Competence development of STE(A)M educators through online tools and communities

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D4: Guide of STE(A)M education practices

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Abstract: This Guide of STE(A)M Education Practices describes 12 successful practices that provide useful insights for teachers interested in adopting the STE(A)M approach to educational activities. The Guide also illustrates the selection principles and criteria to guide the design of an effective STE(A)M experience.
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1 Introduction

This Guide of STE(A)M Education Practices describes 12 successful practices that provide useful insights for teachers interested in adopting the STE(A)M approach to educational activities. As a result of research and creative techniques that will be instrumental among the members of the community, the STE(A)M education framework will be produced, which will include competences, policies, methodologies, educational objects, etc.

The Guide is also intended to fuel discussion among the STE(A)MonEdu community members, providing them with examples, ideas and a baseline for benchmarking their own practices and projects.

The Guide describes each practice in a concise format, with link to the online repository, so that it can be used in different contexts. For each practice the following information are available:

- Basic information (title, language, date, keywords, country, author, audience, applicability area, educational framework);
- Description (including reason, purpose and a summary);
- List of resources;
- Assessment (scores);

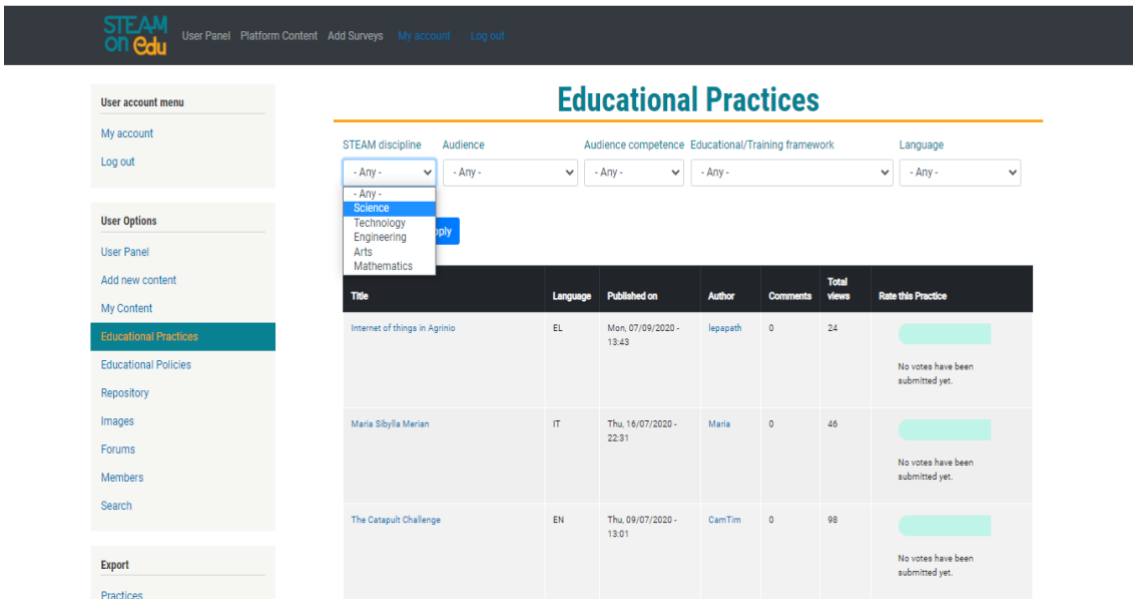
In line with the STE(A)MonEdu project bottom-up approach, the Guide is the result of the involvement of stakeholders (teachers, educators, researchers, policy-makers, education authorities, career consultants, content producers etc.) willing to contribute towards the 2020 EU target of inspiring more of young people to specialize in STEM during their education in order to undertake scientific and technical careers, motivating a multi-disciplinary STE(A)M approach, addressing gender gaps and stereotypes in STEM programmes and supporting educator preparation for this educational reform movements.

The Guide is the result of crowdsourcing and collaboration among the STE(A)MonEdu community members and it summarizes and evaluate good and not so good STE(A)M education practices, based on local and regional initiatives that support STEM and STE(A)M education. It contains also suggestions for improvement and transfer based upon researchers' work and comments on forums by the STE(A)MonEdu community members.

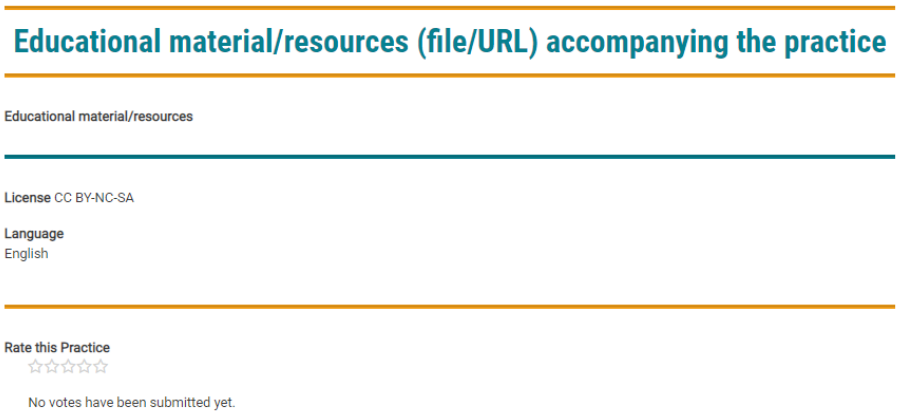
STE(A)MonEdu community members join to an online platform in which good practices have been and are still being collected. Any person interested in joining the community can visit the website *https://steamonedu.eu/platform/practices* and register. The online community will be open during and after the project and it is a very useful tool to share and learn about other's educational experiences.

Only for platform members is also possible to vote the favourite among all the uploaded practices through some simple steps.

Once the platform members have logged in, they have to select the "Educational Practices" item and fill the fields to open the practice to vote for:



The space reserved for voting can be found at the bottom of the page in "Educational material/resources (file/URL) accompanying the practice" section:



1.1 STEAMonEdu project

The aim of the project is to increase the adoption and impact of STE(A)M education, nominating educators as the pillars of implementation of STE(A)M education policies and support their professional development either by blended training or by their participation in a community of stakeholders. The exchange of experience, collaboration and creative work of this community will be supported by online peer learning and crowdsourcing platform.

The project will adopt a bottom-up participatory approach to deliver:

- An **online community of educators** that will collect good practices and collaboratively develop STE(A)M education policies,
- A **STE(A)M education framework**, including STE(A)M body of knowledge, template curricula and learning activities, with a focus on diversity issues
- The **STE(A)M competence framework**, which will detail the competences necessary to design and implement STE(A)M education activities (STE(A)MComp will specialize Digital Competence Framework for Educators – with STE(A)M-specific competences)
- The **STE(A)M educator profile**, that will be designed on the principles of ESCO (European multilingual classification of Skills, Competences, Qualifications and Occupations)
- A blended course delivered via the online platform and using on its content (OERs), including a **MOOC** targeting STE(A)M educators.
- A **Guide** of STE(A)M educational practices
- A **Guide** on STE(A)M Education policies
- The STE(A)M **policy influencer toolkit**
- **A Guide for STE(A)M education policy makers** (Policy recommendations)
- A STE(A)M readiness self-assessment online tool for educational organisations that implement STE(A)M education policies, that will implement or expand SELFIE.

The project website available for any further information is *https://steamonedu.eu/about/*.

2 Definitions and criteria

This chapter lists definitions and criteria that have been used in order to select the practices for the Guide.

2.1 Definitions

There is not an established consensus in the literature about the definitions of several key concepts in STE(A)M education. This section contains the definitions adopted by the partners of the project.

2.1.1 Educational practices

A sequence of structured learning activities linked to informational sources and pedagogical material, that has been implemented into the classroom with students, in order to improve their knowledge, competences and skills. It includes some learning outcomes, that have been assessed in a concrete framework.

2.1.2 STE(A)M approach

- STE(A)M Education is an approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics as access points for guiding student inquiry, dialogue, and critical thinking.
- STE(A)M is an integrated approach to learning which requires an intentional connection between standards, assessments and lesson design/implementation
- STE(A)M experiences involve two or more disciplines from Science, Technology, Engineering, Math and the Arts to be taught AND assessed in and through each other.
- Inquiry, collaboration, and an emphasis on process-based learning are at the heart of the STE(A)M approach.

2.2 Principles and Criteria

Partners agreed upon the principles that characterize a STE(A)M practice and derived 25 evaluation criteria from them.

2.2.1 Principles

In the context of the STE(A)MonEdu project, “Good practice” refers to training and education initiatives that are built and implemented by schools, NGOs, and any education provider, incorporating a majority of the following principles:

Integrated Content

Science, technology, engineering, arts and math are approached from an integrated perspective.

Real-word integration

STEM is taught within real-world application contexts and situations.

STE(A)M and Beyond

A true transdisciplinary framework integrates fine arts, social studies, and language arts to appeal to a broad range of learner interests.

Inclusive STE(A)M education

Effective STE(A)M programs engage and inspire students of all abilities and interests and accommodate a wide variety of learning styles.

Next Generation/21st Century Skills

Promotes problem-solving and critical thinking, creativity, collaboration, communication, time management and adaptability.

Project-Based/Problem-Based Learning

STE(A)M content is learned through hands-on, minds-on projects. Project engagements are motivated by genuine learner inquiry and a problem-based perspective.

Authentic Assessment

Learners document and present their learning through ePortfolios or similar methods.

Integrated Learning System

All program elements, including classroom configuration and quality of the infrastructure, hardware, software, kits and equipment, curriculum and assessment, and professional development support learning objectives.

Technology-Enabled Learning

Professional-standard technology tools are integrated into everyday workflow.

Learning Technology vs. Teaching Technology

Technology is in the hands of the students, not just teachers, administrators, and service providers.

Emphasis on Applied Technology

Application of technology tools is emphasized over specific skills that become obsolete as technology changes.

Teacher as Facilitator

Teachers assume the role of facilitator and students are empowered to take responsibility for their own learning.

Collaboration

Students work in pairs or larger teams. Quality collaboration is as important as the final work product and is part of the regular assessment process.

Open-Ended Learning

Students select an appropriate level of challenge and take their projects as far as they are able.

Supported

Ongoing professional development is an integral program element. Program continuity is not dependent upon a single teacher.

2.2.2 Criteria

Partners agreed on 25 evaluation criteria based upon the principles listed in the previous section. Each criterium has been scored from 0 (not evaluable) to 3 (good), the maximum score attainable by a practice being then 75. Practices scoring over 65 are considered best practices.

Moreover, to be considered a STE(A)M practice the practice must include Arts among the disciplines involved.

The STE(A)M practice is comprehensive

1. Is interdisciplinary and connects numerous subjects?
2. Underlines common principles and approaches?
3. Represents the rich relations between Science, Technology, Engineering, Arts and Mathematics?
4. Supports a complex growth of the learner including intellectual, emotional, and social development?

The STE(A)M practice leads to holistic learning

Focuses on understanding STE(A)M general idea in STE(A)M rather than accumulating specialized knowledge.

5. Emphasizes the ethical component of STE(A)M?
6. The practice contributes to competence development (includes knowledge, skills, attitudes) and is balanced (between theory and practice)?
7. Is not simply the sum of many components, but holistic in including their various interrelations?

The STE(A)M practice is problem-oriented

8. Can learners explore STE(A)M in a self-regulated and creative way?
9. Are processes iterative, focusing on:
   - training basic skills?

- building profound knowledge?

10. Is practicing, repeated training and applying knowledge reinforcing abilities, skills and competences?

The STE(A)M practice is practical

11. Supports learners in acquiring knowledge, skills and competences through real-world experiences and observations?
12. Are practical experiments essential for the learning process and for the development of practical skills?
13. Is practical lab work developing creativity and following the iterative learning cycle?
14. Are practical exercises stimulating learners' interest and engagement?

The STE(A)M practice is social

15. Is a social activity with human interaction and emotional involvement?
16. Is learner-centred (aiming to impact individuals and the society)?
17. Is inclusive, gender balanced and values diversity?

The STE(A)M practice is sustainable

18. Does it consider any of The Sustainable Development Goals?
19. The technology used and the curriculum resources are regularly updated and augmented?

The STE(A)M practice is transferable

20. Is the STE(A)M practice having enough support and resources to prove it transferable?
21. Does it have the potential of being adapted / applied to different contexts?

The STE(A)M practice is based on collaboration

22. Is quality collaboration as important as the final work product and is part of the regular assessment process?
23. Can it be implemented by more than one educator?

The STE(A)M practice addresses professional development

24. The practice supports the initial professional development for educators, heads of schools/training centres?
25. Are educators acting as facilitators of learning?

3 List of good practices

3.1 Visions of the future / Science fiction (STE(A)M oriented)

Table 1: Visions of the future / Science fiction (STE(A)M oriented)

Type of information	Contents
Title	Visions of the future / Science fiction (STEAM oriented)
Link	https://steamonedu.eu/platform/node/36
Abstract	The practice had been planned with to aim to program two robots entirely from scratch, one of which was used in a theatrical play. The first was called Ev3 and the second S4A (this one works with a Leonardo Arduino). The Ev3 was "taught" to move and understand its surroundings and conduct certain tricks. Also, it was made an internet page and some apps.
Language	English
Duration	3 months
KeyTerms	Ev3, Java, LeJOS, Eclipse, Robotic, Arduino, S4A, Theatrical Play, Fricandela
STE(A)M discipline	Arts, Engineering
Country	Greece
Author	Evagelia Kounavi
Educational framework	• Audience competence: Capable • Age Range: 14-17
Educational details	
Description of the practice	The work includes, among other things, the planning and participation of a robot in the role of an actor in a theatrical performance. Students of the Informatics Group, using their knowledge of JAVA, programmed the Lego EVO3 Mindstorm model in LeJos, Eclipse environment and enabled it to feel and react to obstacles, to sing carols (here students also combined knowledge from physics and music frequencies-notes), to sing and dance on stage in the role of a regular actor with the other students of the Theater Group in the play "Fricandela the witch who hated carols". Programming language: JAVA Programming environment: Eclipse, LeJOS
List of resources	• https://twinspace.etwinning.net/59281/pages/page/416539
Assessment	The STE(A)M practice is complicated: 12/12 The STE(A)M practice is holistic: 8/9 The STE(A)M practice is problem oriented: 9/9 The STE(A)M practice is practical: 12/12 The STE(A)M practice is social: 9/12 The STE(A)M practice is transferable: 6/6

	The STE(A)M practice is based on collaboration: 7/9 The STE(A)M practice addresses professional development: 4/6

3.2 Create a smart home with Calliope

Table 2. Create a Smart home with Calliope

Type of information	Contents
Title	Create a Smart home with Calliope
Link	https://steamonedu.eu/platform/node/node/55
Abstract	Students get an impression of intelligent living with the support of technological solutions. They create their own Smart homes while combining to program sensors of Calliope and making creative boxes that represent a flat or a building. Thereby Calliope is a single board computer that is easy to handle. It has sensors that measure temperature, light, acceleration, motion, compass, or acoustic signals. The activity is suitable to introduce knowledge about electricity and programming as well as creativity while defining the interior/exterior design of the homes.
Language	English
Duration	10 hours
KeyTerms	Calliope, Smart Home, Power Circle, Electricity
STE(A)M discipline	Science, Technology, Arts
Country	Germany
Author	Maria Kruse
Educational framework	• Audience competence: Beginner • Educational/EQF level: 2 • Age Range: 8-10
Educational details	
Description of the practice	The activity was implemented in a primary school. It was a good opportunity to talk about modern living. In new houses or buildings already operating, panels have been preinstalled to control radiators, blinds, or lights. Many people benefit from controlling their technologies at home with their smartphones or use a voice-controlled intelligent personal assistant. The MIN(K)T learning activity supports its understanding and combines the basic aspects of electricity and programming. The activity makes use of the Calliope mini-technology. Students learn how to code in a block programming environment. With a few commands, results are already visible, as the Calliope directly displays something: tones, LEDs light up, display text, radio. It consists of different sensors (light, noise, temperature, position). Step one is to illustrate a power circuit. For that students learn how to program a simple if-when-loop. Step two is the integration of the light sensor and speakers, e.g. the light sensor measures the brightness. Those technologies can be combined with different situations of use. • Light sensor: It can be an alarm system if a drawer of a cupboard is opened. It also can be an automatic light switcher that puts lights in the room when it's getting dark. You could also build a simple LED series circuit that switches on when there is movement or

	increasing darkness. Or music could be played. Or turn on the television. Also, talk about sustainable use (water consumption/electricity/heating), gradually the educator explains the variation of opportunities about the possibility of sensors: light sensor, temperature sensor, light sensor, acceleration and motion sensor, compass and microphone. The educator demonstrates together with students how to program. • Position sensor: In case of movement of the house (earth-quake) an alarm can ring to protect people. • Temperature sensor: If it's getting cold, the heating can be turned on. • Pins: Programming pins means that they could show when plants need water. • Radio: Two Calliope "communicate" via alarms and sending signals to turn on/off electrical devices. Afterward, students choose two possibilities of programming and start to program in combination with creating their Smart houses. Sometimes, educators supported the pupils while programming, providing code snippets to choose from.
List of resources	• https://www.infgsnds.de/doku.php
Assessment	The STE(A)M practice is complicated: 11/12 The STE(A)M practice is holistic: 7.5/9 The STE(A)M practice is problem oriented: 9/9 The STE(A)M practice is practical: 12/12 The STE(A)M practice is social: 10.5/12 The STE(A)M practice is transferable: 5/6 The STE(A)M practice is based on collaboration: 7.5/9 The STE(A)M practice addresses professional development: 4.5/6

3.3 Fairytale Mathematics

Tabulla bella

Title	Fairytale Mathematics
Link	https://steamonedu.eu/platform/node/node/60
Abstract	This program is designed in the context of the eTwinning STEM 2.0 action and aims to approach Kindergarten Mathematics through known or unspoken stories and myths, using the first child-encoding-robot coding equipment or from independent activities. At the same time, communication, cooperation, and interaction with other schools in Europe are encouraged. The goal of the Mathematics Kindergarten program is to process and exploit new data, to compare and transform simple relationships and processes with testing and testing. You are interested in inventing and solving problems and utilizing modern technology. In the process of solving problems, both individually and in groups, children develop special skills such as comparing and connecting objects, understanding certain properties, relationships, and combinations, and finally measuring and recognizing simple patterns in the environment.
Language	Greek
Duration	8 months
KeyTerms	Mathematics, STE(A)M, E-Twinning
STE(A)M discipline	Mathematics, Arts
Country	Greece
Author	Georgia Pagania
Educational framework	• Audience competence: Beginner • Age Range: 5-8
Description of the practice	Objectives: • Reflect on and research a variety of situations, build on previous knowledge and experience, make simple assumptions and come to relevant conclusions • manage and use materials, tools, and situations related to everyday life • exploit the potential for numerical applications within the limits of their capabilities • gradually build the concept of numbers • interpret 'general' elements of the world that surround them through observation and description, comparison, classification, matching, sequencing, and symbolic representations • Organize and expand their knowledge of numbers • perform simple mathematical operations • to measure using arbitrary or conventional units of measure • Understand simple spatial relationships • enrich the language and words associated with mathematics, communicate and leverage technology The objectives of the program have been achieved through known or untold stories, STEM 2.0 equipment, or other activities. A contributor to children's discoveries is Detective Mythis with his robot assistant. Each month the partners uploaded relevant activities on the twin space to update and comment on the rest. Also, each partner was free to choose one or more fairy tales, as he or she wished. Indicative fairy tales: The 3 little pigs, Snow White and the 7 dwarfs, the 7 goats, Little Red Riding Hood, Cinderella, Aesop's myths,

	traditional fairy tales, and more. The expected results are the creation of a collaborative story with mathematical concepts and its illustration with collaborative paintings.
List of resources	• https://blogs.sch.gr/15nipat/wp-admin/post.php?post=14212&action=edit • https://blogs.sch.gr/15nipat/wp-admin/post.php?post=14219&action=edit • https://www.youtube.com/watch?time_continue=1&v=wY6QtUFMnbM&feature=emb_title • https://padlet.com/ioaferm22/j7x4trs5ztlp • https://padlet.com/evaggeliasariggoli/qjtczepm9zzq • https://blogs.sch.gr/15nipat/2020/01/05/paramythenia-mathimatika-stem-dekemvrios-2019/ • https://blogs.sch.gr/15nipat/2020/02/04/paramythenia-mathimatika-stem-ianoyarios-2020/ • https://blogs.sch.gr/15nipat/2020/03/14/etwinning-paramythenia-mathimatika-stem-fevroyarios-2020/ • https://blogs.sch.gr/15nipat/2020/03/14/etwinning-paramythenia-mathimatika-stem-fevroyarios-2020/ • https://blogs.sch.gr/15nipat/2020/04/08/etwinning-paramythenia-mathimatika-stem-o-mythis-kai-to-rompotaki-toy-se-drasi-exapostaseos-epikoinonias/ • https://www.storyjumper.com/book/read/85108735/5ee0c7116a938 • https://view.genial.ly/5eda8ebc9543960d59dbe31c/presentation-etwinning-stem-fairytaile-mathematics?fbclid=IwAR05m829OSjECJvy8PyQrib-wHEPuzLYaI9vk8Qrpo-xuXZ252uL7E14ppQ
Assessment	The STE(A)M practice is complicated: 12/12 The STE(A)M practice is holistic: 9/9 The STE(A)M practice is problem oriented: 9/9 The STE(A)M practice is practical: 12/12 The STE(A)M practice is social: 11/12 The STE(A)M practice is transferable: 6/6 The STE(A)M practice is based on collaboration: 9/9 The STE(A)M practice addresses professional development: 5/6

Table 3. Fairytale Mathematics

3.4 EuroSTE(A)M

Type of information	Contents
Title	EuroSTE(A)M
Link	https://steamonedu.eu/platform/node/node/63
Abstract	The Erasmus+ EuroSTE(A)M project looked into the deficit of STE(A)M skills in young students throughout Europe. The aim of the project was to identify how we can use more interactive and creative teaching methodologies in our classrooms in order to excite and engage students in STE(A)M subjects. The seven EuroSTE(A)M partners from across Europe bring to you exciting lesson resource which are open source and free to use on your classroom to excite young students about the opportunities in STE(A)M careers. The project produced 3 main outcomes: • *STE(A)M comparative analysis report* which has identified shortcomings within the STE(A)M subjects and highlighted how we can introduce different learning methods into our classrooms to reduce these skills gaps in the future. • *STE(A)M Camps*: In order to give educators a starting block for introducing these subjects in the classroom, we have created 3 camps with different themes and focuses. These camps have been fully explained through resources and guides in different languages (English, Dutch, Italian Portuguese and Spanish) and are openly available to Educators. • *Online Toolkit*: EuroSTE(A)M produced this online toolkit which will act as a library for educators throughout Europe to access if they need to run a STE(A)M based lesson or workshop within their classroom. This is open sources a freely available to use for students and teachers.
Language	English
Duration	1 month
KeyTerms	Coding, Scratch, Binary Counting, Interactive Science, Creativity and logic, Problem Solving, Contest and challenge
STE(A)M discipline	Science, Technology, Engineering, Arts, Mathematics
Country	Belgium, Great Britain, Netherlands, Italy, Portugal, Spain
Author	EuroSTE(A)M Consortium
Educational framework	• Audience competence: Beginner • Age Range: 25-70
Educational details	
Description of the practice	The EuroSTE(A)M Camps are designed as a series of mixed activities where students working in small groups face different problems. This choice, as for all the 3 Camps, triggers a conceptualization process, stimulated by the challenge, where students organize information in a structured knowledge system. The challenge aims to solve a given problem and compare the results achieved among workgroups; during each session, it's important to create the correct team dynamics by dividing tasks among single members and planning effectively the time available.

	- Coding & Technology (Camp 1): Coding and Technology camp is based on computer activities using a platform and a widely known interface such as Scratch. The choice of an activity such as programming came from the need to engage young students in a playful and exciting educational experience which could at the same time stir their interest in enhancing knowledge such as maths, reading comprehension, and science, transversally and using one language. - Creativity and Logic (Camp 2): The creativity and Logic Camp introduces students to concepts and principles related to the world that surrounds us (learning binary numbers upon which the digital world is based, ability to comprehend and summarise a text, learning new math aspects, spurring problem-solving through experimentation). In our contemporary society, where learners do not take information out of the real world but use conceptual structures to interpret it and understand it, science, technology, engineering, art, and maths are currently considered as access points to guide students to search, communicate and think critically. - Contest and Challenges (Camp 3): Contest and Challenges camp is designed as a series of mixed activities where students working in small groups face different problems. Each module features a challenge to be faced as a team; each challenge has a subject emphasizing logic, text analysis, maths, and engineering. This choice, as for all the 3 Camps, triggers a conceptualization process, stimulated by the challenge, where students organize information in a structured knowledge system. The challenge aims to solve a given problem and compare the results achieved among workgroups; during each session, it's important to create the correct team dynamics by dividing tasks among single members and planning effectively the time available. During this camp, teachers drop their "boss-like" role and become facilitators.
List of resources	• Resources are available in different languages (English, Dutch, Italian Portuguese and Spanish) on the project website: http://www.euroSTE(A)Mproject.eu/
Assessment	The STE(A)M practice is complicated: 11.5/12 The STE(A)M practice is holistic: 8.5/9 The STE(A)M practice is problem oriented: 8.5/9 The STE(A)M practice is practical: 12/12 The STE(A)M practice is social: 8.5/12 The STE(A)M practice is transferable: 5.5/6 The STE(A)M practice is based on collaboration: 8/9 The STE(A)M practice addresses professional development: 5.5/6

Table 4. EuroSTE(A)M

3.5 Creating music with SonicPi

Type of information	Contents
Title	Creating music with Sonic Pi
Link	https://steamonedu.eu/platform/node/node/62
Abstract	Electronic sounds and music are the product of programming via the open-source tool Sonic Pi. It is a code-based music creation and performance tool. It allows in a simple way of coding to produce music. The software was developed to find simple ways of dealing with music and programming.
Language	English
Duration	8 hours
KeyTerms	Programming, Coding, Creativity, Sound Set, Live Music
STE(A)M discipline	Technology, Engineering, Arts
Country	Germany
Author	Sam Aaron and Sonic Pi core team
Educational framework	• Audience competence: Beginner • Educational/EQF level: 1 • Age Range: 8-99
Educational details	
Description of the practice	The software was created to develop young student's programming skills. As programming can be a very complex activity the purpose of developing this software was to get output immediately after writing in a programming language. Further, the code visualizes musical ideas of songs. The students are enabled to set up and influence sounds, rhythms, and the speed of musical components. Educators can provide ideas for students of what music refers to: - confrontation and analyzing existing music styles - create new sound-combinations - live music and programming performances For implementing this STE(A)M learning activity students need digital devices: PC or Tablet. The software should be installed on all devices.
List of resources	• https://in-thread.sonic-pi.net/t/sonic-pi-online-resources/17 • https://re-publica.com/de/session/horbar-programmieren-sonic-pi
Assessment	The STE(A)M practice is complicated: 11/12 The STE(A)M practice is holistic: 7/9 The STE(A)M practice is problem oriented: 8/9 The STE(A)M practice is practical: 11.5/12 The STE(A)M practice is social: 9/12 The STE(A)M practice is transferable: 6/6 The STE(A)M practice is based on collaboration: 7.5/9 The STE(A)M practice addresses professional development: 5/6

Table 5. Creating music with Sonic Pi

3.6 Makers in the classroom at Raval district (Barcelona)

Type of information	Contents

Title	Makers per la inclusió (Makers for inclusion)
Link	https://steamonedu.eu/platform/node/node/90
Abstract	Initially, Makers for Inclusion carry out an awareness-raising task, based on carrying out outreach activities that arouse interest and encourage the learning of techniques related to digital manufacturing. It is also essential for the involvement of educational agents in the territory and the development of complementary activities to the educational curriculum, extracurriculars, open workshops ... In which areas? Scratch programming, electronics with Arduino and free hardware, sound technologies, digital manufacturing and 3D printing, video game creation, internet of things, etc. When arousing interest in these matters, we work in three lines: • Work on technological vocations, directing participants to less precarious work camps • Work to improve the self-perception, autonomy, and empowerment of the participants. Although they do not end up working in this branch, the acquisition of knowledge and skills a priori far from their experience improves their social situation. • Analyze possibilities of new professional profiles around technology and education, based on detected needs of the school community in the neighbourhood
Language	English
Duration	1 year
KeyTerms	Makers, Inclusion, 3D Printing, Internet of Things, Video-game Creation
STE(A)M discipline	Technology, Engineering, Arts, Mathematics
Country	Spain
Author	Martina Mayrhofer
Educational framework	• Audience competence: Starter • Educational/EQF level: 3 • Age Range: 6-15
Educational details	
Description of the practice	Makers for Inclusion is a project that offers citizens an opportunity to approach and appropriate digital manufacturing in a broad sense. From playful and educational activities it wants to introduce concepts, work skills and bring knowledge and techniques that, a priori, are not accessible to citizens living in the Raval. The focus on approaching these new techniques and technologies is strongly marked by a socio-economic bias. While it is true that in Barcelona many experiences bring digital manufacturing closer to the public, successful experiences continue to occur among sectors of the population with a medium-high socio-educational profile. Spaces and projects in this area are often not permeable to neighbourhoods where there is a high risk of exclusion, where the socio-economic level of its inhabitants is below the city average, and where the results of the education system require special support. We are in a situation where we run the risk of creating a two-speed

	Barcelona, an innovative and creative one, and one that goes after it, creating a second-level digital divide. This project wants to work to avoid this crack in the Raval of Barcelona, a neighbourhood where we have been working at the community level since our birth and where we are already making bets for the social transformation of our environment, and the social and solidarity economy. Makers for Inclusion is aimed at children and young people, women, vulnerable groups, or those at risk of exclusion, families, agents of the educational community, non-profit organizations, and social education professionals.
List of resources	• https://docs.google.com/presentation/d/e/2PACX-1vTcdnrV8t1jMs6xTd4xZ5XdPGdcjBgfY5g3cbIdawDQ2yOBP8Y1mPGpvSj2lqMZiBVWB58pqjPlUMtg/embed?start=false&loop=false&delayms=3000&slide=id.p • https://docs.google.com/presentation/d/e/2PACX-1vSjsospuRvVYFHEmYXBMLvkNQGjKBl0wvxUtlVEAVIHAuFxY_n5Kzd0_yVqgUMRYetEKR5KFVDxUrZf/embed?start=false&loop=false&delayms=3000&slide=id.g76faeab4a6_0_57
Assessment	The STE(A)M practice is complicated: 11/12 The STE(A)M practice is holistic: 9/9 The STE(A)M practice is problem oriented: 9/9 The STE(A)M practice is practical: 12/12 The STE(A)M practice is social: 11/12 The STE(A)M practice is transferable: 5/6 The STE(A)M practice is based on collaboration: 9/9 The STE(A)M practice addresses professional development: 6/6

Table 6. Makers per la inclusió (Makers for inclusion)

3.7 CODINC "Coding for inclusion"

Type of information	Contents
Title	CODINC "Coding for inclusion"
Link	https://steamonedu.eu/platform/node/node/61
Abstract	The CODINC Erasmus+ project aimed at fostering STEM education of disadvantaged youth through an inclusive educational approach based on a peer-learning pedagogical method for formal and non-formal educational contexts in Europe. The project-specific objectives are: Increase and improve teachers' and trainers' capacity to foster the STEM education of disadvantaged youth through an inclusive educational approach based on peer-learning Empower disadvantaged young people in the acquisition and development of IT and collaborative competences as well as problem-solving, self-confidence, and creativity through a peer-learning training programme on Coding
Language	English
Duration	2 years
KeyTerms	Coding, Robotics, Computational Thinking, Programming
STE(A)M discipline	Technology, Engineering, Arts
Country	Belgium, Cyprus, Germany, Italy, Spain
Author	The CODINC "Coding for Inclusion" Consortium
Educational framework	• Audience competence: Starter • Educational/EQF level: 3 • Age Range: 5-18
Educational details	
Description of the practice	The CODINC Erasmus+ project aimed at fostering STEM education of disadvantaged youth through an inclusive educational approach based on a peer-learning pedagogical method for formal and non-formal educational contexts in Europe. CODINC was coordinated by ALL DIGITAL and implemented in 5 European countries (Belgium, Cyprus, Germany, Italy, and Spain) from January 2018 until January 2020. CODINC methodology covers the widest range of topics including computational thinking, algorithmic thinking, programming, and robotics. What makes CODINC particularly unique is how it not only engages in computational thinking and coding but how it does so with a structured peer-learning methodology. The CODINC Methodology gives guidance to trainers and teachers on how to deliver the CODINC peer-learning training of 15 hours with primary and secondary school students and gives some background on supporting STE(A)M education and computation thinking. The CODINC Toolkit offers a database of exercises that can be delivered according to the structure of the toolkit. The toolkit allows for flexibility and adaptability to local circumstances and curriculum. It allows the teachers

	and trainers to select and adapt modules according to their capacities and the needs of students. The piloting of CODINC took place in schools identified as disadvantaged in Berlin, Leipzig, Barcelona, Nicosia, Ghent, Brussels, and Naples involving 222 secondary school students trained in coding and learning pedagogies in 15-hour workshops in and outside school hours. The secondary school students then went on to teach 481 primary school students in peer-to-peer workshops with students in 8 schools and 20 teachers involved in 7 cities in 5 countries.
List of resources	• The CODINC project resources (methodology, Toolkit, Pilot Evaluation report, policy recommendations etc.) are available in different languages (Catalan, Dutch, English, German, Greek, Italian Spanish) on the project website: http://codinc.fun/
Assessment	The STE(A)M practice is complicated: 8/12 The STE(A)M practice is holistic: 9/9 The STE(A)M practice is problem oriented: 9/9 The STE(A)M practice is practical: 12/12 The STE(A)M practice is social: 11/12 The STE(A)M practice is transferable: 6/6 The STE(A)M practice is based on collaboration: 9/9 The STE(A)M practice addresses professional development: 5/6

Table 7. CODINC "Coding for Inclusion"

3.8 GoodNewsnotFakeNews

Type of information	Contents
Title	GoodNewsnotFakeNews
Link	https://steamonedu.eu/platform/node/node/45
Abstract	"GoodNews not FakeNews" is the result of a coding process within the Olympics of Problem Solving (MIUR-UniBo) project. The project is annually organized by the University of Informatics of Cesena, aiming to facilitate the development of young students' social competencies, including computational thinking through logical-mathematical, active citizenship skills, and digital skills. At the same time, the project contributes to the overall formation of the student, according to the EU key competencies. The activities aim to develop mature and aware students, responsible for themselves and others, and capable of cooperating. Fifth-grade primary school students are the project target. Students took part in activities of coding, making, and programming competitions, where we noticed strong participation and activeness by the girls. These activities are designed for the conception and implementation of a program based on a given theme. The production environment is Scratch: an easy and very effective tool to teach the basics of block codes for programming to primary school students. Studying math through coding to produce something fun and creative is a very impactful way of providing complex and ordered reasoning skills to young students. This method is particularly effective as the learned topics stick to the long term memory instead of the short term. The students were divided into teams to realize a series of animation spots entitled "GoodNews NOT FakeNews" to explain to their peers how insidious the world of the web can be and how to defend against misleading information. This activity was very important as part of the vertical curriculum and also for the development of transferring skills and mutual learning. The topic was selected through a discussion between the students, contributing to boosting students to critical thinking, and to express and build their opinion. When the topic was chosen each team chose different ways of presenting the topic. Some chose to take inspiration from the fairy tale "Pinocchio", others through a structure similar to a TV spot. Students presented the work done with great "professionalism", illustrating the methodological and technical aspects of the project and its implementation process, in particular, they exposed how it was organized, how it was carried out, which were the roles and how the team worked together in collaboration. Then, they illustrated in details the planning of the developed code and its operation by explaining to the Computer Engineering Department of Cesena professors which were the challenges they faced and what technical solutions they chose and applied.

	By applying the typical Problem Solving processes, pupils discovered the principles of computer science, acquired technological skills, but above all enhanced their cognitive and methodological skills.
Language	Italian
Duration	3 months
KeyTerms	Coding, Scratch, Problem solving, fake news
STE(A)M discipline	Technology, Arts
Country	Italy
Author	Silvia Mazzeo
Educational framework	• Audience competence: Beginner • Age Range: 9-14
Educational details	
Description of the practice	The students, divided into teams, caught the topic of fake news and researched to understand what it is. With careful research on the Internet, they identified the elements that distinguish real news from false ones and decided to implement a project that could also serve other friends to understand that it is important to be careful about what you read on the web. Project's final animation plot 1: two boys meet at a shopping center in front of the school to go to a concert; when they arrive at their destination they find nothing and realize that they have fallen for fake news. The two boys provide peers with some useful tips and a small handbook to recognize false information. Project's final animation plot 2: Pinocchio, the prince of lies, enters the scene and he too understood he was wrong. The programming includes changes of background and characters' costumes, the dialogues are very simple, but the final animation result is well structured in time and content.
List of resources	• https://scratch.mit.edu/projects/287189728 • https://drive.google.com/file/d/1_3P8XTW5H_gUDDMeduw6jPyYt9Kc_V4g/view • http://www.icmontaltotaverna.edu.it/ic2/2019/04/13/cesena-finale-nazionale-olimpiadi-di-problem-solving/
Assessment	The STE(A)M practice is complicated: 9.5/12 The STE(A)M practice is holistic: 7/9 The STE(A)M practice is problem oriented: 9/9 The STE(A)M practice is practical: 11.5/12 The STE(A)M practice is social: 10.5/12 The STE(A)M practice is transferable: 5.5/6 The STE(A)M practice is based on collaboration: 7/9 The STE(A)M practice addresses professional development: 5/6

Table 8. GoodNewsnotFakeNews

3.9 INNOV@DIDATTICA: STE(A)M, THINKERING & CLIL on a scientific web radio and web tv

Type of information	Contents
Title	INNOV@DIDATTICA: STE(A)M, THINKERING & CLIL on a scientific web radio and web tv
Link	https://steamonedu.eu/platform/node/node/70
Abstract	How can Students learn basic physics contents about phenomena we observe around us? How can we increase a student's interests in Maths and Physics if he studies at Linguistic Lyceum? We believe that STE(A)M education and Thinkering laboratory is the answer. By using CLIL methodology, CBL approach, and BYOD technique, during our laboratory we found that the laboratory approach is the most effective way to engage students with STEM subjects. The project's core activities consisted of challenges between small students' groups (3-4 people) creating and exposing experiments about physics everyday life phenomena. The experiments were presented through videos, animations, or podcasts as they were episodes of a scientific web radio or web tv. They produced video or audio reports using their devices (laptops, smartphones, tablets, etc.). The interaction between the teacher and the classmates was just in English.
Language	English
Duration	1 year
KeyTerms	Scientific Web Radio, Web TV, STE(A)M, THINKERING, BYOD, Arts, Maths, Physics, CLIL, Creativity, Logic, History
STE(A)M discipline	Science, Engineering, Arts, Mathematics
Country	Italy
Author	Tamara Maio
Educational framework	• Audience competence: Beginner • Educational/EQF level: 4 • Age Range: 14-99
Educational details	
Description of the practice	We have encouraged our students to experiment by using recyclable materials, this way also introducing our students to the concept of sustainability. During the laboratory, the students were asked to make autonomous research on the internet to look for experiments to explain specific phenomena. After finalizing the research, they had to create scientific reports through video, animations, or multimedia presentations (web radio or a web tv). The autonomous research was very successful, as the students showed great ability in finding good materials and create their contents from these. The reports' contents became then open educational material to be used at school by teachers and students. The laboratory experiments always had to involve the use of materials found in the surrounding environment, to make our students aware that we can

	find references of STEM subjects everywhere around us and that all disciplines are interdependent. Following this multidisciplinary methodology, we studied topics like logarithmic curve, kinetic, and potential energy. Coding was also introduced through the use of Arduino to learn what is a cycle of instruction and variable definition (example: programming Christmas tree lighting synchronization to music; functioning of traffic light). 3D modeling was also experienced through Thinkercad. These activities were particularly useful for the students' acquisition of planning and programming skills. To make our activities even more interdisciplinary, we used both the English language and arts to discuss the different STEM subjects. Our students took part also in the project Europe Square (Crowddreaming) and other cultural heritage projects involving VR, and activities with the National Space Agency.
List of resources	• https://drive.google.com/file/d/1GuRgrpsCUlyOFTy4xTUkFFfKDWkLjle-/view?usp=drivesdk
Assessment	The STE(A)M practice is complicated: 10.5/12 The STE(A)M practice is holistic: 7.5/9 The STE(A)M practice is problem oriented: 5.5/9 The STE(A)M practice is practical: 10/12 The STE(A)M practice is social: 11/12 The STE(A)M practice is transferable: 5/6 The STE(A)M practice is based on collaboration: 5.5/9 The STE(A)M practice addresses professional development: 4.5/6

Table 9. INNOV@DIDATTICA: STE(A)M, THINKERING & CLIL on a scientific web radio and web tv

3.10 "In the traces of Pythagoras"

Type of information	Contents
Title	"In the traces of Pythagoras" (a programming robots approach of Pythagoras theorem)
Link	https://steamonedu.eu/platform/node/node/74
Abstract	Brief teaching of the Pythagorean theorem to 20 students coming from seven European countries, i.e., Poland, Portugal, Spain, Finland, Romania, Italy, and Germany, in the frame of the Erasmus project ran by our school, entitled "Learning with Arts". The teaching combined the theoretical presentation of the Pythagorean Theorem with its practical application, using two specially made LEGO EV3 robots. The purpose of the course was to help students get to know and 'experience' the Pythagorean theorem.
Language	English
Duration	3 hours
KeyTerms	Geometry, Robotics, Mathematics, Pythagorean Theorem, History
STE(A)M discipline	Technology, Engineering, Arts, Mathematics
Country	Greece
Author	Petros Stavroupolos
Educational framework	• Audience competence: Beginner • Educational/EQF level: 1 • Age Range: 10-13
Educational details	
Description of the practice	Initially, Pythagoras and the Pythagorean Theorem were presented in combination with examples of calculating the length of the hypotenuse of a right triangle. Then a worksheet was handed out and the students, divided into groups, were invited to calculate the length of the hypotenuse of a right triangle according to the examples they had been earlier exposed to. During the next step, the students learned about the LEGO EV3 robotics kit and its programming environment. Also, an interactive whiteboard featured an exercise in Geogebra that showed the relationship between the perimeter of a circle and its calculation of the distance a robot covers when its wheel makes a complete rotation. There was also a presentation on π = 3.14 and on the way of calculating the perimeter of a circle, which was necessary for the experiential exercise that would follow. Finally, the guest students were given an EV3 robot, made by the pupils of the robotics group (E-F class), with a marker adapted on it, so that it could write on paper. Also, each group was given a sheet of paper designed with two vertical lines (vertical triangle lines), as well as rulers on how to measure their length. The students of the robotics group (E-F class) had created a program in the programming environment of LEGO EV3, which took as inputs the values of the perpendiculars of a triangle and calculated the hypotenuse of the triangle, and moved the robot for the corresponding period.

	In this phase of the task, the guest students were asked to count the two vertical lines and then enter them into the program, download them to the robot and draw the underlying sheet on the sheet they were earlier given, confirming the correct calculations made following the rules of the Pythagorean Theorem.
List of resources	• https://steamonedu.eu/platform/sites/default/files/2020-06/Pythagoras-2.pdf • https://steamonedu.eu/platform/sites/default/files/2020-06/Pythagoras-Worksheet.pdf
Assessment	The STE(A)M practice is complicated: 12/12 The STE(A)M practice is holistic: 9/9 The STE(A)M practice is problem oriented: 8/9 The STE(A)M practice is practical: 12/12 The STE(A)M practice is social: 11/12 The STE(A)M practice is transferable: 6/6 The STE(A)M practice is based on collaboration: 7.5/9 The STE(A)M practice addresses professional development: 5.5/6

Table 10. "In the traces of Pythagoras" (a programming robots approach of Pythagoras theorem)

3.11 Scratch și..... Gool!

Type of information	Contents
Title	Scratch și..... Gool!
Link	https://steamonedu.eu/platform/node/node/33
Abstract	Scratch și..... Gool! project aimed to increase confidence in programming, precisely because we focus on making connections between the real world and the world of technology. Students realized that programming can be available to anyone, that it does not only remain at the level of code but has correspondences in everyday life. The proposed event is part of our concerns to increase the impact of an event awarded in the international competition Meet and Code 2018, which was declared the winner in the Kick and Code category, due to the involvement of all participants in activities.
Language	Romanian
Duration	14 hours
KeyTerms	Coding, Football, Scratch, Primary School
STE(A)M discipline	Science, Technology, Engineering, Arts, Mathematics
Country	Romania
Author	Asociatia Pro Teodor Murasanu Turda
Educational framework	• Audience competence: Beginner • Age Range: 9-11 • Educational/EQF level: 2
Educational details	
Description of the practice	In the Scratch language, football movements will be scheduled to be tested on the school sports field. The ground will be marked with washable paint, in 6/8 squares with a side of 2 m. The gates of the field will be marked with milestones. In each team, 5 students will read the codes representing the movements, printed on paper, and another 5 will execute the codes on the football field. A student will be the referee. Medicinal balls will be used so that they can be easily stabilized. Content elements: familiarization with Scratch, transcription of ball movements in Scratch language.
List of resources	• https://bogdanmin8.wixsite.com/proiecteprogramare/scratch-si-gool
Assessment	The STE(A)M practice is complicated: 10/12 The STE(A)M practice is holistic: 7.5/9 The STE(A)M practice is problem oriented: 7.5/9 The STE(A)M practice is practical: 12/12 The STE(A)M practice is social: 9/12 The STE(A)M practice is transferable: 5/6 The STE(A)M practice is based on collaboration: 7.5/9 The STE(A)M practice addresses professional development: 4.5/6

Table 11. Scratch și..... Gool!

3.12 Turtle Coder and the Turtle Coding Box

Type of information	Contents
Title	Turtle Coder and the Turtle Coding Box
Link	https://steamonedu.eu/platform/node/node/53
Abstract	The TurtleCoder is an inclusive programming environment specifically designed to introduce all children from up to 8 years to programming. The programming language Logo serves as a basis. The development environment "TurtleCoder" offers the possibility to program own small scripts in Logo on the computer or the Tablet-PC. The purpose of TurtleCoder is to define the way the turtle must walk. While walking it draws a line and designs pictures. Completely without previous knowledge and self-explanatory. It is based on the platform Touchdevelop and does not use block programming, but uses the principle of visual programming. Children can write their lines of code in the app and approach the programming language Logo like a new foreign language, including vocabulary, rules, and syntax. A suggestion list helps to avoid errors. In addition to its simple structure, another strength of the LOGO programming language is that the individual commands can be discovered by the children not only digitally in a programming environment, but also offline in the classroom. Educational material for inclusive STE(A)M education is provided with the "Turtle Coding Box". Within that box, educators/teachers find learning activities for digital and analog STE(A)M-education. Within the analog activity, children themselves slip into the role of the turtle and run or move the required figures according to the sequences of commands in the room - an outstanding principle for converting their movements into code. The learning material supports and encourages educators and teachers to provide Coding-Art-lessons while benefiting from the algorithm. With the Turtle Coding Box, ALL kids can learn how to code, regardless of social background, physical or mental abilities, or disabilities. The resource provides: • the coding app TurtleCoder with integrated assistive technologies for learners with disabilities • the Turtle-Book as digital, interactive teaching resource with a complete curriculum for informatics basic education with 7 lesson plans, video-tutorials for teachers & students, task cards & working material • selected material with Braille, special videos with sign language What is unique about the resources is that both the didactic approach and the technology are designed for inclusive learning. Teachers can teach coding with very diverse learners within one group at the same time. Children with and without disabilities, highly gifted ones, or with learning difficulties – for the first time ALL students code together with just one resource and foster digital skills together. This enables future opportunities!
Language	German
Duration	5 hours
KeyTerms	Art, Coding, Turtle, Graphics
STE(A)M discipline	Technology, Arts, Mathematics

Country	Germany
Author	Helliwood media & education at fjs e.V:
Educational framework	• Audience competence: Beginner • Age Range: 8-16 • Educational/EQF level: 1
Educational details	
Description of the practice	The TurtleCoder is a programming environment for beginners, in which a small virtual turtle is given commands via lines of code, which it implements as movement on the screen. It traces the path it has traveled and creates the so-called Turtle graphics, which range from simple geometric figures to artistic drawings. The programming language LOGO is easy for children to understand and learn. With just a few basic commands (forwards, backward, turn left, turn right) children can start their first learning experiments and learn important programming principles step by step in combination with drawing and designing the screen. The clear, simple commands and constructions can be understood and worked on by children with different previous knowledge, disabilities, and different needs. In addition to the simple structure, another strength of the LOGO programming language is that the individual commands can be discovered by the children not only digitally in a programming environment, but also in the classroom. Thus learning activities are hybrid - they can be rolled out online and onsite. The children themselves slip into the role of the turtle and run or move the required figures according to the sequences of commands in the room - an outstanding principle to convert their movements into code. Also, all learning units contain exercises in which the teacher simulates the programmer and the executing computer program with the children. This supports the discovery learning of programming. To enable learners to make independent discoveries in the sense of constructivist learning, it is recommended that teachers increasingly take on the role of learning guides. The way they are learning is problem-based as children learn immediately in the programming environment. The students benefit greatly from programming and drawing if they can solve the tasks in small teams. It is therefore advisable to always have two children working on one computer or tablet. In this way, they can construct their solutions together, and the exchange of ideas promotes their ability to cooperate, collaborate, and communicate. Reaching the goal together strengthens the group cohesion.
List of resources	• http://player.edudesk.de/Book/cyl_das-turtlebuch/page/2
Assessment	The STE(A)M practice is complicated: 12/12 The STE(A)M practice is holistic: 9/9 The STE(A)M practice is problem oriented: 9/9 The STE(A)M practice is practical: 12/12 The STE(A)M practice is social: 11/12 The STE(A)M practice is transferable: 6/6 The STE(A)M practice is based on collaboration: 7/9 The STE(A)M practice addresses professional development: 5/6

Table 12. Turtle Coder and the Turtle Coding Box