

# Evaluation of existing resources (study/analysis)



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## **Abstract**

Within TACCLE 3 – Coding European Union Erasmus+ KA2 Programme project, a review and evaluation of a set of resources that can contribute to teaching programming to younger children has made. This document represents the TACCLE 3 O4 deliverable entitled “Evaluation of existing resources (study/analysis)”.

## **Keywords**

Computational Thinking; Coding; Resources; TACCLE 3

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## 1. Introduction

Many European countries are introducing computing, with a special emphasis in programming issues, as a core curriculum subject (Balanskat & Engelhardt, 2015). Some have already done so; many others are intending to.

TACCLE 3: Coding is an Erasmus+ KA2 project (Ref. 2015-1-BE02-KA201-012307) (García-Peñalvo, 2016a, 2016b, 2016c; TACCLE 3 Consortium, 2016) 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.

Specifically, TACCLE 3 project has three main objectives:

1. To equip fellow classroom teachers, whatever their level of confidence, with the knowledge and the materials they need to teach coding effectively.
2. To develop a website of easy-to-follow and innovative ideas and resources to aid teachers in teaching coding. They will also find a review of the current academic research and an overview of the resources currently available for teaching coding.
3. To provide national and international in-service training courses and other staff development events to help support and develop confidence and competences in teaching coding.

This document gathers the annotated resource catalogue and a survey of the reviewed resources (García-Peñalvo et al., 2016) for introducing coding into schools.

The rest of this document is organised as follows. Section 2 explains the review methodology. Section 3 presents an overview of the analysed resources. Section 4 gathers the resource catalogue. Section 5 makes a deeper survey of two resource categories. Finally, Section 6 closes the paper with the conclusions.

## 2. Methodology

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.

In the TACCLE 3 coding project, a lack of didactic material for teachers to get started teaching coding to young pupils from primary school level on, was identified. In order to compensate such deficit, a survey of resources and starter kits to support the teachers' approach to teach coding at primary school level was undertaken.

A collection of ideas, and pupil oriented tools and environments such as iconic programming software, literature, and examples of good practice in video towards coding, computational thinking and STEM (Science, Technology, Engineering and Mathematics) (CEDEFOP, 2015) was reviewed, analysed and evaluated by partners of 6 countries (Belgium, Estonia, Finland, Germany, Spain and United Kingdom).

During the April-September 2016 period resources have been analysed, evaluated and documented following the TACCLE 3 template (García-Peñalvo, 2016d). In this template the resources were classified following the TACCLE 3 criteria in these categories: Algorithms, Using logic, Controlling things, and Creating and Debugging.

After that, in order to create a resource catalogue for introducing to programming, a resource map has been generated using other complementary classification: App for teaching coding, Robotic, Maker stuff, Programming language, Book, Info site, and Training course.

It is important to underline that the same resource might be classified in multiple TACCLE 3 and Complementary categories.

With the record-set of the reviewed resources, more detailed information is elaborated and published in the project website (TACCLE 3 Consortium, 2016).

### 3. Review results

TACCLE 3 has a resource database with 37 records, most of them have a free or creative common license (See Figure 1). Following figures summarize the results of this review. Table 1 presents the title and the license of the reviewed resources.

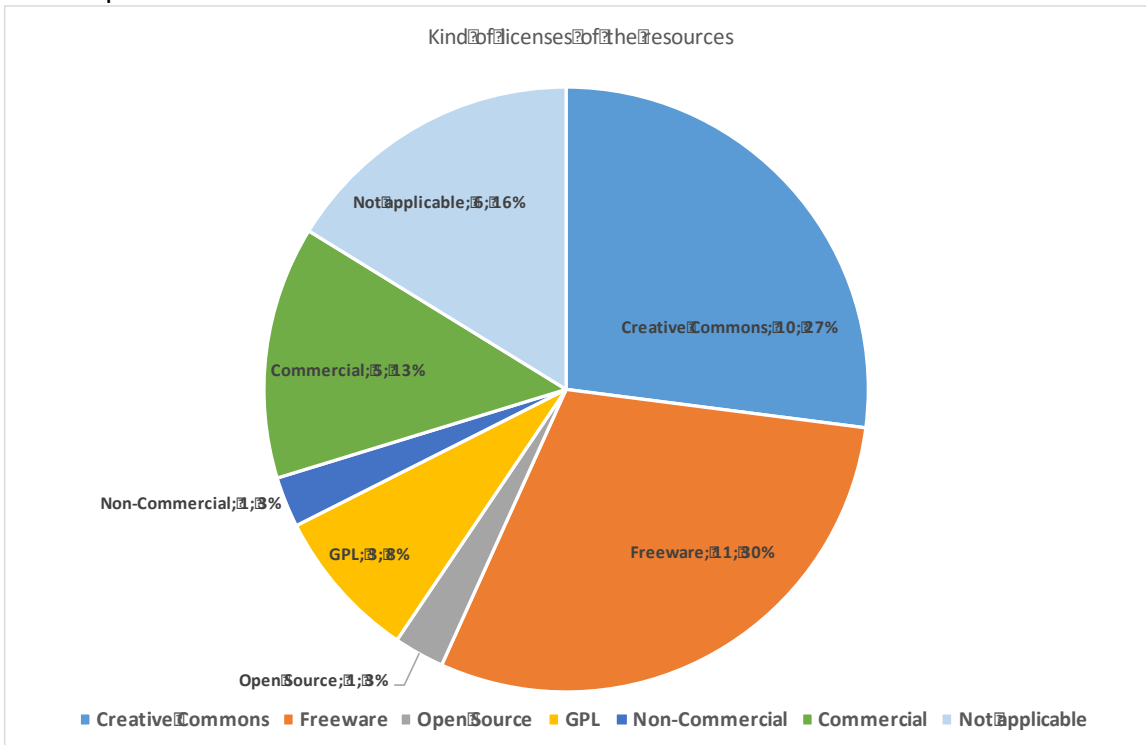


Figure 1. Licenses of the reviewed resources

Table 1. Reviewed resources list

Title	License
BAXTER ROBOT	Commercial
Geomagic Touch Haptic	Commercial
Minecraft	Commercial
SCRATCH	Creative Commons
Pedagogical Conversational Agent: Dr. Roland	Creative Commons
Sphero Kids	Freeware
AMICI Programming Environment with an iconic interface for Arduino LilyPad and Smart Textile	GPL
EduWear Starter Kit: Wearable Intelligence for clothes, sports and games	GPL
Zauberschule Informatik: Ein erster Einblick in die Welt der Informatik	Creative Commons
Kodu Game Lab	Personal and Non-Commercial
3pi Robotics Platform e-course	Creative Commons
MSW Logo	Freeware
Studio.code.org Course 2	Creative Commons
Ozobot	Commercial
Minetest	LGPL
Soy Minero	-
TACCLE 3: Coding website	Creative Commons
123D Design	Freeware
Tynker Coding for Code	-
Tynker Hour of Code	-
Blockly for Dash & Dot Robots	Freeware
Path for Dash Robot	Freeware
Code.org	-
Code Studio	-
Code.org Hour of Code	-
MIT App Inventor	Creative Commons
MaKey MaKey	Commercial
Arduino	Open Source
CS Unplugged: Computer Science without a computer	Creative Commons
Making-Aktivitäten mit Kindern und Jugendlichen: Handbuch zum kreativen digitalen Gestalten	Creative Commons
Magical Clothing	Freeware
Koodiaapinen	Creative Commons
Koodikirja	Freeware
Hello Ruby	Freeware
Koodikoulu	Freeware
The Foos	Freeware
ProgeTiger	Freeware

Figure 2 presents the reviewed resources classified by the TACCLE 3 criteria.

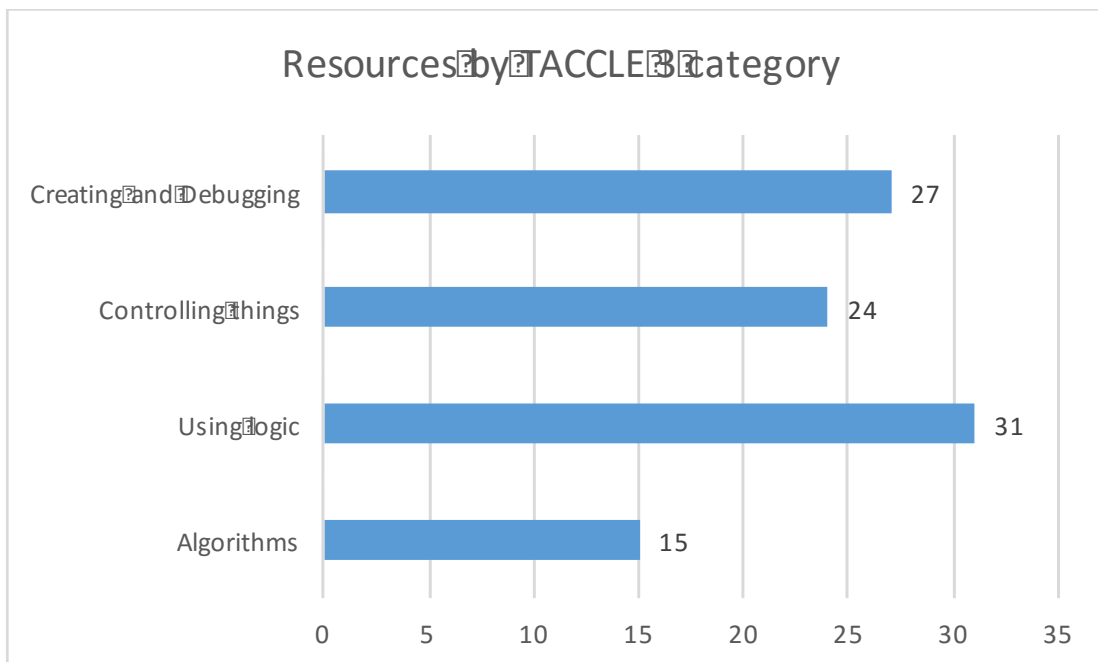


Figure 2. Reviewed resources classified by category

Figure 3 shows the reviewed resources classified by the complementary category, which present a significant presence of information websites and apps for teaching coding.

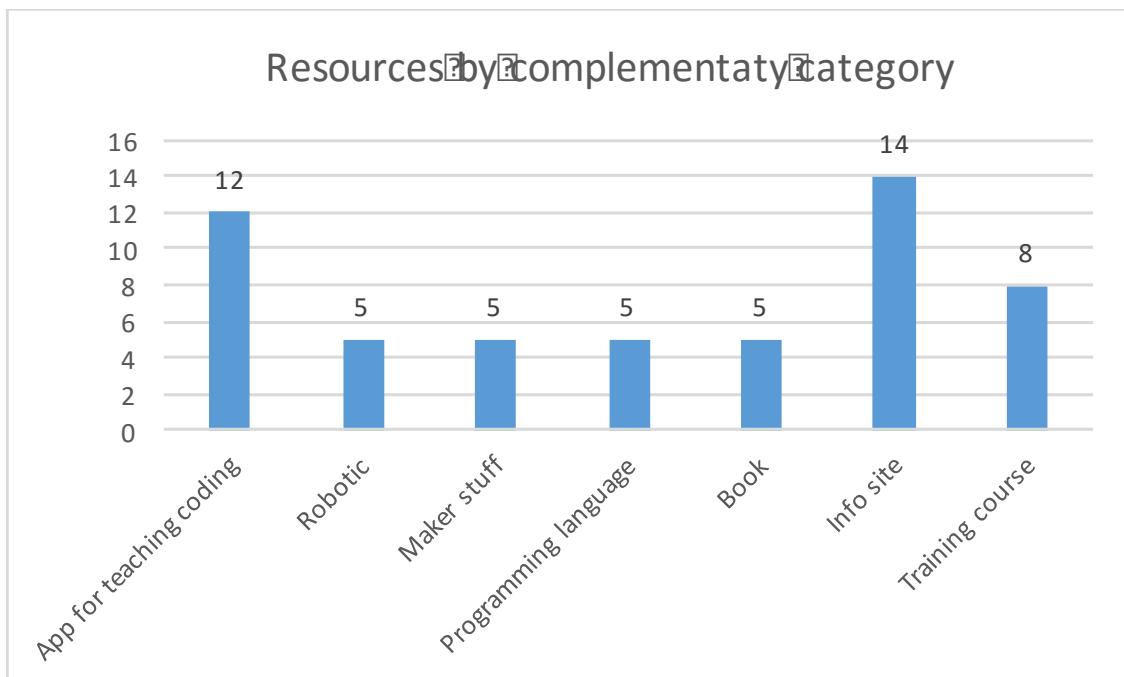


Figure 3. Reviewed resources classified by the complementary classification

Figure 4 shows the languages in which the resources are available. English is the most usual language.



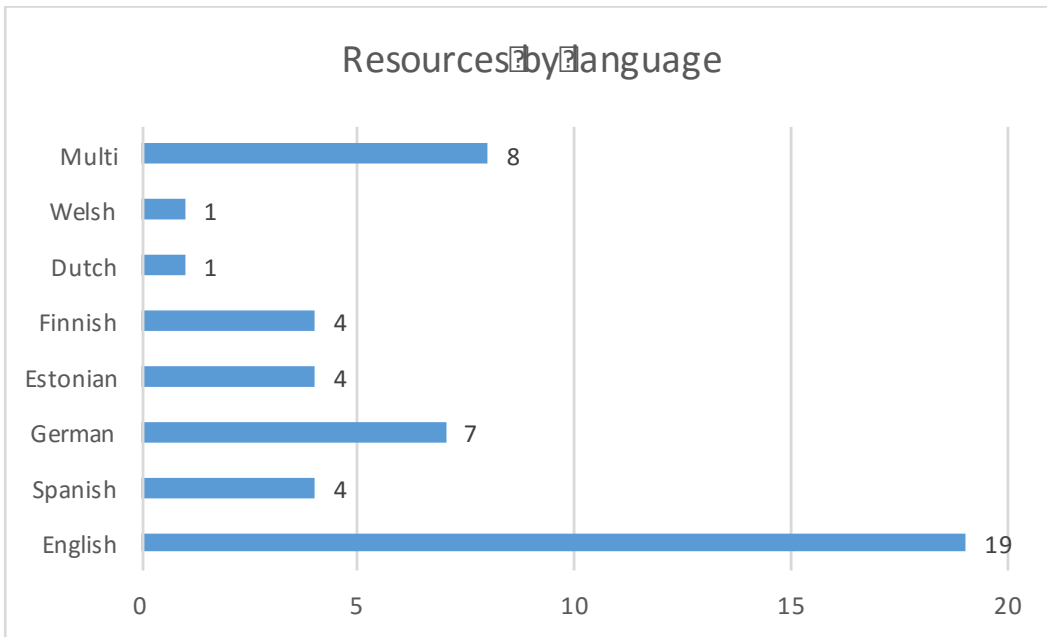


Figure 4. Languages of the reviewed resources

#### 4. Resources catalogue for introducing programming

TACCLE 3 resource database is composed by 37 records that have been documented following the proposed template (García-Peñalvo, 2016d).

The following pages gathers this resources.

#### 4.1. Baxter robot



**Title:** BAXTER ROBOT

**Description:** Baxter is an [industrial robot](#) built by [Rethink Robotics](#), a start-up company founded by [Rodney Brooks](#). It is a 3-foot tall (without pedestal; 5'10" - 6'3" with pedestal), two-armed robot with an animated face. It weighs 165 lbs without the pedestal and 306 lbs with the pedestal. It is used for simple industrial jobs such as loading, unloading, sorting, and handling of materials. Brooks stated that Baxter was designed to perform the dull tasks on a production line.

**Link:** <http://www.rethinkrobotics.com/baxter/>

**License:** Commercial

**Languages:** English. It can be managed in several

**Target groups:** pre-university, university students, teachers

**Known uses:** used to carry out industrial and repetitive tasks, in an autonomous or tele-operated way. In educational context it can be used to show repetitive tasks, to analyse the human-robot interaction and even to act as a teacher. Moreover, it can be programmed by students to carry out some tasks.

**Pedagogical level:** -

**TACCLE Classification:** Using logic, Controlling things

**Quality:** 4

**Open comments:** -

**Date:** 16/06/2016

## 4.2. Geomagic Touch Haptic



**Title:** Geomagic Touch Haptic

**Description:** 3D Systems haptic devices provide true three-dimensional navigation and force feedback, integrating a sense of touch into the [Geomagic® Freeform®](#) and [Geomagic® Sculpt®](#) 3D modelling systems as well as for research and commercial applications.

**Link:** <http://www.geomagic.com/en/products-landing-pages/haptic>

**License:** Commercial

**Languages:** English. It can be managed in several

**Target groups:** pre-university, university students, teachers

**Known uses:** it is used to simulate the sense of touch so it can be applied in several areas and especially in the educational field to facilitate the acquisition of expert knowledge related to touch sense or to understand concepts related to touch. For instance, how the resistance of a surface can affect the movement

**Pedagogical level:** -

**TACCLE Classification:** Using logic, Controlling things

**Quality:** 4

**Open comments:** -

**Date:** 16/06/2016

### 4.3. Minecraft



**Title:** Minecraft

**Description:** Minecraft is a game about using blocks to create constructions and going on adventures of characters. Explore randomly generated worlds and build amazing things from the simplest of homes to the grandest of castles.

**Link:** <https://minecraft.net/>

**License:** Commercial. Not allowed for commercial use

**Languages:** Several, more than 91

**Target groups:** pre-university and university students

**Known uses:** use as a game, use to solve and understand problems related to programming. Examples of its use in education: <http://education.minecraft.net/>

**Pedagogical level:** -

**TACCLE Classification:** Using logic; Creating and Debugging

**Quality:** 4

**Open comments:** This resource is very useful with the students because is something visual that they can manipulate, and specially with pre-university students because most of them have previously used Minecraft as a game.

**Date:** 16/06/2016

#### 4.4. Scratch



**Title:** Scratch

**Description:** **Scratch** is a free [visual programming language](https://scratch.mit.edu/). Scratch is used by students, scholars, teachers, and parents to easily create animations, games, etc. and provides a stepping stone to the more advanced world of computer programming.

**Link:** <https://scratch.mit.edu/>

**License:** Creative Commons ShareALike2.0

**Languages:** Multilanguage

**Target groups:** pre-university, university students, teachers

**Known uses:** used to create animations, games, resources, etc. In education it can be used to develop programming skills

**Pedagogical level:** -

**TACCLE Classification:** Algorithms, Using logic, Creating and Debugging

**Quality:** 4

**Open comments:** Very useful to show students basic programming structures

**Date:** 16/06/2016

#### 4.5. Dr. Roland



**Title:** Pedagogical Conversational Agent: Dr. Roland

**Description:** Pedagogic Conversational Agents (PCA) are e-learning interactive systems that teach students through a conversation in natural language. These systems have been used at higher levels of education successfully, and in recent years there has been increasing interest in use at lower levels from Primary Education to Children Education. Dr. Roland is used to improve understanding and thus the resolution, and It has revealed other notable benefits such as an increase of motivation and concentration.

**Link:** Dr. Roland will be freely available in September 2016.

**Languages:** Spanish

**Target groups:** Students

**Known uses:** The agent has been used in Social and Natural Sciences, Physical Education and Mathematics.

**Pedagogical level:** Primary and secondary education.

**TACCLE Classification:** Algorithms, Natural language, Conversational Pedagogical Agent, user-centred design, understanding, Human Computer Interaction

**Quality:** 4

**Date:** 27-06-2016

#### 4.6. 5sphero Kids



**Title:** 5sphero Kids

**Description:** The application facilitates the interaction from a smartphone with a robotic ball with autonomous movement capabilities ( Sphero ). The proposed application consists of three modules in which various concepts from early childhood curriculum are covered: (1) introduction to the addition/subtraction combined with gross motor skills, (2) colours and introduction to reading and writing combined with fine motor skills, and finally, (3) geometric forms, which have been treated based on both type of motor skills.

**Link:** The app will be uploaded to Google Play. It is intended to control a Sphero device <http://www.sphero.com/>

**License:** The initial version is expected to be releases as a freeware.

**Languages:** Spanish.

**Target groups:** 4-6 year-old kids.

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

**Pedagogical level:** First level of elementary school (Kindergarten). In Spain, "Educación Infantil" level.

**TACCLE Classification:** Using logic, Controlling things.

**Quality:** 3.

**Open comments:** The use of bots has been acknowledged to contribute to develop special concept and psychomotricity.

There is a very limited number of educational apps geared to 5-year-old kids that contribute to develop gross motor skills. The few ones that can be found for this age focus on fine motor ones, such as Kids Shapes & Colors Preschool, Bee-bot, Lego Education WeDo and Sphero ColorGrab.



Sphero device is resistant and it is based on a sturdy design, that makes it suitable for developing gross motor skills.

The concept is interesting, however some efforts should be carried out to improve its design and user interface.

**Date:** June 29<sup>th</sup>, 2016.

#### 4.7. 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:** -

**Pedagogical level:** -

**TACCLE Classification:** Using logic, controlling things, creating and debugging

**Quality:** -

**Open comments:** -

**Date:** 27 April 2016

#### 4.8. EduWear Starter kit: Wearable intelligence – for clothes, sports and games



**Title:** EduWear Starter kit: Wearable intelligence – for clothes, sports and games

**Description:** Through the [EduWear EU project](#), Smart Textiles have become an important component of the TechKreativ program. As part of this project, a toolkit was developed, which is supposed to make access to Information and Communication Technology easier. In this context young people can actively shape and co-design technologies and learn how to use them in a confident and competent manner.

**Link:** <http://dimeb.informatik.uni-bremen.de/eduwear/>

Can be ordered online at: <http://www.watterott.com/en/EduWear-Kit?x551db=ff6675b35d38ab19ea25217fa291109a>

Further information 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:** The kit contains Smart Textiles (for example conductive yarn and fabrics), LEDs, vibrating motors, buzzers, light sensors, heat sensors, motion detectors and a small and handy micro-controller which can be used for the construction of intelligent clothes. Amici is a visual programming language which enables programming novices to program Arduino boards without having to master the textual programming language Arduino. Further info here [EduWear Project](#). Amici is Since the Arduino software is based on the open-source open (source code on request), released under the GPL.

**Languages:** English, German, Portuguese, Danish (software)

**Target groups:** novices to programming

**Known uses:** -

**Pedagogical level:** -

**TACCLE Classification:** *Using logic, Controlling things, Creating and debugging*

**Quality:** -

**Open comments:** -

**Date:** 28 June 2016

#### 4.9. Zauberschule Informatik - Ein erster Einblick in die Welt der Informatik



**Title:** Zauberschule Informatik - Ein erster Einblick in die Welt der Informatik

**Description:** This unplugged lesson consists of 6 modules. The materials are downloadable. It explains the students the bases of computers: binary numbers, recursion, debugging, optimisation, pictures and components of the PC

**Link:** <http://schuelerlabor.informatik.rwth-aachen.de/modul/zauberschule-informatik-ein-erster-einblick-die-welt-der-informatik>

**License:** Creative Commons

**Languages:** German

**Target groups:** Grammar school kids

**Known uses:** As project in Schools, for interested Kids visiting university

**Pedagogical level:** complete lesson module, requiring 2 teachers and 3 hours of work. It's theme is "magic"

**TACCLE Classification:** Algorithms, Using logic, Controlling things, Creating and Debugging are all mentioned in the modules

**Quality:** Not tested

**Open comments:** It is a comfortable, ready to print lesson. Its modular composition makes it possible to tear it apart into smaller activities. The creators of the project are still actively giving projects with the material. They are available for questions.

**Date:** 23.5.2016

#### 4.10. Kodu Game Lab



**Title:** Kodu Game Lab

**Description:** Kodu lets kids create games on the PC and Xbox via a simple visual programming language. Kodu can be used to teach creativity, problem solving, storytelling, as well as programming. Anyone can use Kodu to make a game, young children as well as adults with no design or programming skills.

**Link:** <http://www.kodugamelab.com/>

**License:** Kodu for the PC is available to download for free. Kodu for the Xbox is also available in the USA on the Xbox Marketplace, in the Indie Games channel for about \$5.

**Languages:** It can be managed in several. In Estonian tutorial for using Kodu Game Lab is available from <http://progekodu.weebly.com>

**Target groups:** primary school children

**Known uses:** use as a game, use to solve and understand problems related to programming. Examples of its use in education (with lesson plans and teacher's book): <http://progekodu.weebly.com/> (in Estonian); <http://www.kodugamelab.com> (in English)

**Pedagogical level:** Primary education

**TACCLE Classification:** Algorithms, using logic, creating and debugging

**Quality:** 4

**Open comments:** Very good environment for learning programming in early years. On Estonian page <http://progekodu.weebly.com> in addition to game tutorial you can find

the teacher's book with 30 lesson plans. Using those lesson plans any teacher can teach the basics of programming in primary school.

**Date:** 28.06.2016

#### 4.11. 3pi robotics platform e-course



**Title:** 3pi robotics platform e-course

**Description:** The aims of the E-course are: 1) to develop programming and structural thinking skills and to practice programming of a popular 3pi robot (small mobile robot, that is made to follow lines and go through a maze made of lines) in C-programming language; 2) to change learning ICT curriculum (programming and creating apps) more attractive and simpler, to motivate children to take more interest in natural science.

**Link:** [http://home.roboticlab.eu/et/projects/3pi?s=translation\\_true](http://home.roboticlab.eu/et/projects/3pi?s=translation_true)

**License:** Creative Commons 4 (Attribution - Non Commercial).

**Languages:** Estonian

**Target groups:** primary, secondary and high school students and teachers

**Known uses:** The course can be completed at various speeds. The course will teach you the programming language C.

**Pedagogical level:** from primary school

**TACCLE Classification:** Algorithms, using logic, controlling things, creating and debugging

**Quality:** 4

**Open comments:** Very good e-course for children and teachers. The course includes theoretical and practical teachings.

**Date:** 29.06.2016

#### 4.12. MSW Logo



**Title:** MSW Logo

**Description:** MSW Logo is a Logo-based programming environment, intended for educational purposes. Because it is easy to learn, it is a great introduction to programming for kids or those who want to get started in programming. It's not all boring either - although graphs and charts are its main application, MSW Logo can be used to create games or programs for Windows.

**Link:** <http://www.softronix.com/logo.html>

**License:** MSW Logo is available to download for free.

**Languages:** English, German, Portuguese, Japanese, French

**Target groups:** Primary school children

**Known uses:** Examples of its use in education (with lesson plans, teacher's book and videos): <http://progemswlogo.weebly.com/> (in Estonian). Other pages: <http://www.ise.ee/cdrom/cd3/logo/> (tutorial in Estonian), <http://www.mathcats.com/gallery/15wordcontest.html> (the drawings with Logo, in English)

**Pedagogical level:** Primary education

**TACCLE Classification:** Algorithms, using logic

**Quality:** 3

**Open comments:** Very limited usefulness. On the downside, if the game isn't available with the native language, then the algorithms must be written in foreign language, which means that in addition to programming a foreign language must be learnt as well. Suitable for those who like drawing. Teaching materials found on the Estonian site <http://progemswlogo.weebly.com> are really helpful for teachers.

**Date:** 29.06.2016



#### 4.13. Studio.code.org -course 2



**Title:** Studio.code.org -course 2

**Description:** Course 2 is for students who can read and have no prior programming experience. In this course students will create programs to solve problems and develop interactive games or stories they can share.

**Link:** <https://studio.code.org/s/course2>

**License:** Other than the proprietary videos and artwork - Creative Commons 4 (Attribution-Non Commercial). More information from <https://code.org/tos>

**Languages:** 30+

**Target groups:** Recommended for grades 2-5.

**Known uses:** online learning. Examples of its use in education: -.

**Pedagogical level:** primary education

**TACCLE Classification:** Algorithms, using logic, controlling things, creating and debugging

**Quality:** 5

**Open comments:** Very good e-course for young children who have no prior programming experience. Instructions at hand are simple and learning is done through different playful exercises. The course has 19 different stages which contain different playful exercises. It encourages students to learn online.

**Date:** 10.07.2016

#### 4.14. Ozobot



**Title:** Ozobot

**Description:** Measuring slightly over an inch, Ozobot is one of the world's smallest smart robot toys which combines digital and physical game play, along with robotics and coding using simple colours. Starting with colour markers, Ozobot takes kids on a fun and mesmerizing experience through creative drawing, problem solving and group challenges by colouring code commands in the form of basic colour combinations.

**Link:** <http://ozobot.com/>

**License:**

**Languages:** English

**Target groups:** primary and secondary school students

**Known uses:** Examples of its use in education: <http://portal.ozobot.com/lessons>. You can find additional material about Ozobot from its home page: drawing games: <http://ozobot.com/play/drawing-games>; printable games <http://ozobot.com/play/print-games>; on-line games: <http://ozobot.com/play/web-games>; apps: <http://ozobot.com/play/apps>; programming games: [http://games.ozoblockly.com/?\\_ga=1.190173675.1918529750.1457965164](http://games.ozoblockly.com/?_ga=1.190173675.1918529750.1457965164); on-line programming environment OzoBlockly (depending on the version of the robot, it is either free or not): <http://ozoblockly.com/editor>; introduction videos for OzoBot in YouTube: [https://www.youtube.com/results?search\\_query=Ozobot](https://www.youtube.com/results?search_query=Ozobot).

**Pedagogical level:** Primary and secondary education

**TACCLE Classification:** Algorithms, using logic, controlling things.

**Quality:** 4

**Open comments:** Ozobot is small, compact, easily programmable and simple to use in classroom. In addition, Ozobot makes programming interesting for children.

**Date:** 10.07.2016

#### 4.15. Minetest



**Title:** Minetest

**Description:** Minetest is a near-infinite-world block sandbox game and a game engine, inspired by InfiniMiner, Minecraft, and the like.

**Link:** <http://www.minetest.net/>

**License:** LGPL

**Languages:** English

**Target groups:** pre-university and university students

**Known uses:** use as a game, use to solve and understand problems related to programming. Examples of its use in education:

<http://wiki.minetest.net/Mods:Learning>;

<http://wiki.mrcoderdojo.org.uk/index.php/MineTest>

**Pedagogical level:** Primary and Secondary students.

**TACCLE Classification:** Using logic; Creating and Debugging

**Quality:** 5

**Open comments:** An open solution to use in education the potential of Minecraft.

**Date:** August 6<sup>th</sup>, 2016

#### 4.16. Soy Minero



**Title:** Soy Minero

**Description:** A blog about Minecraft and some of its most interesting mods from the automation point of view.

**Link:** <https://soyminero.wordpress.com/>

**License:** -

**Languages:** Spanish

**Target groups:** pre-university, university students, teachers

**Known uses:** info site

**Pedagogical level:** Secondary students.

**TACCLE Classification:** Using logic; Controlling things, Creating and Debugging

**Quality:** 4

**Open comments:** An interesting blog to discover the powerful of Minecraft as computational thinking tool.

**Date:** August 6<sup>th</sup>, 2016

#### 4.17. TACCLE 3: Coding web site



**Title:** TACCLE 3: Coding web site

**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 inservice 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:** Primary and Secondary students.

**TACCLE Classification:** Algorithms, Using logic; Controlling things, Creating and Debugging

**Quality:** 5

**Open comments:** Useful teaching resource bank.

**Date:** August 6<sup>th</sup>, 2016

#### 4.18. 123D Design



**Title:** 123D Design

**Description:** 123D Design is a free, powerful, yet simple 3D creation and editing tool which supports many new 3D printers.

**Link:** <http://www.123dapp.com/design>

**License:** Free

**Languages:** English

**Target groups:** Teachers, Primary, Secondary and University students

**Known uses:** 3D modeller

**Pedagogical level:** Primary and Secondary students.

**TACCLE Classification:** Creating and Debugging

**Quality:** 4

**Open comments:** Good 3D modeller tool to help kids introducing into 3D modelling area.

**Date:** August 6<sup>th</sup>, 2016

#### 4.19. Tynker



**Title:** Tynker Coding for code

**Description:** Tynker is a computing platform to make games and learn coding.

**Link:** <https://www.tynker.com>

**License:** -

**Languages:** English

**Target groups:** Teachers, Parents, Primary, Secondary and University students

**Known uses:** Programming platform

**Pedagogical level:** Primary students.

**TACCLE Classification:** Using logic, Controlling things, Creating and Debugging

**Quality:** 4

**Open comments:** Interesting for introducing kids in programming.

**Date:** August 6<sup>th</sup>, 2016

#### 4.20. Tynker Hour of code



**Title:** Tynker Hour of code

**Description:** Online courses for children to learn coding at home. It uses Tynker coding platform.

**Link:** <https://www.tynker.com/hour-of-code>

**License:** -

**Languages:** English

**Target groups:** Teachers, Parents, Primary, Secondary and University students

**Known uses:** Learn to code

**Pedagogical level:** Primary students.

**TACCLE Classification:** Using logic, Controlling things, Creating and Debugging

**Quality:** 4

**Open comments:** Interesting for introducing kids in programming.

**Date:** August 6<sup>th</sup>, 2016



#### 4.21. Blockly for Dash & Dot Robots



**Title:** Blockly for Dash & Dot Robots

**Description:** Android and iPad app for introducing young kids (K-5) in the programming fundamentals with a block-based approach. They can program funny virtual robots with code blocks, with plenty of creative options and lots of fun.

**Link:** <https://www.commonsense.org/education/app/blockly-for-dash-dot-robots>

**License:** Freeware

**Languages:** English

**Target groups:** Primary students

**Known uses:** Learn to code

**Pedagogical level:** Primary students.

**TACCLE Classification:** Using logic, Creating and Debugging

**Quality:** 4

**Open comments:** Interesting app for introducing young kids in programming.

**Date:** August 6<sup>th</sup>, 2016

#### 4.22. Path for Dash Robot



**Title:** Path for Dash Robot

**Description:** Android and iPad app. Path makes programming logic fun and tangible for kids as they program paths for a robot and experience the lighting and sound effects. Kids can quickly and easily progress through the scenes in Path, unlocking dozens of special effects that they can then use to create their own programs.

**Link:** <https://www.commonsense.org/education/app/path-for-dash-robot>

**License:** Freeware

**Languages:** English

**Target groups:** Primary students

**Known uses:** Students can learn programming logic and robotics working with Dash. Drawing the path with their fingers gives them a visual representation of the order that the events occur. Then they can drag the visual icon for each event into place in the program.

**Pedagogical level:** Primary students.

**TACCLE Classification:** Using logic, Controlling things

**Quality:** 4

**Open comments:** Path for Dash Robot is a free app that requires the Wonder Workshop robot Dash. The other companion robot, Dot, does not work with Path. Dash requires a device with a Bluetooth connection and must be connected to the app each time kids play.

**Date:** August 6<sup>th</sup>, 2016

#### 4.23. Code.org



**Title:** Code.org

**Description:** Code.org is a non-profit dedicated to expanding access to computer science. It has different courses and a block-based coding platform (Code Studio)

**Link:** <https://code.org>

**License:** -

**Languages:** Multilanguage

**Target groups:** Primary and Secondary students, Teachers

**Known uses:** Courses and block-based programming platform

**Pedagogical level:** Primary and Secondary students.

**TACCLE Classification:** Using logic, Creating and Debugging

**Quality:** 5

**Open comments:** Impressive site to promote Computer Science in schools. It has resources for teachers but also to students that can learn with autonomy. It is interesting to emphasize the coding platform Code Studio and the courses in the Hour of Code section.

**Date:** August 6<sup>th</sup>, 2016

#### 4.24. Code Studio



**Title:** Code Studio

**Description:** The block-based coding platform of code.org

**Link:** <https://studio.code.org/>

**License:** -

**Languages:** Multilanguage

**Target groups:** Primary and Secondary students, Teachers

**Known uses:** Courses and block-based programming platform

**Pedagogical level:** Primary and Secondary students.

**TACCLE Classification:** Using logic, Creating and Debugging

**Quality:** 5

**Open comments:** Coding platform and courses.

**Date:** August 6<sup>th</sup>, 2016

#### 4.25. Code.org Hour of Code



**Title:** Code.org Hour of Code

**Description:** Practicing with code.org. Tutorials.

**Link:** <https://code.org/learn>

**License:** -

**Languages:** Multilanguage

**Target groups:** Primary and Secondary students, Teachers

**Known uses:** Practice with coding

**Pedagogical level:** Primary and Secondary students.

**TACCLE Classification:** Using logic, Creating and Debugging

**Quality:** 5

**Open comments:** Practice with Code.org.

**Date:** August 6<sup>th</sup>, 2016

#### 4.26. MIT App Inventor



**Title:** MIT App Inventor

**Description:** MIT App Inventor is a beginner's introduction to programming and app creation that transforms the complex language of text-based coding into visual, drag-and-drop building blocks. The simple graphical interface grants even an inexperienced novice the ability to create a basic, fully functional app within an hour or less.

**Link:** <http://appinventor.mit.edu/>

**License:** Creative Commons

**Languages:** English

**Target groups:** Primary and Secondary students, Teachers

**Known uses:** Creating apps. Introduction to programming

**Pedagogical level:** Primary and Secondary students.

**TACCLE Classification:** Algorithms, Using logic, Creating and Debugging, Controlling things

**Quality:** 5

**Open comments:** In the web site there are multiple and useful resources

**Date:** August 6<sup>th</sup>, 2016

#### 4.27. MaKey MaKey



**Title:** MaKey MaKey

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

**Link:** <http://makeymakey.com/>, <http://web.media.mit.edu/~ericr/makeymakey/>

**License:** Commercial

**Languages:** English

**Target groups:** Primary and Secondary students, Teachers

**Known uses:** Creativity

**Pedagogical level:** Primary and Secondary students.

**TACCLE Classification:** Controlling things, Creating and debugging

**Quality:** 5

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

**Date:** August 6<sup>th</sup>, 2016

#### 4.28. Arduino



**Title:** Arduino

**Description:** Arduino is an open-source electronics platform based on easy-to-use hardware and software. It's intended for anyone making interactive projects. Arduino senses the environment by receiving inputs from many sensors, and affects its surroundings by controlling lights, motors, and other actuators. You can tell your Arduino what to do by writing code in the Arduino programming language and using the Arduino development environment.

**Link:** <https://www.arduino.cc/>

**License:** Open Source

**Languages:** Multilanguage

**Target groups:** Primary and Secondary students, Teachers

**Known uses:** Creativity, controlling things.

**Pedagogical level:** Primary and Secondary students.

**TACCLE Classification:** Using logic, Controlling things, Creating and debugging

**Quality:** 5

**Open comments:** In the web site there are multiple and useful resources.

**Date:** August 6<sup>th</sup>, 2016



#### 4.29. CS Unplugged



**Title:** CS Unplugged. Computer Science without a computer

**Description:** CS Unplugged is a collection of free learning activities that teach Computer Science through engaging games and puzzles that use cards, string, etc. The activities introduce students to Computational Thinking through concepts separated from the distractions and technical details of having to use computers. Importantly, no programming is required to engage with these ideas.

**Link:** <http://csunplugged.org/>

**License:** Creative Commons BY-NC-SA

**Languages:** English (part of the information in different languages)

**Target groups:** Primary and Secondary students, Teachers

**Known uses:** Unplugged has been used around the world for over twenty years, in classrooms, science centres, homes, and even for holiday events.

**Pedagogical level:** Primary and Secondary students.

**TACCLE Classification:** Algorithms, Using logic

**Quality:** 5

**Open comments:** CS Unplugged is a project by the CS Education Research Group at the University of Canterbury, NZ. It is suitable for people of all ages, from elementary school to seniors, and from many countries and backgrounds. It is a very huge collection of activities to learn computational thinking. The activities are designed to be done without a computer and are excellent to introduce children in computational thinking concepts. Most of them may be done in groups using funny elements that may be constructed by the teachers or the students themselves. There are many materials in the site, but also a book is available for free download.

**Date:** August 16<sup>th</sup>, 2016

#### 4.30. Making-Aktivitäten mit Kindern und Jugendlichen. Handbuch zum kreativen digitalen Gestalten



**Title:** Making-Aktivitäten mit Kindern und Jugendlichen. Handbuch zum kreativen digitalen Gestalten (Hrsg: Sandra Schön, Martin Ebner, Kristin Narr)

**Description:** *A short, but significant resource description:*

Making handbook to introduce a variety of making activities. The handbook is a collection of experiences made with the "Maker Days for Kids", in order to spread the information for adults and also to supplement with experiences of other Making Assets. "Maker Days for Kids" was the first open, free online course on "the making with children" on the platform iMooX.at in autumn 2015. More than 600 participants / inside have to February 2016 participated in the course. The project descriptions in the class are now available for this manual updated and provided with further texts.

The free online course for adults (parents), who want to start with Making stuff with children, was launched on the platform iMooX.at in October 2015. The course is up to June 2016 and can be accessed online, all (openly licensed) course materials are still available or are available through other channels (for example, the videos on Youtube).

A replay of the online course is planned for autumn 2016. Participating thereby obtained at successful completion of a certificate of attendance.

One chapter dealing with programming is entitled "simple programming and digital design". It contains an introduction into scratch (online tutorial) including tips and tricks

Target group parents and pre-school children.

Another chapter is entitled "simple roboter design (construction) and working with LED". It contains exercises for soldering. Other maker projects are included (developing vibrobots, makey makey (Banana piano), programming with Raspberry Pi and Minecraft (6<sup>th</sup> grade), introduction to Arduino (9<sup>th</sup> grade), using the plotter (children age 10)

**Link:** *Link to the resource:* Website: PDF full text available online at

[http://www.bimsev.de/n/userfiles/downloads/making\\_handbuch\\_online\\_final.pdf](http://www.bimsev.de/n/userfiles/downloads/making_handbuch_online_final.pdf)

Source: Sandra Schön, Martin Ebner und Kristin Narr (2016) (Hrsg.): Making-Aktivitäten mit Kindern und Jugendlichen. Handbuch zum kreativen digitalen Gestalten:

**License:** *What kind of licensing system the resource has* CC licence / Lizenztext can be accessed at: <https://creativecommons.org/licenses/by/3.0/de/>

**Languages:** German

**Target groups:** *main target groups of this resource:* novices to make stuff and programming, adults/parents who want to introduce children and teenagers to making.

**Known uses:** -

**Pedagogical level:** *pedagogical level of resource:* For beginners who want to teach programming

**TACCLE Classification:** *Controlling things*

**Quality:** -

**Open comments:** Wider target group, not only primary or pre-school level

**Date:** 9 September 2016

#### 4.31. Magical Clothing



**Title:** "Magical Clothing" (Zauberhafte Kleidung) workshop tutorial for teachers developed by the DiMeB, University of Bremen

**Description:** "Magical Clothing" is a short workshop, which gives an insight into "Digital media and interaction" as part of the field of computer science.

In 90 minutes, the participants programme a T-shirt, so that changes the color of a sewn- RGB - LED are realized after arm movements. The workshop is suitable for formats such as the Girls' Day or Future and other trial hands-on workshop offers. Participants do not need any previous experience and should be about 10 years or older.

Work is carried out with the Arduino LilyPad, a RGB - LED (which is addressed via the PWM pins), and a quadruple switch is programmed with the Amici Software.

Here are the instructions for conducting and preparing the workshop

[http://dimeb.informatik.uni-bremen.de/techkreativ-new/media/anleitungen/Anleitung\\_zauberhafteKleidung.pdf](http://dimeb.informatik.uni-bremen.de/techkreativ-new/media/anleitungen/Anleitung_zauberhafteKleidung.pdf).

In the zip file there are all the necessary files, for example, the Amici files and handouts to print:

[http://dimeb.informatik.uni-bremen.de/techkreativ-new/index.php?option=com\\_content&view=article&id=144%3Aschnupperworkshop&catid=47%3Amaterial&Itemid=70&lang=de](http://dimeb.informatik.uni-bremen.de/techkreativ-new/index.php?option=com_content&view=article&id=144%3Aschnupperworkshop&catid=47%3Amaterial&Itemid=70&lang=de).

**Link:** *Link to the resource:* Website: [http://dimeb.informatik.uni-bremen.de/techkreativ-new/media/anleitungen/Anleitung\\_zauberhafteKleidung.pdf](http://dimeb.informatik.uni-bremen.de/techkreativ-new/media/anleitungen/Anleitung_zauberhafteKleidung.pdf)

Further information 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:** The Amici software can be access for free at <http://dimeb.informatik.uni-bremen.de/eduwear/>

**Languages:** English, German, Portuguese, Danish (software)

**Target groups:** novices to programming

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

**Pedagogical level:** *pedagogical level of resource: For beginners who want to teach programming*

**TACCLE Classification:** *Controlling thing*

**Quality:** -

**Open comments:** -

**Date:** 31 August 2016

#### 4.32. Koodiaapinen



**Title:** Koodiaapinen

**Description:** Koodiaapinen, or "Code ABC" or "Code Alphabet", is a grassroots initiative by teachers and educational researchers. Koodiaapinen organizes coding MOOCs to teachers and provides coding materials in web site library.

**Link:** <http://koodiaapinen.fi/>

**License:** The license icon shows the Creative Commons logo (CC) followed by icons for Attribution (BY) and Share-Alike (SA).

**Languages:** Finnish (short introduction in English)

**Target groups:** Comprehensive school teachers

**Known uses:** Koodiaapinen has educated over 1 000 teachers to teach coding at school starting in 2015. Koodiaapinen runs a coding MOOC and presents coding materials on their web site.

**Pedagogical level:** High. Koodiaapinen was launched by cutting-edge professionals in education, teaching, learning, school curricula and technologies.

**TACCLE Classification:** Algorithms, Using logic, Controlling things, Creating and Debugging

**Quality:** 5

**Open comments:** Participation in the coding MOOC is highly recommended.

**Date:** September 8, 2016

#### 4.33. Koodikirja



**Title:** Koodikirja

**Description:** Koodikirja (“Code book”) has been created as for material in Koodikoulu (<http://www.koodikoulu.fi/>). It is still under development but the first chapter directs basics of programming. Koodikirja introduces two basic structures of coding, that is commands and repetition, to children and school teachers by using Turtle Roy

**Link:** <http://www.koodikirja.fi/>

**License:** Free for non-commercial use, copying and delivery. Open source. Code available in GitHub.

**Languages:** Finnish

**Target groups:** Children 4+ working together with an adults, young people, school teacher

**Known uses:** The book has been created for material in Koodikoulu (<http://www.koodikoulu.fi/>).

**Pedagogical level:** High

**TACCLE Classification:** Algorithms, Using logic, Controlling things, Creating and Debugging

**Quality:** 4. With more material 5.

**Open comments:** Koodikirja is a good start to coding for understanding commands and repetition as key structures. Special thanks for understandable and lively language and easy-to-follow instructions for PCs, Macs and Linux. No software installations needed.

**Date:** September 8, 2016

#### 4.34. Hello Ruby



**Title:** Hello Ruby

**Description:** Web material and story book to children who want to hear and learn about coding in inspiring, narrative way. Computational thinking related materials, such as worksheets and exercises, designed for children are available in the web site. Web site supports the storybook Hello Ruby that was a starting point of the whole Hello Ruby story.

**Link:** <http://www.helloruby.com/>

**License:** Web material free to use.

**Languages:** English

**Target groups:** children 5+

**Known uses:**

**Pedagogical level:** High

**TACCLE Classification:** Algorithms, Using logic, Controlling things, Creating and Debugging

**Quality:** 5

**Open comments:** Materials are very girlish that is an advantage in the coding domain. Plays and tasks introduce coding to children as a story that includes key elements of computational thinking.

**Date:** September 8, 2016



#### 4.35. Koodikoulu



**Title:** Koodikoulu

**Description:** Koodikoulu is a collection of coding materials that are targeted to adults.

**Link:** <http://koodikoulu.fi>

**License:** What kind of licensing system the resource has, if available (e.g. if videos are considered rather than software)

**Languages:** Finnish

**Target groups:** Teachers and adults who are interested in or need to teach coding at schools

**Known uses:** Koodikoulu is a collection of coding materials that are targeted to adults.

**Pedagogical level:** Average

**TACCLE Classification:** Algorithms, Using logic, Controlling things, Creating and Debugging

**Quality:** 3

**Open comments:** Useful set of coding materials and initiatives that works well for getting more extensive understanding about coding at schools.

**Date:** September 8, 2016

#### 4.36. The Foos



**Title:** The Foos

**Description:** Game-type-of activity for learning to code. Step-by-step instructions guide children from creating single commands in sequences to repetition and conditions. Codes are created by graphical images so not even ability to read is required. The Foos is available both for mobile devices (Android and iOS) and desktop use by web browser.

**Link:** <http://thefoos.com>

**License:** Free use (desktop use, iOS, Android)

**Languages:** English

**Target groups:** young children

**Known uses:**

**Pedagogical level:** Good

**TACCLE Classification:** Algorithms, Using logic, Controlling things, Creating and Debugging

**Quality:** 5

**Open comments:** Easiness to step in the coding is an advantage of the Foos. Minimal amount of adult's facilitation is needed and the app works well also with children who cannot read.

**Date:** September 8, 2016

#### 4.37. Proge Tiger



**Title:** Proge Tiger

**Description:** Teaches programming, web applications and website creation during classes or in hobby clubs to students from grades 1 to 12. The proge tiger aims to develop students' logical thinking, creativity and mathematical skills, demonstrate that programming can be interesting and done by anyone, teach the basics of programming through practical activity and teach students to use different age-appropriate programming languages. There is information about the ProgeTiger program, the competitions and teacher trainings, and also news and learning materials on this website.

**Link:** <http://progetiiger.ee/>

**License:** Free use

**Languages:** Estonian

**Target groups:** Teachers

**Known uses:** There is also a link (<http://bit.ly/progelingivastused>) to materials which teachers have created or found to be interesting for the other teachers. There are so many good ideas for all levels of teaching.

**Pedagogical level:** High

**TACCLE Classification:** Algorithms, Using logic, Controlling things, Creating and Debugging

**Quality:** 5

**Open comments:** Although there is much valuable information on this website the most valuable for teachers is probably the information under the label 'learning materials'. There are so many good materials: presentations, lesson plans, tutorials, apps, links to the other topic-related websites etc.

**Date:** September 8, 2016

## 5. Resource surveys

Once the resources database is made and TACCLE 3 researches have the resources catalogue, it is possible to make more detailed surveys oriented to pre-university in-service teachers or future teachers.

Following sections reflects two different developed surveys, one about the best apps for teaching programming, and other about the best robotics kits.

### 5.1. Apps for teaching programming survey

In (Hughes, 2016) comments about these apps may be also found.

#### 5.1.1. ScratchJr

In this app, kids, ages 5 to 7 can learn to program their own games and interactive stories. Kids snap together programming blocks to make their characters move, jump, dance, and sing. ScratchJr was inspired by the popular Scratch programming language (Resnick et al., 2009), developed by MIT. It is a great way to introduce young kids to programming. Figure 5 shows the app logo.



Figure 5. ScratchJr logo

#### 5.1.2. Tynker

Kids with no knowledge of programming can learn logic with this iPad app. The app contains story puzzles that kids can solve through dragging and dropping to make visual code blocks. Kids learn to recognize patterns and break down a problem into small steps. Tynker includes one free game and additional games are available with in-app purchasing. Recommended for ages 9 to 11. Figure 6 shows the app logo.



Figure 6. Tynker logo

### 5.1.3. ScriptKit

ScriptKit is best for older kids, ages 12 and up. ScriptKit is a drag and drop programming app for the iPad. With it, kids can build simple mobile prototypes using native iOS UI components and social media APIs. This means they can design and write code on the iPad. Figure 7 shows the app logo.



Figure 7. ScriptKit logo

### 5.1.4. Hopscotch: Coding for Kids

Kids, ages 8 to 12, can use simple, intuitive building blocks to create games, animations, and apps. They can drag and drops blocks of code to create anything they can dream up. Figure 8 shows the app logo.



Figure 8. Hopscotch logo

### 5.1.5. Lightbot

In this game, your kids, ages 9 to 11, can guide a robot to light up tiles and solve the different levels using commands. Lightbot can help introduce kids to programming concepts and coding. There exists an easier version of Lightbot designed for younger kids, ages 6 to 8, it is so called Lightbot Jr. Figure 9 shows the app logo.



Figure 9. Lightbot logo

#### 5.1.6. Kodable

With this free app, your kids can help the fuzzFamily explore the planet Smeeborg's Technomazes. While playing, they'll get a kid-friendly introduction to programming concepts. Gameplay is easy, you just drag and drop instructions for your fuzzes to follow and help them get through their mazes. Perfect for kids ages 5 and up. Figure 10 shows the app logo.



Figure 10. Kodable logo

#### 5.1.7. Robozzle

Kids can use simple commands to help a robot solve puzzles, follow a linked list, or even count in binary. With a growing database of over 1,000 puzzles, the kids will have plenty of opportunities for problem solving and fun. Figure 11 shows the app logo.



Figure 11. Robozzle logo

### 5.1.8. Cargo-Bot

Cargo-Bot is a puzzle game where children teach a robot to move crates. The game features 36 puzzles. It was created entirely on the iPad using a program called Codea. Figure 12 shows the app logo.



Figure 12. Cargo-Bot logo

### 5.1.9. SpaceChem Mobile

In this game, kids will take on the role of a Reactor Engineer working for SpaceChem. They can create factories to transform raw goods into valuable products, and streamline designs to meet production quotas and beat other engineers. Figure 13 shows the app logo.



Figure 13. SpaceChem logo

### 5.1.10. Code Combat

Code Combat is an on-line game where children use JavaScript to advance through levels, defeat ogres and wizards. With single-player and multi-player levels, it is perfect for any aged kid. Plus, it is free to play and a fun way to learn coding. Figure 14 shows the app logo.



Figure 14. Code Combat logo

### 5.1.11. Puzzlets

With Puzzlets (formerly called Ludos), kids can use plastic pieces on a base connected to their tablet to direct the character in the game and solve puzzles. The pieces have simple commands directing the character in the game to go up, right, down, and even jump. Figure 15 shows the app logo.



Figure 15. Puzzlets logo

### 5.1.12. Bee-Bot

Bee-Bot is another app that is perfect for the younger kids. Help kids, ages 4 and up, learn directional language and programming while directing their bee robot through various scenarios. Figure 16 shows the app logo.



Figure 16. Bee-Bot logo

### 5.1.13. KidsRuby

Kids can learn the programming language Ruby through this downloadable computer program. While not a game like the other apps, KidsRuby lets you write code and see the output instantaneously. The help files will take you step-by-step through the process. Figure 17 shows the app logo.



Figure 17. KidsRuby



## 5.2. Robotics kits survey

This section explores the most outstanding robot kits for introducing kids to the robotic world.

### 5.2.1. Lego Mindstorms EV3

Lego Mindstorms series is an educational robotics platform by Lego. There have been quite several versions of Mindstorms, EV3 series being the most recent one. While Mindstorms has been around for a while, there is a large community of users playing around with it so if you stuck to any challenges, getting help won't be an issue. EV3 robots are programmed with a specific visual programming environment with a drag-and-drop interface. Although Legos are not prone to damage, the programmable EV3 intelligent brick has a display that breaks easily if it is dropped. For users with an experience on programming languages, EV3 can be programmed with some popular programming languages such as Java and Python.

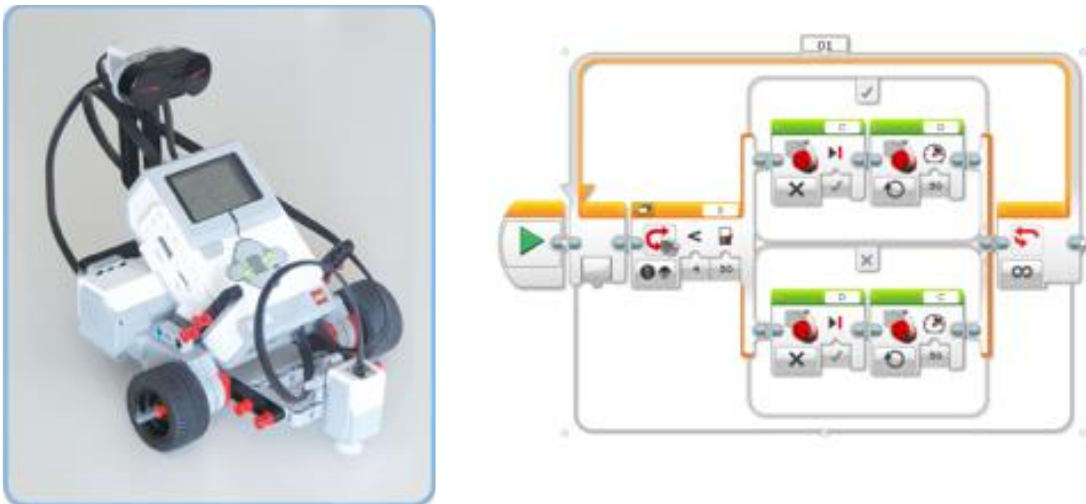


Figure 18. Lego Mindstorms EV3

While the EV3 set (which costs about 250€) provides sensors, motors, EV3 intelligent brick and some Legos, you can design and build your robot with regular Legos too, so EV3 series is very flexible and in the end, only your imagination is the limit. The visual programming environment is easy to use and learn. This does not however mean that the programming environment would not be powerful: kids can program their robot to follow the line or avoid obstacles but also it is possible to program a soccer playing team of robots to compete in robot soccer (See Figure 18).

EV3 robots can be used in various settings; it can be used at elementary schools but it has been also used at the university level. The visual programming environment supports basic programming structures such as loops and conditional statements. EV3 robots can also be controlled remotely with a smart phone with a specific app that can be downloaded from the app stores (Google play and App store).

The Mindstorms series is mature robotics kit so the hardware or the software don't suffer from bugs or constant changes. The set can be bought from a larger stores and it can be ordered online. While EV3 is flexible, powerful and widely used, it is relatively

expensive and the programmable intelligent brick breaks easily. The battery life of EV3 is relatively long lasting and can last even days.

Pros:

- Flexible (can be extended with regular Legos and many sensors).
- Easy to program.
- Very powerful.
- Popular.
- Wide scope of use scenarios from elementary schools to university level.

Cons:

- Expensive.
- EV3 intelligent bricks breaks easily.

More information available at <http://www.lego.com/en-us/mindstorms/about-ev3>.

### 5.2.2. Bee-Boot

Bee-Bot (see Figure 19) is an affordable robotics kit that includes only the Bee-Bot robot. Bee-Bot is a colourful and easy-to-operate robot designed especially to younger children. Bee-Bot is programmed with buttons that are placed in the top of the Bee-Bot robot. Bee-Bot remembers up to 40 command and executes the commands sequences by moving around. Bee-Bot does not break easily and because it is very easy to use and does not require computer to program it suits well for young students.



Figure 19. Bee-bot

Even if a robotics kit uses visual programming environment it can take a long time for students to learn to program the robot. This is the case especially with younger children. Bee-Bot is designed to be easy to use. The commands that Bee-Bot can take are: forward, backward, left and right. Bee-Bot executes the first given command for some

time (something like 1 second) and then moves to execute the second command. Bee-Bot is a good way to teach children logical thinking and problem solving.

Bee-Bot is powered by battery that is charged from USB-port. It is not clear how long the battery survives, but it is likely that it is powerful enough to cater the need in most typical use scenarios. The Bee-Bots are relatively cheap: a unit costs about 25 euros. Because Bee-Bot is designed for younger children, older learners might find it boring after some time because of low level of challenges it provides. Bee-Bots cannot be extended with additional building blocks or such.

Pros:

- Very easy to use.
- Cheap.
- No computer needed for programming.
- Durability.

Cons:

- Not very challenging.
- Cannot be extended and is not very flexible.

More information available at <https://www.bee-bot.us/>.

### 5.2.3. Robbo

Robbo offers two different robotics kits. The first kit, so called “Lab kit” is a board with different sensors and buttons attached to it. The Lab kit is connected to a computer with USB cable or with Bluetooth and it can be used together with Scratch programming environment. Because Lab kit is built with Arduino microcontrollers, it can also be programmed with Arduino programming language. This is a good option for more advanced learners. The Lab kit sends commands to the computer and it can be used for example to control characters in Scratch. The price of the Lab kit is around 100 euros.

While Lab kit itself cannot be extended with different Arduino equipments, the programming environment is very flexible because all of the Scratch-based commands are available. It is a good way to extend the Scratch to the physical world. The price of the Lab kit is reasonable (taking into account that it features an Arduino board). The kit is reasonably durable, although it is not recommended to drop it many times as the plastic housing may get damaged. Because Lab kit can be programmed with Scratch, it suits well for younger students but also because it can be used together with Arduino programming language, older students can use it and find challenges on it. Lab kit has a microphone, light sensor, speaker, leds and for example buttons that can be used together with Scratch.

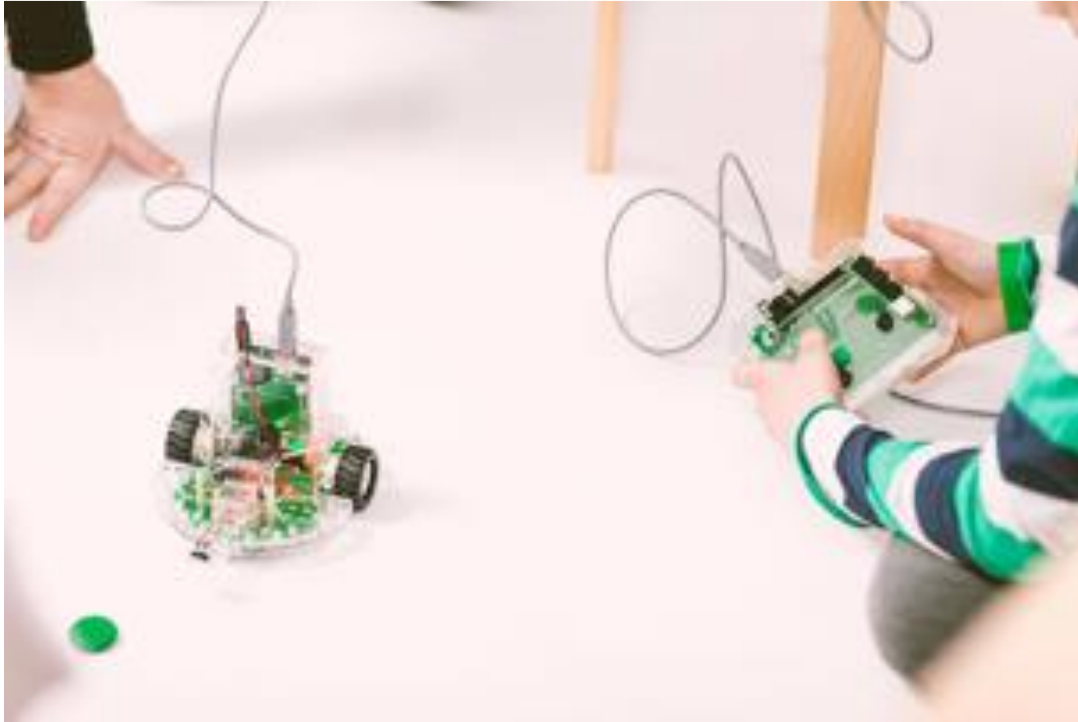


Figure 20. Robbo moving around

Robbo also provides an Arduino-based robot, “Robot kit”. Robot kit is an assembled Arduino robot that has flash light, light sensor, touch sensor, proximity sensor, two line sensors and motors to move the robot around (see Figure 20). The sensors can be mounted to a robot with a magnet so they are easy to add and remove. Robot kit, like the Labkit, can be programmed with both Scratch and Arduino so the children and youth from various age groups can use with and find it challenging.

Besides plug and play -type of sensors, Robot kit cannot be extended with regular Arduino parts so it is not super flexible. The price is relative expensive with the price tag of 250 euros.

Robot kit seems to be durable although it should be handled as carefully as any high-tech device. Both Lab kit and Robot kit are good alternatives for Mindstorms. Although Mindstorms' focus is in both programming and building the robot, Robbo puts its focus in just programming the robot. Although Robbo a newcomer in the market, the community behind Arduino and Scratch is wide, and getting help will not be a problem. The company producing Robbo kits is driven with open source principles, and they provide complete set of blueprints and schematics for both products to be used in do-it-yourself projects.

Pros of Lab kit:

- Relatively cheap (150€).
- Durable.
- Can be programmed with both Scratch and Arduino.

Cons of Lab kit:

- Limited flexibility.

Pros of Robot kit:

- Can be programmed with both Scratch and Arduino.
- Different sensors.
- Durable.

Cons of Robot kit:

- Expensive (250€).
- Limited flexibility.

More information available at <http://robbo.world/>.

#### 5.2.4. Cubelets

Cubelets are block-like robots that can be paired with other Cubelets. There are three different types of Cubelets: Sense blocks that sense the world with different type of sensors, Think blocks that can be used for logical thinking such as calculating mathematical equations and Act blocks that have motors. The way that Cubelets act is based on their order how they are connected to each other and students learn this by trial and error. Although Cubelets can also be programmed with C programming language or controlled remotely with your tablet or smart phone. Cubelets are meant to engage students to think logically.

Cubelets are very flexible and can be extended for example with Legos (see Figure 21). The number of Cubelets connected to each other is unlimited. The downside of Cubelets is that they are very expensive: 12 Cubelets starter kit costs around 320 euros. However, a set of 12 Cubelets is enough for even bigger group of students.

Cubelets offer challenges to different age groups since they can be programmed by connecting them to each other but also they can be plugged to also a computer and programmed with C programming language. There is also an app for smart devices that allows you to remotely control your Cubelets so finding new applications for Cubelets is not an issue.

Pros:

- Very flexible.
- Various ways to program.
- Durability.
- For different age groups.
- Enhance logical thinking.

Cons:

- Very expensive (320 euros for 12 Cubelets).

More information available at <http://www.modrobotics.com/cubelets/>.



Figure 21. Cubelets

#### 5.2.5. Ozobots

Ozobot is a small and cheap robot with a novel approach to learn programming. Ozobot uses colours to control its movements and actions so the students can release their imagination and program Ozobot with drawings (see Figure 22). Ozobot has a colour sensor attached at the bottom, and it has pre-programmed behaviour so it will act differently when encountering different colours. Ozobot can also be programmed with smart phones or tablets to widen the use cases of Ozobot.

The programming environment of Ozobot is visual and similar to Scratch. It is easy to use and learn. However, it is clearly designed for the younger children and older students might not find Ozobot so challenging or fun. For a cheap and novel way to engage the younger students in programming with multidisciplinary approach, Ozobot might be a good choice.

Besides the robot itself, Ozobot offers printable mazes, apps for programming and playing and other accessories to modify the appearance of Ozobot so there will be a lot of playing with.

Pros:

- Cheap (55€).
- Novel way to program.
- Easy to learn, designed for children.
- A lot of accessories.

Cons:

- Robot itself cannot be extended.
- Perhaps not the right choice for older students.
- Battery life unknown.

More information available at <http://ozobot.com/>.



Figure 22. Ozobots

#### 5.2.6. Edison

Edison robots are cheaper alternatives for Mindstorms series since their price is just about 50 euros. Edison robots include motors, microphone, distance sensor, light sensor and remote control opportunity (see Figure 23). Edison robots can be extended with regular Legos. Sensors and motors of Edison robots are fixed so extending the robot with different sensors or motors is not possible. Edison robots are also able to read bar codes, which is a remarkable feature especially for younger children that Mindstorms series does not provide.

The programming of Edison robots is made with a visual programming environment similar to Mindstorms' environment (see Figure 24). The programming environment



works with both computers and smart devices, such as iPads or Android phones. There is also a Python based robot programming environment available. Although Edison robots cannot be extended with external sensors or motors, the basic set offers all important sensors and two motors and students can extend Edison robots with regular Legos.



Figure 23. Edison

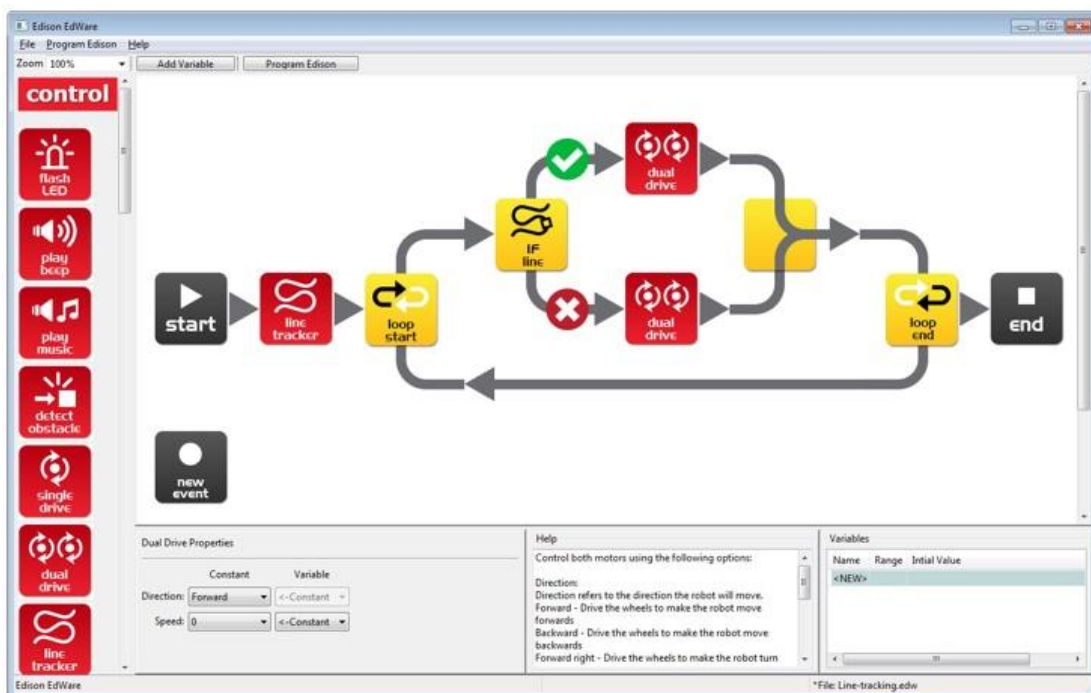


Figure 24. EdWare Robot Programming Software



Although much cheaper, Edison robots do not give such flexibility that EV3 robots give due the fact that no different motors or sensors can be used with Edison. Yet, Edison is a good alternative to EV3 robots with fewer opportunities and cheaper costs.

Pros:

- Cheap (50€).
- Can be extended with Legos.
- Visual and Python programming environments.
- Bar code reading.

Cons:

- Sensors and motors are fixed.

More information available at <https://meet Edison.com/>.

### 5.2.7. mBot

assemble the robot with motors and sensors without requiring students to know anything about electronics (see Figure 25). Sensors and motors to mBot are easy to plug with cables and the programming of mBot is made with Scratch environment. Being Arduino-based platform, it is possible to use Arduino programming language too. The aim of mBot is to provide a platform that can be mainly used to learn programming, so the assembling the mBot has been made easy.

mBot can be remotely controlled and it is relative cheap (about 90 euros). The Arduino board is modified so that sensors and motors can be plugged with cables in the same way as in Lego's EV3 robot. Lego bricks and similar can be used to extend mBot. Even if mBot is easy to program, extending mBot with Arduinos requires knowledge in electronics. mBot might not be the most durable option in the hands of younger students.



Figure 25. mBot

Pros:

- Cheap (90€).
- Flexible and can be extended.
- Visual programming and Arduino programming.
- Large user community.

Cons:

- Sensors and motors are fixed.

More information available at <http://www.makeblock.com/mbot-stem-educational-robot-kit-for-kids/>.

## 6. Conclusions

Introducing coding or programming in the pre-university studies is a big challenge for all. Timing and decision making to act formally at the curricula level is not an easy way. Too many teachers are introducing computing far away the digital literacy competences but usually they make it isolated in their subjects.

TACCLE 3 project is trying to create a significant teacher community, which shares the objective of introducing programming and/or computational thinking in their classes, and also looking for breaking this isolation effect and making an attraction effort for new teachers that want to but do not dare to give a step beyond.

The first step to create the community is having a website with attractive resources. In this paper we have presented the first approach to build up a resource catalog and some surveys to help them to find suitable teaching paths and make decision to introduce activities that help students to discover or go further into the programming and computational thinking.

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