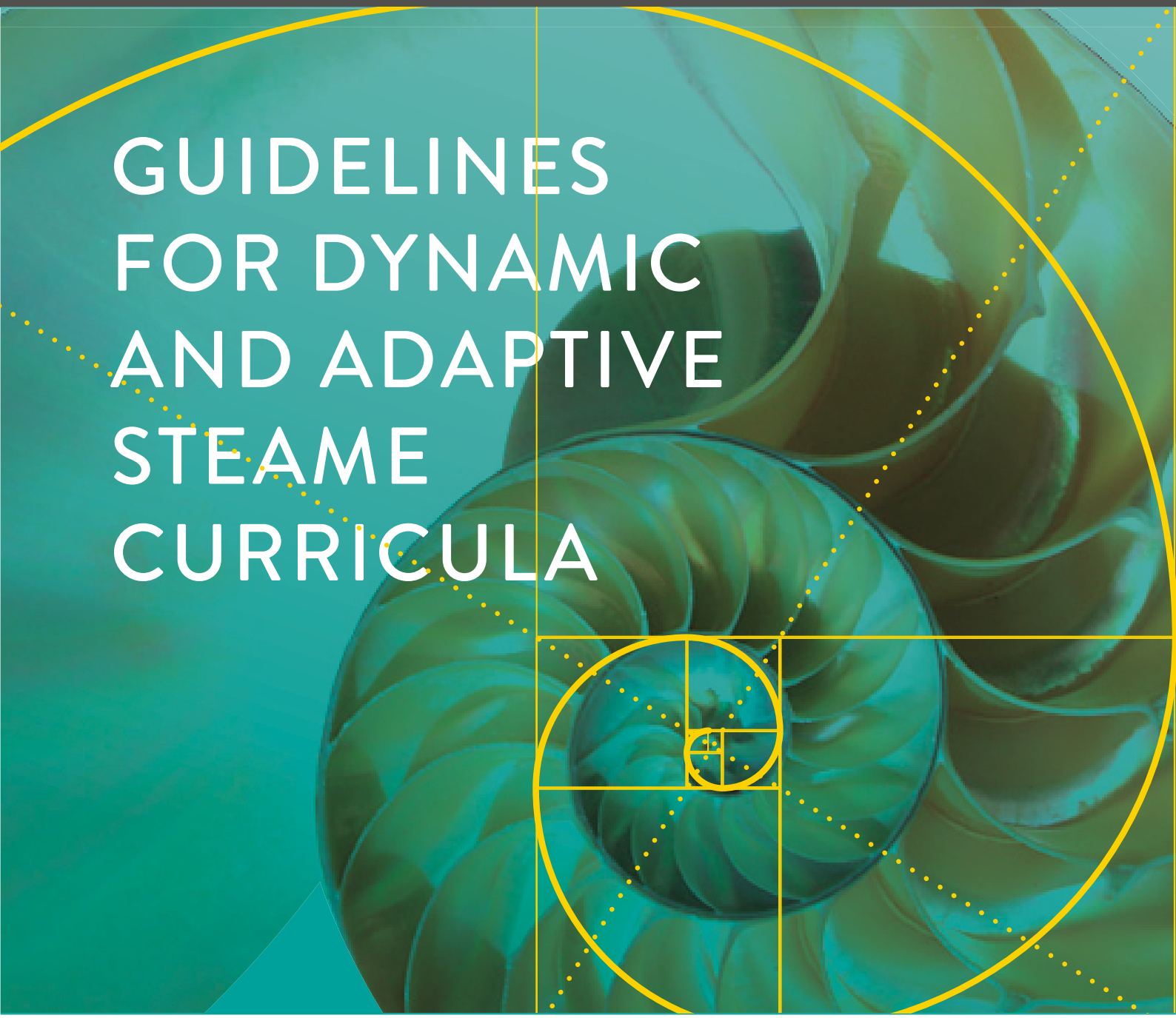
STEAME

GUIDELINES FOR DYNAMIC AND ADAPTIVE STEAME CURRICULA



ISBN: 978-9963-713-38-7

Co-funded by the Erasmus+ Programme of the European Union

Guidelines for Developing and Implementing STEAME Schools

101: GUIDELINES FOR DYNAMIC & ADAPTIVE STEAME CURRICULA

Editors:

Cyprus Mathematical Society
Gregoris A. Makrides

Pedagogical University of Krakow
Tomasz Szemberg, Justyna Szpond

Authors:

Cyprus Mathematical Society
Gregoris A. Makrides, Andreas Skotinos, Andeas Demetriou,
Giorgos Chimonides, Kyriacos Mattheou

Cyprus Pedagogical Institute – Cyprus
Eleni Papageorgiou, Georgios Tsalakou

Pedagogical University of Krakow – Poland
Tomasz Szemberg, Justyna Szpond

Prof. Ivan Apostolov Private English Language School – Bulgaria
Milena Koleva, Barbara Peychinova, Hristo Veselinski, Konstantin Ilchev,
Margarita Trencheva, Elena Karaivanova, Milena Koleva, Nikola Tomov, Deyan Doykov

Institute of Accelerating Systems and Applications (IASA) – Greece
Evangelos N. Gazis, Eleni S. Adamidi

Douka Ekpaideftiria AE-Palladion Lykeion-Doukas School – Greece
Yannis Kotsanis, Thomas Economou

ITC Pacle Morante Limbiate – Italy
Antonella Corrado, Luigina Giovannotti

STEAME
Guidelines for Developing and Implementing STEAME Schools

Reference Number: 2019-1-CY01-KA201-058240

I01: GUIDELINES FOR DYNAMIC & ADAPTIVE STEAME CURRICULA

www.steame.eu

ISBN: 978-9963-713-38-7

Co-funded by the Erasmus+ Programme of the European Union

The STEAME project has been funded with support from the European Commission. This publication reflects the views only of the project partners, and the Commission cannot be held responsible for any use which may be made of the information contained herein.

Table of Contents

Foreword

This document, *Guidelines for dynamic and adaptive STEAME curricula*, has been developed to support European teachers' knowledge and understanding of creating successful STEAME learning activities. STEAME stands for Science, Technology, Engineering, Arts, Mathematics and Entrepreneurship. It is also meant to assist schools in developing and implementing STEAME curricula. The guidelines provide examples of how teachers gather information about scientific progress and STEAME achievements, use this information to enrich their own teaching and learning, and report this information to fellow teachers within the STEAME education community.

Introduction

STEAME education is an essential part of every pupil's curriculum. However in a traditional school curriculum all or most of subjects constituting STEAME are taught separately. This is a tradition of the school model introduced in Prussia in XIX century. However social, economic, political and cultural developments of mankind take place globally and seem to demand new approaches to eductaion. As sir Ken Robinson used to say: It is time to stop schools depriving our kids of creativity and imagination. The STEM approach to teaching, together with its variants STEAM and STEAME is viewed as one of possible answers to needs of modern society addressed to school system.

The purpose of this document is to support teachers by providing guidelines for dynamic and adaptive STEAME curriculum. The curricula themselves need to be worked out by teachers themselves.

The document contains five core chapters accompanied by an Introduction, a glosary of basic notions, which can be consulted by teachers new in the STEM area. It concludes with evaluation and statistics on projects and schools analyzed from the perspective necessary for this document. These statistics might be of independent interest, as this is, to the best of our knowledge, the first time that the data is collected and presented from this angle.

The core chapters are devoted to

- Approaches to teaching. It contains abstracts of lessons and other supporting material relevant to prepare teaching units. There are descriptions of collections of worksheets and specific descriptions of projects which can be carried out. The chapter contains also information on available creativity plans and links to relevant materials on approaches to teaching based on gamification, inquiry learning and others.
- Materials for teaching. These include videos and other audiovisual materials, descriptions and reports from field visits, suggestions for prototypes and reports from industry visits. The chapter concludes with several links to materials on infographics and further guidelines for teachers.
- Entrepreneurship aspects. This chapter might be of particular interest as it highlights materials relevant for the second E in the STEAME acronym, the entrepreneurship, which is an innovative perspective taken on in our project.
- Organizational suggestions for STEAME-oriented teaching. This chapter is of local interest to teachers but also of a large scale interest to school directors. It contains also suggestions for the flip-classroom approach.

- Propositions and analysis of STEAME-oriented curriculum. Adaptability and dynamics characteristics. It provides an overview of materials relevant for the adaptability aspects of curricula and conludes with links to the dynamics aspects of curricula with emphasize on its relations to various methodologies.

The final part of the document explains how it was created and provides statistical information on available materials (very sparse in some cases) and its relevance subject to our judgement.

How to use this document?

This document provides quick overview of materials available in the STEAME-Observatory. As the Observatory itself is supposed to be dynamic and addaptive, and growing, the document gives only a sample of material available at the moment of its creation. Each unit is clearly distinguished in the text. It is ordered by the part of Observatory it belongs to, with name being self-explaining. For example O1-Chapter1-A-Lesson-Abstract2 refers to chapter 1, i.e. Approaches to teaching, and contains suggestions for a lesson. The O1 at the front marks the relevance of the unit for the dynamic and adaptive curriculum. Many units contain a field “Grades”, which mark clearly their relevance for one of the age groups. Most of units are linked to a reference file in the Observatory. In our example it is the file O1-Chapter1-A-Lesson-Abstract2-File1.pdf. There are units containg several reference files. They are numbered by consecutive numbers at the end, e.g. O1-Chapter1-B-CreativityPlan-Abstract2-File1.jpg and O1-Chapter1-B-CreativityPlan-Abstract2-File2.pdf. In some cases there is only direct external link available. Such links are provided for most material. The advantage of the Observatory is that the material collected there is stable and will be available for years, whereas external links tend to lose their utility. In our example the external link is https://icse.eu/international-projects/masdiv/.

The STEAME Observatory is residing in the project website www.steame.eu , where you open it through a decoted banner. Then one of the Obervatory Banners/Folders is labeled as STEAME Project Outputs. In this folder you will find the subfolder with the reference files as explained above.

Basic Notions

In this part we introduce and explain basic notions and concepts used in this document. The definitions are borrowed, and modified to necessary extent, from UNESCO International Bureau of Education. We hope the reader will find this collection useful. It should also serve as explanation and recallection of various, sometimes neglected, aspects of constructing a useful and efficient curriculum.

Curriculum Guidelines

is a document or set of documents usually providing guidance for teachers and instructors on approaches and procedures for a successful planning and implementation of the curriculum at school, local or national level. Guidelines can focus on a specific learning area or subject (e.g. STEAME education curriculum guidelines), a particular educational level (e.g. curriculum guidelines for primary school education), a specific group of learners (e.g. learners with special educational needs, minorities, immigrants) or more broadly on the curriculum (e.g. curriculum, instruction and assessment guidelines). Curriculum guidelines can provide ideas, suggestions and recommendations intended to help teachers to make informed decisions, or be more prescriptive and detailed specifying the content, activities, tasks, and materials to be used by teachers.

Curriculum adaptation

is a process of adjusting the existing curriculum to meet the diverse needs of learners of all abilities and take into account recent developments in science and technology.

Curriculum change

are modifications introduced in the curriculum to improve or adapt it to new circumstances or priorities. This can be done through: minor adjustments that do not affect the curriculum structure; modernization to ensure that the curriculum remains current and relevant, reflects new developments in society and adequately prepares learners for life; innovation that brings new approaches and solutions; and large scale, system-wide reform that entirely reshapes the existing curriculum.

Curriculum development

is the process of designing the national, local or school curriculum. In order to produce a quality curriculum, this process should be planned and systematic. It should value the input of stakeholders and also cater for sustainability and long-term impact. In contemporary educational practice curriculum

development is seen as a comprehensive cycle of development, implementation, evaluation and revision to ensure that the curriculum is up-to-date and relevant. The dynamic character of the curricula suggested here guarantee its relevance, accuracy and coherence with science and technology progress.

Curriculum harmonization

is intended to harmonize curricular contents, standards, and assessment in some subject areas such as mathematics and science education, as a way to foster integration and facilitate the mobility of students and teachers across schools, teaching systems and countries. Harmonization is seen as a means of achieving an increasingly networked and interrelated group of curriculum and examination systems and improving education against common agreed benchmarks of excellence. Curriculum harmonization is a crucial issue within extra and interdisciplinary education approach.

Chapter 1
Approaches to teaching

In this project we explore the issues arising from moving towards a broad and balanced science education for all young people. This chapter contains abstracts of lessons and other supporting material relevant to prepare teaching units. There are descriptions of collections of worksheets and specific descriptions of projects which can be carried out. The chapter contains also information on available creativity plans and links to relevant materials on approaches to teaching based on gamification, inquiry learning and others.

A Lesson

O1-Chapter1-A-Lesson-Abstract1	
Title	**The Value of Art Literacy Lessons**
Content	In 2002-03 Beaverton Art Literacy began to align its lessons to help BSD meet their Curriculum Learning Targets for the Visual Arts in grades K-8. The Contents of an Art Literacy Lesson focus on the learning outcomes for the four areas of History, Criticism, Aesthetics and Production. Collaboration is essential between staff, Art Literacy coordinators, parent and community volunteers who bring this program to the students. The objectives are measurable and are tied to the vocabulary presented in the lesson. The Introduction section of the lesson is a way to engage students at the beginning of an Art Literacy presentation. It acts as a transition from any activity the students were engaged in. Notes to volunteers are scattered throughout the lesson to offer ideas and instructions on classroom management, required materials, and presentation tips. Text/books in boxes may or may not be included in a lesson. If included, they contain additional information about the artist and/or art history. When it comes to art education the saying “it’s the process, not the product”; just about says it all. Each student has different talents, skill level and interests. A student is successful in creating art if he or she meets the objectives of the production which are not based on artistic talent. For instance, did a student create a landscape using warm or cool

	colors? These are easily measured objectives. Evaluating artwork with this kind of criteria allows for all students to be successful. A big part of how Art Literacy is different from art done in the classroom is in the learning of new vocabulary, historical information, processes, materials, reasons for creating art and how we feel about it.
Grades	ALL
Reference files	O1-Chapter1-A-Lesson-Abstract1-File1.pdf
Link	https://www.beaverton.k12.or.us/departments/student-programs/art-literacy

O1-Chapter1-A-Lesson-Abstract2	
Title	**Supporting mathematics and science teachers in addressing diversity and promoting fundamental values**
Content	The European program MaSDiV - Supporting mathematics and science teachers in addressing diversity and promoting fundamental values aims to support teachers who teach STEM courses to address the diversities that exist in a classroom. For this purpose, it utilizes learning through questioning. Appropriate contexts are chosen, which on the one hand increase students' interest in the subject and on the other hand give the teacher the opportunity to discuss with his/her students topics related to the context, but which may fall into other areas of human activity, such as art, economics, fundamental values, etc. The website of the project contains many examples with lesson plans. Lessons prepared in the framework of this project can be extended to include aspects of art and/or entrepreneurship. The supplied document contains several examples of such lessons.
Reference files	O1-Chapter1-A-Lesson-Abstract2-File1.pdf
Link	https://icse.eu/international-projects/masdiv/

O1-Chapter1-A-Lesson-Abstract3	
Title	**Phi Learning**
Content	The aim of this activity is to support teachers who teach STEAME courses to provide their students with the mathematical constant phi. They measure dimensions of “natural objects” and calculate ratios of the measured values. They can relate all these measurements to the golden ratio and to the Fibonacci sequence. Moreover, they can use a robot model to draw the Fibonacci spiral as an extension to their STEAME activities.
Grades	6-8
Reference files	O1-Chapter1-A-Lesson-Abstract3-File1.pdf
Link	https://www.teachengineering.org/curriculum/browse?q=physics

O1-Chapter1-A-Lesson-Abstract4	
Title	**Problems in the real world context**
Content	The attached document tries to provide problems in real world contexts for year 7-9 students in order to support teachers who teach mathematics and wants to provide some hands-on problems to their students. The main areas address to this document are the concepts of Area and dimensions, percentages, lines of symmetry, trigonometry and statistics.
Grades	7-9
Reference files	O1-Chapter1-A-Lesson-Abstract4-File1.pdf

B Creativity Plan

O1-Chapter1-B-CreativityPlan-Abstract1	
Title	**Earth System**
Content	Students are learning how scientists use depth soundings and sonar to help "see" what is on the ocean floor. Working in teams, students select a mystery box with an ocean floor landscape hidden within. Using wooden sticks as probes, they poke through holes in the lid of the box. The students then record and map their data, using the information to create their own 3D map of the "ocean floor" out of cardstock. Maps complete, they open their boxes to compare the shape of their models to their mystery landscape.
Grades	7
Reference files	O1-Chapter1-B-CreativityPlan-Abstract1-File1.pdf O1-Chapter1-B-CreativityPlan-Abstract1-File2.pdf
Link	https://www.ucls.uchicago.edu/program/middle-school

O1-Chapter1-B-CreativityPlan-Abstract2	
Title	**Car project**
Content	The goal is: to design and build a foot-long car—basswood frame, electronic circuits, two batteries—that can move forward and in reverse and flash its headlights. In older ages, this challenge opens up new pedagogical possibilities as students have the advantage of additional math knowledge. It evolves with a unit on Newton's laws of motion. Students test basics on inclined planes, and then move into electricity and magnetism when it's time to tinker under the hood.

Grades	8
Reference files	O1-Chapter1-B-CreativityPlan-Abstract2-File1.jpg O1-Chapter1-B-CreativityPlan-Abstract2-File2.pdf
Link	https://www.ucls.uchicago.edu/program/middle-school

O1-Chapter1-B-CreativityPlan-Abstract3	
Title	**Full STEAM ahead for better education**
Content	In this Erasmus+ funded project called "Full Steam ahead for better education" there is a nice creativity plan for grades 7–9. It's called "Why make a chain reaction?". The students at the seven participating schools are challenged to build the best rube-goldberg-machine. In this arty STEM-project children's CREATIVITY is put to the test. Problems that WILL arise have to be tackled in the best possible way. Children have to think in steps: What is the problem? / How can we fix it? / We execute! / We evaluate! ... and we start this process over and over again until things work as originally planned. Children are obliged to COOPERATE within school in order to make the chain strong and they have to learn how to COMMUNICATE with each other in a crisis situation. The main goal of the project is too make children enthusiastic about technology. Each school creates a Rube Goldberg machine. The outcome of the project is a fully STEAMed European Chain Reaction - all the chains combined into one big chain reaction.
Grades	7-9
Reference files	O1-Chapter1-B-CreativityPlan-Abstract3-File1.pdf
Link	https://vimeo.com/265873302

O1-Chapter1-B-CreativityPlan-Abstract4	
Title	**BASIS.ed**
Content	The culture on which the school is based is the culture of collaboration and all the teachers want the students to learn passionately. It's not about the result, it's about the process, it's about creating critical thinkers, about developing the sense of organization. Teachers are expert in what they teach but they are also learning experts, so it's like children had two teachers all the time: the LET (learning expert teacher) and the SET (subject expert teacher). The program includes Martial Arts, Music, Drama, Engineering, Mandarin, Maths, Science. In the primary students need to explore and to be creative. There is a special class called "the All-Connections Class" that demonstrates for students how knowledge is connected by overlapping subjects, and how curiosity in one area leads to answers in another. You don't need to know the answer, but how to find the answer and you don't have to give up to get the answer even if the answer is more questions. The curiosity is the first for knowledge and it's inspiring. Students keep asking what's next.
Link	https://youtu.be/9czFhPwMpoU

O1-Chapter1-B-CreativityPlan-Abstract5	
Title	**EL-STEM Project**
Content	The Erasmus+ program EL-STEM aims at fostering an innovation "ecosystem" that will facilitate more effective and efficient user-centric design for personalised STEM learning and teaching. EL-STEM supports training and motivating secondary school teachers in addressing lack of interest concerning STEM studies/careers through outputs focused on developing innovative educational approaches and learning material to increase students' motivation in choosing STEM fields of study and/or profession.

	For this purpose, it provides an innovative Methodological Framework and related AR/MR Learning Resources that will equip teachers with a wealth of practical experiences and methods of IBSE that can help foster children's learning and motivation towards STEM. The website of the project contains suggestions on how to create lesson plan supported by augmented reality, how to share lesson plan with others, and many examples with lesson plans.
Reference files	O1-Chapter1-B-CreativityPlan-Abstract5-File1.pdf
Link	http://elstem.eu/resources/educational-material

O1-Chapter1-B-CreativityPlan-Abstract6	
Title	**Supporting mathematics and science teachers in addressing diversity and promoting fundamental values**
Content	The European program MaSDiV - Supporting mathematics and science teachers in addressing diversity and promoting fundamental values aims to support teachers who teach STEM courses to address the diversities that exist in a classroom. For this purpose, it utilizes learning through questioning. Appropriate contexts are chosen, which on the one hand increase students' interest in the subject and on the other hand give the teacher the opportunity to discuss with his/her students topics related to the context, but which may fall into other areas of human activity, such as art, economics, fundamental values, etc. The website of the project contains many examples with lesson plans. Lessons prepared in the framework of this project can be extended to include aspects of art and/or entrepreneurship. The supplied document contains several examples of such lessons
Reference files	O1-Chapter1-B-CreativityPlan-Abstract6-File1.pdf
Link	https://icse.eu/international-projects/masdiv/

O1-Chapter1-B-CreativityPlan-Abstract7	
Title	**Phi Learning**
Content	The aim of this activity is to support teachers who teach STEAME courses to provide their students with the mathematical constant phi. They measure dimensions of "natural objects" and calculate ratios of the measured values. They can relate all these measurements to the golden ratio and to the Fibonacci sequence. Moreover, they can use a robot model to draw the Fibonacci spiral as an extension to their STEAME activities.
Grades	6-8
Reference files	O1-Chapter1-B-CreativityPlan7-File1.pdf
Link	https://www.teachengineering.org/curriculum/browse?q=physics

C Work Sheets

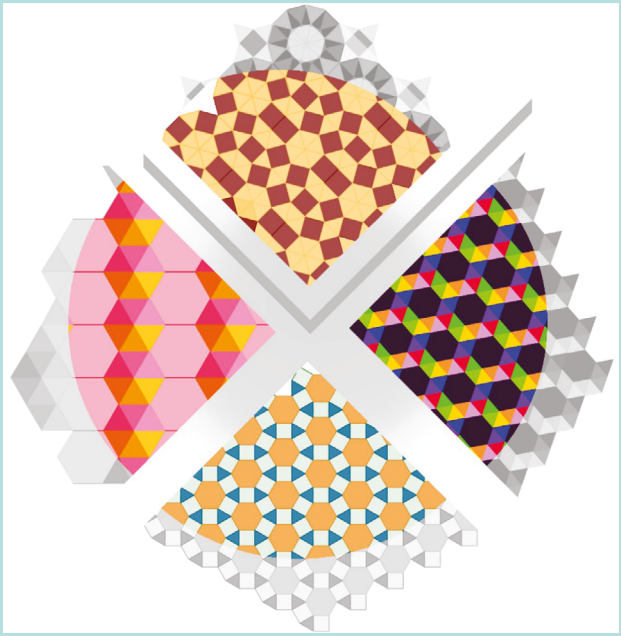
O1-Chapter1-C-WorkSheet-Abstract1	
Title	**Collection**
Content	This file contains examples of tools for out-of-school Stem activities and examples of tools for school Stem activities such as pre & post questionnaires for 10-14-year-old teens participating in stem activities, pre & post questionnaires for educators and experts participating in Stem activities, interviews for teens, for educators and a post diary for volunteers designed and used by the festival of curiosity.
Grades	ALL
Reference files	O1-Chapter1-C-WorkSheet-Abstract1-File1.pdf

O1-Chapter1-C-WorkSheet-Abstract2	
Title	**Supporting mathematics and science teachers in addressing diversity and promoting fundamental values**
Content	The European program MaSDiV - Supporting mathematics and science teachers in addressing diversity and promoting fundamental values aims to support teachers who teach STEM courses to address the diversities that exist in a classroom. For this purpose, it utilizes learning through questioning. Appropriate contexts are chosen, which on the one hand increase students' interest in the subject and on the other hand give the teacher the opportunity to discuss with his/her students topics related to the context, but which may fall into other areas of human activity, such as art, economics, fundamental values, etc. The website of the project contains many examples with lesson plans. Lessons prepared in the framework of this project can be extended to include aspects of art and/or entrepreneurship. The supplied document contains several examples of such lessons.
Reference files	O1-Chapter1-C-WorkSheet-Abstract2-File1.pdf
Link	https://icse.eu/international-projects/masdiv/

O1-Chapter1-C-WorkSheet-Abstract3	
Title	**Problems in the real world context**
Content	The attached document tries to provide problems in real world contexts for year 7-9 students in order to support teachers who teach mathematics and wants to provide some hands-on problems to their students. The main areas address to this document are the concepts of Area and dimensions, percentages, lines of symmetry, trigonometry and statistics.
Grades	7-9
Reference files	O1-Chapter1-C-WorkSheet-Abstract3-File1.pdf

D Project description

O1-Chapter1-D-ProjectDescription-Abstract1	
Title	**Math & Art in Athens**
Content	This is a Geogebra-based Project. Students and teachers of Doukas School visited museums, churches and monuments in the city of Athens. They focused on details of sculpture, table, mosaic and decorative elements and observed the paving in the building, the temple, the stained glass windows, the draft railings. They discussed about the way all the above were developed and combined by the artists and the architects; all these different patterns, shapes, surfaces and solid objects. During the implementation of the project, they recognized specific mathematical objects behind all of these structures, they explored their properties they study the way in which famous mathematicians dealt with all these objects in the past, they reproduce them using the appropriate software (GeoGebra) and they presented their results and conclusions. As the project involved students from different classes, four groups of students were formed that, respectively, dealt with: • Belt symmetries - friezes • Paving with the use of regular polygons • Paving techniques through Escher's work • Platonic solids - symmetry in space. The whole project constitutes a constant involvement of the school community, which results in the enrichment of the produced material. The presentation of any results on a Google map – type platform, promote the museums and architectural elements of Athens in a different way, revealing the 'hidden math' underneath them.
Reference files	O1-Chapter1-D-ProjectDescription-Abstract1-File1.zip
Link	https://www.geogebra.org/m/NvUk8RTC

Graphics	

O1-Chapter1-D-ProjectDescription-Abstract2	
Title	**Robotics Competition**
Content	The Bronx High School of Science IDEAS Initiative is a good example of expanded curriculum in Robotics, Engineering and Computer Science. Students work all year on mini-projects and challenges to prepare them to enter the FIRST Robotics competition, an international competition focused on solving a specific problem each year. Students develop their electrical and mechanical engineering skills while also further develop their computer programming skills. Most critically, students develop their teamwork, analytical and problem solving skills.
Reference files	O1-Chapter1-D-ProjectDescription-Abstract2-File1.pdf
Link	https://www.bxscience.edu/apps/pages/index.jsp?uREC_ID=275111&type=d

O1-Chapter1-D-ProjectDescription-Abstract3	
Title	**Full STEAM ahead for better education**
Content	To many students STEM education can be theoretical and difficult to approach. This project approaches STEM education not in a theoretical way, but in a new one: instead of teaching each subject as such, it emphasizes methods and ways of teaching that students already have a positive and pleasurable relationship to. In this project schools develop new strategies and a new methodology combining maths and science with e.g. drama, art and physical activities and create synergies between different fields of education adapting the STEM learning to what the students are really interested in. In order to obtain this teachers need to be empowered, to think new thoughts, to think out of the books and out of the box. In turn this will benefit students. During the project new material is to be developed for all to use, but equally important is the methodology behind. That's why we use a new definition of the STEAM acronym in this work: S - search, T- think, E - experience, A - active learning and M -motivation. The teachers will learn to work using this strategy / methodology which is also in line with the "21st century skills" - critical thinking, creative thinking, collaboration and communication.
Grades	7-9
Reference files	O1-Chapter1-D-ProjectDescription-Abstract3-File1.pdf
Link	https://twinspace.etwinning.net/23298/home

O1-Chapter1-D-ProjectDescription-Abstract4	
Title	**Harker School**
Content	At Harker, we believe a solid foundation in science, technology, engineering and math (STEM) opens doors for all students to find success in college and in their future careers. Our STEM program is hands-on, collaborative and

	project-based, giving our students the experience of solving real-world problems in the classroom. All of our STEM classes take place in our science and technology center, Nichols Hall, a state-of-the art, LEED-certified facility with leading-edge technology like our interactive virtual cadaver dissection table and 30-foot Foucault pendulum.
Grades	10-12
Reference files	O1-Chapter1-D-ProjectDescription-Abstract4-File1.pdf
Link	https://www.teachengineering.org/curriculum/browse?q=physics

E Inquiry Based Learning Activities

O1-Chapter1-E-InquiryBasedLearningActivities-Abstract1	
Title	**Lakeside School**
Content	Inquiry based learning activities could be: • Debate: students in this class will learn to present hot-button issues in a concise, clear, persuasive way through mock debates. They will learn how to organize ideas, write speeches, and present a line of reasoning. Have fun getting into friendly yet lively arguments about real-life issues! • DNA to Disease: Where do diseases come from? How do they spread? Get ready to dive into the mysteries of biology and explore some big questions, be prepared to investigate biology in a completely hands-on and interactive way. • Thinking like a Mathematician: thinking like a Mathematician revisits elementary mathematical ideas through a new lens, not as formulas to remember but as naturally occurring truths which are all around us in

	the world. This inquiry-based course will explore puzzling pictures, perplexing patterns, and powerful propositions.
Grades	7-9
Reference files	O1-Chapter1- E-InquiryBasedLearningActivities-Abstract1-File1.pdf
Links	http://lakesideschool.org/

O1-Chapter1-E-InquiryBasedLearningActivities-Abstract2	
Title	**Introduction to Psychology**
Content	What does it mean to think like a psychologist? With this question, students explore three central psychological perspectives -- the behavioural, the cognitive, and the sociocultural -- in order to develop a multi-faceted understanding of what thinking like a psychologist encompasses. The additional question of "How do psychologists put what they know into practice?" informs study of the research methods in psychology, the ethics surrounding them, and the application of those methods to practice. Throughout the course, students collaborate on a variety of activities and assessments, which often enable learning about each other's unique perspectives while building their research and critical thinking skills in service of understanding the complex field of psychology.
Grades	10-12
Reference files	O1-Chapter1- E-InquiryBasedLearningActivities-Abstract2-File1.pdf
Links	www.blakeschool.org

O1-Chapter1-E-InquiryBasedLearningActivities-Abstract3	
Title	**CATE's School**
Content	Traditionally, a teacher delivers a lesson to explain concepts or demonstrate skills and then assigns problems so students can practice or apply the objectives of that lesson. In Cate's PBL math courses, students explore on their own before discussing an explanation in class the next day. The teacher facilitates group discussion by highlighting important misconceptions, important realizations, and by prompting students to generalize from their solutions. In this way students "discover" mathematical systems through problems rather than being told via lecture. This helps in building a **problem-based learning (PBL)** curriculum and can consist also an example of a **flip-classroom** approach that is mentioned in Chapter 4 as an organizational approach for STEAM schools.
Reference files	O1-Chapter1-E-InquiryBasedLearningActivities-Abstract3-File1.pdf

O1-Chapter1-E-InquiryBasedLearningActivities-Abstract4	
Title	**The Case of Cate**
Content	Founded in 1910, Cate is a four-year, coeducational college preparatory boarding school in Southern California, USA. In this school we can find good examples of inquiry-based learning activities in science. The science program cultivates scientific inquiry skills for all students through a Physics First program that uniquely scaffolds scientific practices through the core courses, Physics, Chemistry, and Biology. Proficient in the methods of science, seniors further develop and apply these skills in advanced, college-level courses (advanced electives). The science teachers design and guide inquiry-based learning experiences that are active and aimed at exercising scientific thinking and practices. Students are expected to tap into their natural curiosity, ask questions, develop models, and find evidence to support their claims (see **Science and Engineering Practices (SEPS)**). Collaboratively, they carry out

	investigations, analyze data, communicate findings, and argue from evidence using Argument-Driven-Inquiry (ADI labs) — developing these skills through depth of study is prioritized over breadth of subject matter. Science teachers recognize the importance of interdisciplinary thinking and acknowledge other ways of knowing and pursuing questions.
Reference files	O1-Chapter1-E-InquiryBasedLearningActivities-Abstract4-File1.pdf
Links	https://www.cate.org/inquiry-in-science/#1553530330005-59320938-820c

F Gamification

O1-Chapter1-F-Gamification-Abstract1	
Title	**Apps design**
Content	IOS App Design: Learn how to design and build apps for the iPhone and iPad and prepare to publish them in the App Store. Students will work much like a small start-up: collaborating as a team, sharing designs, and learning to communicate with each other throughout the course. Students will learn the valuable skills of creativity, collaboration, and communication as they create something amazing, challenging, and worthwhile. Additional courses are Medical Problem Solving I and II. In these courses students will solve medical mystery cases, similar to the approach used in many medical schools. Additional learning experiences will include studying current issues in health and medicine, building a community-service action plan, interviewing a patient, and creating a new mystery case.
Grades	10-12
Reference files	O1-Chapter1-F-Gamification-Abstract1-File1.pdf
Links	http://www.blakeschool.org

O1-Chapter1-F-Gamification-Abstract2	
Title	**Geometry and cryptography**
Content	The aim of this game is to test knowledge of students in STEM while encouraging them to learn by working together. The class is divided into four groups and all groups have to cooperate to complete a level before moving to a higher, more difficult one. The objective of each group is to build a Platonic solid. On each solid part of an enigma is displayed. The class has to solve the enigma together, to answer questions on various subjects, to complete experiments or to pass memory tests. The role of the teacher is to encourage participation in a fun, informal yet content-rich experience. The main strategy is to design a tool to directly impact students' self-efficacy and a flowchart to indirectly impact students through their educators.
Grades	7-9
Reference files	O1-Chapter1-F-Gamification-Abstract2-File1.pdf

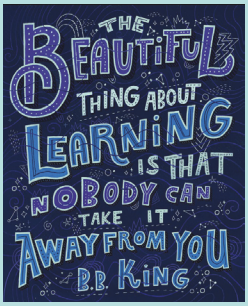
O1-Chapter1-F-Gamification-Abstract3	
Title	**Robo-Wonderers**
Content	Robo-Wonderers is a project that implemented the action STEM by the Greek National Support Service of eTwinning. The project introduces Educational Robotics with the learning of physics, technology, mathematics and engineering (STEM) in practice, without theories and unnecessary terminology, via analysis and problem-solving methods. At the same time, it is possible to develop skills of ingenuity, algorithmic and programming models and team spirit demonstration. Robo-Wonderers consists an interesting example of gamification approach for STEAM educational learning that could be adopted directly in schools.

Grades	10-12
Reference files	O1-Chapter1-F-Gamification-Abstract3-File1.pdf
Links	https://prezi.com/p/qz8bgmfhqqa2/robo-wonderers/

G Other

O1-Chapter1-G-Other-Abstract1	
Title	**Learning Camp**
Content	Investigative Learning Camp afternoon activities include: • Field Sports such as dodge ball, kick ball, soccer, and capture-the-flag. They focus on fun and teamwork, with a different game every day. • International Cooking: chef demonstrations and hands-on cooking to learn a variety of cooking skills, cooking methods and recipes from all over the world. The cooking boot camp will culminate in a friendly group "top chef" competition on the final day of the journey! • Makerspace: you use building materials such as craft sticks, corks, cardboard, dowels, hot glue and duct tape to engineer structures for friendly competitions. Projects may include designing a dream bedroom, building a dancing robot, or personalizing a stuffed animal. • Musical Theatre: students work on healthy singing technique, as well as basic acting and staging. • Textile Art • Yoga: to learn basic yoga poses, improving balance and flexibility, and practicing mindfulness in this fun-filled afternoon activity!
Grades	7-9
Reference files	O1-Chapter1-G-Other-Abstract1-File1.pdf

O1-Chapter1-G-Other-Abstract2	
Title	**BASIS Charter Schools**
Content	**BASIS Diploma** The BASIS Diploma prepares students to fully participate in the exciting and unpredictable world of the 21st century. Students who earn this mark of distinction possess the best possible foundation as independent and resourceful problem solvers. The BASIS Diploma provides graduates with a plethora of college and career choices. The job of BASIS Charter Schools is to fully prepare them to succeed. **Awards and Recognition** BASIS Charter Schools consistently rank among the very top schools in the country. Check out our history of academic excellence and yearly rankings from U.S. News & World Report and recognition from The Washington Post that demonstrate why BASIS Oro Valley is one of America's best and most challenging high schools.
Grades	10-12
Reference files	O1-Chapter1-G-Other-Abstract2-File1.pdf
Links	https://www.basised.com/academics/the-basis-diploma/ https://www.basised.com/oro-valley/academics/awards-and-recognition/

O1-Chapter1-G-Other-Abstract3	
Title	**Teaching Tolerance**
Content	Provides free resources to educators - teachers, administrators, counselors and other practitioners - who work with children from kindergarten through high school. Educators use our materials to supplement the curriculum, to inform their practices, and to create civil and inclusive school communities where children are respected, valued and welcome participants. All these help a community of more than 500,000 educators and bring relevance, rigor and social emotional learning into their schools. A learning plan is mainly a combination of objectives, essential questions, lessons, texts, teaching strategies, student tasks, external links and other resources, etc., including ready menus of grade level, subjects, topics, social justice domain. There are more than ready-to-use 500 classroom lessons, 580 short texts, 50 student tasks and 70 teaching strategies. Also resources include film kits, nice printable posters and the “mix it up!”, a simple call to action for students or events hosted by schools on any day of the year. There are not many ready-to-use STEAM learning plans in the existing 3.000+ but the functionality of a customized learning plan from ready-to-use or new building blocks is easy, friendly, and effective.
Reference files	O1-Chapter1-G-Other-Abstract3-File1.png
Links	https://www.tolerance.org/classroom-resources https://www.tolerance.org/learning-plan/eqstream-equity-in-sci-tech-eng-art-math-for-representation
Graphics	

Chapter 2
Materials for teaching

As more aspects of daily life are tied to technology, the need to improve and expand STEM education across the curriculum gets more pressing. Exposing students to STEM experiences at a young age encourages critical thinking skills, increases science literacy, and fosters creative problem solving. More and more public and private organizations recognize that STEM educators play a key role in increasing the number of students pursuing STEM careers. The number of resources available to support STEM education grows rapidly. Their quality differs. This chapter introduces the STEAME collection of quality checked materials including videos and other audiovisual materials, descriptions and reports from field visits, suggestions for prototypes and reports from industry visits. The chapter concludes with several links to materials on infographics and further guidelines for teachers.

A Videos

O1-Chapter2-A-Videos-Abstract1	
Title	**PowToon Video about Marie Curie**
Content	This is a very well made **video about the life of scientist Marie Curie**, created by the Poland team in the project "Raising Steam in Education"/Cyprus March 2018 meeting. It resembles how **students may use their creativity** to create a high-quality biography of a famous person, featured in the school curriculum. PowToon or similar sites may be **incorporated in a presentation/project assignment** where students focus on visualization of concepts.
Grades	10-12
Reference files	O1-Chapter2-A-Videos-Abstract1-File1.mp4
Link	https://www.youtube.com/watch?time_continue=129&v=W8ejA-I1V_U&feature=emb_logo

O1-Chapter2-A-Videos-Abstract2	
Title	**Students create their own camera**
Content	This video shows **all stages of students creating a basic camera**. The students are from the Greek team in the project "Raising Steam in Education"/Cyprus March 2018 meeting. It resembles how **students learn by creating** their own product with the help of a teacher/tutor. This is a good example of how students can **not only create something** within a given subject but **also present each stage of their work**, using a slideshow video.
Grades	10-12
Reference files	O1-Chapter2-A-Videos-Abstract2-File1.mp4
Link	https://www.youtube.com/watch?time_continue=80&v=mb21tNfPQbQ&feature=emb_logo

B Field visits

O1-Chapter2-B-Field visits-Abstract1	
Title	**Travel and exchange programs**
Content	Strake Jesuit Preparatory Travel program develops along exchange programmes , cultural immersion and Mission trips. The aim is for students to combine college preparation with cultural and intellectual growth by travelling to other countries in a group of their peers and learn about different cultures. In Mission trips students serve many capacities assisting in programs; from education and rebuilding efforts to community programs for sustainability, working with and for impoverished populations, thereby developing their solidarity and citizenship skills.
Reference files	O1-Chapter2-B-Field visits-Abstract1-File1.pdf

O1-Chapter2-B-Field visits-Abstract2	
Title	**“Nature Science 5th grade“**
Content	The Erasmus+ project STEAM4U field visit named “Nature Science 5th grade- exploring water by the lake” involved teachers and children participant to the project. The activity implied the collection of water samples and the study of the samples at school with the assistance of local experts. The link and documents attached contain visual material of the visit and a lesson plan of the activity.
Reference files	O1-Chapter2-B-Field visits-Abstract2-File1.pdf
Link	https://docs.google.com/presentation/d/1swUwZfpOCJbOUgiO2lbBk3yLmy-N08oXr24SJtBS1JE/present?slide=id.g1b96fa40b4_0_0

O1-Chapter2-B-Field visits-Abstract3	
Title	**A visit to Warsaw Old town (gamification)**
Content	This is a **set of guiding questions** meant to **engage students as they explore** the Old Town of Warsaw. This activity has taken place as part of the project “Raising Steam in Education”/Poland October 2017 meeting. It is a good example because students **interpret the field visit as a game and compete** with their peers. It can be **applied to any subject (city locations, museums, parks etc.)** and any age group (guiding questions may need to be adjusted etc.)
Grade	7-9 and 10-12
Reference files	O1-Chapter2-B-Field visits-Abstract3-File1.pdf
Link	http://steam-erasmus.eu/wp-content/uploads/2019/09/The-Old-Town-and-the-Royal-Tract.pdf

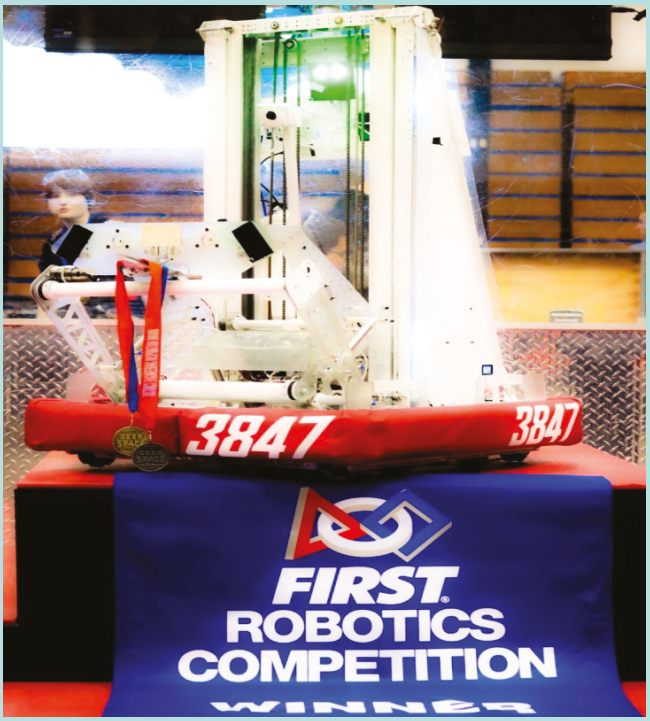
O1-Chapter2-B-Field visits-Abstract4	
Title	**Visits to two separate green areas/"green engineering"**
Content	This is a **description** of two separate **field visits** (one to Peccei Park and one to Environmental Park in Turin, Italy) as part of the project "Raising Steam in Education"/Italy October 2018 meeting. Peccei Park is a good example of how previous industrial areas have been **requalified as green areas** with playgrounds, relaxation areas and solar panels while the Environmental Park shows students a **successful implementation of eco-buildings**. It can be **used in connection with the sciences - ecology**, respecting nature and harnessing "green energy" in general.
Reference files	O1-Chapter2-B-Field visits-Abstract4-File1.pdf
Link	http://steam-erasmus.eu/?page_id=358 (under "Wednesday, October 17th Morning activities")

O1-Chapter2-B-Field visits-Abstract5	
Title	**Boston Leadership Institute**
Content	The **Boston Leadership Institute**, one of the top-named providers of STEM programs for high-achieving teens (7th grade and above), is a very good place to begin form the future in STEM entrepreneurship. We believe that one of the best practices that this Institute implements towards STEM entrepreneurship is the field trips. Students have the opportunity to get a first-hand look at some of the tech and biotech companies that were launched in the greater Boston area on field trips and may visit start-up company incubators in Boston and Cambridge. In the past, students have gone on field trips to tour Harvard University, MIT, Babson College, the Artisan's Asylum and the Cambridge Innovation Center. After all, inspiration and mentoring in forming an entrepreneurial spirit are key aspects.

Reference files	O1-Chapter2-B-Field visits-Abstract5-File1.pdf
Link	https://www.bostonleadershipinstitute.com/
Graphics	Some memories of field visits are shown below:  

C Prototypes

O1-Chapter2-C-Prototypes-Abstract1	
Title	**STEM EVENTS**
Content	Examples of engineering prototypes invented and built by STEM students of Strake Jesuit College Preparatory together with St.Annes Academy in Houston, a robotics team called Spectrum 3847 are shown below. "Spectrum 3847 is a year round program which puts on engineering STEM events for young students who can put their technical knowledge into practice. The hosting of multiple STEM events and the participation to prestigiuos Engineering Awards and tournaments helps promote STEM education and obtain recognition for Inspiration and inventiveness.
Reference files	O1-Chapter2-C-Prototypes-Abstract1-File1.pdf
Links	http://spectrum3847.org/
Graphics	

O1-Chapter2-C-Prototypes-Abstract2	
Title	**GSSM Elementary STEAM Bus**
Content	The South Carolina Governor's School for Science & Mathematics (GSSM) is a high school for academically motivated juniors and seniors pursuing studies in science, technology, engineering and math, one of only 16 specialized, residential high schools in the nation. The GSSM Elementary STEAM bus launched in Hartsville and Darlington County travels the state, bringing hands-on, standards-based activities to elementary schools across South Carolina. The inside of the bus has been transformed into a modular science lab, complete with computers, a Lego wall, a 3-D printer, and a YUMI robot. Elementary students will be able to explore and participate in hands-on activities related to science, technology, engineering, art, and mathematics, upholding the learning of the state's science standards. Students will have the opportunity to partake in a variety of projects related to things such as engineering, chemistry, and electronics.
Reference files	O1-Chapter2-C-Prototypes-Abstract2-File1.pdf

Link	https://www.scgssm.org/news-article/gssm-announces-launch-elementary-steam-bus
Graphics	

O1-Chapter2-C-Prototypes-Abstract3	
Title	**Workshop in robotics: Constructing Robot RALLY**
Content	This activity incorporates **predicting/planning, constructing and comparing RALLY lego kit robots with peers**. Students follow a **set of instructions** while learning about robot definitions, applications, assembly, brainstorming and analyzing results. It also involves **practical modifications**, also in relation to concepts like velocity and torque (mathematics/physics). The activity **finishes off with a RALLY race**. The activity was part of the project "Raising Steam in Education"/Greece February 2019 meetingIt is a good example of an **engineering/robotics guided prototype activity** and how **terms from other subjects** can be incorporated/better understood.
Reference files	O1-Chapter2-C-Prototypes-Abstract3-File1.pdf
Link	http://steam-erasmus.eu/?page_id=427

O1-Chapter2-C-Prototypes-Abstract4	
Title	**Chemistry and Art and Art in Chemistry**
Content	This activity involves **scientific experimentation, following a set of specific questions**. The goal is to use chemicals and their interaction in order to **achieve a goal. Example questions include** "Is it possible to prepare artificial blood using inorganic compounds?", "Is it possible to create ink for painting a picture using iron(III) chloride and salycilic acid?" This activity took place as part of the project "Raising Steam in Education"/Poland October 2017 meeting. This is a good example of **formulating engaging questions/goals in a lab setup**.
Reference files	O1-Chapter2-C-Prototypes-Abstract4-File1.pdf
Link	http://steam-erasmus.eu/wp-content/uploads/2018/09/Chemistry_Warsaw.pdf

D Audiovisual material

O1-Chapter2-D-Audiovisual material-Abstract1	
Title	**Educational Television**
Content	Strake Jesuit Educational Television, SJET, is a communications network, including internet-based video, closed circuit television, and live streaming of events. It comprises extracurricular and curricular activities to learn many aspects of digital media creation, television production and video technologies. SJET's production studio is equipped for special effects and computer editing and it provides television multiple channels for the classrooms. SJET reporters and announcers and the technical crew work daily to broadcast the school Morning Show with daily announcements about school events, editorials, interviews via classroom projector or digital streaming media. SJET is a student organization that produce and edit projects

	for other classes and for the entire school community. Students may enter SJET by enrolling to related classes.
Reference files	O1-Chapter2-D-Audiovisual material-Abstract1-File1.pdf
Links	https://www.strakejesuit.org/student-life/sjet

O1-Chapter2-D-Audiovisual material-Abstract2	
Title	**"How to survive in Warsaw" - a guide for students by students**
Content	This video is a **guide - made by students, for students** visiting their hometown. It gives **valuable advice** to peers regarding orientation, transportation, communication, discounts, apps, weather, hotspots etc. This video was created as part of the project "Raising Steam in Education"/Poland October 2017 meeting. It is a good **example of hospitality** and **initiative** by students to **help others/share their knowledge**. It is a very useful idea for the hosts **when peers from other cities/countries are visiting their school**.
Grades	7-9 and 10-12
Reference files	O1-Chapter2-D-Audiovisual material-Abstract2-File1.mp4
Links	https://www.youtube.com/watch?time_continue=270&v=ab0xav9JTr0&feature=emb_logo

O1-Chapter2-D-Audiovisual material-Abstract3	
Title	**"Maths bring water to Samos"**
Content	This video, created by Greek students, shows **how mathematics was used in ancient times** to **create an aqueduct to Samos (Greece)**. Students combined pictures, slideshow and video in order to create a final product. They also made

	a **connection to the Pythagorean theorem** (mathematics). This was created as part of the project "Raising Steam in Education"/Cyprus March 2018 meeting. It is a good example of students **creating a compiled video** and thereby **presenting applications of an idea** from one of their school subjects. Note that this video does not include sound but it combines visual imagery in various forms.
Grades	7-9 and 10-12
Reference files	O1-Chapter2-D-Audiovisual material-Abstract3-File1.mp4
Links	https://www.youtube.com/watch?time_continue=1&v=1quqx3tS7X0&feature=emb_logo

O1-Chapter2-D-Audiovisual material-Abstract4	
Title	**Dr. Dragon**
Content	HSMSE Dr. Dragon is a school's student produced a bi-annual magazine that focuses on math, science, engineering and architecture. The mission of this magazine is to give HSMSE students the opportunity to take the school's core subjects and explore subtopics that particularly interest them, on any topic related to the STEM field. Students on the magazine staff research and write about subjects of their choice. They are also involved with the whole production of the magazine, and learn about everything from design and magazine digital preparation to fundraising and budgeting. An indicative example of this entirely student production is the attached 15th issue "The Influence of SCI FI" and the two interesting articles: STEM Heroes! and The Spageti Problem.
Grades	7-12
Reference files	O1-Chapter2-D-Audiovisual material-Abstract4-File1.pdf
Links	https://hsmsedrdragon.wixsite.com/website/about

E Industry visits

O1-Chapter2-E-Industry visits-Abstract1	
Title	**BASIS Project**
Content	The BASIS Diploma Senior Project (Basis Oro Valley School) is the culmination of the School Curriculum before students earn the BASIS Diploma with High Honors. The program is a selective program consisting of high-level off-campus research chosen and designed by grade 12 students. Students select a school faculty member as their advisor and work with a mentor at a research site. These projects may be completed anywhere in the world. At the end of the trimester, students return to campus and present an analysis of their findings to peers, staff, and parents. The program also relate to activities included in schools' entrepreneurship guidance.
Reference files	O1-Chapter2-E-Industry visits-Abstract1-File1.pdf
Links	https://www.basised.com/oro-valley/academics/senior-projects/

O1-Chapter2-E-Industry visits-Abstract2	
Title	**Excursion to University; Research groups**
Content	Students have **visited three departments in the Faculty of Science**, Pavol Jozef Šafarik University in Košice (Slovakia), exploring the work done by **modern research teams. Examples** include natural medicinal sources with anti-viral and anti-cancer activity, carcinogenesis (**Biology/Ecology**), degradable biomaterials and modern technologies for miniaturization and automation of analytical measurements (**Chemistry**), 3D geospatial modelling of natural phenomena, renewable energy resources and population dynamics (**Geography**). This activity took place as part of the project "Raising Steam in Education"/Slovakia April 2019 meeting. This is a good example of **how**

	scientific research is performed and what kinds of **modern research fields** exist. It is worth noting that large industries may perform their own research or work together with the universities. Such visits are **motivational** for students and can be incorporated as activities in most school subjects, including science/engineering/entrepreneurship.
Grades	7-9 and 10-12
Reference files	O1-Chapter2-E-Industry visits-Abstract2-File1.pdf
Links	http://steam-erasmus.eu/wp-content/uploads/2019/09/Excursion-to-university.docx

O1-Chapter2-E-Industry visits-Abstract3	
Title	**Visit to University; Workshop and Prototype**
Content	Students **have attended a robotics workshop** at University of Macedonia, Thessaloniki (Robotics Academy). The Academy is both nationally and internationally known, with many awards and distinctions. The activity was part of the project "Raising Steam in Education"/Greece February 2019 meeting. It is a good example of how students can **visit a university** and **learn about research by creating something themselves**.
Grades	10-12
Reference files	O1-Chapter2-E-Industry visits-Abstract3-File1.mp4
Links	https://www.youtube.com/watch?time_continue=155&v=9vtT-jDvPX4&feature=emb_logo http://steam-erasmus.eu/?page_id=427

F Infographics

O1-Chapter2-F-Infographics-Abstract1	
Title	**Infographics**
Content	All schools employ infographics to convey a visual representation of information for quick and easy reading. Similar representations are adopted for dissemination purposes in project management. Infographics deal with "qualitative" or soft subjects. Useful examples of such uses are projects e-magazines, online school magazines or billboards for news and announcements, as shown in the content material below.
Reference files	O1-Chapter2-F-Infographics-Abstract1-File1.pdf
Links	https://sites.google.com/ikrs.no/full-steam-ahead/norway/coding-robotics?authuser=0 http://www.basisschools.org/downloads/outcomes-brochure.pdf?__hstc=146244011.52cfa32990829d1aaafb8b1612572114.1576060983286.1576060983286.1576060983286.1&__hssc=146244011.15.1576060983287&__hsfp=797674445 https://www.lakesideschool.org/about-us/news-and-announcements

O1-Chapter2-F-Infographics-Abstract2	
Title	**CollectEdNY Collection of Infographics**
Content	Collection of infographics used by NYS teacher leaders with their students, that has been developed by CUNY Adult Literacy and HSE leadership development Program. This educational material is included at the CollectEdNY resources for New York State educators, according to the CUNY HSE Curriculum Framework in Math, Science and Social Studies (integrated with reading and writing), CUNY HSE Curriculum Framework available for free.

Reference files	O1-Chapter2-F-Infographics-Abstract2-File1.pdf O1-Chapter2-F-Infographics-Abstract2-File2.pdf O1-Chapter2-F-Infographics-Abstract2-File3.pdf O1-Chapter2-F-Infographics-Abstract2-File4.pdf O1-Chapter2-F-Infographics-Abstract2-File5.pdf O1-Chapter2-F-Infographics-Abstract2-File6.pdf O1-Chapter2-F-Infographics-Abstract2-File7.pdf O1-Chapter2-F-Infographics-Abstract2-File8.pdf
Links	https://www.collectedny.org/frameworkposts/collection-of-infographics http://www.collectedny.org/2016/03/hseframework

O1-Chapter2-F-Infographics-Abstract3	
Title	**What is Art? What is Science? - summary of international student meeting**
Content	This video was created by the Polish team as a **summary of the collaboration** between students from five countries. It is essentially a compact **Prezi slideshow**, illuminating the main topics, features and activities of the project. It was created as part of the project "Raising Steam in Education"/Poland October 2017 meeting. It is a good example of how **Prezi can be used to create short visuals/infographics**. It is a great way to quickly summarize a number of activities and **highlight important aspects** of an international project.
Grades	7-9 and 10-12
Reference files	O1-Chapter2-F-Infographics-Abstract3-File1.pdf
Links	https://prezi.com/fuyib1tumzml/warsaw-16-20-october-2017/?utm_campaign=share&utm_medium=copy https://prezi.com/

O1-Chapter2-F-Infographics-Abstract4	
Title	**Norman Leto - a presentation/infographic about an artist**
Content	This slideshow/infographic **concisely covers** the life and work of Polish artist Norman Leto. It covers **many aspects in sufficient detail and great scope**. This presentation has been created as part of the project "Raising Steam in Education"/Cyprus March 2018 meeting. It is another very good example of **what can be done with Prezi**. It may be used by students to create a **good combination of text and visuals** for any purpose/project and in any subject.
Grades	10-12
Reference files	O1-Chapter2-F-Infographics-Abstract4-File1.pdf
Links	https://prezi.com/p/6eaqvjju_hgr/norman-leto/

G Guidelines for teachers

O1-Chapter2-G-Guidelines for teachers-Abstract1	
Title	**STEAM4U**
Content	The knowledge and competences required of a STEM teacher reflect the purpose of a STEM-oriented curriculum: accelerate traditional curriculum to allow students to take more STEM related courses, research and intership in fields of interests, promote enquiry style teaching, provide opportunities in and out of the classroom, develop literacy in STEM disciplines and promote a learning community which extends beyond the school (Dutch Fork School). Teachers are required to be skilled in their field, and possess communication, organizational and leadership skills, and have a strong proficiency in technology. (**Strake Jesuit** Preparatory). **The New York City Department of Education** sets down guidelines for career development for model teachers

	and peer collaborative teachers. The **STEAM4U project** provides workshop material to help teachers assess the needs and aspirations of STEM students by empathising with them and 'putting themselves in their shoes.'
Reference files	O1-Chapter2-G-Guidelines for teachers-Abstract1-File1.pdf
Links	https://www.schools.nyc.gov/careers/teachers/career-development-for-teachers

O1-Chapter2-G-Guidelines for teachers-Abstract2	
Title	**Hypatia Project & Toolkit**
Content	Hypatia is an EU Horizon 2020 funded project that aims to develop a theoretical framework on gender inclusive STEM education and to produce, test and promote a toolkit with practical solutions and modules for schools, businesses, and science centers and museums across Europe. The current toolkit is a ready-to-use digital collection of 19 activities aimed at teenagers to be used by teachers, informal learning organisations, researchers and industry. The modules focus on gender-inclusive ways of educating and communicating STEM, empowers teenagers and explores the range of skills that are needed for a great variety of STEM studies and careers open to young people. Each module is composed of guidelines specific for each activity, guidelines dedicated to the theme of gender inclusion and guidance for facilitators on how to on how to manage the group dynamics by implementing different facilitation strategies.
Reference files	O1-Chapter2-G-Guidelines for teachers-Abstract2-File1.pdf
Links	http://www.expecteverything.eu/hypatia

O1-Chapter2-G-Guidelines for teachers-Abstract3	
Title	**Loving Vincent and lesson plans**
Content	This is an **article** about the world's first painted feature film (Loving Vincent) and it also includes useful art links. In relation to **watching the movie with students**, the author has brought up **either preparatory or follow-up activities** which **include** practicing grammatical constructions such as Present Continuous Tense, Past Tenses and modal verbs, writing a critical analysis, preparing listening comprehension activities, practicing asking questions and a few other guidelines. The lesson plan ideas have been prepared as part of the project "Raising Steam in Education"/ Poland October 2017 meeting. The guideline is a **good example of how various activities can be formed** around a **single movie**. It also includes specific ideas for any language subject in school.
Grades	7-9 and 10-12
Reference files	O1-Chapter2-G-Guidelines for teachers-Abstract3-File1.pdf
Links	http://steam-erasmus.eu/wp-content/uploads/2018/09/Article-about-Loving-Vincent-and-lesson-plans.pdf

O1-Chapter2-G-Guidelines for teachers-Abstract4	
Title	**Mosaic Math**
Content	This is a **guideline to *Mosaic Math* -** an activity based around the use of mosaics by ancient Roman culture, **discovering mathematical symmetry** in mosaics as well as **student design of their own mosaic shapes**. It **includes** a materials list, background information, word bank, teacher guidelines related to tutoring students on how to do research, identify patterns and create their own mosaic. It also includes notes on assessment and reflection on the new knowledge. This project guideline was created as part of the project "Raising

	Steam in Education"/ Cyprus March 2018 meeting. It is a **good example of a well-rounded** teacher guideline that encompasses a specific student project. It also appears to **relate three subjects -** history, art and mathematics (patterns).
Grades	10-12
Reference files	O1-Chapter2-G-Guidelines for teachers-Abstract4-File1.pdf
Links	http://steam-erasmus.eu/wp-content/uploads/2019/07/Mosaic-Math.pdf

O1-Chapter2-G-Guidelines for teachers-Abstract5	
Title	**Basis.ed**
Content	According to the BASISed. academic program, teachers focus on being creative and are not concerned about results so much as about the process and the development of critical thinkers by stimulating curiosity, enquiry and exploration and a sense of organization in children. Teachers must be learning experts (LET) as well as subject experts. In this way children have two teachers at the same time. At primary level their main interest is to expand children's options and opportunities, to allow them to explore and being creative. The program offers a variety of subjects like Martial arts, music, drama, engineering alongside core subjects for a well rounded curriculum. A key experiment is the Connection Class, a class which shows how knowledge is connected by overlapping subjects and how curiosity in one area leads to answers in another. This methodology teaches children that learning is for life. That is why the program may be referred to as providing guidelines for teachers.
Reference files	O1-Chapter2-G-Guidelines for teachers-Abstract5-File1.pdf
Links	https://www.basised.com/ https://youtu.be/9czFhPwMpoU

O1-Chapter2-G-Guidelines for teachers-Abstract6	
Title	**STEAM4U**
Content	The UniXMaths workshop carried out inside the ERASMUS + project STEAM4U is an example of how learning can be acquired through motivation-oriented activites and task-based methodology. The workshop shows that the commonly assumed concept among children of Maths being uninteresting and useless can be proved wrong by engaging children on 'hands-on 'activities through Math games and challenges. Children change they perspective because they have a sense of accomplishment and success; they learn more and more easily, they feel better because they feel capable. They learn that Maths can be useful to solve real everyday problems. Another essential learning value of this methodological approach is peer collaboration and differentiation teaching strategies.
Reference files	O1-Chapter2-G-Guidelines for teachers-Abstract6-File1.pdf
Links	https://www.youtube.com/watch?v=Qct5bRA6R4M&feature=emb_logo

Chapter 3
Entrepreneurship aspects

Entrepreneurship is the development of a solution and the establishment of a corresponding business to fill a void or solve a problem. Entrepreneurship is taking the creativity and inspiration involved in being an innovator and sharing the solution with the public. Entrepreneurship is a driving force in our world. Career paths in science, technology, engineering, and mathematics disciplines are increasingly entrepreneurial. It is likely that the engineering and science students of today are preparing for jobs that do not currently exist. Having a firm grounding in entrepreneurship with an emphasis on innovation and invention may be the best way for science students to prepare for the 21st century workforce. This chapter provides access to materials relevant for the Entrepreneurship part of the STEAME education.

O1-Chapter3-Entrepreneurship aspects-Abstract1	
Title	**Marlborough School**
Content	It is the oldest independent girls' school in Southern California. It is a very good example of STEAME curriculum for Middle School (Grades 7, 8, and 9) and Upper School (Grades 10, 11, and 12). The school has Entrepreneurship and Innovation Center focused in five interdisciplinary areas: Entrepreneurship, Media, Robotics, Research, and Computer Science. It is organized as an incubator for ideas where students work together with teachers on projects across the above disciplines and programs. Full description is saved in the file “Entrepreneurship at Marlborough school”. It can be used for STEAME curriculum development and STEAME organizational structure with the specially designed Center for Entrepreneurship and Innovation. Details about the course of study are saved in the file “Course of Study at Marlborough school”. There are good examples of how to develop STEAME cross-disciplinary projects and other activities for creativity plans
Reference files	O1-Chapter3-Entrepreneurship aspects-Abstract1-File1.pdf O1-Chapter3-Entrepreneurship aspects-Abstract1-File2.pdf
Link	https://www.marlborough.org/

O1-Chapter3-Entrepreneurship aspects-Abstract2	
Title	**Saint Patrick High School**
Content	Saint Patrick is recognized as a leading all-male Catholic high school in Chicago. It provides project-based learning where STEAM is a track of studies. The full description is saved in file "STEAM Program at Saint Patrick high school". It is a very good example of STEAME curriculum where Entrepreneurship is implemented under an Incubator program. INCubator is the high school students "shark tank" (described in file "INCubator in Saint Patrick high school"). It is a yearlong entrepreneurship course and students create and develop their own product and/or service supported by business owners and managers. Students work in teams with the help and guidance by mentors and coaches. It can be used as an example of STEAME structure with implemented Entrepreneurship under an incubator program. It is an example of curriculum and activities and student projects for creativity plans (it is described in the file "INCubator in Saint Patrick high school").
Reference files	O1-Chapter3-Entrepreneurship aspects-Abstract2-File1.pdf O1-Chapter3-Entrepreneurship aspects-Abstract2-File2.pdf
Link	https://www.stpatrick.org/academics/steam/

O1-Chapter3-Entrepreneurship aspects-Abstract3	
Title	**Strake Jesuit College Preparatory**
Content	Strake Jesuit College Preparatory, Houston implements an Internship Program by partnering with area professionals to enhance the education of their students through providing relevant field experience. An internship provides students with an opportunity to step outside the classroom and build their resumes, gain professional knowledge, test drive a potential new career, network with alumni and gain a "real world" perspective on an occupation before graduation. In some cases internships lead to jobs or part-time

	employment. Internships are offered to students in a variety of career fields and they are completed through summer school and are not for pay. Students receive course credit for their time and service. The school provides instructions on the steps for students to follow. A successful internship placement is beneficial for the students, for the school, and companies alike.
Reference files	O1-Chapter3-Entrepreneurship aspects-Abstract3-File1.pdf
Link	https://www.strakejesuit.org/student-life/internship-program

O1-Chapter3-Entrepreneurship aspects-Abstract4	
Title	**Integrated activities**
Content	The **Harker School** (upper- school grades) in San Jose, Ca has an integrated activities offer related to entrepreneurial skills development. First, a Business and Entrepreneurship department with Economics courses, and honors Startup Incubator I and II. The curriculum develops real-world business skills through business simulations, case studies, competitive opportunities and projects. The course consists of separate modules throughout the year: marketing, accounting & finance, entrepreneurship, and strategy & management. Students experience "learn by doing" as they simulate roles of CEO, consultant, CFO. This also relates to class management, lesson planning and enquiry-based strategies. The school collaborates with business organizations integrating classroom instruction with applied learning. Finally, the career preparatpry program comprises mentorship and panel discussions with professionals in the fields of law, medicine, computer science/engineering and business/entrepreneurship. The **Staten Island Technical Schoo**l (SITS) focuses on work-based leaning as can be seen in the attachment.
Reference files	O1-Chapter3-Entrepreneurship aspects-Abstract4-File1.pdf
Link	https://www.harker.org/upper-school/programs-extracurriculars/business-entrepreneurship

O1-Chapter3-Entrepreneurship aspects-Abstract5	
Title	**Boston Leadership Institute**
Content	Many of the world's greatest Tech companies, including Dell, Apple, Facebook, and Microsoft were founded by kids not much older than teens. The **Boston Leadership Institute**, one of the top-named providers of STEM programs for high-achieving teens (7th grade and above), is a very good place to begin form the future in STEM entrepreneurship. Students participate in brainstorming sessions to generate ideas for improving the way that companies do business. Students develop a plan for their own revenue-generating business or a small money-producing venture. Students examine and analyze real-life entrepreneurial stories from film and best-seller lists using the concepts learned during lectures. They then develop a business plan and investor pitch for their own company. This program is great for teens interested in both STEM and business. We believe that one of the best practices that this Institute implements towards STEM entrepreneurship is the field trips. Students have the opportunity to get a first-hand look at some of the tech and biotech companies that were launched in the greater Boston area on field trips and may visit start-up company incubators in Boston and Cambridge. In the past, students have gone on field trips to tour Harvard University, MIT, Babson College, the Artisan's Asylum and the Cambridge Innovation Center. After all, inspiration and mentoring in forming an entrepreneurial spirit are key aspects.
Reference files	O1-Chapter3-Entrepreneurship aspects-Abstract5-File1.pdf
Link	https://www.bostonleadershipinstitute.com/stem-entrepreneurship/

O1-Chapter3-Entrepreneurship aspects-Abstract6	
Title	**Skriware Company**
Content	Skriware created an educational ecosystem that focuses on teaching creative problem solving and critical thinking using 3D printing to create hands-on experience. With the current technological advancement and its speed, most educational models worldwide are not really suited for challenges that students will face when they enter future job market. Skriware goal is to spark their interest in learning and ignite passion in STEAM fields (Science, Technology, Engineering, the Arts, Mathematics). According to Skriware approach "*a successful employee thinks outside the box and solves problems collaboratively with an interdisciplinary team – this is what the STEAM model is all about. Let's confront students with an issue, let them work together, make mistakes and correct them. After all, this is how they will work in the future*".
Reference files	O1-Chapter3-Entrepreneurship aspects-Abstract6-File1.pdf
Link	https://skriware.com

Chapter 4
Organizational suggestions for STEAME-oriented teaching

Whatever approach teachers take in the classroom, their work is affected by numerous factors beyond their direct control. Particularly important are factors that affect teachers' knowledge and skills—their preparation, support for new teachers, and ongoing professional development—and the climate and organization of the schools in which they teach. In this chapter we focus on strategies on building the organizational capacity of schools. This chapter is of local interest to teachers but also of a large scale interest to school directors. It contains also several suggestions for the flip-classroom approach.

A Organization of classroom

O1-Chapter4-A-Organization of classroom-Abstract1	
Title	**Academy High School in Texas**
Content	This video shows the school Academy High School in Texas, USA, which operates as a STEAM school and shows how the students work in groups in projects applying inquiry based learning approaches. The school does not have any classrooms but mainly open spaces and laboratory areas where students can develop their cooperative work, express their talent and creativity and complete project work. The following link is a 3,5 min video showing how the students work in a school day. One can also observe the school infrastructure and design. The video is saved with name Video1 in mp4 format.
Reference files	O1-Chapter4-A-Organization of classroom-Abstract1-File1.mp4

O1-Chapter4-A-Organization of classroom-Abstract2	
Title	**William F. West High School**
Content	William F. West High School, commonly referred to as W. F. West, is a public high school in Chehalis, Washington, United States. It consists a great example of STEM school structure since it has created a new STEM wing at W.F. West High School that adds 16,500 square feet, of state-of-the-art classrooms and science labs for students. The design celebrates the building structure for the benefit of its students, featuring exposed roof joists in the classrooms and exposed T&G 2x decking and beams at the vaulted corridors throughout the building. The building brings a fresh look to an existing high school campus that will benefit the community for years to come. The exterior walls are integrated with multiple windows, canopies, and doors to provide better daylighting and visibility into the classroom experience. Steel columns and beams were added to the wall structure to provide a seamless transition between the architecture and the structure. The steel structure allowed exterior walls to be framed with traditional 2x6 wall studs, maximizing the usable square footage. The design incorporated continuous clerestory windows along the corridor; in order to provide uninterrupted daylight without shear walls, steel columns were added at mullions to laterally brace the upper roof and eliminate the solid wall requirements for shear walls.
Reference files	O1-Chapter4-A-Organization of classroom-Abstract2-File1.jpg O1-Chapter4-A-Organization of classroom-Abstract2-File2.jpg O1-Chapter4-A-Organization of classroom-Abstract2-File3.jpg

O1-Chapter4-A-Organization of classroom-Abstract3	
Title	**STEAM4U**
Content	In the STEAM4U project big importance is given to how to build up a good STEM classroom environment. Actions included in this type of strategy are aimed at:

	• Change and challenge the roles of students in the classroom promoting positive exchanges between peers for example review how roles are shared in a project to break negative associations between students and roles. • Carry out cooperative activities instead of competitive activities to promote peer learning and reduce the activity stress. • Review verbal and non-verbal judgments to emphasize positive messages and to promote optimism.
Reference files	O1-Chapter4-A-Organization of classroom-Abstract3-File1.pdf
Link	http://steam4u.eu/

B Organization/structure/equipment/laboratories in school

O1-Chapter4-B-Organization/structure/equipment/laboratories in school-Abstract1	
Title	**Science LinX & STEAM Faculty of Science and Engineering**
Content	Science LinX reaches out and engages pupils, teachers, schools, civil society and the general public, to spark interest in science and engineering at the University of Groningen and show the Faculty's value; to the City, the Region, and beyond. Science Linx develops science exhibitions for the faculty buildings and festivals, fosters dialogue activities and a series of programmes to stimulate STEM teaching. Science LinX coordinates the regional schools network (Netwerk Noord), involving 5000+ students, 300+ teachers and about 40 schools. These networks offer different teacher professionalization activities and many science education activities for students. With a fresh and tailor-made approach, it facilitates continuous learning across borders of science, education, work and civil society. Each year Science LinX involves some 50.000 visitors in its activities.

Reference files	O1-Chapter4-B-Organization-structure/equipment-laboratories in school-Abstract1-File1.pdf

O1-Chapter4-B-Organization/structure/equipment/laboratories in school-Abstract2	
Title	**STEM building at Strake Jesuit school**
Content	The STEM building at Strake Jesuit school, Houston is a recent facility which allows for classes in the same departments to be scheduled in the same building, which is home to the Science and Engineering, Math and Computer Science departments. Totaling 68,000 square feet, its design features three labs each for Biology, Chemistry, and Physics, two Computer Science labs, an Engineering lab and an Engineering Computer lab. In addition there are 21 traditional classrooms as well as a Lecture Hall, Greenhouse and 25 faculty offices. The new facility will enable the Science, Computer Science, and Math classes and faculty offices to be located in one space, with a positive impact on teachers who can collaborate and work across curriculum in shared disciplines areas and on students who, thanks to the extensive laboratory space as well as the enhanced curriculum can take a variety of STEM electives to determine the areas they might want to pursue in their studies.
Reference files	O1-Chapter4-B-Organization-structure-equipment-laboratories in school-Abstract2-File1.pdf
Links	https://www.youtube.com/watch?v=keBm-DoxwA8&feature=youtu.be&app=desktop

O1-Chapter4-B-Organization/structure/equipment/laboratories in school-Abstract3	
Title	**Intrinsic Schools**
Content	“Intrinsic Schools” is a network of public charter schools in Chicago that features integrated team-taught blocks in big open spaces. The goal was to

	build a different kind of school, creating a new educational model for STEM and Humanitarian education. In order to better prepare students for success in college, career, and life. At Intrinsic, personalization and independence are achieved via a holistic, one to one application of technology, which empowers team-teaching in flexible, data-driven classrooms—called pods—where 60 students supported by three teachers may be moving from self-directed work to instruction to collaboration and project-based learning. This will permit to completely reinvent the school and classroom space to promote STEM and blended learning.
Reference files	O1-Chapter4-B-Organization-structure-equipment-laboratories in school-Abstract3-File1.pdf
Links	https://intrinsicschools.org/

O1-Chapter4-B-Organization/structure/equipment/laboratories in school-Abstract4	
Title	**Staten Island Technical High School, New York**
Content	Students receive an iPad mini as incoming freshmen. All of the school's classrooms are equipped with Smart Boards, and some even have 3-D printers. SITHS turns classroms into simulated workplace with 3D printing. Full color 3D printing allows students to deliver better results in science, technology, engineering and math (STEM) studies. Computer-aided design (CAD) makes the classroom mirror a corporate design engineering department. It's a simulated workplace, and students are the designers. The teacher issues design challenges, and they find solutions. Like professional engineers, SITHS students start with a concept, move to a 2D sketch and progress to a 3D CAD model. The printer is also used to create prototypes that help teacher explain design challenges at the outset of an assignment. Students enhance these designs as they meet the assigned challenges. 3D printing enriches engineering education in a number of ways, First, it gives students an impressive portfolio they can present to admissions personnel at colleges and universities. Second,

	it familiarizes them with equipment that's on industry's leading edge and rapidly becoming standard for competitive companies. SITHS students can expect to expand their use of 3D printing in the future. Science classes, for example, use it to print out microscopic objects like DNA molecules. Electronics students use it to better understand electrical designs. There is a public-private interaction, such as printing models of buildings for nearby architectural firms.
Reference files	O1-Chapter4-B-Organization-structure-equipment-laboratories in school-Abstract4-File1.pdf O1-Chapter4-B-Organization-structure-equipment-laboratories in school-Abstract4-File2.pdf
Links	https://www.siths.org/

O1-Chapter4-B-Organization/structure/equipment/laboratories in school-Abstract5	
Title	**Harker High School, San Jose, CA, USA**
Content	The Harker School has four campuses, one for each division: preschool, lower school, middle school and upper school. PRESCHOOL: the Harker Preschool campus was designed as little village with a working farm with vegetables, chickens and rabbits. The classrooms sit around a central lawn and they are equipped with spaces for small and large group activities, individual play opportunities, specialty class lessons, rest time, open areas for circle time, child-directed areas inside and out, an art studio, a STEM lab, a music and movement room. LOWER SCHOOL: at Harker's lower school students have a spacious campus with ample room to run, play, learn and socialize. The 9-acre campus includes 51 classrooms, music and dance rooms and a library for students to explore their subjects or curl up with their favorite books. Harker has a completely separate kindergarten area with toys, play structures and a physical space that

	is appropriate for this age level. The lower school campus has a swimming pool, gym, play structures and two playing fields. MIDDLE SCHOOL: at Harker's middle school students have a spacious campus with ample room to run, play, learn and socialize. The 12-acre campus includes 46 large classrooms, a theater and a library for students to spread out and explore their subjects. The middle school students enjoy a regulation gym, a smaller gym, two playing fields and six tennis courts. The spacious grassy amphitheater is perfect for gathering, and there is lots of space for clubs to meet. UPPER SCHOOL: Harker's upper school campus serves upper school students, grades 9-12. It includes a new library and 79 large classrooms and labs, some of which are housed in Harker's LEED Gold certified science and technology center, Nichols Hall. There are a lot of extracurricular spaces too.
Reference files	O1-Chapter4-B-Organization-structure-equipment-laboratories in school-Abstract5-File1.pdf
Links	https://www.harker.org

C Flip-classroom approach

O1-Chapter4-C-Flip-classroom approach-Abstract1	
Title	**Stanford Online Highschool**
Content	Stanford OHS is a school that draws strength from its students, its instructors, and its online nature. The students are passionate about learning, ready to take intellectual risks, and engaged in significant pursuits beyond the classroom. Stanford OHS has established a truly amazing community of learners, educators and supporters. The school provides a unique hybrid space with online flipped classrooms enriched by in-person opportunities through regional meetups and residential programs.

	The mission of Stanford Online High School is to create a worldwide learning community of diverse, intellectually passionate students and teachers. Through vibrant seminars, the rigorous curriculum challenges students to reason analytically, think creatively, and argue critically. Beyond the classroom, collaborative extracurricular activities cultivate lasting relationships among students and teachers. The school's supportive environment fosters independence, strength of character, and a lifelong pursuit of knowledge.
Reference files	O1-Chapter4-C-Flip-classroom approach-Abstract1-File1.pdf O1-Chapter4-C-Flip-classroom approach-Abstract1-File2.pdf

O1-Chapter4-C-Flip-classroom approach-Abstract2	
Title	**Full STEAM ahead for better education**
Content	At the level of curricula, teaching methods and student assessment, the Thematic Working Group emphasizes the need to teach science appreciation and science in context. This is what we do in our project. Through our new methodology we put away the "classical" way of teaching each subject as such, often telling the facts and giving the students the answers before they want to know or see the "problem". To many students this is boring as they often are active and curious youngsters. Our interpretation of "in context" is to see STEM subjects in connection with other subjects and different approaches by giving the students the opportunity to explore and find out for themselves instead of being told the answers to questions they have not asked.
Reference files	O1-Chapter4-C-Flip-classroom approach-Abstract2-File1.pdf
Links	https://twinspace.etwinning.net/23298/home

Chapter 5

Propositions and analysis of STEAME-oriented curriculum. Adaptability and dynamics characteristics.

The STEAM acronym revisited: Search, Think, Experience, Active Learning, Motivation, explains the methodology common to STEM schools and grades. The methodology is also in line with the "21st century skills" - critical and creative thinking, collaboration and communication. Because STEM subjects are banded together to other subjects and other approaches, a student active methodology is fundamental. School curricula must favor applied knowledge, enquiry-based teaching and invention: students' individual strenghts emerge as they are confronted with challenges. Students acquire independent thought, learn to make decisions and act on them. At higher levels the overall educational programs giving content, mindsets, competencies, and skills works together with other special programs like internships and intensives. Educational goals must be centred around experience-based knowledge to develop critical reflection and commitment to action. At advanced courses students work independently and are encouraged to offer thoughtful responses to given questions and to think more abstractly. Through Work Based Learning experiences in STEAM subjects and Career Development programs centering on entrepreneurship, students develop an aptitude for real-world leadership and problem solving focusing on teamwork, communication and interpersonal skills.

A Adaptability to level of ability/difficulty

O1-Chapter5-A-Adaptability to level of ability/difficulty-Abstract1	
Title	**BASIS School model**
Content	A combination of strategies is adopted to compensate ability or difficulty differences. The Lakeside School (grades 5-12) creates inclusive and equitable classrooms and programs. At BASIS Charter Schools, every student is prepared for the next level of education thanks to the support of subject expert teachers in grades K through 12, and a STEM-inspired curriculum. Choate Rosemary Hall has a Teaching and Learning Center (TLC) providing support and services for students: coaching and time management and organization

	skills as well as academic and technological support to those with documented disabilities. IUSD offers an Integrated Mathematics Pathway K-12 to best prepare students for success in college and career, career, and life. Staten Island Technical School practices formative and individualized pedagogy with real-time feedback and a system for students to ask for extensions and resubmittance of their work. The Blake School has counselors who provide students with short-term individual and group counseling. Learning specialists work with individuals and small groups of students with learning differences, and with parents in support of their children. The project Bear to Bear Tutoring is a student-led tutoring organization in partnership with The Blake Middle School, fostering a one-to-one student relationship between Upper Schoolers and Middle Schoolers to practice and help with study habits and homework.
Reference files	O1-Chapter5-A-Adaptability to level of ability/difficulty-Abstract1-File1.pdf

B Adaptability to domain evolution and progress in technology

O1-Chapter5-B-Adaptability to domain evolution and progress in technology-Abstract1	
Title	**The Lakeside School model**
Content	Dependable access to technology is a fundamental aspect of education, and STEAM education in particular. This includes a dedicated digital device, access to the internet at school and home, and technological support. At **Lakeside** school students in grades 5 and 6 receive a digital tablet for use at school and starting in grade 7, families are responsible for the purchase of a laptop for each of their student (financial aid is provided if needed). Also **Choate Rosemary Hall** has a one-to-one program using iPads as media creation tools that can help to manage students' academic work and personal lives, and provide a window on the world for the gathering of information.

	Teachers integrate technology that supports learning both in and out of the classroom. The Office of Academic Technology offers iPad workshops throughout the year designed to educate faculty members on the appropriate use of technology in the classroom. At **Orovalley** they use technology to connect a network of schools into an integrated system with data-driven quality control and best practices. This helps ensure that innovation is guided by their teachers, not a centralized bureaucracy. At **Strake Jesuit** the availability of digital infrastructures with the creation of a dedicated and technologically equipped STEM building is guaranteed in campus.
Reference files	O1-Chapter5-B-Adaptability to domain evolution and progress in technology-Abstract1-File1.pdf

C Dynamics in relation to various methodologies

O1-Chapter5-C-Dynamics in relation to various methodologies-Abstract1	
Title	**Examples of Methodologies**
Content	STEAM curriculum includes challenging courses in humanities, mathematics, sciences, languages and the arts. Great examples of STEAM curriculum courses are given in the following attached files: St. Paul's School (New Hampshire) course catalog which includes a description of all the available courses in the aforementioned fields as well as in interdisciplinary studies. The approach of focusing also in interdisciplinary studies is adopted by many STEAM schools nowadays. Filename O1-Chapter5-C-Dynamics in relation to various methodologies-Abstract1-File1.pdf Teach Engineering is a digital library comprised of standards-aligned engineering curricula for K-12 educators to make applied science and math

	come alive through engineering design. Examples of STEAM curriculum units that can be used in grades 7-12, are given in the following files: O1-Chapter5-C-Dynamics in relation to various methodologies-Abstract1-File2.pdf. Fluid mechanics, the study of how forces are applied to fluids, is outlined in this unit as a sequence of two lessons and three corresponding activities. O1-Chapter5-C-Dynamics in relation to various methodologies-Abstract1-File3.pdf. Through a 10-lesson series with hands-on activities students are introduced to seven systems of the human body (skeletal, muscular, circulatory, respiratory, digestive, sensory, and reproductive) as well as genetics. At every stage, they are also introduced to engineers' creative, real-world involvement in caring for the human body. This engineering curriculum aligns to Next Generation Science Standards (NGSS).
Reference files	O1-Chapter5-C-Dynamics in relation to various methodologies-Abstract1-File1.pdf O1-Chapter5-C-Dynamics in relation to various methodologies-Abstract1-File2.pdf O1-Chapter5-C-Dynamics in relation to various methodologies-Abstract1-File3.pdf

O1-Chapter5-C-Dynamics in relation to various methodologies-Abstract2	
Title	**Basis Charter Schools**
Content	At BASIS Charter Schools, internationally-acclaimed academic program was founded on the notion that any student can be taught to love learning. Every BASIS Charter School student is prepared for the next level of education thanks to the support of subject expert teachers in grades K through 12, and STEM-inspired, accelerated liberal arts curriculum. The BASIS Charter School Curriculum is a good example of integrated STEAM approach by curricula developed for different age groups and levels

	of education starting from kindergarten. The school has distinctive curriculum which provides adaptability: • Kindergarten Curriculum • Grades 1–3 Curriculum • Grades 4–7 Curriculum • Grades 8–12 Curriculum • Connections Curriculum It is a good example of Dynamics in relation to various methodologies as the school uses a flexible approach for teaching - meaning that teachers use only guidelines and not fully written lesson plans. The school provides interdisciplinary studies: Primary students, for example, take blocks of humanities, math, science, and fine arts, and study the interdisciplinary connections between their courses. This approach teaches students to organize their thinking around conceptual synthesis.
Grades	ALL
Reference files	O1-Chapter5-C-Dynamics in relation to various methodologies-Abstract2-File1.pdf
Links	https://www.youtube.com/watch?v=yFICN6yV5Ps https://www.youtube.com/watch?v=QtRlAqHEgKY https://www.youtube.com/watch?time_continue=128&v=0Kk0SBneL9Y&feature=emb_logo https://www.youtube.com/watch?v=9czFhPwMpoU

Evaluation of projects and schools

By the way of preparation for the delopment of these Guidelines, we have carried out a rough analysis of European and Global characteristics in terms of activities, curricula and organizational structure. We have decided to analyse results of recent EU founded projects on STEM or STEAM. Additionally, we have analyzed a number of best, mostly US-based STEM oriented schools. The complete list of considered subjects follows.

- School of Science and Engineering - http://semagnetschool.org/
- School for the Talented and Gifted - http://tagmagnet.org/
- Stanford Online High School - http://ohs.stanford.edu/
- Bronx High School of Science - http://bxscience.edu/
- STEAM COMMUNICATION IN EUROPE - http://www.steamsummerschool.eu/
- EUROSTEAM - http://www.eurosteamproject.eu/
- LEARNING STEAM THROUGH A PLAYFUL ONLINE PLATFORM, SOCIAL LEARNING AND CONTENT CO-CREATION - https://steamdecks.deusto.es/
- Academic Magnet High School - http://amhs.ccsdschools.com/
- BASIS Tucson North - http://basistucsonnorth.org/
- BASIS Chandler - http://basischandler.org/
- Thomas Jefferson High School for Science and Technology - http://tjhsst.edu/
- University of Chicago Laboratory Schools - http://ucls.uchicago.edu/
- Liberal Arts and Science Academy - http://lasahighschool.com/
- The Early College at Guilford - http://ecg.gcsnc.com/pages/Early_College_At_Guilford
- Maine School of Science and Mathematics - http://mssm.org/
- ADDRESSING UNDERACHIEVEMENT IN STEAM EDUCATION THROUGH REAL PRODUCT DESIGN AND MAKING PRACTICES - https://makeitreal.info/
- GREENING THE SKILLS OF ARCHITECTURE STUDENTS VIA STEAM EDUCATION - http://archisteam.com
- EUROPE IN CHANGE: STEAMING AHEAD TOWARDS OUR FUTURE - http://www.steamon.eu
- Itineris Early College High School - http://iechs.org/
- The Mississippi School for Mathematics and Science - http://themsms.org/
- Northside College Preparatory High School - http://northsideprep.org/
- Baltimore Polytechnic Institute - http://www.bpi.edu/

- Cranbrook Schools - http://schools.cranbrook.edu/page
- Massachusetts Academy of Math and Science - http://massacademy.org/
- BASIS Scottsdale - http://basisscottsdale.org/
- Illinois Mathematics and Science Academy - http://imsa.edu/
- FULL STEAM AHEAD - https://twinspace.etwinning.net/24870/home
- INNOVATION STARTS WITH ACTION! STEAM - http://innovationsteam.weebly.com/
- ENVIRONMENTAL EDUCATION THROUGH STEAM - http://edusteam.eu
- The Davidson Academy - http://davidsonacademy.unr.edu/
- Phillips Exeter Academy - http://exeter.edu/
- Troy High School - http://fjuhsd.org/Troy
- Middlesex County Academy for Science, Mathematics, and Engineering Technologies - https://www.mcvts.net/edison
- Bergen County Technical High School - Teterboro - http://bcts.bergen.org/index.php/2016-05-10-17-30-50/teterboro-campus
- Bergen County Academies - http://bergen.org/bca
- Gwinnett School of Mathematics, Science and Technology - http://gsmst.org/
- Winsor School - http://winsor.edu/
- RAISING STEAM IN EDUCATION - http://steam-erasmus.eu/
- INCLUSIVE STEAMY LEARNING IN EUROPE - http://dolms.be
- Germantown Friends School - http://germantownfriends.org/
- Marlborough School - http://marlborough.org/
- Signature School - http://signature.edu/
- Raleigh Charter High School - http://raleighcharterhs.org/
- Cate School - http://www.cate.org/
- St. Paul's School - http://sps.edu/page
- Pine Crest School - http://pinecrest.edu/
- West Lafayette Junior/Senior High School - http://wl.k12.in.us/
- ART CREATIVITY CODING- FULL STEAM AHEAD! - http://twinspace.etwinning.net/71752/home
- STEAM TIME - SOLVE UNESCO CRIME - http://steamtime.eu
- Academy of Aerospace and Engineering - http://aaen.crecschools.org/
- Ransom Everglades School - http://ransomeverglades.org/page
- St. Mark's School of Texas - http://smtexas.org/page

- Ithaca Senior High School - http://ithacacityschools.org/
- Hopkins School - http://hopkins.edu/
- South Carolina Governor's School for Science and Mathematics - http://scgssm.org/
- Michael E. DeBakey High School for Health Professions - http://houstonisd.org/debakey
- Boston University Academy - http://buacademy.org/
- DISEŃANDO PUENTES ENTRE CIUDADANOS EUROPEOS A TRAVÉS DE STEAM - https://sites.google.com/iesmestreramonesteve.com/designingbridgesthroughsteam
- TRANSFORMING FABLABS INTO STEAMLABS - http://tfisteamlabs.com/index.php
- Benjamin Franklin High School - http://bfhsla.org/
- Essex High School - http://www.ewsd.org/ehs
- Mariemont High School - http://mariemontschools.org/
- High School Math Science and Engineering at The City College of New York (CCNY) - http://hsmse.org/
- Dutch Fork High School - http://lexrich5.org/
- BASIS Oro Valley - http://basisorovalley.org/
- Strake Jesuit College Preparatory School - http://strakejesuit.org/
- Lakeside School - http://lakesideschool.org/
- RAISING STUDENTS' PERCEIVED SELF-EFFICACY IN STEAM TO PROVIDE OPPORTUNITIES FOR ALL - http://steam4u.eu/
- FULL STEAM AHEAD FOR BETTER EDUCATION - https://twinspace.etwinning.net/23298/home
- University High School (Irvine) I - http://iusd.org/
- Telluride High School - http://tmhs.tellurideschool.org/
- Staten Island Technical High School - http://siths.org/
- Choate Rosemary Hall - http://choate.edu/
- EL-STEM: Enlivened Laboratories for Science, Technology, Education and Mathematics
- EUSEA Science Engagement Platform
- Hypatia Project EU Horizon 2020

The evaluation was carried out by all partners involved in the STEAME project. It was conducted using a google docs questionary with questions and items worked out and carefully designed during the project's first meeting.

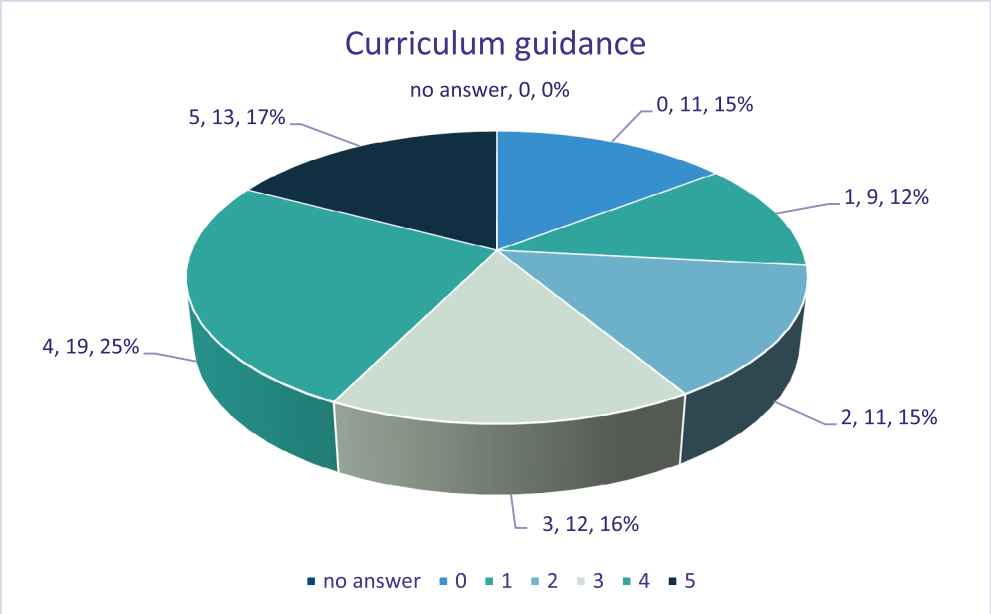
Below we present the structure of the questionary and our findings.

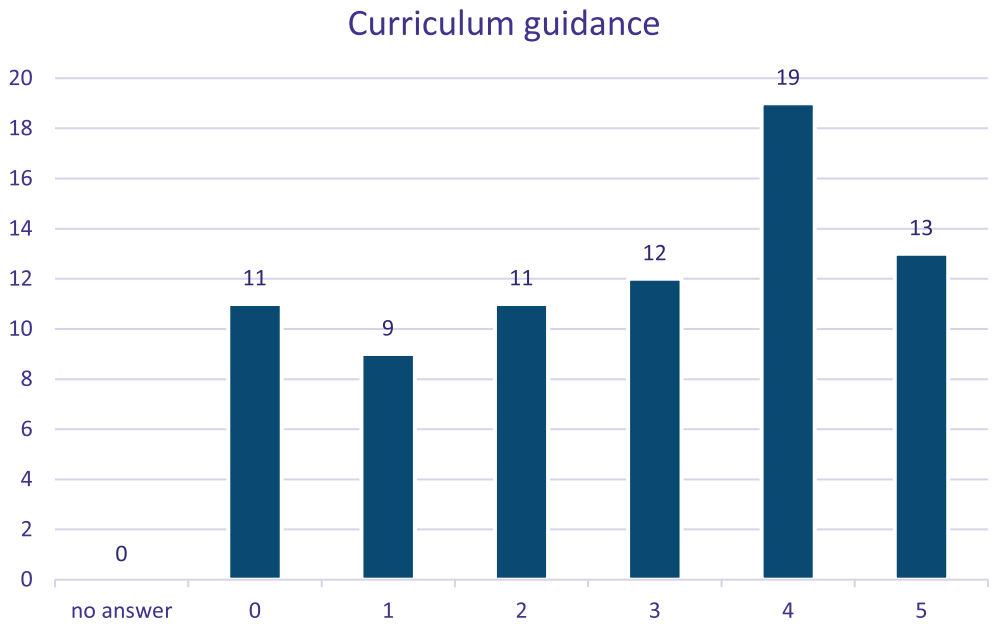
Each time "no answer" appears, it implies that a project/school were not relevant from the view point of the considered question. The note "0" means that the evaluated object claimed relevance for the considered characteristic and the partners of this project found no usefulness of object with respect to this characteristic. This methodology allowed us to obtain more accurate assesments.

The circular diagrams are to be read as follows. Each question was assigned either an integral value of points ranging from 0 to 5, or no answer could be given. The no answer option was chosen, if the subject showed no rellevance for the considered aspect. It is to be distinguished clearly from the 0 note, which corresponds to these cases where relevance was claimed but was evaluated either as wrong or useless. To each piece of the diagram, there are 3 numbers assigned in the format a, b, c%. The first number "a" represents the note given to a subject. Its value is either "no answer" or an integer in the range 0-5. The second number "b" stands for the number of cases evaluated with note "a". The third number "c%" expresses the number of cases evaluated with note "a" compared to the total number of cases, its percentage. The same data is repeated in the bar chart. We feel that showing data in two types of diagrams increases its utility.

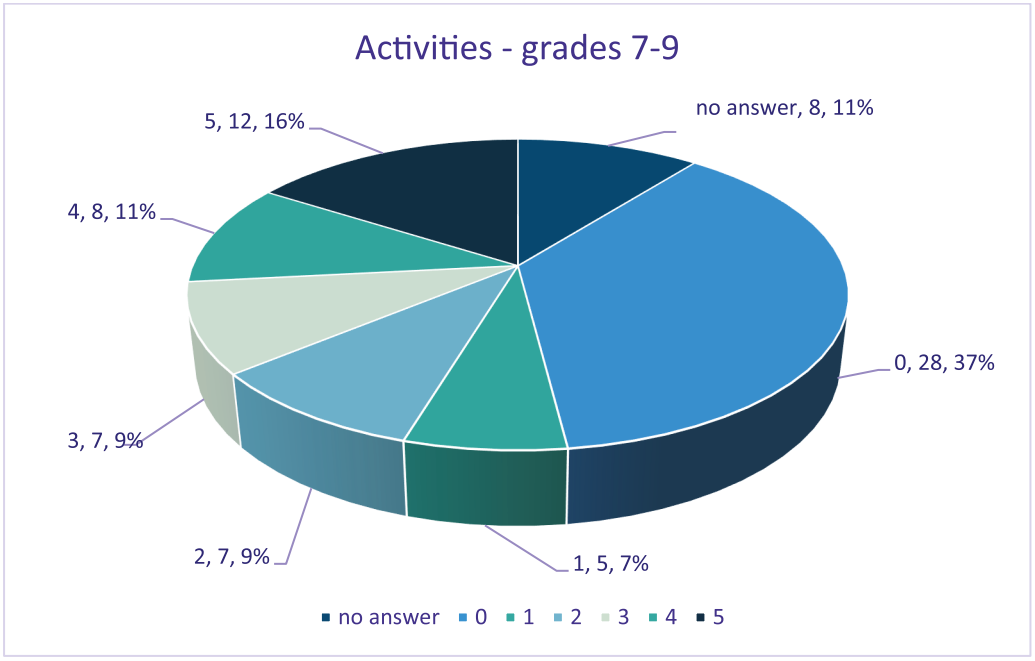
QUESTIONS

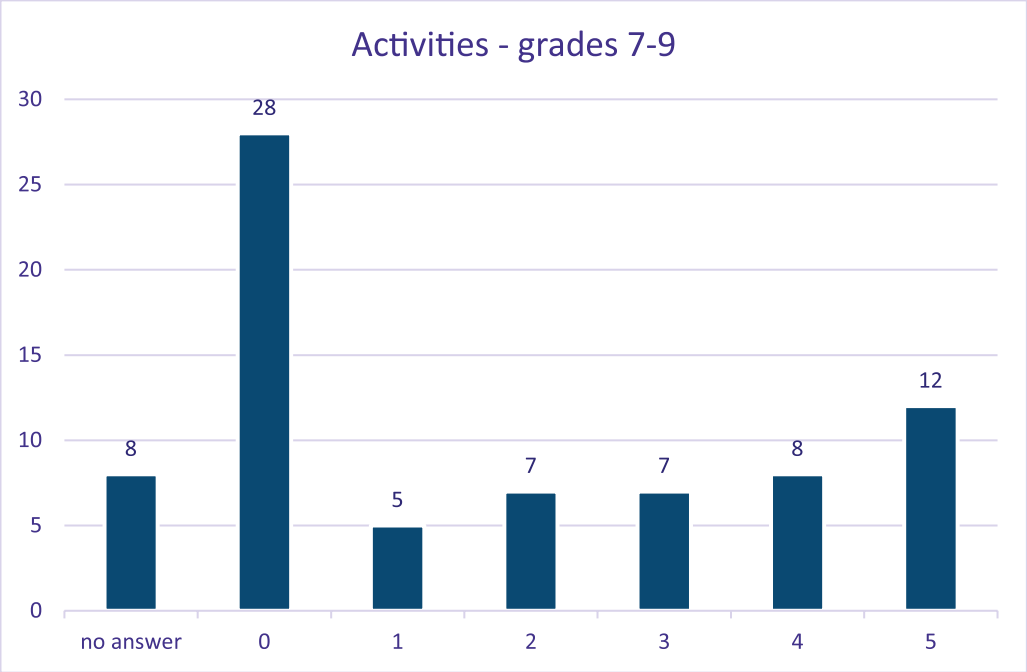
1. Evaluate the usefulness of the subject for
    a. Curriculum guidance (scale 0-5)



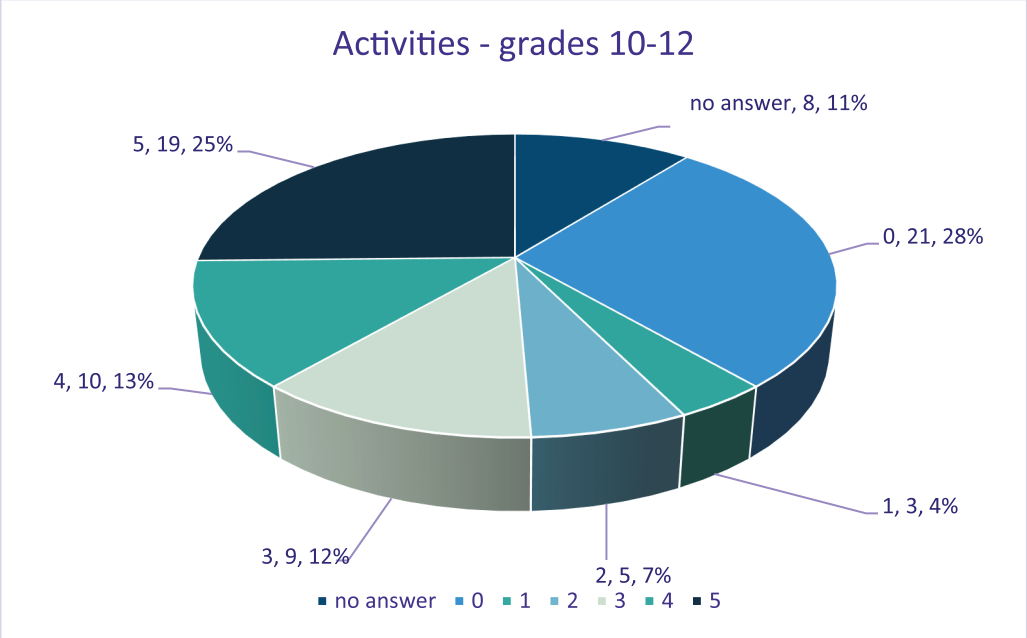


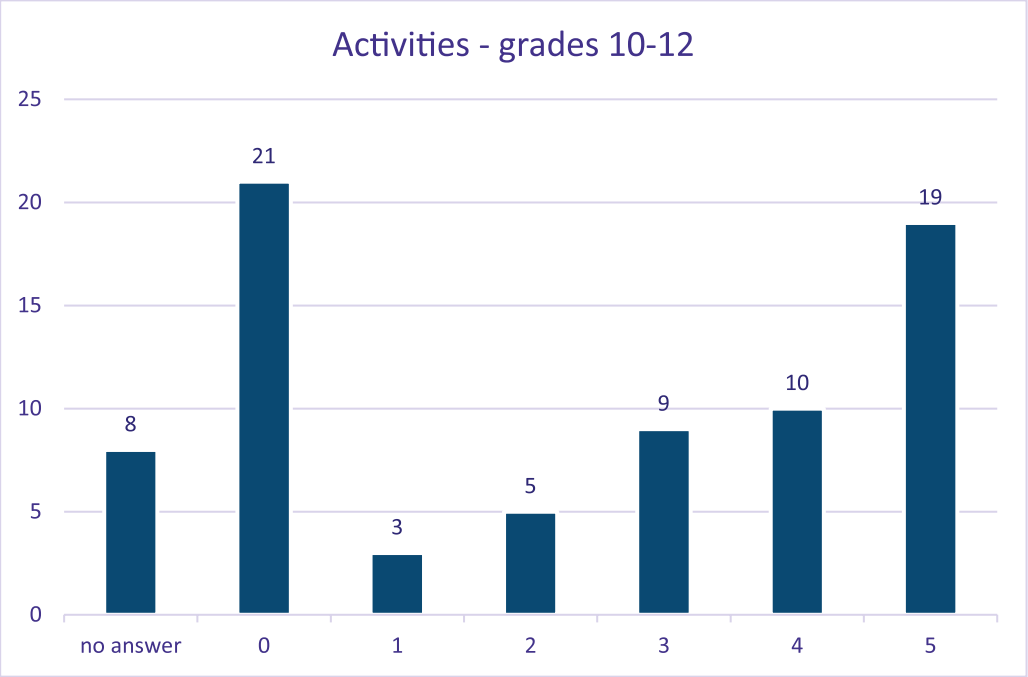
b. Activities - grades 7-9 (scale 0-5)



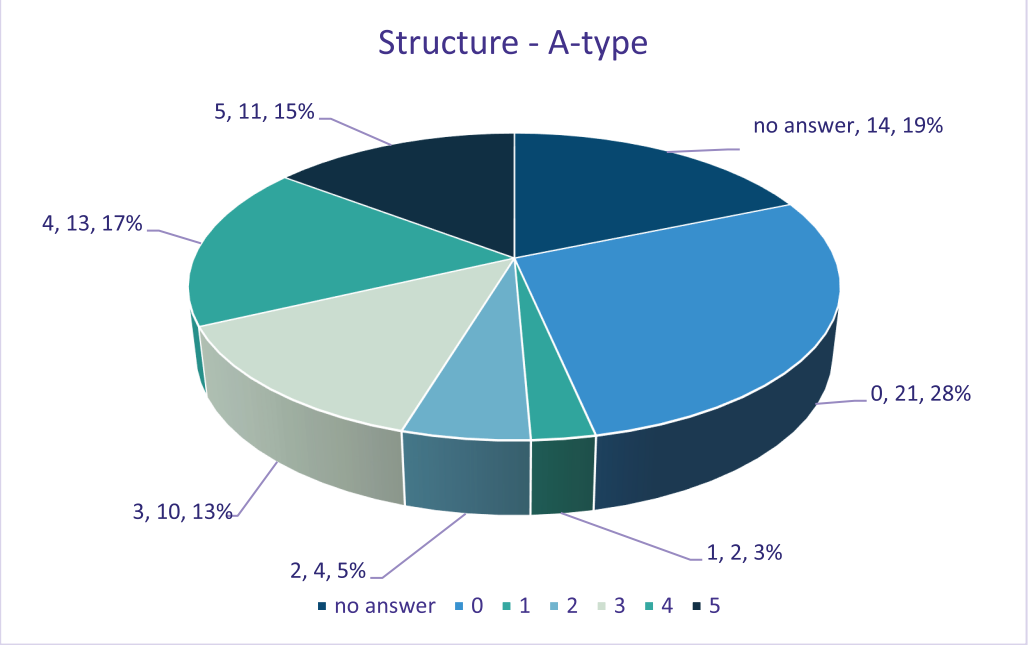


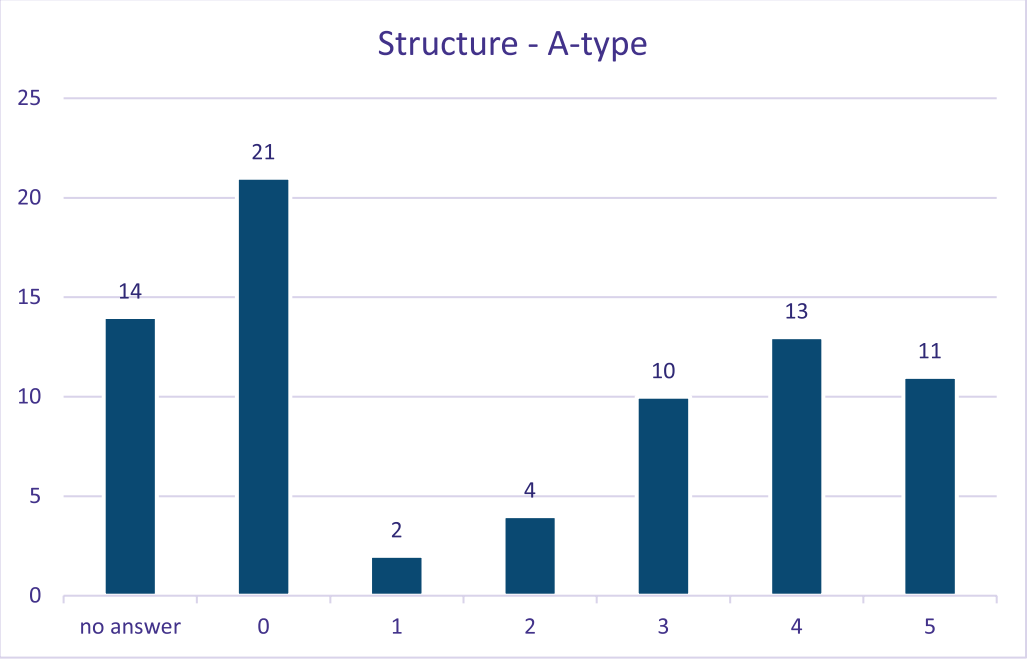
c. Activities - grades 10-12 (scale 0-5)



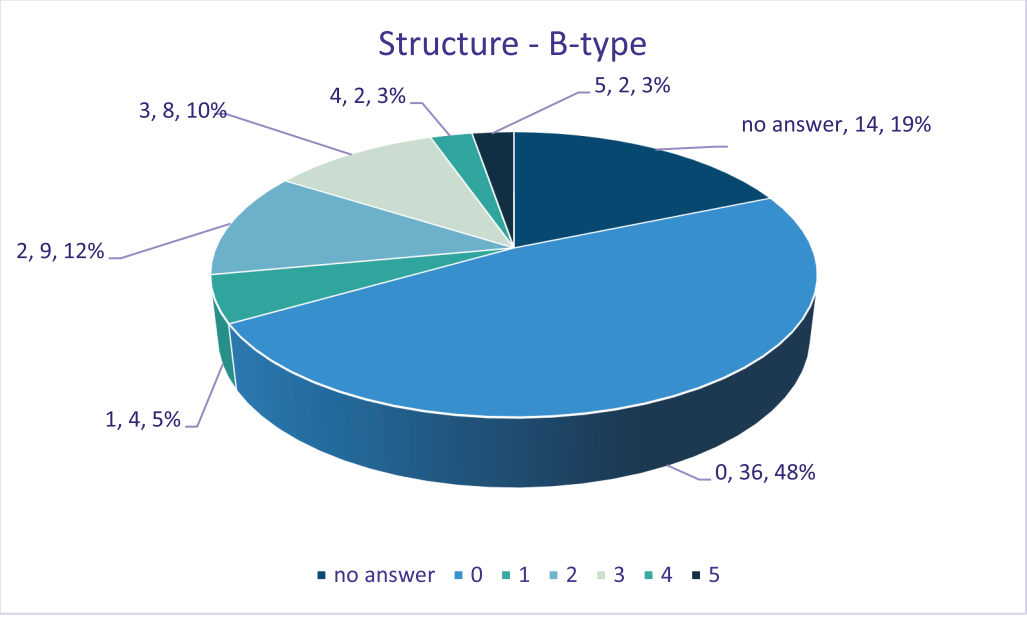


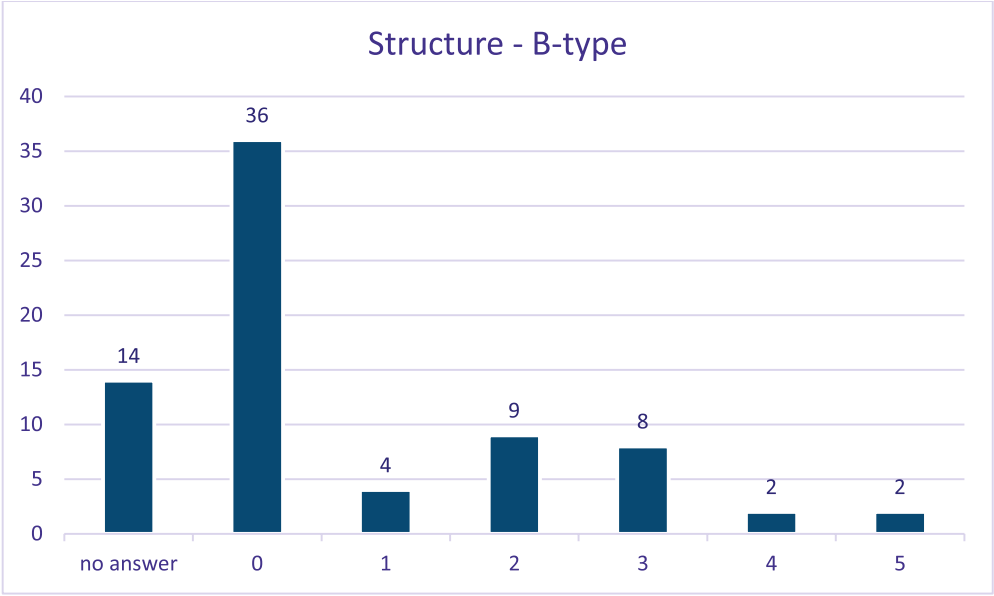
d. Structure - A-type (scale 0-5)





e. Structure - B-type (scale 0-5)





The remaining items of the questionnaire were not evaluated in the point scale. Their purpose was to gather information, sort it in categories the partners found relevant for the project and prepare material for the STEAME Observatory.

2. Upload any files here
    a. Lesson;
    b. Creativity plan;
    c. Work sheets;
    d. Project description;
    e. Inquiry based learning activities;
    f. Gamification;
    g. Other.
3. Provide links to
    a. Videos;
    b. Field visits;
    c. Prototypes;
    d. Audiovisual material;
    e. Industry visits;
    f. Infographics;
    g. Guidelines for teachers.
4. Highlight entrepreneurship aspects, if any.

5. Include extract of organizational suggestions for STEM-oriented teaching.
    a. Organization of classroom;
    b. Organization/structure/equipment/laboratories in school;
    c. Flip-classroom approach.
6. Include propositions/analyzis of STEM-oriented curriculum. Name adaptivity and/or dynamics characteristics if any
    a. Adaptability to level of ability/difficulty;
    b. Adaptability to domain evolution and progress in technology;
    c. Dynamics in relation to various methodologies.
7. List of useful quotations, marking exactly where there are taken from.

STEAME

ISBN: 978-9963-713-38-7

www.steame.eu