STEM ART = STEM + ART: An Erasmus+ STEAM project for K-12 education

Milan Hausner¹, Paraskevi Karypidou², Maria Gratiela Popescu³, Serkan Altınöz⁴, Laura Bozzo⁵, Olya Mihova⁶, Petra Mikše⁷

1. Zakladni skola Praha 3, Lupacova 1/1200, Czech Republic,
2. 1st Primary School of Diavata, Thessaloniki, Greece,
3. Scoala Gimnaziala nr 7, Buzau, Romania,
4. Topalli Ortaokulu, Antalya, Turkey,
5. Fedac, Manresa, Spain,
7. Osnovna Sola Jozeta Krajca, Rakek, Slovenia.

Abstract. The STEMART project focuses on European educational priorities, mainly the support of STEM education. Seven countries (Czech Republic, Greece, Romania, Turkey, Spain, Bulgaria, Slovenia) will organize seven scientific weeks and competitions on chosen topics, to which an international approach will be shown. There are scientific explorations, technical inventions, biological experiments, programming and also construction activities. A permanent sharing of experiences, creation of a scientific ledger and various outputs gives students new horizons and perspectives. As can be clearly seen, a precise evaluation of outputs will create an exceptionally rich scientific and technological experience which can have a strong effect on the future job orientation of students. All products will be published under Creative Commons License. This approach will also involve national bodies, institutions and political representatives in the dissemination of this project. The project will be organized under the auspices of the Czech commission of UNESCO and the representative of European parliament.

Keywords: STEM, STEAM, education, Erasmus+, K-12.

1. Introduction

The priorities which have been chosen are essential to the future of Europe because they create active roles for prospective citizens and also support and strengthen their own motivation, challenges and involvement. In a time when STEM has become one of the most important values in European education the aim should be to develop other priorities, which are creativity, motivation, cooperation and team work on an international scale. All of these priorities are part of the partner school framework, but this project will give them new multicultural and social impacts. Because this project will be the focus of all school partners, it will also become the flagship of international education in all municipalities in partner countries.

The STEAM (STEM with ART) project is an Erasmus+ project for K-12 institutions with duration of two years, starting on September 2016. The project is coordinating by the Czech school with six more partners from six countries (Czech Republic, Greece, Romania, Turkey, Spain, Bulgaria, Slovenia).

STEM (Science, Technology, Engineering and Mathematics) [2], [3], [11], is an acronym that refers to the academic disciplines of science, technology, engineering and mathematics. STEM education combined with Arts education (STEAM) should provide us with the education system that offers us the best chance for regaining the innovation leadership essential to the new economy [4], [5], [6], [8], [10].

The challenges of our generation will demand creative solutions, so innovation in art and sciences needs to be encouraged. For example all European schools are currently going through some important changes. The old system is not related to the work field so current
curriculum need to be revisited and rearranged. It is essential to update our educational system because employment opportunities are different. The schools have to change as soon as possible. Teachers should find the students’ learning styles in order to adapt teaching methods to the pupils' needs. Teachers are expected to personalize lesson scenarios or work differently with students while considering the learning style of the students (by groups). All of these priorities could create an exceptionally rich project with a large impact on the future existence of partner schools.

Another priority which is fully included in the STEAM project is the fact that all partner countries significantly contributed to STEM knowledge for mankind and to present these endeavors to the younger generation. One example comes from history (from Turkish aqueducts to the viral remedies of modern Czech scientists). In STEAM typical and unique national products will be used to show how STEM will contribute to them. Such examples could be the unique Mercur construction set or Spanish programming applications.

Skills in Science, Technology, Engineering and Maths (STEM) are becoming an increasingly important part of basic literacy in today’s knowledge economy [12]. According to the EUN Schoolnet webpage [8], to keep itself growing, Europe will need one million additional researchers, technologists and mathematicians in applied science by 2020 (European 2020 Initiative). The creativity of the international teams, sharing of own and mutual values, each school's own work in the field of STEM, mutual offline and online meetings together with development of digital content – all of these skills in one project creates a fantastic challenge not only for students but also for teachers. When discussed with municipalities in all countries, full support and a will to cooperate were given. The project will involve all parent organizations and parents of students in schools, as without them it wouldn’t be possible to fulfill all the goals which are the following. This approach will support another aspect of modern Europe – the family bonds which are being so dramatically destroyed in these modern times. Another aspect is international understanding and support for European mobilities. Europe has recently been facing the migration crisis with a lot of prejudices, xenophobia and racism. Cooperation with various nations in one group, creating work together and their sharing of it could be a real asset for such a goal. It will not overcome all barriers, but it could help the way children approach the issue of migration.

In this paper, Section 2 introduces the goals and methodology of the project. Section 3 presents the main implementation principles and planned outcomes of the project. Section 4 outlines the expected impact and Section 5 briefly mentions some of the planned dissemination actions and expected exploitation of the project results.

2. Goals and Methodology

The methodology of the STEMART project mainly focuses on supporting challenges and activities targeted to student groups and team collaborative learning, in various environments of the participating schools and in each location. This will bring together education with polytechnic real tutoring. There is a list of activities in partner schools which will be provided both online and offline. Other important features of the project are regularity and complexity. Each partner will prepare their own program of activities with focus on the international level. This organizational model will also be a part for the evaluation board of partners, who will check procedures and protocol of the project.

The opening staff meeting (Prague) is an essential part of project. It will provide a necessary start to all other activities and outcomes as benchmarks, quality and methodology plans are to be discussed. Recognition of the personal motivation of all school project managers is the second must. This meeting will open not only professional cooperation, but also personal
bonds. At this meeting the situation of the school regarding social status, location and possibilities will be discussed and evaluated from various aspects.

The second staff meeting (Buzau, Romania) will have the goal of evaluating works done so far and create the possibility to improve results achieved. It is also a good place for retrospective evaluation and an opportunity to discuss a precise plan for dissemination.

Since all staff in schools will have to be involved, it is essential to give them appropriate challenges and motivation. The extent of outcomes can’t be attained without the vast support of teachers and school community.

The project has clearly set and quantified outputs, so it will be easier to evaluate overall quality metrics. Quality assurance will also be introduced into the system by a board of evaluators. This quality assurance will especially evaluate the impact of the outcomes of students for all schools.

Daily activities in all partner schools will provide motivation and appropriate challenges for involvement in international cooperation. That is why the workshop topics cover all STEM parts (Science, Technology, Engineering and Math by virtue of ART) and the variety of options will ensure that the majority of the students will be able to find a number of activities where they can be involved. All student outcomes will be presented to their respective local school communities and the best of them will be shown in the international project conferences.

3. Implementation and Outcomes

Because each school is fully responsible for the complex development of student personality, there also has to be support of the sense of art and culture as essential parts of life. Some of the STEM activities could also be seen through DIALOGUE OF ART WITH STEM.

Students and teachers in all partner schools will choose one topic of interest from STEM as the priority for the school, region and country. The list of such priorities is listed below. The school together with the local community will prepare for 5 days of school workshop activities to show a complex view of the topic chosen. It will involve students, teachers, parents, municipal politicians and also of course local institutions working in the area. This conference will be organized in partner schools and the school will create all possible support for other partner schools in this field. They will organize webinars, online discussion, creative writing, an art contest and all imaginable activities to create a challenge for the students in this field. Such workshops will be organized in all partner schools.

The partner school community will develop support for topics offered in a way that at least 10 assets (clip, art work, multimedia presentation) will be included in every topic. They will organize an indoor school contest with the participation of local institutions and also small school mini-conferences to choose 4 participants for the international conference in a partner school. It is expected that about 70% of students in the age range of 10-12, 12-14 will somehow be involved.

As the project sets 100 mobilities as the limit which it supports, every partner has to choose at least 4 conferences for their presentation internationally. All schools will endeavor to find other sources of finance in order to participate in more than three conferences.

3.1 Learning, Teaching and Training activities

These activities will also be introduced in a flipped classroom. Workshops will be held in all partner schools and led by students as well as by various experts from the country of the organizer. 7 week workshops will have a mini-conference, terrain work, excursions,
socializing, challenge games as well as various discussions with experts on chosen topics. The value of such learning is based on the diversity of environments, various ages of presenters, and most valuably on 'hands-on' activities. Visits to real lab environments and enterprises facilitate students and teachers to attain a new in depth view into real scientific, artificial and business life. These activities are the core of this scientific and art project as it facilitates the creation of the international working framework and gives all students full access to European shared youth knowledge.

**Czech Republic**: "3D virtual science models": A set of workshops focused on modeling through construction sets. Visits to science laboratories and museums. Streamlined pupil’s conference about 3D models. Presentation of models of partner countries. Cultural events with historical and political presentation. Visits to the regional town hall and socializing activities.

**Romania**: "House full of experiments": Set of scientific experiments which will be provided by students from the host and from visitors. Cultural and political socializing together with a streamlined conference to the other participants. Visits to local monuments.

**Spain**: "Programming Code": Presentation of pupils Android and Win applications. Special workshop for Google (Android) programming. Presentation of applications of students. Contest for the most efficient and attractive Android application. Cultural and social meetings. Streamlined conference and official publication of the applications.

**Turkey**: "Historical inventions": Presentations by pupils about historical inventions in their home country, visit to the museums and workshops about the historical inventions. Presentation of national inventors and his/her endeavors for recent and future time. Streamlined conference. Presentation of Scientific Ledger and Database of inventors and scientists. It will be organized with the help of Mediterranean University together with cultural and social events in Antalya.

**Slovenia**: "Art under microscope": Presentation of microscope images made by pupils in all partner schools, Art exhibition of microscopic structures. Workshops for students from other countries. Presentation of parts of their cultural heritage. Organization event supported by local media, local representatives and school ministry. Streamlined workshop to the other partners.

**Bulgaria**: "Architecture around us": Presentation of typical architectonic styles from partner countries, visit to the national monuments and comparative workshop about architecture. Presentation of various architectonic styles and streamlined conference. Presentations of 3D models derived from various construction sets. Models could not only be typical buildings, but also technical endeavors such as bridges, viaducts, roads etc.

**Greece**: "Lego Mindstorm robotics": Exhibition and workshop based on Lego programming. Workshop based on Mindstorm Lego programming for students from both schools. Presentation of applications by the visitors. Streamlined conference. The cultural and social part of the visit is connected to the history and local landscape. Presentation of results to the political bodies.

### 3.2 Expected project outcomes

There are various outcomes planned. School workshops are not mentioned here as they are listed below. General products are as follows:

1. LOGO of project – the first international contest will be focused on development of a logo for the project.
2. STEM QUEST – multilateral questionnaire with prizes in both cultural and STEM topics which will show partner schools and also represent the national approach in this field.
3. STEM CALENDAR – the International calendar presenting STEM achievements for all partner countries (at least 12 events per every partner).
4. STEM VIP PERSONS – the international multimedia database for at least 15 persons whose achievements are important both for STEM and country.
5. 7 STEMbyART TRAVELING EXHIBITION – in the last three months there will be this three day exhibition both for students and school community. Because of complicated logistics a part of the exhibition will be done by video-stream from the partners responsible for the topic shown. 3D objects will be presented in the partner school which is responsible for the theme.
6. INTERNATIONAL STEM JOURNAL – web based journal about new achievements in STEM which will be edited by students. Every partner is responsible for creating 70 references during the project time. All of these references will be tagged and cross referenced. It will consist of scientific, technological, engineering and mathematical achievements at national levels.
7. STEM YOUTUBE CHANNEL – Partner schools will edit its own YouTube channel with the STEM topic where all videos will be published and i-framed for http://stem.lupacovka.cz
8. MINI-CONFERENCE PROCEEDINGS WITH STUDENT, GUESTS PRESENTATIONS. These products will be available at least one month after the school's mini-conference. Every proceeding will have at least 70 articles. Proceedings will be shown only online and no printouts will be published.
9. SCHOOL STEM WEB LEDGER – Work on the project could be followed by a web ledger which is already available at http://stem.lupacovka.cz.
10. CULTURE AND NATURE POSTCARDS – every partner will prepare introductory spots about their country, region, school and participants (One presentation per country – video on YouTube channel.)
11. CREATIVE COMMONS LIST OF COPYRIGHTS All participants (students and teachers) involved in the project will get a CERTIFICATE OF COPYRIGHTS to show their personal copyrights to the mental works. Such an approach will support activities which try to overcome copyright abuse by personal experience.

3.3 Accessibility of Project Outcomes

Because all products will be created in the framework of project, all products will be accessible under Creative Commons License Attribution 4.0 International (CC BY NC 4.0) which allows: adaptation, remix, but not commercial use of the products [1].

As the target group is meant to be mainly K-12, there is no official instrument to validate the results of the conference. The team of evaluators will consist of experts on a national level and these experts will evaluate results of students and all proceedings by their statements. Such statements will be the essential part of project. There will be the international board of experts who will declare their statements to the online proceedings of all conferences.

A special award for the best participants in all workshops will be given together with a list of copyrights (Creative Commons) to all authors of student products.

Another evaluation will be created by mutual questionnaires and polls among students who will participate in the online and offline workshops. Evaluation will be the vital part of all 7 proceedings from the workshops. Preformatted questionnaires will be published.
Because the project is based on STEM, the project will be certified by a listing in the EUN STEM project on the web:// http://www.eun.org/focus-areas/stem. This portal will be the essential reference and dissemination tool on the European level.

4. Impact

The most expected impact is for the target group to increase their motivation for STEM subjects, as these subjects were very often reduced in comparison to the teaching of languages. The real use of language in another subject (CLIL) is the other possible impact. A project of this scale requires full participation of all school staff because of the diverse topics included in the project. It could support school team work, as it is well-known that teachers are very often individualists and that sharing of content is not always their first priority. The sharing of experience and materials is another impact for the future. The questionnaire at the start of project will be repeated and statistic verification of the improvement of student attitudes to STEM and to polytechnic subjects is expected.

Students will learn that STEM creates the future and language connects people. This is a simple definition, but for the motto of the project, it is essential.

4.1 Impact assessment

As was mentioned above, all results have quantitative and qualitative benchmarks which will be discussed in the final report. The number of publicized articles and discussions will be one of the most important impacts. Questionnaires for evaluation of attitudes to STEM and project satisfaction will evaluate the impact on participants and on the target groups. A group of experts will publish their own statement at the national level (politician, a teacher from another school, scientist, and journalist). Awards for best presentations and children's products will be given and published, so all the European community will have access to all 7 workshops results as the main part of the dissemination activities. A visitor counter with detailed Google analytics will be implemented, so at the end of the project a complete analysis of the results will be available.

This project shows other ways of cooperation when compared with Comenius. It is built on real scientific and educational activities with clearly described outcomes and products. In addition, recognition of not only cultural and historical aspects, but also of STEM issues, is included in many identification benchmarks in all countries and contributes to the advancement of the international understanding and cooperation among the project partners. According to earlier research, no other project with such activities has so far been organized, and all outcomes will define unique educational materials, which can be shared via European http://lre.eun.org as the main European portal for learning objects.

At the national level, the project will be introduced into the national LO object contest called DOMINO http://domino.nidv.cz and http://dum.rvp.cz. All materials will be published in all national portals for learning objects. The project will have strong media support at the regional and national level and it will also be introduced to EUN bodies and to the social media.

One of the desired impacts of the project, even before its launch, is a new concept of school club which will be open during summer 2016 and is called “STEM school club”. The special school club for kids aged 6-11 will be established and organized by ZŠ Lupáčova and these premises will also be used for some project activities in the next two years. A view of this club can be seen on http://kreativita.lupacovka.cz.

All results will be published and disseminated at both national and European levels as a project of such versatile content is completely unique and follows all European priorities. In
all partner countries the official dissemination links will be adopted and carefully checked for partner share in this field.

4.2 Sustainability

The project aspires to create a new school community based not only on professional cooperation, but also on personal bonds created during two years of mutual work. A group like this ensures a possible new common creativity. Results published in the school portal will give everybody new challenges. A large number of outcomes and all activities are expected, in which such content was created can easily be repeated and new threads to the event could be added. The creation of a Gallery of scientists and Science Ledger offers the chance to create new items and local follow-ups of these products. The Polytechnic education STEM, as was also mentioned, has become a part of a new School club concept and the output of students could be another motivation. 3D Merkur virtual models [7] can also create challenges for mechanical engineering in the class.

5. Dissemination and Use of Results

The first target group for which the results will be shared with is the teachers' community in the educational portals of EUN. Among them the most important ones are:

  a) [http://lre.eun.org](http://lre.eun.org), where results will be shared under Creative Commons license.

  b) [http://www.eun.org/focus-areas/stem](http://www.eun.org/focus-areas/stem) will be the essential European community where in all results will be introduced and shared.

  c) In accordance with Mr. Poche, representative of European parliament, this project will also be introduced to the Youth panel in: [http://www.europarl.europa.eu/european-youth-event/en/take-part!.html](http://www.europarl.europa.eu/european-youth-event/en/take-part!.html).

The main section of results will be streamlined and published via You Tube. They will also be offered for publication on the SCIENTIX EUN portal [9], both for final and intermediate evaluation and assessment purposes. All countries will also individually discuss with NA publication in recommended sources and conferences.

Because of the vast content and complexity intermediate project results are to be presented in December 2018 at EMINENT/SCIENTIX conference.

Some of the planned national dissemination activities are listed below:

**Czech Republic** - In school: peer program in other classes, Erasmus Days + corner, PTA meetings, presentation to the representative from the Town Hall. Publication in local and national media. The UNESCO ASP school will present the project on the UNESCO associated school network as well as on the member of Asia Europe Classroom Network, for partners in this circle.

  1) [http://rvp.cz](http://rvp.cz) - National educational portal where examples of best practices in education can be published

  2) [http://praha3.cz](http://praha3.cz) - Local portal of Prague 3 municipality

**Greece** - Erasmus Days meeting with briefings at school, diffusion within the school, update school website, update teacher community – afternoon meeting with parents. Municipality of Delta complex presentation to local bodies. Local TV channel. Participation in the:

  3) [http://www.dimosdelta.gr](http://www.dimosdelta.gr) - Local web portal of Delta municipality

  4) [http://www.sch.gr](http://www.sch.gr) - The Greek School Network portal

  5) [http://dipe-v-thess.thess.sch.gr](http://dipe-v-thess.thess.sch.gr) - West Thessaloniki Elementary School Admin. portal
Turkey - Erasmus Days in school and community, social events with local politicians and parents. Presentation of project to local administration and to local media.
6) http://aksu07.meb.gov.tr/ - School webpage
7) http://www.antalyaaksu.gov.tr/ - Local governmental webpage for region
8) http://topalliortaokulu.meb.k12.tr/ - Local school portal

Romania - The school's magazine: A spy in the school; meetings with other teachers from other schools in our town/county; local TV and Local newspapers, presentation to the local administration, PTA meetings
9) http://www.scoala7bz.webs.com - school site
10) http://www.primariabuzau.ro/ - official administrative portal of Buzau, Romania

Spain - Erasmus School Days, PTA meetings, School Board presentation, local feasts and children’s presentation. Meetings with other teachers during professional CPD.
11) http://www.regio7.cat/ - this is the web of the county's newspaper
13) http://canaltaronja.tv/bages/ - local TV mainly focused for regional news

Slovenia - Erasmus School Days+ corner, Local municipality gathering, PTA association meetings and also local newspaper
14) http://www.cerknica.si/ - local administration official webpage
15) http://osrakek.si/ - school website

Bulgaria - Erasmus School Days+ corner, Local municipality gathering, PTA meetings, presentation to the Teacher association in Bulgaria
16) http://svishtov-news.com/ - local info server
17) http://www.beta-iatefl.org/ - Bulgarian teacher association

6. References
[1] Creative Commons, https://creativecommons.org/