D1.4 – Intellectual Output #1 – Part #2

Deliverable 1.4 - Evaluation grids

AN EDUCATIVE PLATFORM BASED ON MAKECODE, CIRCUITPYTHON & SCRATCH FOR CREATIVITY AND PARTICIPATORY SCIENCES USING IOT BOARDS

Let's STEAM

An educative platform based on MakeCode, CircuitPython & Scratch for creativity and participatory sciences using IoT boards

D1.4 – Evaluation grids

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Let's STEAM aims at developing a training of teachers' programme dedicated to computational thinking and creativity skills using IoT board and digital tools at larger scale. The project runs from September 2019 to August 2022. It involves 8 partners and is coordinated by Aix-Marseille Université.

More information on the project can be found on the project website: www.lets-steam.eu

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1. INTRODUCTION

Assessment in the context of STEAM (science, technology, engineering, arts and mathematics) education requires a multidisciplinary approach. STEAM education activities take advantage of the creative computing (Brennan, Balch & Chung, 2014) and maker culture approaches (Dougherty, 2012; Peppler, Halverson & Kafai, 2016) developed in an increasing number of formal and informal settings in recent years. Within the Let's STEAM project we consider creativity as a process that could be supported not only by computers but also by diverse digital technologies, such as robotic components and micro controller cards. Learning-by-making and by tinkering in STEAM activities serves to develop a creative computing approach aiming to engage the learners in the construction of digital and tangible artefacts using technologies (Martin, 2015). According to Mclaren, Stables & Bain (2017) "the articulation and externalization of personal and creative thinking from the 'minds eye' to a tangible outcome is a central issue when engaging in design activity". Maker-based education and STEAM activities through maker-based approaches could therefore be considered as a form of design-based learning in which the learners are engaged in modelling and prototyping a physical, and often digital-enhanced, artefact (Lille & Romero, 2017).

In order to develop a common approach for the partners of Lets' STEAM we developed a mixed methods approach in which self-reported measures are combined with activity-based observations including a modular robotic activity (CreaCube) and a playful activity (Rock paper scissors with Micro:Bit).

This document introduces the evaluation grids that will serve to evaluate the teachers' digital competencies (COMDID-A) and participants' creativity and computational thinking through the CreaCube task (Romero, 2017; Romero, David, & Lille, 2019), a problem solving task which through which we evaluate computational thinking as creative problem solving. In creative problem solving in robotic tasks, the person cannot solve the task through an analytical problem solving, but requires exploring the task in a divergent, associational, or discontinuous solution processes.

2. METHODOLOGY

Let's STEAM project assessment is developed through a mixed methods approach combining self-reporting measures in the context of teachers' digital competencies (COMDID-A), but also direct observables through the CreaCube task. Let's STEAM project assessment includes evaluations concerning the different stakeholders of the project activities. The assessment will be based on 3 different areas, according to the main aims of the four different designed assessment activities:

- A1. Computational thinking among learners and teachers
- A2. Teacher Digital Competency (TDC) and students' digital competence
- A3. Pedagogical integration of the activities
- A4. Teachers' attitudes toward STEAM education and its integration in curriculum.

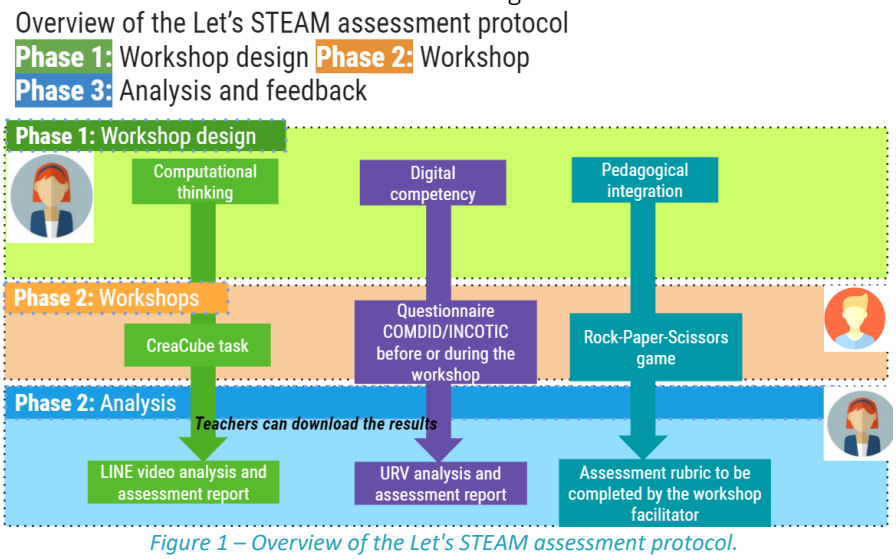


Figure 1 – Overview of the Let's STEAM assessment protocol.

3. TERMINOLOGY & GLOSSARY

COMDID-A	Name of the survey to assess the self-perception of Teacher Digital Competency (TDC) designed by URV
CreaCube	Playful task to evaluate computational thinking
INCOTIC	Name of the survey to assess the digital competency of students designed by URV
Micro:bit	Pocket-sized, codable computing device, designed to allow children to get engaged and creative with technology
Rubric	Scoring guide used to evaluate the quality of students' constructed responses

4. ASSESSMENT ACTIVITIES

4.1 COMPUTATIONAL LEARNING THROUGH CREACUBE TASK

The assessment of computational thinking among learners and teachers is developed through CreaCube task and the questionnaire on algorithmic thinking in charge of Learning, INnovation and Education (LINE) research team. CreaCube is a playful task to evaluate computational thinking (Romero, David, & Lille, 2019), here is a description: https://www.researchgate.net/publication/329040986_CreaCube_a_playful_activity_with_modular_robotics. More information about the CreaCube task, recording the video and send it to the CreaCube team for its analysis can be accessed through: https://frama.link/HowToCreaCube

On March 2020 meeting in Athens, all the partners were introduced to the CreaCube protocol for data collection.

DESCRIPTION OF APPARATUS. The CreaCube tasks uses a set of four Cubelets which has been given to each Let's STEAM partner during the meeting in Athens. The set of Cubelets include the drive cube (white cubes with wheels and motor), the battery cube (dark blue with a on/off switch and a mini USB charger), the distance cube (black cube with a distance sensor) and the inverse cube (red cube without no visible feature). The cubes are magnetic and can be assembled to act as a robotic system. When the four cubes are assembled in a certain order, the red cube has the potential to inverse the distance sensor signal and allows the system to activate the wheels motor.

PROCEDURE. The cubes are set separately as coins of a square instead of aligned in order to avoid a Gestalt bias of regrouping the cubes in a linear way. The special visible features (wheels in the white cube, on/off switch and mini USB charger on the blue cube, distance sensors in the black cube) are hidden by a cover from the participants' perspective in order to avoid to notice them without prior manipulation.
First, the participant is invited to listen to the instructions: "You need to build a vehicle of four pieces that move autonomously from the red point to the black point". The recorded inscriptions inform the participant the experimenter cannot provide any help, but the participant has the possibility to listen again the instructions. When the instructions are finished to be played, the experimenter remove the cover that hides the cubes making them finally visible to the participant.

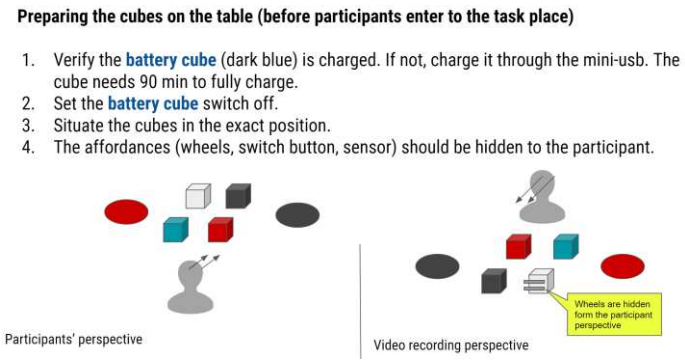


Figure 2 - Location of the cubes and the landmarks prior to manipulation.

Figure 3 - Introduction to the CreaCube task in Athens

4.2 TEACHER DIGITAL COMPETENCE

Teacher Digital Competence is made up of a set of capacities, abilities and attitudes that the teacher must develop in order to incorporate digital technologies into his or her professional practice and development (Lázaro Cantabrana & Gisbert Cervera, 2015). In particular, the TDC is concreted in 4 dimensions, as in the work of Lázaro Cantabrana (2015), which are the following:

- D1 - Didactic, curricular and methodological aspects
- D2 - Planning, organization and management of digital technological resources and spaces
- D3 - Relational aspects, ethics and security
- D4 - Personal and professional aspects

For the Let's STEAM project, TDC will be measured as self-perceived, which refers to the extent to which teachers think they have their TDC developed. This assessment will be carried out through the COMDID-A questionnaire, based on the rubric published in Lázaro Cantabrana (2015) (URV team). In this rubric, 4 different areas (classroom, educational center, educational community and environment, and professional development) are considered for each dimension in which the TDC takes place. Moreover, 4 different levels of development are considered in the rubric. More information about the description of the areas, levels of development and items can be found in D1.2. The English version of the questionnaire can be accessed through the following link: https://pedagogia.fcep.urv.cat/application_src/index.php/quiz/view/51. A pdf version of the questionnaire can be also accessed through the following link: https://www.dropbox.com/s/void5lct2jm1877/COMDID-A-Professors_eng_LEts_STEAM2.pdf?dl=0, although this version does not provide immediate feedback to participant, which is one of the key features of the on-line questionnaire.

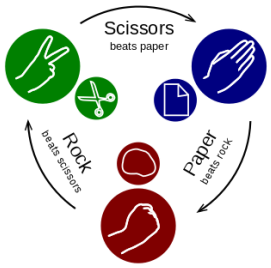
Based on participants' ratings in the questionnaire, their answers are classified into one of the 4 different levels of the TDC. As a formative feedback, at the end of the questionnaire, results are shown to the participant, as well as possible recommendations to improve own's TDC. To assess the impact of each activity on participants' TDC, pre and post tests will be conducted using this described tool before and after teachers' participation in the Let's STEAM activities. Teacher Digital Competence (TDC) is made up of a set of capacities, abilities and attitudes that the teacher must develop in order to incorporate digital technologies into his or her professional practice and development (Lázaro-Cantabrana, Usart-Rodríguez, & Gisbert-Cervera, 2019).

For the Let's STEAM project teachers' self-perception of their Teacher Digital Competence (TDC) will be measured, which refers to the extent to which teachers think they have their TDC developed. This assessment will be carried out through the COMDID-A questionnaire, based on the rubric published in Lázaro-Cantabrana, Usart-Rodríguez, & Gisbert-Cervera, (2019) (Université Rovira i Virgili team). The evaluation of the Teacher Digital Competence considers four dimensions: (i) the didactic, curricular and methodological aspects; (ii) the planning, organization and management of digital technological resources and spaces; (iii) the relational aspects, ethics and security; and (iv) the personal and professional aspects.

Digital competence of students, in a nutshell, is defined by their competence in the use of different ICT and their competence in the management of information (Universitat Rovira i Virgili, URV, 2009). It is evaluated through the **INCOTIC questionnaire**, which evaluates students' digital competence considering five dimensions: (i) characterization of the access to digital resources and the degree of ICT use in general; (ii) knowledge and use of particular digital resources; (iii) culture and respect in the use of digital information; (iv) efficient access to information; (v) levels of use and efficiency in the communication of information. More information about the description of these dimensions is published in González Martínez, Espuny Vidal, De Cid Ibeas, & Gisbert Cervera (2012) (in Spanish).

4.3 ASSESSMENT OF THE PEDAGOGICAL INTEGRATION OF THE ACTIVITIES

The assessment of the pedagogical integration is developed through two **assessment tables** (see below) for the activities Micro:Bit Rock-Paper-Scissors (https://microbit.org/) game evaluated in prior studies (Ball et al., 2016), which is based in the traditional game Rock-Paper-Scissors (Figure 1). The Rock-paper-scissor is a Micro:Bit activity, which can be accessed through the following links: http://www.ahc.me.uk/blog/bbc-microbit/bbc-microbit-rock-paper-scissors-lizard-spock-project



Rock, paper and scissors activity [1]

Some variants of the Rock-Paper-Scissors game can be found here: https://www.kreativekorp.com/miscpages/rps/.
The assessment tables of the Rock-Paper-Scissors game evaluate the workshop facilitator and the participant are the following:

- **Workshop facilitator questionnaire:**

English : https://enquetes.unice.fr/index.php/735286?lang=en
Français: https://enquetes.unice.fr/index.php/735286?lang=fr

- **Workshop participant questionnaire (for each participant) :**

English : https://enquetes.unice.fr/index.php/717888?lang=en
Français: https://enquetes.unice.fr/index.php/717888?lang=fr

Table 1 - Workshop facilitator assessment

Workshop facilitator	Not observed	Not clearly observable	Observed
Identification of participants' prior knowledge			
Activity orchestration. The facilitator organises the activity allowing all participants to actively engage in the activity			
Problem solving. The facilitator takes advantage of participants' problems to develop their problem-solving capacities.			
Debriefing. After the task, the debriefing helps to learn concepts developed through the activity.			

Table 2 - Workshop participant assessment

Participant	Not observed	Not clearly observable	Observed
Design of simple algorithms using loops, and selection i.e. if statements.			
Declaration and assignation of variables.			

[1] https://en.wikipedia.org/wiki/Rock_paper_scissors

Use of variables and relational operators within a loop to govern termination.			
Use of logical reasoning to predict outcomes.			
Detection and correction of errors i.e. debugging, in algorithms.			
Creation of programs that implement algorithms to achieve given goals.			
Understanding that programming bridges the gap between algorithmic solutions and computers.			

4.4 TEACHERS' ATTITUDES TOWARD STEAM EDUCATION AND ITS INTEGRATION IN CURRICULUM

In order to understand the teachers' attitudes toward STEAM education and its integration in the classrooms, the questionnaire CS-STEAM will be proposed to the teachers. A special focus is put on the teachers' understanding of Computer Science in relation with STEAM and its place in the curriculum. The questionnaire includes three parts: 1) teacher's profile; 2) teacher's vision of Computer Science as a science; 2) teacher's attitudes toward integration of STEAM and Computer science in a class. The questionnaire will be distributed during the Workshop 1 after the CreaCube task (in order do not influent on the participants' reasoning during its solving) and before the teachers' trainings (including the Rock-Paper-Scissors game with MicroBit).

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Creating a training of teachers programme dedicated to computational thinking

1. Develop the programming skills of teachers to benefit fully from the advantages of digital solutions in the classroom
2. Enhance interdisciplinarity and creativity in the learning process by developing computational thinking approach for teachers
3. Provide best practices and examples of innovative pedagogies in teaching STEAM at secondary schools

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