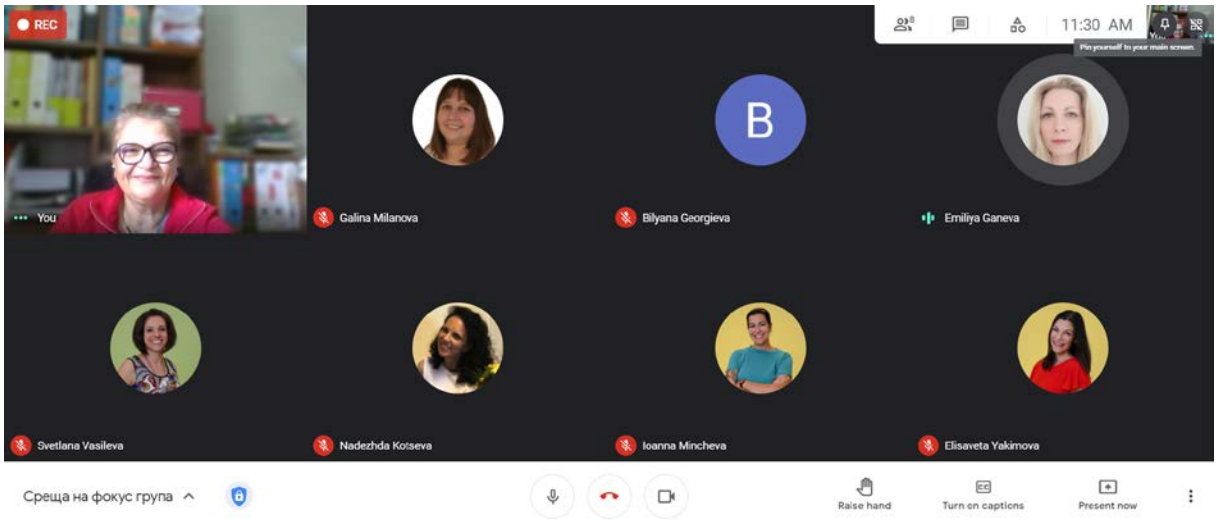
Challenges or difficulties in organising this meeting sessions

The coordination and registration period prior to the interviews had been relatively long due to the spring vacation and Easter holidays in Bulgaria. Time preferences of the candidate-participants varied too, so not all educators who expressed interest towards participation in the interviews had a chance to join the sessions.

Profile of Participants

Focus group parents

The focus group of the parents was formed on a random principle. In the interview took part 7 parents. All participants with exception of one were urban citizens. All participants were with completed higher education. Among them: 2 were parents with one child, 5 - with two children. Parents with two children of different genders were 3.



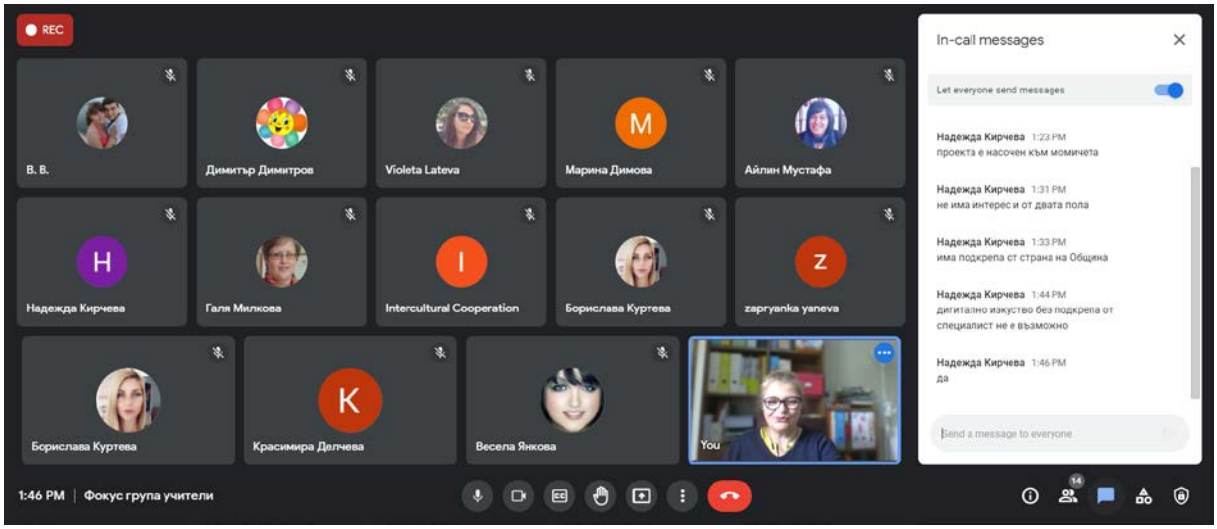
The registration for the focus group required collection of only basic necessary data for identification and communication with the participants. No personal data about family and social status had been collected, in line with the principles of discretion and objectivity.

Focus group teachers

Two interviews with teachers had been organized. Given the number of the respondents, which had to be engaged, it was considered appropriate to split them into 2 subgroups. Altogether 18 teachers took part in the interviews. From them 22% were teachers in primary schools and 78% teachers and headmasters from kindergartens.

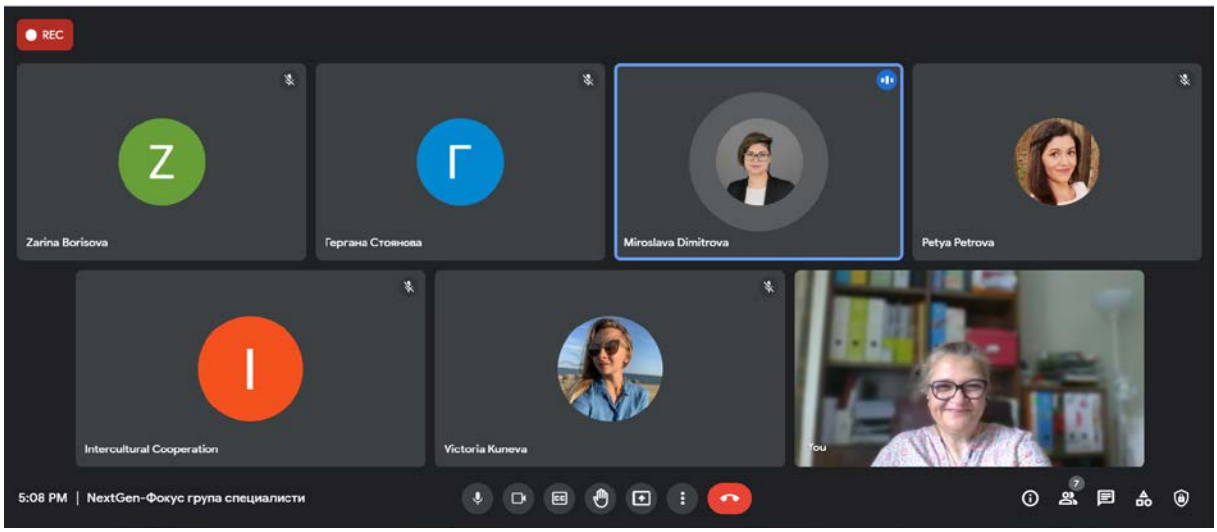
With the view of the aims of the project and its target groups, invitations for the focus groups had been spread mainly outside the capital, in regions with high number of minority

population and high rate of economically motivated emigration. Most of the educators who registered for the interviews were from Sevlievo and Haskovo regions.



Focus group of young scientists and art educators

In this focus group took part 2 young female STEM professionals, 2 young female art educators and 1 young lady who is both artist (musician and music tutor) and STEM professional (trainer in educational technologies).



Summary of Comments and Findings

Each conversation started with brief reminder on the context that brought together the participants for this interview – the international project "Next Generation Science Standards Through STEM", cofounded by the EC under Erasmus+ through the Turkish National Agency.

Participants confirmed they are acquainted with the short information about the project that had been shared in advance.

What is the meaning of STEAM? What is the difference between STEM and STEAM?

Parents in general were not well informed about the exact meaning of the term STEM as confirmed by most of the participants in the parents' focus group. Nevertheless, at least one parent (P4) knew the difference between the terms STEM and STEAM and elaborated that STEAM includes also the word "art" in itself. The same parent provided accurate wording of the abbreviation STEM as related to sciences, technologies, engineering and mathematics.

Taking in consideration the relative uncertainty among the prevailing part of the parents regarding the terminology, the moderator asked an additional question:
When you hear STEM/STEAM do you perceive it as a cumulative abbreviation that allows shorter and quicker reference to several terms (similarly to saying "sciences") or you have different understanding about the term?

P2 shared that she perceives the term as an *umbrella* (i.e. cumulative term) that refers to several subjects and scientific areas rather than any integrative (cross-reference) approach to teaching / learning those subjects. The rest of the parents confirmed the same understanding. According to parents, referring to STEM does not imply integrative approach to teaching sciences, technologies, engineering and mathematics.

Teachers on their end were much better informed about the meaning of the terms STEM and STEAM, even though they did not always accurately pronounce them. Contribution to the popularity of the term among educators has the fact that in 2020 the Bulgarian Ministry of Education implemented a National Program "Building a STEM School Environment" aimed to ensure adequate school infrastructure (STEM centers) for increasing students' interest and their achievements in the field of science and technology (for more information see above in the *Desk research* part of the report).

All teachers who took part in the focus groups were also aware that the term STEAM includes also the element of "art". T16 commented that the abbreviation STEAM brings to her association with the word "team" and to her opinion contains an invitation for a team work.

Interestingly, one of the teachers (T8) interpreted the term through the perspective of children's skills, not through the perspective of the teacher and teaching. According to her words, STEM applies to „the child's ability to transform the world around him, from his immediate environment through the methods of mathematics, engineering, the construction of some form or location of an object in space, involving different senses; the child's ability to handle materials purposefully".

According to the teachers STEM and STEAM suggest *integrative approach* to sciences, technologies, engineering and mathematics. However, this is more so for the kindergarten teachers than to the school teachers. The learning situations in the kindergartens usually include elements that address and engage all senses of the kids. For instance: a learning situation in maths contains goals for language development, music, physical activity, social topics (T10). Educators also acknowledge that it is important to work on the abilities of teachers to understand the integrative essence of STEM in order to be able to implement this approach in their everyday practice (T8).

For the school teachers, the integration between the disciplines in STEM/STEAM is mostly perceived as integration of digital technologies in the school subjects.

Integration of the digital technologies into the teaching and learning practices was declared as a subject of interest to the kindergarten teachers. For them this is still a novelty and they would like to learn more about the good practices of integration technologies in the teaching.

What are your expectations related to the implementation of STEAM?

Teachers underline that STEM and STEAM are beneficial for the development of creative thinking, team work, communication skills, entrepreneurship. They mentioned that STEM is favorable for development of child's imagination and could help for building future explorers. They also think that STEM / STEAM would contribute to the development of mathematical thinking, which is an essential skill in life even for people who would not choose a profession linked to math and engineering.

Teacher also underlined that the great value of STEM / STEAM is the opportunity for the kids to construct things with their hands, to engage in experimentations.

Asked to specify **difficulties in implementing STEM / STEAM approach** some teachers underline that they received their initial pedagogical education in times when [digital] technologies were still not developed and not included in the university courses for pedagogues (T4). For them catching up with the technological novelties in education is a challenge.

One of the teachers (T4) mentioned also that the methodological support for teaching STEM is scarce and *teachers have to learn by themselves*.

Another difficulty mentioned was the need of specifically equipped environment for teaching and learning STEM. Well-equipped environment and labs (similar to those demonstrated by some high-schools) is a prerequisite for an extensive involvement of pupils in STEM / STEAM activities. It was also estimated as stimulating for kids' imagination (T3).

Some teachers commented that in the kindergartens the big number of kids in one group (up to 25) creates difficulties for their work. Kids first should gain experience to work in smaller teams before they can engage effectively in experimentations (T11). Furthermore, the presence of a second teacher or at least an assistant for such activities would be essential.
As possible approach to teaching STEM / STEAM in the pre-school environment is considered splitting the standard groups in smaller teams of kids who will engage in thematic activities in spaces that are appropriately equipped.

Teachers mentioned that technologies enter schools much faster than kindergartens. Often kindergartens are not considered for funding in the initiatives launched by the Ministry of Education and Science, or are offered much less funds than those available to schools (T2, T8). As a result, building proper environment for teaching STEM at a pre-school level is more difficult – commented teachers (T3, T8).

Educators also underlined that **textbooks and digital aids are not sufficient** stimuli and that particularly for STEM would be useful to have more constructors and other aids which kids could touch and manipulate with hands. Availability of varied materials for hand manipulation is directly related to the brain development in the early childhood education. Engaging kids in learning-by-doing activities helps them to make connection between what they learn and the real world. While kids in upper school levels can have personal sets of tubes, flasks, litmus paper and engage in scientific experiments themselves, kids in the primary school level do not have such sets, which makes it difficult to handle scientific experiments (T5).

Ensuring an opportunity to work with authentic lab materials at school is important particularly for economically disadvantaged students whose families could not afford to buy them toys of this kind. Important for disadvantaged students are also digital equipment which allow access to simulations and attractive visual materials. Using digital equipment and applications is appealing for the pupils who are economically disadvantaged and helps for reducing the school absenteeism among the minority children (T6). Creating opportunities to the kids is important – they should be exposed to different knowledge and materials for learning, to have options and choices (T4).

Since teachers placed all difficulties they face outside the classroom and their own power to solve them, there was no clear answer to the question **How you overcome the difficulties you meet?** The answers what kind of support do they need for teaching STEM could be summarized to: *more information, methodical support and in-service training would be beneficial for all* – teachers and learners (T4). "If we don't know those things, we can't offer them to the children" elaborates the teacher.

What kind of strategies could you use to motivate and engage pupils for STEAM lessons?
Several teachers mentioned that going outside the classroom (T3) and outside the curriculum would be beneficial for motivating children to learn STEM. In particular, teachers think that this could be done with *project-based learning, practical activities in various environments* and through *demonstrating practical implementations of things written in the textbooks*.

Teachers shared also that sometimes the resources which school has for extracurricular work are not sufficient to answer the needs of the talented kids. This forces parents to search for clubs and solutions offered by private or municipal organisations, which is time-consuming and sometimes requires additional expenses. That is why turning school into a *learning hub* that offers extracurricular opportunities for all kids is important (T3).

The focus group of the young scientists came up with fresh ideas about techniques for engaging children in STEM lessons. One of the major points of their suggestions was *authenticity* – children must work and use authentic tools and instruments, not just toy ones. The power of technologies should be used for AR and VR solutions in cases when facing real animal or plant, or visiting a place abroad is not possible (E1).

The art educators also had similar suggestion. They pointed out than when engaging pupils in real experimentation is not possible, showing video-clips of *kids speaking about science or demonstrating scientific experiments* would be stimulating and would raise positive response (E5). Such examples would stimulate kids to think that they can do such activities too. As an example was shared the following clip of an 8-year old girl who makes scientific experiments and records them:
https://www.youtube.com/watch?v=7q5N9LjMX28&ab_channel=%D0%A1%D0%B2%D0%B5%D1%82%D1%8A%D1%82%D0%BD%D0%B0%D0%9D%D0%B5%D0%BB%D1%81%D0%B8

Do you notice any behavioral difference among children of different genders towards STEM and is there any differences in their emotional reaction?

Some of the parents shared accounts on perceived different attitudes of children of different genders related to STEM. However, with the input from the parents of two children with the same gender became clear that the reported differences in the attitude could not be attributed to gender specifics. The prevailing opinion of the parents with two children from the same gender is that any differences they observe (or had observed) between their children in respect to STEM are not gender determined, but rather depend on the child's personality.

P4, parent of two girls at 7 and at 5 shared that her daughters have Lego Education set (BricQ Motion Essentials) and regularly play with it. "This is the only toy (not exactly toy, in fact) in which [my children] didn't lose interest in just 2-3 days".

Similarly, both parents of girls and boys reported interest of their children in the broadcasts of DaVinci Kids[1] educational TV channel.

No specifics had been reported as linked to the age of the children. No significant characteristics could be established as typical for the first-born children or to those who are younger in the family.

On the other hand, teachers were firm that **there is no difference between boys and girls** in engaging into STEM activities at the NGSS targeted age groups (pre-primary and primary school age) – kids are open, active and inquisitive. One of the teachers (T3) even mentioned that girls generally show more initiative than boys.

When it comes to specific subjects at school (like the curriculum in Digital modelling – a compulsory subject in the main school curriculum for 3rd and 4th graders), teachers report that the interests and performance of the kids depend on their abilities and talents (T6), but these are no gender related.

Young scientists and artists who have experience in educational activities with children also confirm that there is no difference between boys and girls in engaging into learning activities.

While teaching STEAM/ or any science lessons, do you take the pupils` social and emotional learning process into account, and do you involve activities to motivate them?

Teachers confirm that they are trying to engage pupils' emotions in order to grab their attention, to wake up their curiosity and to involve them into learning. These approaches are important part of the pedagogy for pre-school and early school years. However, the pre-school

[1] **Da Vinci Kids** is an educational TV channel for children aged 6–12 and families. Its hedquarters are in Berlin (Germany), but the channel is broadcasted in 19 language versions worldwide.

didactic counts more on engagement of multiple senses in a single learning situation than the school one. While in most learning situations at kindergarten music, dance, painting are engaged together with learning topics from the curriculum, at school this is rarely done in such integrated way. At school this multisensory learning is achieved through the alternation of different subjects in the program and sequencing STEM subjects with language, music and arts classes. Nevertheless, teachers are doing their best to keep the playful element in the learning, to use gamification when proper (T3, T5). Offering *clubs* and *activities of interest*[2] at school is another way to engage pupils in learning on topics they feel passionate about.

School teachers generally consider that they are constrained by the curriculum and it is difficult to introduce integrative approach to learning and acknowledge that blending STEM and arts can much easier be achieved / applied during the *extracurricular activities of interest*.

What benefits if any do you think could there be for schools to collaborate in an international STEAM community?

All teachers acknowledge that the main benefit would be learning from the experience of their colleagues abroad, exchange of good practices, colaboration, expanding their view-points and professional expertise.

Teachers also consider that international collaboration would be ocassion for positive communication with parents, for demonstrative activities and fests. All these would raise the image of the educational institution, which is particularly imporant for those situated in smaller towns and villages. Not the least, teachers also consider that this would have a positive effect for the pupils.

Specific questions for parents:

Have you ever talked to your children about the value of Science and Art? If so, what topics were the children curious about?

On the matter of science and arts engagement, some parents admit gender specific approaches, like: *in our family, girls are engaged in ballet dancing and arts during their childhood* (P1).

In this respect, the equal treatment, which is obligatory at public education institutions (kindergartens and schools) allows boys and girls to take their chance and to compete on equal terms in all spheres, including STEM. Similarly, education institutions are the places that would

[2] Extracurricular activities are offered in the frames of the full-day school time organization, which is now compulsory offered by the primary schools (up to 7th grade), but is optional for parents to choose. Similar initiatives and clubs are also offered by the *Support and personal development centers* and/or *Community centers*, which function with the financial support from the local municipalities.

allow children from disadvantaged background to practice and learn in the spheres of knowledge, which they might not have a chance to experience otherwise.

Parents who took part in the focus group acknowledge that they make efforts to expose their children to sciences, culture and arts, but in general are led by the interests of their kids and try to support them. Nevertheless, it is clear that families with limited economic resources face difficulties to provide opportunities to their children. This increases the role of the schools and the public provision of free of charge extracurricular activities, accessible to all children.

What kind of educational toys do you choose for your children in terms of social and emotional learning?

P4 admitted that for the SEL she chooses books rather than any toys and commented that she could not determine what should be the SEL characteristics of the toys. She shared that a book on the emotions[3] helped her a lot to deal with kid's anger, rivalry and other negative emotions.

P6 shared that their practice is to choose games that allow the whole family to get together and to do things together. Similarly, the family came up with tactics that helped their little boy to accept defeats in the games, which at the beginning he faced with anger and tears.

P5 communicated that their family has two pats – a cat and a dog – and that both animals are great teachers in SEL. Through the interaction with the animals, kids learn many new things without noticing and without their parents' direct involvement.

Outside the prepared questions that had been asked, partners shared two additional opinions which we consider relevant for the context:

Parents consider that the feedback they receive from their kids' teachers is insufficient and often superficial. Instead of linked to the interests, learning challenges and achievements of the children, often the feedback is limited to their behavior and nutritional habits.

The second observation shared by the partners is that teacher's personality and attitudes are very important incentives for kid's learning and interests, especially in STEM area. The example of the favorite teacher as a powerful motivator for considering STEM-related career had been mentioned both by parents and young scientists.

[3] "A great book of emotions" of Chiara Piroddi.

Recommendations

With respect of the feedback from the focus groups the following recommendations could be summarized:

- More attention to the continued professional development of the teachers and methodological support to their work should be paid. The teachers' professional development should cover development of skills for collaboration with parents, as well as awareness of the role of the teachers as a role models and influencers for the future career choices of their students;
- Kindergartens should be offered the same chances and opportunities as the schools in terms of improvement of the infrastructure and supplies. In the school context, the primary education should be treated equally to the high-school education level;
- Hands-on activities should not be underestimated and substituted with theoretical lessons. Children and pupils should have opportunities to engage in learning by doing and in creating meaningful artefacts[4];
- Public education institutions should be supported to offer extracurricular activities and opportunities to the students since not all families have sufficient resources or time to develop children's talents;
- Girls and boys should be treated equally and the stereotypic thinking should be avoided. In this respect the adults' awareness should be risen (both the one of the parents and the teachers);
- When teaching kids, we should try to ensure them with authentic experience and work with real tools and materials, not with a toy-ones.

Conclusion

The Bulgarian educational context has several **strengths** in respect to teaching STEM and STEAM:

- There are integrated subjects in the primary school and early childhood education;
- The gender discrimination is generally not a big issue due to the traditions from the socialists past, so the girls and the boys are treated equally at the educational institutions.

The following **opportunities** exists:

[4] **Seymour Papert,** a disciple of Jean Piaget and professor at the MIT Media Lab, developed ideas over the years that eventually took the form of a new learning theory: **Constructionism**. Papert stated that humans construct their knowledge especially well when they participate in the construction of shareable 'artefacts' that are personally meaningful to them. According to him, children (and humans, in general) construct knowledge in their mind while building something with their hands. These 'artefacts' can be anything from a sand castle to a robot, to any tangible object (ref. "Creative technologies – synopsis" from UdiGitalEdu – University of Girona).

- Awareness at the policy-making level about the importance of STEM / STEAM and the need of STEM infrastructure in the educational institutions;
- Availability of equal rights' legislation and strategy;
- Planned financial provisions for the development of STEM infrastructure in the schools in the near future.

The **weaknesses** are:

- Lack of sufficient level of knowledge on how to plan and build sustainable and innovative STEM/STEAM centers at the schools;
- Lack of sufficient skills and qualifications of teachers to carry out effective integrated STEM education for the best development of their students' competences.

The **threats** are:

- Long tradition of overregulation of the distribution of funds in education, which might lead to inefficient spending of the funds that will be made available for STEM centers in the schools,
- Spending for standard solutions and lack of innovation in the STEM centers;
- Lack of future funding for sustainable support to the STEM school centers which will lead to their inefficient operation in the long-run.

More visibility of the good practices from NGOs and private sector stakeholders should be given, to allow schools to learn from the best examples.

Resources

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Annex I: Pre-defined questions for the focus groups

(authored by PANEMISTIMIO KRITIS, Greece and VALAHIA UNIVERSITY of TARGOVISTE, Romania)

Generic questions:

The first question is **for teachers, STEM and ARTS professionals and parents**:

What do you understand is the difference between STEM and STEAM?

Next questions are only **for STEM and ARTS professionals and parents**, asked after or between the specific questions concerned:

What kind of strategies could teachers use to motivate and engage the pupils in Science lessons?

What benefits if any do you think could there be for schools to collaborate in an international STEAM community?

Questions for teachers:

What kind of experience did you have with STEM/STEAM approach; what do you know about STEM/STEAM?

What difficulties do you face/ or could you face in implementing this approach (difficulties related to infrastructure, logistics, framework provided by the national curriculum, with the design of the lesson plans etc.)?

How did you overcome these difficulties; which aspects helped you the most or the least; did you have any support from policy makers or other stakeholders?

What are your expectations related to the implementation of STEAM?

How do you feel about the effects of STEAM teaching on children?

What kind of strategies could you use to motivate and engage pupils for STEAM lessons?

What is your experince in engaging the girls and disadvantaged students in STEAM courses?

What do you expect from school management to help you teach a class of girls?

What kind of training, educational programs, materials, seminars, tool and platforms do you expect for STEM?

How well prepared do you feel to plan STEM/STEAM lessons?

Do you think you need more training on STEAM? Have you taken any training courses? What kind of support do you need to be more efficient and motivate your pupils?

While teaching STEAM/ or any science lessons, do you take the pupils` social and emotional learning process into account, and do you involve activities to motivate them?

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Questions for female STEM professionals/trainers/researchers/Art and design professionals

When you are doing Science do you think you are doing ART? (question for ART PROFESSIONALS)

When creating ART do you think you are doing Science? (question for STEM PROFESSIONALS)

What kind of methodology do you use in order to make STEM/STEAM more attractive to girls and disadvantaged students?

What would you do to help girls and disadvantaged students become familiar with tools and other devices?

Questions for parents of mainstream and of disadvantaged pupils

Do you notice any behavioural difference among your children of different genders of while they learn Science and there any differences in their emotional reaction?

Do you notice differences among your children of different gender in activities such as watching cartoons, playing toys, etc.?

What kind of educational toys do you choose for your children in terms of social and emotional learning?

Have you ever talked to your children about the value of Science and Art? If so, what topics were the children curious about?