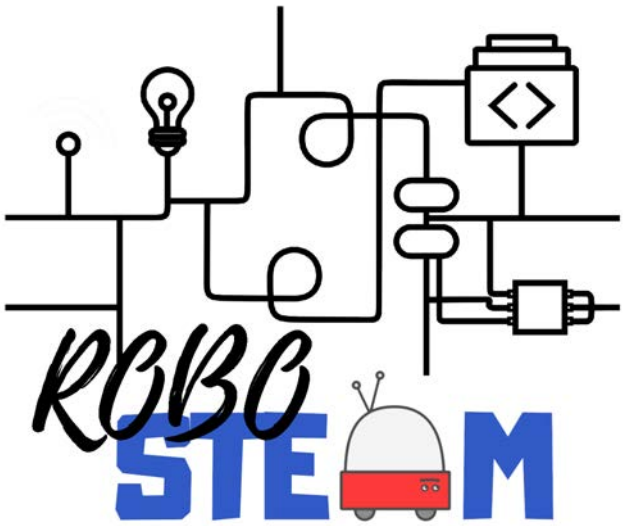
Compilation of STEAM challenge tools and guides – O3.A2



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Version History

Version	Date	Comments
0.1	01/06/2019	Definition of a template
0.2	01/07/2019	Template review
1.0	01/09/2019	Compilation of resources

Table of Contents

1. O3.A1

This document describes part of the work of the Output 3 – RoboSTEAM Environment [1]. The output aims to define an educational environment which will offer to schools and teachers a complete set of tools, activities, guides and support to manage the implementation of STEAM challenges. An important part of this output is a compilation of resources. This activity is described as follow in the proposal:

> "Compilation of STEAM challenge tools and guides (definition and/or compilation of tools and guides that may be used to carry out STEAM challenges). This is the core functionality of RoboSTEAM environment. This compilation should include:
> - Online and desktop software for designing action/activity plans.
> - Online questionnaires about integrating STEAM.
> - Integration systems with open source LMS environments (Moodle, Sakai, etc.).
> - Report generator tools.
> - Learning analytics tools.".

2. The process

In order to facilitate the compilation and classification of recourses a template is done. This template is validated by the partners and employed to classify some testing samples. Later each partner provides resources of the different types

2.1. The template

Based on previous projects experiences [2-7], RoboSTEAM project [8, 9] decides to use the following template.

Template for a resource description

Draft. Version 1.
June 1th, 2019

Title: The resource title.

Description: A short, but significant resource description.

Link: Link to the resource if it is available.

License: What kind of licensing system the resource has, if available.

Languages: In which languages the resource is available.

Target groups: Which are the main target groups of this resource.

Known uses: Examples of the use of the resource, it they exist (including videos, text-based descriptions, links, etc.).

Pedagogical level: Resource pedagogical level.

Classification: The classification of the resource taking into account if it is (Tools to develop STEAM Challenges, Questionnaires about integrating and assessing STEAM, Frameworks, Report Tools, Learning Analytics Tools, Other).

Quality: Perceived quality of the resource [scale 1-5].

Open comments:

2.2. Sample

A sample of a resource can be the next one

Title: Skype.

Description: Skype is a well-known tool that que be applied in Challenge based learning environments to facilitate the communication of the team members when they are not working together and also to interact with expert. It includes the possibility to chat, make voice and video calls, group video conferences, etc.

Link: https://www.skype.com/

License: Copyrithted by Microsoft, proprietary license, free version. More information: https://www.skype.com/en/legal/

Languages: Almost all.

Target groups: In the challenge-based learning context the target groups could be students, teachers, parents and experts.

Known uses:
https://www.youtube.com/watch?v=S38e-t6rhKA;
https://support.skype.com/es/faq/FA6/que-es-skype

Pedagogical level: Any level (from 12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 4.

Open comments: One of the most common tools to use for communication with peers and experts in challenges.

3. Bank of Resources

The resources added in an initial upload are included in this report. However new resources are added as part of the O3.A4.

3.1. Tools to develop STEAM Challenges

1. AMICI programming environment with an iconic interface for Arduino LilyPad and smart textile.
2. Arduino.
3. Codeweek website of the EU.
4. CoSpace Robot.
5. Discord.
6. eCraft2Learn maker project platform.
7. Fritzing.
8. How to sketch with electronics.
9. Hummingbird robots.
10. Instruction on how to build a fever Teddy.
11. Making activities with children and young pPeople.
12. Making things wearable by René Bohne.
13. MBlock.
14. mBot robot.
15. Micro:bit.
16. Microsoft Teams.
17. MIT Media Lab; High-Low Tech Website (Tutorials).
18. OpenSCAD.
19. Padlet.
20. Pearltrees.
21. Scratch.
22. SimTwo.
23. Sketchup.
24. Skype.
25. Step by step tutorial/getting started with Arduino LilyPad and Amici-Technology.
26. TACCLE3 – Coding website.
27. Telegram.
28. The CONSTRUIT! Environment.
29. The PBL CANVAS.
30. Thingiverse – Digital Designs for Physical Objects
31. TinkerCAD.
32. TinkerCAD Circuit.
33. Trello.
34. Tutorial Arduino LilyPad Construction Kit.
35. WhatsApp.
36. Zoom.

3.1.1. AMICI Programming environment with an iconic interface for Arduino LilyPad and Smart Textile

Title: AMICI Programming environment with an iconic interface for Arduino LilyPad and Smart Textile.

Description: Visual programming language which enables programming novices to program Arduino boards without having to master the textual programming language Arduino. Amici builds on the Arduino IDE (further information can be found at arduino.cc). It was developed in the European research project EduWear.

Link: http://dimeb.informatik.uni-bremen.de/eduwear/
Further resources can be accessed at the Website of the research group "Digital media in education" at the University of Bremen (Prof. Dr. Heidi Schelhowe): http://dimeb.informatik.uni-bremen.de/eduwear/resources/

License: Since the Arduino software is open-source Amici is open as well (source code on request), released under the GPL.

Languages: English, German, Portuguese, Danish.

Target groups: novices to programming.

Known uses: BMBF-project MediaArt@Edu n Smart textile; TACCLE 3 coding Workshop for teachers.

Pedagogical level: Any level (from 12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 4.

Open comments:

3.1.2. Arduino

Title: Arduino.

Description: Open-source electronic prototyping platform enabling users to create interactive electronic objects.

Link: https://www.arduino.cc

License: The Arduino hardware and software are open source. The source code for the Java environment is released under the GPL and the C/C++ microcontroller libraries are under the LGPL.

Languages: Resources are available in almost all languages.

Target groups: In the challenge-based learning context the target groups could be students, teachers, parents and experts.

Known uses:
https://howtomechatronics.com/arduino-projects/
https://www.makeuseof.com/tag/10-great-arduino-projects-for-beginners/
https://circuitdigest.com/arduino-projects

Pedagogical level: Any level (from 12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 5.

Open comments: One of the most common tools to prototype mechatronic Systems.

3.1.3. Codeweek Website of the EU

Title: Codeweek Website of the EU.

Description: A website where users can insert different materials. This has resulted in a larger collection of suggestions for computer science teaching.

Link: http://award.codeweek.de/lernmaterial/ (in German).

License: Mostly open-source, Creative Commons License.

Languages: German.

Target groups: All groups/ age groups 10-14, 14-18.

Known uses: -

Pedagogical level: Any level (from 10 to 18).

Classification: Tools to develop STEAM Challenges.

Quality: 4.

Open comments:

3.1.4. CoSpace Robot

Title: CoSpace Robot.

Description: The CoSpace Robot, consists of real robot, virtual robot, and simulator. It is a new robotic concept that combines and connects robotics in a real, physical space with a 3D virtual-reality world in cyber-space. The CoSpace Robot allows users to create and program robots in both virtual and real environments using the same programming logic. It is designed to integrate infocomm technology, digital game-based learning with educational robotics to interest, excite and engage young generation into STEM (science, technology, engineering, and mathematics), computational thinking and programming.

Link: https://www.cospacerobot.org/index.php

License: Copyright 2015 RoboCupSingapore.org. All rights reserved. (The base program is free).

Languages: English.

Target groups: In the challenge-based learning context the target groups could be students, teachers, parents and experts.

Known uses:
https://youtu.be/BI9yfPV4-L8
https://youtu.be/DUlGHxyS614

Pedagogical level: Any level (from 12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 4.

Open comments: One complete set for the implementation of STEAM challenges.

3.1.5. Discord

Title: Discord.

Description: Discord is a free, proprietary voice over IP application designed for gaming communities. It can be applied in Challenge based learning environments to facilitate the communication of the team members.

Link: https://discordapp.com/

License: Copyrighted by Discord, Inc, proprietary license, free version.
More information: https://discordapp.com/

Languages: Almost all.

Target groups: In the challenge-based learning context the target groups could be students, teachers, parents and experts.

Known uses: Gamers community
https://www.youtube.com/watch?v=le_CE--Mnvs

Pedagogical level: Any level (from 14 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 4.

Open comments: One of the most common tools to use for communication with peers while developing challenges.

3.1.6. eCraft2Learn maker project platform

Title: eCraft2Learn maker project platform.

Description: A digital workspace for maker projects, results of eCraft2Learn H2020 project (coordinated by UEF).

Link: https://ecraft2learn.github.io/uui/

License: Open source.

Languages: English.

Target groups: School kids (10+ years), teachers, maker community.

Known uses: https://project.ecraft2learn.eu/what-can-you-do-with-it/

Pedagogical level: 10+ years school kids, teachers; suitable to implement many challenges in the project context.

Classification: Tools to develop STEAM challenges.

Quality: 4.

Open comments: The UUI environment combines some of the PD&R programming tools, as well as tools for design and planning the project. Some of the tools are equipped with learning analytics features so that the teachers can gain analytics insights from the learning process.

3.1.7. Fritzing

Title: Fritzing

Description: Software for the design of electronics hardware, to support designers and students from experimenting with a prototype to building a more permanent circuit.

Link: https://fritzing.org

License: GPL.

Languages: English.

Target groups: Students, Teachers.

Known uses: Develop PCB.

Pedagogical level: High.

Classification: Tools to develop STEAM Challenges.

Quality: 5.

Open comments: None.

3.1.8. How to sketch with electronics

Title: How to sketch with electronics.

Description: A Video of Leah Buechley presenting projects for sketching electronic on the TED conference. "Designing electronics is generally cumbersome and expensive -- or was, until Leah Buechley and her team at MIT developed tools

to treat electronics just like paper and pen. In this talk from TEDYouth 2011, Buechley shows some of her charming designs, like a paper piano you can sketch and then play" (TED-Website).

Link:
https://www.ted.com/talks/leah_buechley_how_to_sketch_with_electronics (Video in English), Transcript: https://www.ted.com/talks/leah_buechley_how_to_sketch_with_electronics/transcript and Subtitles https://www.youtube.com/watch?v=vTBp0Z5GPeI

License: Open video (TED).

Languages: Multilingual.

Target groups: All groups.

Known uses: MIT research group high low-tech workshops http://highlowtech.org/?cat=6

Pedagogical level: Beginners to advanced.

Classification: Tools to develop STEAM Challenges.

Quality: 3.

Open comments: Tools and creative opportunities opening up using those tools are presented.

3.1.9. Hummingbird robots

Title: Hummingbird robots

Description: Hummingbird robots are based on Micro:bit extension capabilities. The kit contains sensors, and motors which allow students to build a robot out of any materials.

Link: https://www.birdbraintechnologies.com/hummingbirdbit/

License: BirdBrain Technologies, LLC.

Languages: English.

Target groups: School kids (10+ years), teachers, maker community.

Known uses:
https://www.birdbraintechnologies.com/hummingbirdbit/resources/

Pedagogical level: 10+ years school kids, teachers; suitable to implement many challenges in the project context.

Classification: Tools to develop STEAM Challenges.

Quality: 5.

Open comments: The tool gives much flexibility and is based on students' own creativity. The kit engages students to use recycled materials, hence making the end-results unique and artistic. Very good tool for STEAM education.

3.1.10. Instruction on how to build a fever Teddy

Title: Instruction on how to build a fever Teddy.

Description: An instruction on how to build a fever measuring teddy.

Link: http://dimeb.informatik.uni-bremen.de/eduwear/wp-content/uploads/manual/anleitung_teddy.pdf

License: Free.

Languages: German.

Target groups: Students.

Known uses: Techkreativ workshop, University of Bremen: http://dimeb.informatik.uni-bremen.de/

Pedagogical level: Beginners.

Classification: Tools to develop STEAM Challenges.

Quality: 4.

Open comments: Tools to get familiar with the hardware towards. Using logic, wiring circuits.

3.1.11. Making activities with children and young people

Title: Making activities with children and young people.

Description: A Handbook that shows may practical ways to stimulate creative behaviour with digital media in pupils.

Link:
http://www.bimsev.de/n/userfiles/downloads/making_handbuch_online_final.pdf

License: Open source.

Languages: German.

Target groups: Mostly kids, also young people.

Known uses:
https://www.youtube.com/watch?v=aa6MhxxCJLw
https://www.youtube.com/watch?v=qybUFnY7Y8
https://www.youtube.com/watch?v=cv5WLLYo-fk

Pedagogical level: Any level (from 14 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 4.

Open comments:

3.1.12. Making things wearable by René Bohne

Title: Making things wearable by René Bohne.

Description: A German book describing and teaching simple electronic theory behind "intelligent clothing" meaning wearable gadgets.

Link: https://www.oreilly.com/library/view/making-things-wearable/9783955610180/ (information)

License: Available in bookshops e.g. at https://www.amazon.de/Making-Things-Wearable-Intelligente-schneidern/dp/3868991913/ref=sr_1_1?keywords=making+things+wearable&link_code=qs&qid=1570019483&s=gateway&sourceid=Mozilla-search&sr=8-1

Languages: German.

Target groups: Beginners to advanced.

Known uses: BMBF-research project MediaArt@Edu, IBAP/KIT students.

Pedagogical level: Any level (12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 4.

Open comments: Tools to get familiar with the smart textile wearables, hardware Arduino LilyPad towards. Using logic, wiring circuits, constructing ad controlling sensor and actor-based objects.

3.1.13. MBlock

Title: MBlock.

Description: Block-based and code-based programming software designed for Science, Technology, Engineering, Arts and Mathematics (STEAM) education. With this software, it is possible to understand and train the basic programming algorithms and test it in a graphical window or transfer to a physical device.

Link: https://www.mblock.cc/en-us

License: Free.

Languages: English.

Target groups: Students, Teachers.

Known uses: Program and test algorithms in sketch.

Pedagogical level: High.

Classification: Tools to develop STEAM Challenges.

Quality: 5.

Open comments: None.

3.1.14. mBot robot

Title: mBot robot.

Description: The device used is the mBot robot, from Makeblock Co. Ltd., an entry-level STEAM educational robot kit for beginners that makes teaching and learning robot programming simple.

Link: https://www.makeblock.com/steam-kits/mbot

License: Free software based on Scratch 3.0.

Languages: Resources are available mainly in English.

Target groups: In the challenge-based learning context the target groups could be students, teachers, parents and experts.

Known uses:
https://www.makeblock.com/steam-kits/mbot-2#Manuals
https://www.youtube.com/watch?v=chkpweFx6G4
https://www.youtube.com/watch?v=0ElxYhbDQdM

Pedagogical level: Any level (12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 4.

Open comments: One of the most popular robotic kits for secondary school students.

3.1.15. Micro:bit

Title: Micro:bit.

Description: Micro:bit is a handheld, programmable computer that is ideal for creative maker and robotics projects. The board has a set of integrated sensors, buttons, and a LED display. Furthermore, it is possible to connect external peripherals such as sensors and actuators to the board.

Link: https://microbit.org/

License: Copyright by Micro:bit Educational Foundation. The tool is free to use, boards are available from many retailers across the globe.

Languages: English, many European languages.

Target groups: School kids, teachers, maker community.

Known uses: https://microbit.org/ideas/

Pedagogical level: Any level (12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 5

Open comments: Versatile and powerful tool for challenge-based learning scenarios. The board emphasises users' creativity and the graphical programming tool makes progress easy. There are plenty of resources available.

3.1.16. Microsoft Teams

Title: Microsoft Teams.

Description: Microsoft Teams is a powerful team-work application that evolves the Skype application to a real networking tool. It might be applied to challenge-based learning environments and might be integrated with different LMS.

Link: https://www.microsoft.com/es-es/education/products/teams

License: Commercial. Microsoft 365.

Languages: Multilingual.

Target groups: In the challenge-based learning context the target groups could be students, teachers, parents and experts.

Known uses:
https://onedrive.live.com/view.aspx?resid=91F4E618548FC604!2263&ithint=file%2cdocx&authkey=!AMAtJ_tqrNP2lyg
https://onedrive.live.com/view.aspx?resid=91F4E618548FC604!2265&ithint=file%2cdocx&authkey=!ADrTMCACJVjL1YA
https://educationblog.microsoft.com/

Pedagogical level: Any level (from 12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 5.

Open comments: One of the most powerful tools for teamwork.

3.1.17. MIT Media Lab; High-Low Tech Website (Tutorials)

Title: MIT Media Lab; High-Low Tech Website (Tutorials)

Description: A group that engages people to design and build new technologies.

Link: http://highlowtech.org/?cat=20

License: Open source.

Languages: English.

Target groups: All groups.

Known uses: http://highlowtech.org/?cat=5

Pedagogical level: Beginners to advanced.

Classification: Tools to develop STEAM Challenges.

Quality: 4.

Open comments:

3.1.18. OpenSCAD

Title: OpenSCAD.

Description: OpenSCAD is a free software application for creating solid 3D CAD (computer-aided design) objects. It is a script-only based modeller that uses its own description language; parts can be previewed, but it cannot be interactively selected or modified by mouse in the 3D view. An OpenSCAD script specifies geometric primitives (such as spheres, boxes, cylinders, etc.) and defines how they are modified and combined (for instance by intersection, difference, envelope combination and Minkowski sums) to render a 3D model. As such, the program does constructive solid geometry (CSG). OpenSCAD is available for Windows, Linux and OS X.

Link: https://www.openscad.org

License: OpenSCAD is a free software application.

Languages: Resources are available in almost any language.

Target groups: In the challenge-based learning context the target groups could be students, teachers, parents and experts.

Known uses:
https://en.wikipedia.org/wiki/OpenSCAD
https://github.com/openscad/openscad
https://pt.wikipedia.org/wiki/OpenSCAD

Pedagogical level: Any level.

Classification: Tools to develop STEAM Challenges.

Quality: 5.

Open comments: One of the possible free software do create 3D models, in order to develop 3D printed prototype.

3.1.19. Padlet

Title: Padlet.

Description: Padlet is an online noticeboard, which means it can be used for making announcements, keeping notes, online brainstorming or sharing ideas or results. It offers several templates to organize the information. Available for computer and mobile devices.

Link: https://padlet.com

License: With the limited free version, you can create only a few Padlets, but you can always delete an old Padlet to make a new one. There is also a paid Padlet Pro.

Languages: Multilingual.

Target groups: Padlet allows teachers to share contents and students to collaborate online.

Known uses: Teachers or students can post on a wall videos, images, links, documents, videos and voice recordings.

Pedagogical level: Any level (from 12 to 16).

Classification: Tools to develop STEAM Challenges, Report Tools.

Quality: 5.

Open comments:

3.1.20. Pearltrees

Title: Pearltrees.

Description: Tool for Interactive Classroom Collaboration. Individually or in groups, it is possible to create collections of resources, notes, images and organize then visually. It is available for computer or mobile devices.

Link: https://www.pearltrees.com

License: Free.

Languages: English.

Target groups: Help teachers and students collaborate organizing and sharing bookmarks, notes and photos of their projects.

Known uses: Teachers can share information with their students including videos, text-based descriptions, links, etc. or students can collect in groups useful resources for their project.

Pedagogical level: Any level (from 12 to 16).

Classification: Tool to develop STEAM Challenges.

Quality: 5.

Open comments:

3.1.21. Scratch

Title: Scratch.

Description: Scratch is a free visual programming language. Scratch is used by students, scholars, teachers, and parents to easily create animations, games, etc. and provides a steppingstone to the more advanced world of computer programming. It may be used with robots.

Link: https://scratch.mit.edu/

License: Creative Commons ShareALike2.0.

Languages: Multilingual.

Target groups: Pre-university, university students, teachers.

Known uses:
https://www.ro-botica.com/tienda/Scratch
https://scratch.mit.edu/discuss/topic/280849/

Pedagogical level: Any level (from 12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 5.

Open comments: Very useful to show students basic programming structures and control robots.

3.1.22. SimTwo

Title: SimTwo.

Description: Simulation software to develop environment models and simulate them with dynamic movements. It includes hardware in the loop capability.

Link: https://github.com/P33a/SimTwo

License: Free.

Languages: English.

Target groups: Students, Teachers.

Known uses: Simulate and develop robotics models.

Pedagogical level: High.

Classification: Tools to develop STEAM Challenges.

Quality: 5.

Open comments: None.

3.1.23. Sketchup

Title: Sketchup.

Description: SketchUp Free is the simplest free 3D modelling software on the web — no strings attached. Bring your 3D design online and have your SketchUp projects with you wherever you go. You don't need thousands of bells and whistles to draw in 3D. All you need is your idea, and room to draw. Also, you can view 3D models on your mobile device with the SketchUp Viewer app.

Link: https://www.sketchup.com/

License: There are a free version for web, 30-day trial version and premium versions.

Languages: English, Spanish and other languages.

Target groups: Teachers and students.

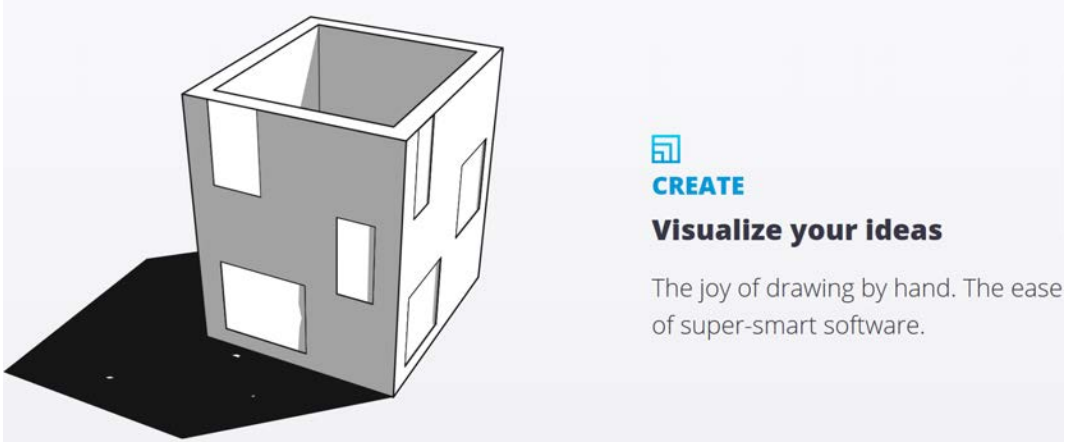
Known uses: You can find tips and tutorials to design your own project in the following https://www.youtube.com/user/SketchUpVideo

Pedagogical level: Any level (from 12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 4.

Open comments:



3.1.24. Skype

Title: Skype.

Description: Skype is a well-known tool that que be applied in Challenge based learning environments to facilitate the communication of the team members when they are not working together and also to interact with expert. It includes the possibility to chat, make voice and video calls, group video conferences, etc.

Link: https://www.skype.com/

License: Copyrighted by Microsoft, proprietary license, free version. More information: https://www.skype.com/en/legal/

Languages: Almost all.

Target groups: In the challenge-based learning context the target groups could be students, teachers, parents and experts.

Known uses:
https://www.youtube.com/watch?v=S38e-t6rhKA;
https://support.skype.com/es/faq/FA6/que-es-skype

Pedagogical level: Any level (from 12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 4.

Open comments: One of the most common tools to use for communication with peers and experts in challenges.

3.1.25. Step by step tutorial/getting started with Arduino LilyPad and Amici-Technology

Title: Step by step tutorial/getting started with Arduino LilyPad and Amici-Technology.

Description: An easy step by step tutorial on how to work with an Arduino Lilypad and Amici- Technology.

Link: http://www.taccle3.eu/deutsch/wp-content/uploads/sites/4/2015/12/Tutorial_Lilypad_aduino_ed.pdf

License: Free.

Languages: English.

Target groups: All groups.

Known uses: BMBF research project MediaArt@Edu: http://www.ibap.kit.edu/mediaartedu/downloads/Handreichung_MediaArt.pdfç TACCLE 3 coding: http://www.taccle3.eu/deutsch

Pedagogical level: For beginners without programming backgrounds.

Classification: Tools to develop STEAM Challenges.

Quality: 4.

Open comments: Tools to get familiar with the software Amici towards. Using if-ten relations/Algorithms, using logic, wiring circuits, controlling and programming sensors and actuators.

3.1.26. TACCLE3 Coding website

Title: TACCLE3 Coding website.

Description: Web site of the EU Project TACCLE3: Coding. TACCLE 3 Coding is a project funded under Erasmus+ that supports Primary School and other teachers who want to teach Computing to 4-14-year olds. TACCLE 3 will equip classroom

teachers with the knowledge and the materials they need by developing a website of ideas and resources together with in-service training courses and other staff development events.

Link: http://www.taccle3.eu/

License: Creative Commons.

Languages: English, Spanish, German, Estonian, Finnish, Dutch, Welsh.

Target groups: Teachers.

Known uses: Info site.

Pedagogical level: Any level (from 6 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 5.

Open comments: Useful teaching resource bank.

3.1.27. Telegram

Title: Telegram.

Description: Telegram is a messaging app with a focus on speed and security, it's super-fast, simple and free. You can use Telegram on all your devices at the same time — your messages sync seamlessly across any number of your phones, tablets or computers.

Link: https://telegram.org

License: Free software based on an open development platform.

Languages: Mainly English.

Target groups: In the challenge-based learning context the target groups could be students, teachers, parents and experts.

Known uses:
https://telegram.org/faq

Pedagogical level: Any level (from 12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 5.

Open comments: One of the most common tools to use for communication with peers and experts in challenges.

3.1.28. The CONSTRUIT! Environment

Title: The CONSTRUIT! Environment.

Description: The CONSTRUIT! environment is a product of an Erasmus+ project (led by University of Warwick, UK). The tool is a result of a decades-long development of Empirical Modelling tools, and the project allowed mainstreaming the toolkit and making them accessible for bigger audience. The environment lets users to construct interactive objects to think with (called *construals*), and they can form interactive learning materials, specific learning objects, mini games, and so on. Construction of the resources is done with *definitive scripts* in a web-based environment.

Link: https://jseden.dcs.warwick.ac.uk/construit/

License: Open source.

Languages: English, many European languages.

Target groups: School kids, teachers, maker community.

Known uses: https://jseden.dcs.warwick.ac.uk/construit/

Pedagogical level: 12+ years school kids, teachers.

Classification: Tools to develop STEAM Challenges.

Quality: 3.

Open comments: The tool requires indeed some time to get into it. The modelling paradigm is powerful yet quite complex to comprehend, especially if one has previous background in procedural or object-oriented programming. Documentation is not very complete. However, once the initial learning curve has been passed, the tool provides very powerful features for building open

educational resources. Linking with physical hardware (i.e. Arduinos) is also possible.

3.1.29. The PBL CANVAS

Title: The PBL CANVAS.

Description: It is a brainstorming template for designing projects.

Link:
https://conecta13.com/canvas/
https://www.google.com/search?q=canvas+for+designing+projects+conecta+3&sa=X&rlz=1C1CHBD_esES832ES832&biw=1366&bih=695&tbm=isch&source=iu&ictx=1&fir=dr3sAcMMZsc-dM%253A%252Cpv8RHNBfrKLKHM%252C_&vet=1&usg=AI4_-kQ7TOfafbbR9XijHx2nG-EGfuHFvQ&ved=2ahUKEwjCyrnUzJnlAhVHDmMBHYAwBt4Q9QEwBHoECAkQCQ#imgrc=dr3sAcMMZsc-dM:

License: CC BY-NC-SA: Creative Commons License Attribution-NonCommercial-ShareAlike.

Languages: Spanish and English.

Target groups: Teachers and students when designing and organizing a project.

Known uses: This canvas will help you draw the big picture of your project, providing a convenient structure that holds all the important data. It is possible to add text, links, images.

Pedagogical level: Any level (from 12 to 16).

Classification: Tool to develop STEAM Challenges.

Quality: 5.

Open comments: You can use Genial.ly for creating your digital canvas https://panel.genial.ly/templates/infographic-h

3.1.30. Thingiverse – Digital Designs for Physical Objects

Title: Thingiverse – Digital Designs for Physical Objects.

Description: A repository of 3D downloadable models.

Link: https://www.thingiverse.com/

License: Creative Commons.

Languages: English.

Target groups: School kids (10+ years), teachers, maker community.

Known uses: https://www.thingiverse.com/education

Pedagogical level: 10+ years school kids, teachers; suitable to implement many challenges in the project context.

Classification: Tools to develop STEAM challenges.

Quality: 5.

Open comments: A plethora of 3D printing resources. The repository benefits the challenges so that students do not need to invent a wheel again, when it comes to 3D design and printing.

3.1.31. TinkerCAD

Title: TinkerCAD.

Description: Tinkercad is a free, easy-to-use app for 3D design, electronics, and coding. It's used by teachers, kids, hobbyists, and designers to imagine, design, and make anything.

Link: https://www.tinkercad.com/

License: Free version.

Languages: Multilingual.

Target groups: Teachers and students.

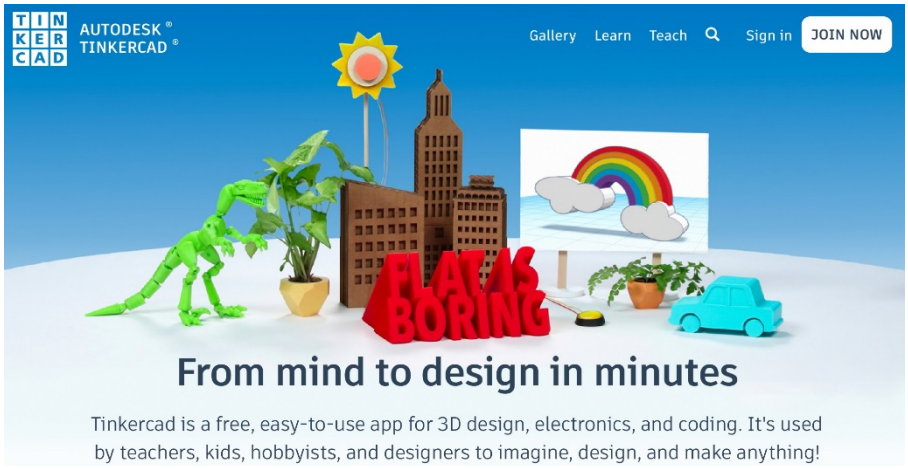
Known uses: You can find some templates and tutorials to design your own project in the following link https://www.tinkercad.com/learn

Pedagogical level: Any level (from 12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 5.

Open comments:



3.1.32. TinkerCAD Circuit

Title: TinkerCAD Circuit.

Description: A web-based tool for designing and learning Arduino circuits. The tool has a vast number of electronic components available, and users can make schematics for wiring the circuits, and simulate real hardware before building the physical solution.

Link: https://www.tinkercad.com/circuits

License: Copyright by Autodesk. Free to use, but a user account is required.

Languages: Čeština, Deutsch, Español, English, Français, Italiano, Magyar, Nederlands, Polski, Português, Русский, Türkçe, 中文 (简体), 中文 (繁体), 日本語, 한국어.

Target groups: 3D hobbyists, teachers, school children of a wide age range.

Known uses: https://www.tinkercad.com/learn/designs

Pedagogical level: Any level (from 12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 5.

Open comments: A very robust and powerful tool to get started with Arduino circuits. Has a great educational value, but the tool is also powerful to engage more advanced users. Good integration with the rest of TinkerCAD tools.

3.1.33. Trello

Title: Trello.

Description: Trello is the easy, free, flexible, and visual way to manage your projects and organize anything, trusted by millions of people from all over the world.

Link: https://trello.com

License: There is a free version and paid for Business and Enterprise versions.

Languages: Multilingual.

Target groups: Teachers and students.

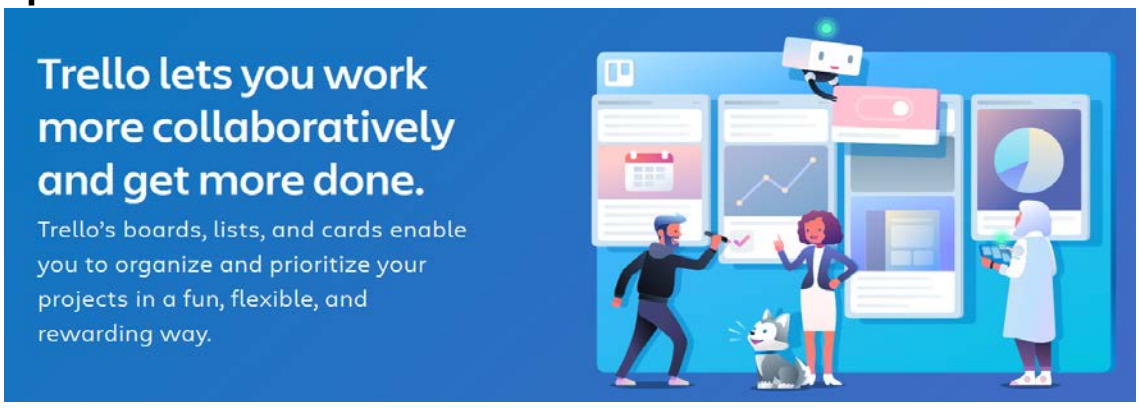
Known uses: You can find some templates to design your own project in the following link https://www.atlassian.design/

Pedagogical level: Any level (from 12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 4.

Open comments:



3.1.34. Tutorial Arduino LilyPad Construction Kit

Title: Tutorial Arduino LilyPad Construction Kit.

Description: A tutorial for a construction kit based on Arduino.

Link: http://dimeb.informatik.uni-bremen.de/eduwear/wp-content/uploads/2010/11/EduwearKit_manual_nov_2010_de.pdf

License: Attribution-Non-commercial-Share Alike.

Languages: German.

Target groups: Kids.

Known uses: http://dimeb.informatik.uni-bremen.de/techkreativ/

Pedagogical level: Any level (from 12 to 16).

Classification: Tools to develop STEAM Challenges.

Quality: 4.

Open comments: Tools get familiar with the hardware. Using logic, wiring circuits, controlling things, creating and debugging.

3.1.35. Whatsapp

Title: WhatsApp.

Description: WhatsApp is a well-known tool that can be applied in Challenge based learning environments to facilitate the communication of the team members when they are not working in person. It includes the possibility to chat, make voice or video calls and share files.

Link: https://www.whatsapp.com/

License: 2019 © WhatsApp Inc.
More information: https://www.whatsapp.com/legal/#key-updates

Languages: Almost all.

Target groups: In the challenge-based learning context the target groups could be students and teachers.

Known uses:

Pedagogical level: Any level (from 14 to 16).

Classification: Tool to develop STEAM Challenges.

Quality: 4.

Open comments: One of the most common tools to use for communication with peers while developing challenges.

3.1.36. Zoom

Title: Zoom.

Description: A state-of-the-art video conferencing tool.

Link: https://zoom.us

License: Commercial product (free personal plans, limitations apply).

Languages: English.

Target groups: Teachers, students (12+ years).

Known uses: https://support.zoom.us/hc/en-us

Pedagogical level: Any level (from 12 to 16).

Classification: Tool to develop STEAM Challenges.

Quality: 5.

Open comments: Probably the best online conferencing tool currently available. Works in various platforms (browser, mobile phones). Works nice with lower bandwidth connections, good sharing features. Ideal for communication between the groups working with challenges.

3.2. Questionnaires about integrating and assessing STEAM

1. BookWidget.

2. Google Forms.
3. Kahoot!
4. LimeSurvey.
5. SurveyMonkey.

3.2.1. BookWidget

Title: BookWidget.

Description: BookWidget is a platform for teachers that allows creating interactive exercises and automatically evaluating the grades, assigning them to our students and giving them a constructive opinion. With this tool, several interactive exercises are designed so that students can relate the different theoretical concepts.

Link: https://www.bookwidgets.com/

License: There is a trial version and paid for Teacher, Teacher group and Standard and Professional versions.

Languages: English.

Target groups: Teachers and students.

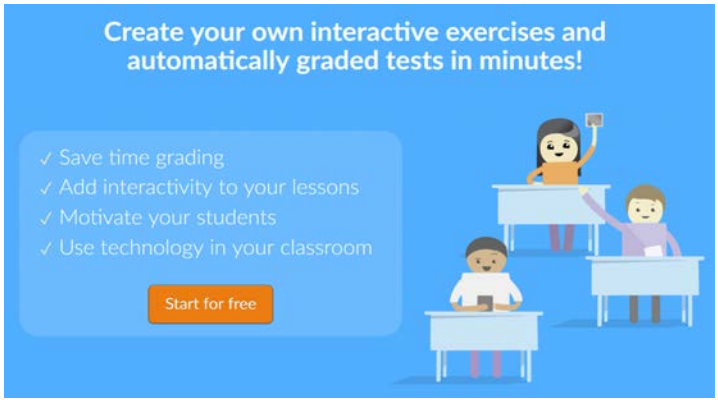
Known uses: You can choose from 40+ digital exercise templates that work on smartphones, tablets, computers, and iBooks the following link https://www.bookwidgets.com/tour/elementary

Pedagogical level: Any level (from 12 to 16).

Classification: Tools for designing questionnaires about integrating and assessing STEAM

Quality: 5

Open comments:



3.2.2. Google Forms

Title: Google Forms.

Description: Google Forms is an online survey tool. It allows users to design surveys, collect responses, and analyse the responses of their created surveys.

Link: https://docs.google.com/forms

License: Free.

Languages: Multilingual.

Target groups: It allows teachers to collect information from students.

Known uses: To create questionnaires and polls and collect responses.

Pedagogical level: Any level (from 12 to 16).

Classification: Tools for designing questionnaires.

Quality: 5.

Open comments: Google Apps.

3.2.3. Kahoot!

Title: Kahoot!

Description: Kahoot! is a game-based learning platform to administer quizzes, discussions or surveys. This software allows to be played by the whole class in real time. Multiple-choice questions are projected on the screen and students answer the questions with their smartphone, tablet or computer.

Link: https://kahoot.com/

License: There is a free Basic version and paid Standard, Pro and Premium versions.

Languages: English.

Target groups: Teachers and students.

Known uses: You can find examples and templates at the following link https://create.kahoot.it/discover

Pedagogical level: Any level (from 12 to 16).

Classification: Tools for designing questionnaires about integrating and assessing STEAM.

Quality: 5.

Open comments:

3.2.4. LimeSurvey

Title: LimeSurvey.

Description: Google Forms is a powerful online survey tool. It allows users to design surveys, collect responses, and analyse the responses of their created surveys.

Link: https://www.limesurvey.org/

License: Open source.

Languages: Multilingual.

Target groups: It allows teachers to collect information from students.

Known uses:
https://www.limesurvey.org/es/ejemplos

Pedagogical level: Any level (from 12 to 16).

Classification: Tools for designing questionnaires.

Quality: 5

Open comments: It may be installed into a server. GRIAL group has an installation that might be used in RoboSTEAM project.

3.2.5. SurveyMonkey

Title: SurveyMonkey.

Description: SurveyMonkey is an online survey tool. It allows users to design surveys, collect responses, and analyse the responses of their created surveys. Users can also get access to survey questions and professional templates.

Link: https://surveymonkey.com/

License: Free and Premium versions.

Languages: Multilingual.

Target groups: It allows teachers to collect information from students.

Known uses: To create questionnaires and polls and collect responses.

Pedagogical level: Any level (from 12 to 16).

Classification: Tools for designing questionnaires.

Quality: 5.

Open comments:

3.3. Frameworks

1. ActiveCollab.
2. Easy Redmine.
3. Evernote.
4. Google Classroom.
5. IceScrum.
6. MaKey MaKey.

3.3.1. ActiveCollab

Title: ActiveCollab.

Description: ActiveCollab is the project management software that gives you complete control over your work. It allows you to track hours and projects with some modules more oriented to agile product planning.

Link: https://activecollab.com/

License: There is a trial version for 14 days and you pay for annual or monthly billing versions.

Languages: English.

Target groups: Teachers.

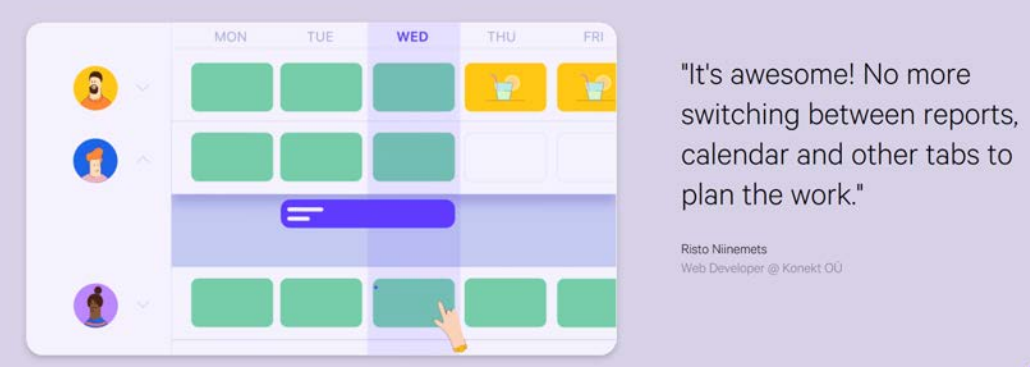
Known uses: You can find some tutorials to design your own project in the following link: https://activecollab.com/help

Pedagogical level: High level.

Classification: Frameworks.

Quality: 3.

Open comments:



3.3.2. Easy Redmine

Title: Easy Redmine.

Description: Easy Redmine is an open source software for project management. Combination of new mobile design with useful plugins & features will make your project management more enjoyable, improve communication, user experience and save your time.

Link: https://www.easyredmine.com/

License: There are a free version for web, 30-day trial version and premium versions.

Languages: English.

Target groups: Teachers.

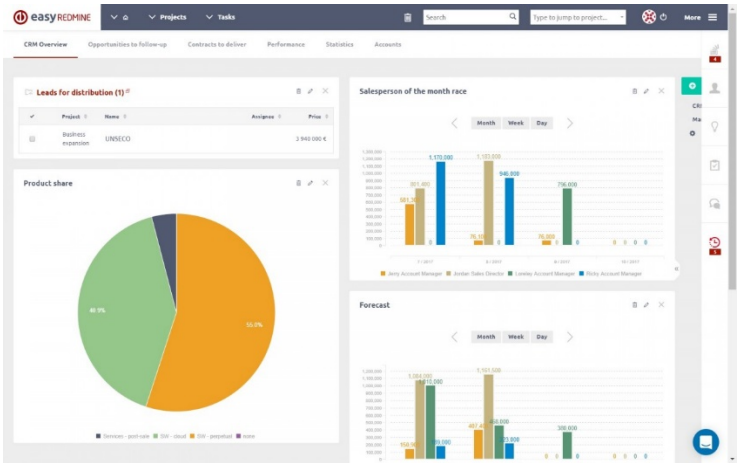
Known uses: You can find some tutorials to design your own project in the following link: https://www.easyredmine.com/redmine-tutorial/

Pedagogical level: High level.

Classification: Frameworks.

Quality: 4

Open comments:



3.3.3. Evernote

Title: Evernote.

Description: This tool facilitates paperless communication between teachers and students. Evernote allows teachers to share information with students, post assignments, organize folders and notes. It is possible to work online and offline. Teachers and students can work using their computers or their mobiles devices.

Link: https://evernote.com/intl/en

License: There is a free Basic version, with some limitations such as 60 MB per month upload limit or that you can use only two devices with one account, and paid Premium or Business versions.

Languages: All languages.

Target groups: Teachers and their students sharing information.

Known uses: Teachers can share information with their students including videos, text-based descriptions, links, etc.

Pedagogical level: Any level (from 12 to 16).

Classification: Frameworks.

Quality: 5.

Open comments:

3.3.4. Google Classroom

Title: Google Classroom.

Description: This tool facilitates paperless communication between teachers and students. Classroom allows teachers to create classes, post assignments, organize folders and view work in real-time.

Link: https://classroom.google.com

License: Free. It is necessary to sign up a Google Apps for Education account for your school. Google Apps domains are free for schools. Then, to be a Google Classroom teacher, log in with your GSuite account and create an active class.

Languages: All languages.

Target groups: Teachers and their students to share information.

Known uses: Teachers can create assignment for their students including videos, text based descriptions, links, etc.

Pedagogical level: Any level (from 12 to 16).

Classification: Frameworks.

Quality: 5.

Open comments:

3.3.5. IceScrum

Title: IceScrum.

Description: iceScrum is a project management software based on the "Scrum" and "Agile" methods, used by many companies. This tool also improves communication within the team, thanks to the scrum method and a post-it system where everyone will be able to propose their ideas and modifications.

Link: https://www.icescrum.com/

License: There are a free version for web, 14-day trial version and paid versions.

Languages: English, Spanish and French.

Target groups: Teachers.

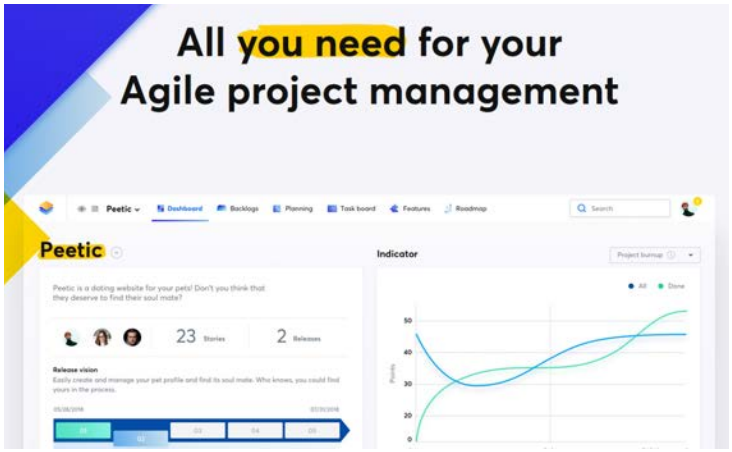
Known uses: You can find some tutorials to design your own project in the following link: https://www.icescrum.com/documentation/manage-product-development/

Pedagogical level: High level.

Classification: Frameworks.

Quality: 4.

Open comments:



3.3.6. MaKey MaKey

Title: MaKey MaKey.

Description: MaKey MaKey is an invention kit for the 21st century.

Link: http://makeymakey.com/

License: Commercial.

Languages: English.

Target groups: Primary and Secondary students, Teachers.

Known uses: http://web.media.mit.edu/~ericr/makeymakey/

Pedagogical level: Any level (from 12 to 16).

Classification: Frameworks.

Quality: 5.

Open comments: In the web site there are multiple and useful resources, apps, lessons for education.

3.4. Report Tools

1. Genial.ly.
2. Google Docs.
3. Issuu.
4. Powtoon.
5. Smartsheet.

3.4.1. Genial.ly

Title: Genial.ly.

Description: Tool to create interactive and enriched contents. There are a lot of templates for presentations, reports, interactive images, infographics, timelines, etc.

Link: https://www.genial.ly

License: Free.

Languages: English, Spanish, French.

Target groups: Help teachers explain contents and students show the process and results of their projects.

Known uses: Teachers or students can create interactive presentations including videos, images, text, links, etc.

Pedagogical level: Any level (from 12 to 16).

Classification: Report Tools.

Quality: 5.

Open comments:

3.4.2. Google Docs

Title: Google Docs.

Description: This is a tool with which students can create, edit and share a written work. Moreover, students can write / edit at the same time, anywhere and on any device.

Link: https://www.google.com/intl/pt-PT/docs/about/

License: https://policies.google.com/terms?hl=pt-PT#toc-protection

Languages: Almost all.

Target groups: In the challenge-based learning context the target groups could be students, teachers and experts.

Known uses:

Pedagogical level: Any level (from 14 to 16).

Classification: Report Tools. Tools to develop STEAM challenges.

Quality: 4.

Open comments: Interactive tool for written work.

3.4.3. Issuu

Title: Issuu.

Description: The Issuu Story Cloud is a powerful digital platform to publish schoolwork, create and share, content and storytelling. We can take PDF, images and text and transform them using our design and Issuu' s templates to display any project on desktop, mobile web, app, Facebook, Instagram, Twitter, Pinterest and all other social media.

Link: https://creatorhub.issuu.com/

License: The Issuu Service is owned and operated by Issuu inc. (https://issuu.com/legal/terms).

Languages: English.

Target groups: In the challenge-based learning context the target groups could be students, teachers, parents and experts.

Known uses:
https://www.youtube.com/channel/UCbGADY4gkWx2GT__dbcelSA;
https://www.youtube.com/watch?v=xI30Y1HRdX8

Pedagogical level: Any level (from 12 to 16).

Classification: Report Tools.

Quality: 4.

Open comments: Innovative tool to use for dissemination of the project.

3.4.4. Powtoon

Title: Powtoon.

Description: Tool to create engaging, animated videos for presentations with a professional look.

Link: https://www.powtoon.com

License: Free and Premium versions.

Languages: English.

Target groups: Help teachers explain contents and students show the process and results of their projects.

Known uses: Teachers or students can create engaging, animated videos for presentations including videos, images, text, links, etc.

Pedagogical level: Any level (from 12 to 16).

Classification: Report Tools.

Quality: 5.

Open comments:

3.4.5. Smartsheet

Title: Smartsheet.

Description: Smartsheet is an online project management solution that claims to be the modern alternative to traditional project management tools like Microsoft Project.

Link: https://www.smartsheet.com/

License: There are a 30-day free trial and paid versions.

Languages: Spanish, English, German, Portuguese and other languages.

Target groups: Teachers.

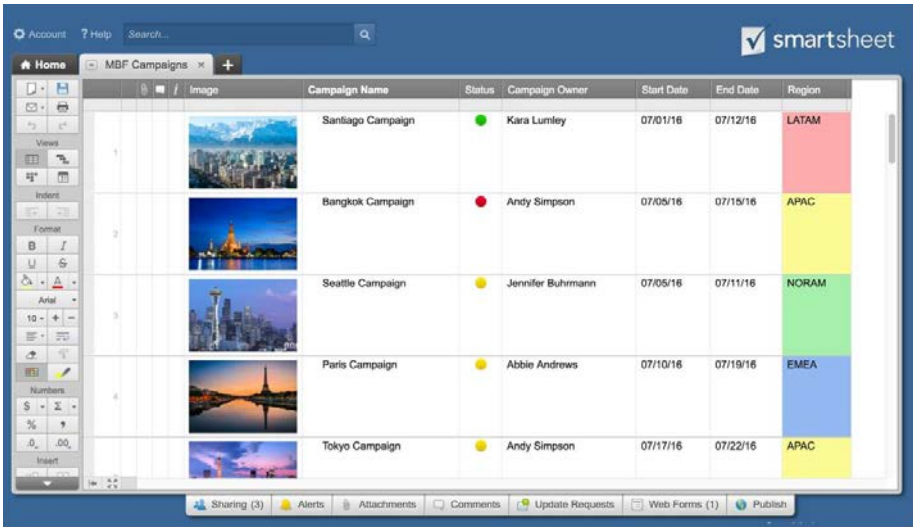
Known uses: You can find some video tutorials to explain in detail some of the tool's features in the following link: https://help.smartsheet.com/learning-track/get-started

Pedagogical level: High level.

Classification: Report Tools.

Quality: 4.

Open comments:



3.5. Learning Analytics Tools

1. GISMO.
2. LOCO-Analyst.
3. Wooclap.

4. Yet Analytics.
5. Zoho.

3.5.1. GISMO

Title: GISMO.

Description: GISMO is a graphical interactive monitoring tool that provides useful visualization of students' activities in online courses to instructors. With GISMO instructors can examine various aspects of distance students, such as the attendance to courses, reading of materials, submission of assignments.

Link: http://gismo.sourceforge.net/

License: Free software under the GPL software license.

Languages: English.

Target groups: Teachers.

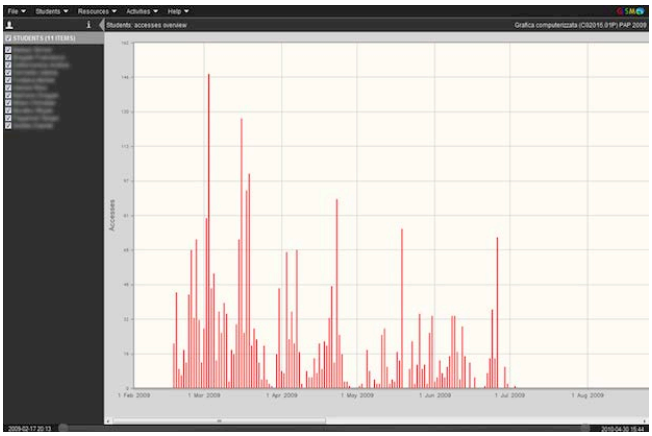
Known uses: You can find a specific documentation for software developer is available in the following link:
http://gismo.sourceforge.net/docs/GismoTechnicalDocumentation.pdf

Pedagogical level: High level.

Classification: Learning Analytics Tools.

Quality: 4.

Open comments:



3.5.2. LOCO-Analyst

Title: LOCO-Analyst

Description: LOCO-Analyst is an educational tool aimed at providing teachers with feedback on the relevant aspects of the learning process taking place in a web-based learning environment, and thus helps them improve the content and the structure of their web-based courses.

Link: http://jelenajovanovic.net/LOCO-Analyst/

License: Free.

Languages: English.

Target groups: Teachers.

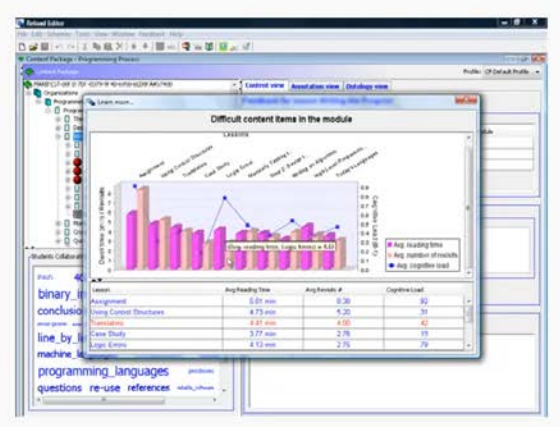
Known uses: You can find some video tutorials to explain in detail some of the tool's features in the following link: http://jelenajovanovic.net/LOCO-Analyst/videos.html

Pedagogical level: High level.

Classification: Learning Analytics Tools.

Quality: 3.

Open comments:



3.5.3. Wooclap

Title: Wooclap.

Description: Wooclap is one the best tool to improve in-class students engagement. It could improve students learning via their playful system of in-class quizzes app. All thanks to students smartphones. It provides analytics to teachers and a feedback wall so that students can communicate to their teachers.

Link: https://www.wooclap.com/

License: You can sign up for free.

Languages: Multilingual.

Target groups: Teachers and students. Teachers will need a computer with an internet connection while the audience needs a mobile device with an internet connection.

Known uses: Quizzes, multiple choice questions, rating, poll, find on an image, word cloud, open questions, guess a number, prioritisation, sorting, matching, filling the blanks, quick slide, brainstorming, video.

Pedagogical level: Any level (from 12 to 16).

Classification: Learning Analytics Tools.

Quality: 5.

Open comments:

3.5.4. Yet Analytics

Title: Yet Analytics.

Description: Yet Analytics is one the best tool to improve in-class students engagement. It could improve students learning via their playful system of in-class quizzes app. All thanks to students smartphones. It provides analytics to teachers and a feedback wall so that students can communicate to their teachers.

Link: https://www.yetanalytics.com/products

License: Free and Pro versions. Yet Analytics provides a number of free resources as well as open source code for developers.

Languages: English

Target groups: Teachers and students. Yet provides lots of different visual analytics to help you improve your learning content and help your students learn as well as possible.

Known uses: measure outcomes in learning and training. It keeps track of formative learning and track of the health and usability of your learning technology ecosystem.

Pedagogical level: Any level (from 12 to 16).

Classification: Learning Analytics Tools.

Quality: 4.

Open comments:

3.5.5. Zoho

Title: Zoho.

Description: Zoho Analytics is a self-service Business Intelligence and data analytics software that lets you create visually appealing data visualizations and insightful dashboards in minutes. This software provides specially optimized mobile apps for both iOS and Android-powered mobile devices. Interact with reports, and drill down into your data. Share and collaboratively analyze reports with your colleagues and students.

Link: https://www.zoho.com/analytics/

License: There are a free version for web, 15-day trial version and paid versions.

Languages: Spanish, English, German, Portuguese and other languages.

Target groups: Teachers.

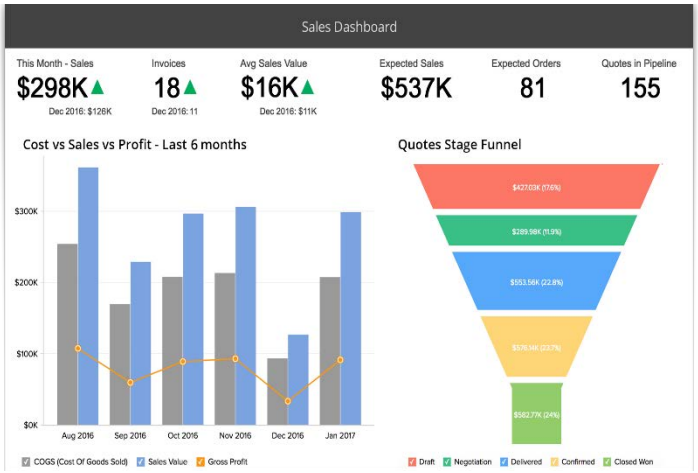
Known uses: You can find some video tutorials to explain in detail some of the tool's features in the following link: https://www.zoho.com/analytics/video-demo.html

Pedagogical level: High level.

Classification: Report Tools.

Quality: 4.

Open comments:



4. Acknowledgements

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