USER GUIDE

The eCraft2Learn Research

Documentation, outputs, impacts and recommendations

eCraft2Learn

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Overview

eCraft2Learn is an EU funded project centred around researching, designing, piloting and validating an ecosystem based on digital fabrication and making technologies for creating computer-supported artefacts.

The project aims at reinforcing personalised learning and teaching in science, technology, engineering, arts and math (STEAM) education, and to assist the development of 21st century skills that promote inclusion and employability for youth in the EU. The eCraft2Learn ecosystem supports both formal and informal learning by providing the appropriate digital fabrication tools and resources.

For learners (13-17 year olds) and their teachers/instructors/coaches who want to learn by making in an engaging and rewarding environment supporting creativity, eCraft2Learn is an integrated learning ecosystem that provides tools, support and training for innovative learning, contributing to opening learning towards innovation through a craft- and project-based pedagogical approach in STEAM education.

You can learn more about the eCraft2Learn Project in Teacher Guide 1 Introducing eCraft2Learn which can be downloaded at: https://project.ecraft2learn.eu/introducing-ecraft2learn/

This guide has been created to provide you with an overview of the eCraft2Learn research project. The guide will take you through the following:

- About the research
- Research documentation
- Project outputs
- Impacts from the pilots
- eCraft2Learn project recommendations
- Learn more

Throughout the guide, you will be signposted to various other more detailed documentation from the eCraft2Learn academic research and project pilots. These documents provide a more detailed insight into how the eCraft2Learn ecosystem was developed and trialled along with the approach and outcomes from the project pilots. Follow the links in the guide to learn more.

About the research

eCraft2Learn was a two year research project that ran from January 2017 to December 2018. This project received funding from the European Union's Horizon 2020 Coordination & Research and Innovation Action under Grant Agreement No 731345.

It was carried out by a consortium of academic and industry partners, co-ordinated by the University of Eastern Finland.

PROJECT OBJECTIVES AND WORK PACKAGES

The project had a number of pedagogical, technical and business objectives:

Pedagogical Objectives:

- Developing innovation management techniques needed to support craft- and project-based learning.
- Developing a different approach to STEAM education.
- Enabling communication and collaboration through online support community platform.
- Ensuring a pedagogical practicability of learning designs.
- Developing the integration of an eCraft2Learn curriculum into already existing STEAM.

Technical objectives:

- Facilitating positive changes in attitudes towards education in science, technology, engineering, arts and math.
- Allowing the learners to use breakthrough technologies for learning, i.e. 3D technologies (modelling, visualisation, simulation and printing).
- Supporting the teachers with real-time analytics containing information about the progress of each learner, and data from previous sessions.

Business objectives:

- Enabling and making sustainable networks of collaboration among industry.
- Enabling learners to become project-solving, ambitiously thinking entrepreneurs.
- Increasing awareness on the need for digital fabrication and making technologies in education through industry-academy led workshops.

These objectives were achieved through six different work packages (WP's):

WP1: Co-ordination management and quality assurance

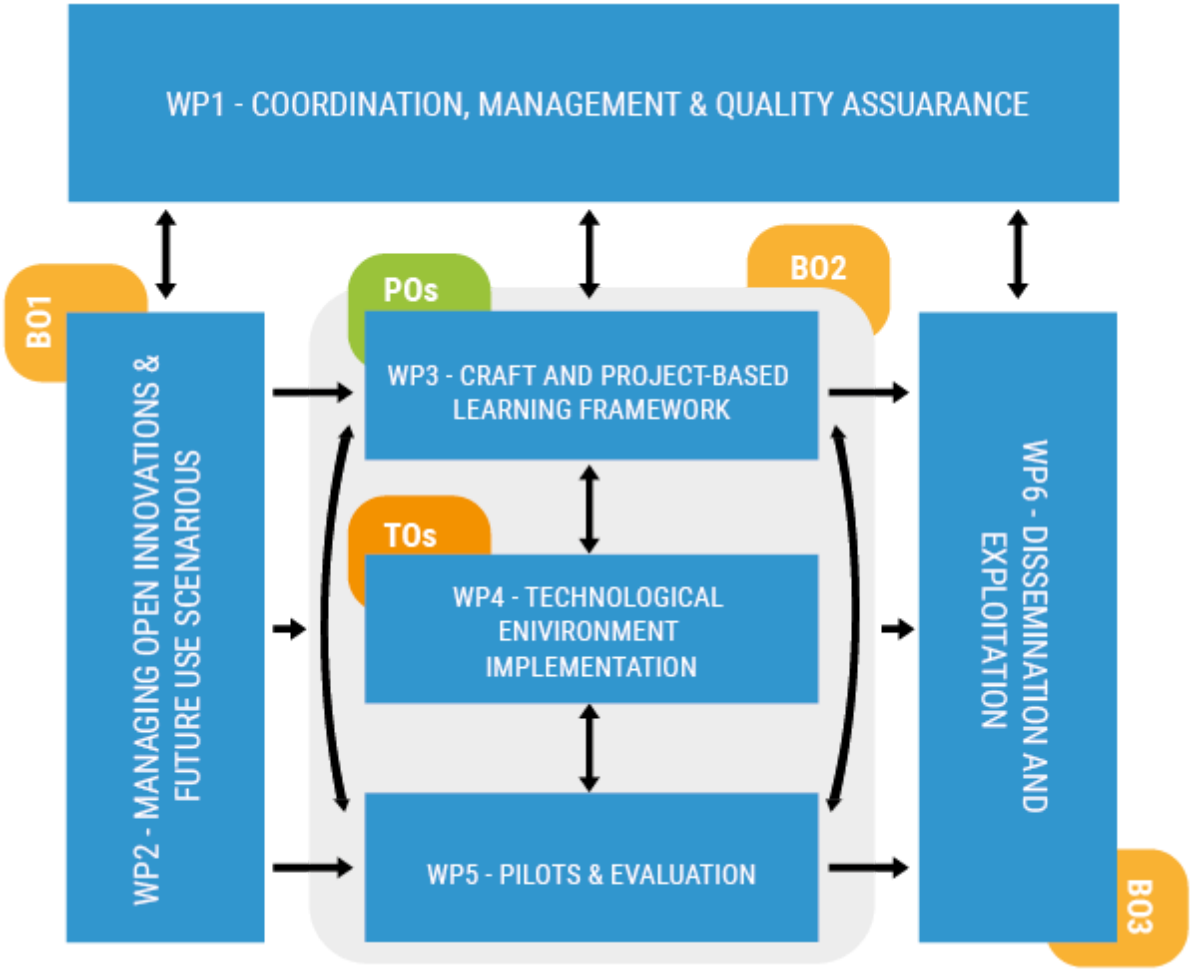
WP2: Managing open innovations and future use scenarios

WP3: Development of personalized, craft and project based learning framework

WP4: Designing and implementing the technological environment

WP5: Small scale validation pilot studies

WP6 Dissemination and exploitation



RESEARCH ACTIVITIES

There were many different activities that made up the research, these include (but are not limited to):

- Creating, refining and documenting the eCraft2Learn project methodology and pedagogical model.
- Creating personas, use cases and example projects.
- Developing eCraft2Learn ecosystem (technology and tools).
- Training teachers in preparation for project pilots and producing a teacher training manual.
- Running two rounds of project pilots in both formal and informal education settings in Greece and Finland.
- Creating documentation and tools to allow for the dissemination and future use of eCraft2Learn.

Research Documentation

A wide range of different documentation is available to support the project, including research deliverable reports, scientific publications, education guides and open education resources.

RESEARCH PROJECT REPORTS

A series of 31 in depth research deliverable reports documenting all of eCraft2Learn development, technologies and delivery. This also includes technical documentation and a detailed teacher training manual.

The Research Project Reports can all be accessed at:
https://project.ecraft2learn.eu/reports/

SCIENTIFIC PUBLICATIONS

During the life of the project academic consortium partners also published many other scientific publications related to the eCraft2Learn project.

The Scientific Publications can all be accessed at:
https://project.ecraft2learn.eu/publications/

EDUCATION GUIDES

A series of ten guides have been produced to introduce and help educators to get started with eCraft2Learn.

The Education Guides can be downloaded at:
https://project.ecraft2learn.eu/getting-started-with-ecraft2learn/

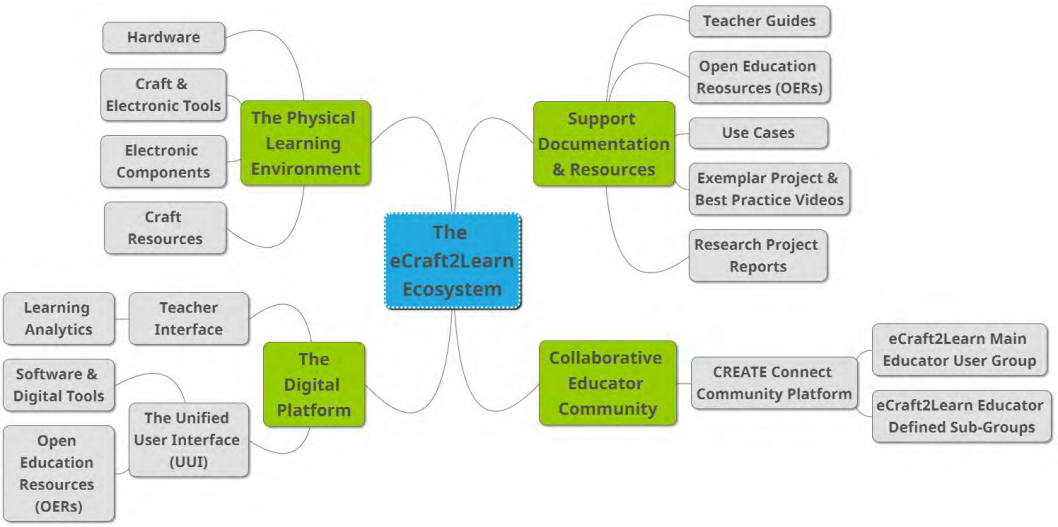
OPEN EDUCATIONAL RESOURCES

A series of resources for educators and students to learn about the various eCraft2Learn tools and technologies including electronics, programming, 3D modelling and 3D printing.

The Open Education Resources can all be accessed from within the eCraft2Learn Project Platform (The UUI) at: https://ecraft2learn.github.io/

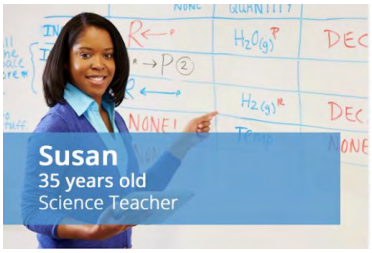
Project outputs

A number of outputs were created during the lifetime of the eCraft2Learn project, the eCraft2Learn ecosystem represented in the diagram below is a good representation of many of the physical outcomes, other outcomes include teacher training and project pilots. The main outcomes are documented in this section, others can be accessed through the individual project reports.



PERSONAS

A series of eleven personas were developed as part of the project. Personas are a type of personal profile that include the basic facts about a person – such as gender, age and profession – the relevant behaviours they exhibit in their daily life and the needs they have in order to pursue certain goals related to the topics of the eCraft2Learn project.



Personas help to:

- Determine what a tool should do and how it should behave. Persona goals and needs provide the foundation for the design effort.
- Communicate with stakeholders and developers. Personas provide a common language for discussing design decisions and also help keep the design centred on the user at all times.
- Build consensus and commitment to the design. Because personas resemble real people they are easy to relate to. Having personas makes it easier to be certain that everyone is on the same page and is using the same language.
- Measure the design's effectiveness. Design choices can be tested on a persona, providing a powerful reality-check for designers trying to solve design problems. This allows design iteration to occur rapidly and inexpensively at the whiteboard. This results in a stronger overall design that can then be tested with real people.

You can view the eleven project personas at:
https://project.ecraft2learn.eu/who-is-it-for/

USE CASES

Use cases can support the understanding of how a product or a tool can be used. The use cases developed in eCraft2Learn are meant to foster this understanding and allowing insights on how a school class, a teacher or single students could handle different projects with the eCraft2Learn learning ecosystem.

The use cases reflect the different needs of teachers and students as well as ideas created by the teachers and aim to further define (or re-define) already existing and planned work or point out new ideas and requests that shall be used as input for further discussion on the development work in eCraft2Learn.

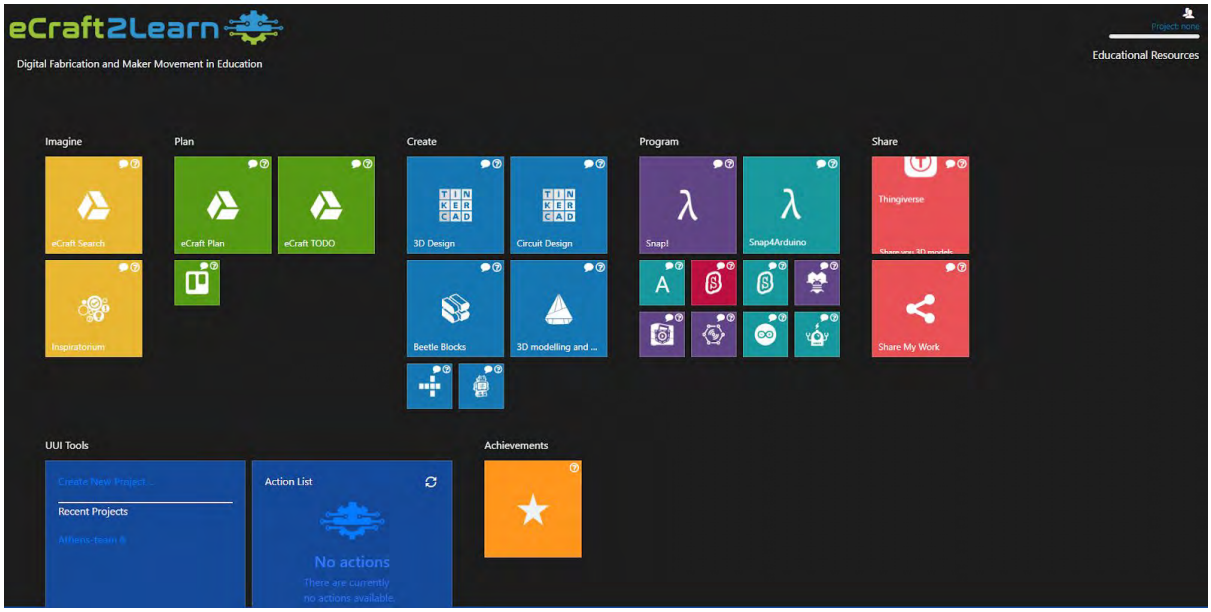
In total, 17 use cases and two variations or adaptations of use cases were created, very different in terms of topic, focus and description in order to reflect on the many different possible environments and usage.

You can view the nineteen project use cases at:
https://project.ecraft2learn.eu/who-is-it-for/

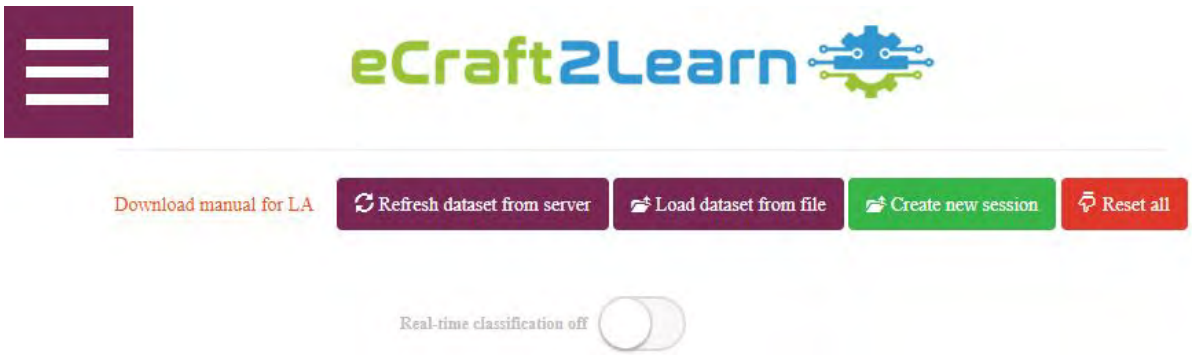
THE ECRAFT2LEARN DIGITAL PLATFORM

The digital platform consists of a Unified User Interface (UUI) that provides a single user gateway to all the digital tools, software and resources students and teachers will require when participating in eCraft2Learn projects. It also consists of a teacher interface where the UUI can be configured for different student sessions/projects and the learning analytics tool can be accessed.

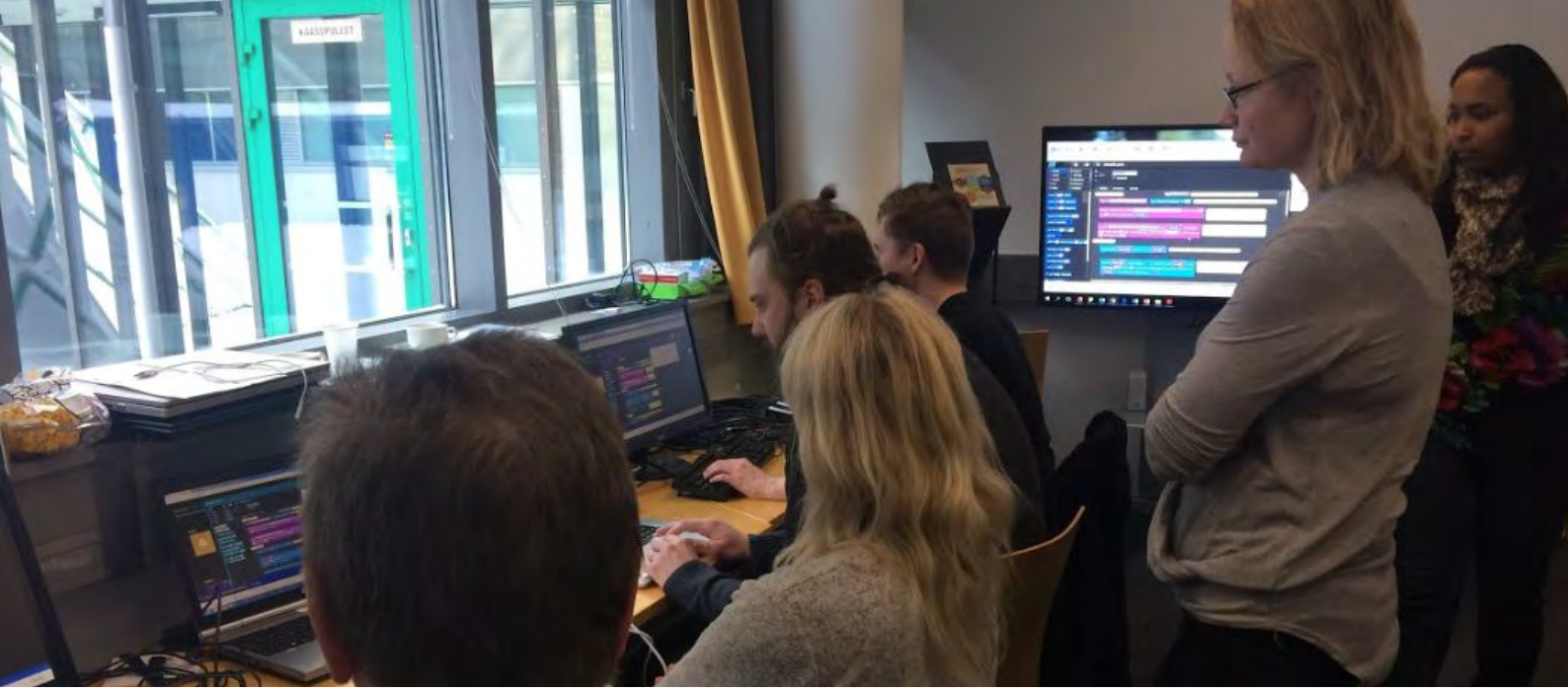
The UUI is the core of the eCraft2Learn ecosystem. We recommend that you take some time exploring both teacher and student interfaces and the various software, tools and resources available within the platform to familiarise yourself with this prior to embarking on a project with students.



The UUI can be accessed at:
https://ecraft2learn.github.io/uui/



The Learning Analytics teacher interface can be accessed at:
https://ecraft2learn.github.io/learning-analytics



TEACHER TRAINING

The teachers leading the pilot programs in their schools/organisations undertook two rounds of training delivered as capacity building workshops. Here the teachers/trainees experience first-hand the kinds of activities that can be developed within the eCraft2Learn ecosystem towards computer-supported artefact creation.

Teacher training follows the axiom 'teachers teach as they are taught and not as they are told to teach'. The eCraft2Learn workshops approach treated teachers as learners first and teachers second, modelling the process of learning for students and showing teachers/trainees what intrinsic motivation, curiosity and creativity is expected. The capacity building workshops took place in an iterative way involving teachers and educators from Greece and Finland.

The first round of teacher training took place in September 2017 with the aim to familiarize the teachers with eCraft2Learn methodology, technologies, tools and resources and to prepare them for the first pilot round with the students.

The second round was conducted after the first pilot with students, with the aim to address possible issues that emerged, and to inform the participant teachers about recent developments in the eCraft2Learn learning ecosystem.

To evaluate the capacity building workshops, a questionnaire with open questions, semi-structured interviews and field notes from group discussions were used, which allowed participants to provide feedback on their experiences, on the overall content, methodology and arrangements of the workshop. An effort was also made to engage the participants in discussions at the end of each session and to collect additional feedback on individual sessions and issues that emerged during that specific session. The feedback gained during the 1st student pilot round informed the teacher training content and methodology in the 2nd round of the capacity building workshops. It is worth noting that a number of other factors (i.e. recent developments in the eCraft2Learn ecosystem, comments raised during the pilot studies, observations made by the research team) also influenced the way the 2nd teacher training round was organized in both Greece and Finland.

You can learn more about how each of the capacity building workshops were structured and delivered along with the teacher feedback in Project Report D5.2 at: https://project.ecraft-2learn.eu/wp-content/uploads/2019/02/D5.2_Capacity-building-workshops-for-teachers-report.pdf

PROJECT PILOTS

A large part of the eCraft2Learn research project was to conduct two rounds of project pilots with groups of educators and students. These took place in both formal and informal education settings in Finland and Greece.

The main aim of the inquiry from the pilots was the impact of the eCraft2Learn methodologies on teachers and students when performing different projects. In addition eCraft2Learn was also interested in drawing in recommendations for teachers that could support the development of a sound pedagogical methodology.

You can learn more about the project pilots in Project Report D5.5 Sections 1-3 at: https://project.ecraft2learn.eu/wp-content/uploads/2019/01/D5.5-Small-scale-case-pilot-report-and-good-practice-videos.pdf

EXAMPLAR PROJECTS AND BEST PRACTICE VIDEOS

During the eCraft2Learn project pilots, students participated in a variety of exemplar projects. These are available as short videos which illustrate the outcomes of these projects. A series of best practice videos where also produced that illustrate the eCraft2Learn pedagogical model.

eCraft2Learn Good Practices - The 'Video Game Joypad' Project

The Exemplar Projects videos can be viewed at:
https://youtu.be/QZHyYlv87no

The Best Practice videos can be viewed at:
https://www.youtube.com/playlist?list=PLgKtrHOACe-I448iS4eAzpvFEbT3lDD20

You can access exemplar projects and best practice documentation in Project Report D5.5 Section 4 at: https://project.ecraft2learn.eu/wp-content/uploads/2019/01/D5.5-Small-scale-case-pilot-report-and-good-practice-videos.pdf

THE COLLABORATIVE EDUCATOR COMMUNITY

CREATE Connect is an open-source social community platform for STEAM educators. This allows like minded educators to connect, communicate and collaborate with each other. Within the platform a specific user group has been set up for eCraft2Learn. Educators will be able to join the eCraft2Learn group and connect with each other. It will provide a platform for sharing projects and examples of student outcomes, discussing experience and expertise. Users will also be able to set up their own private eCraft2Learn sub-groups within the community to collaborate on specific projects or initiatives or to connect with local educators also using eCraft2Learn.

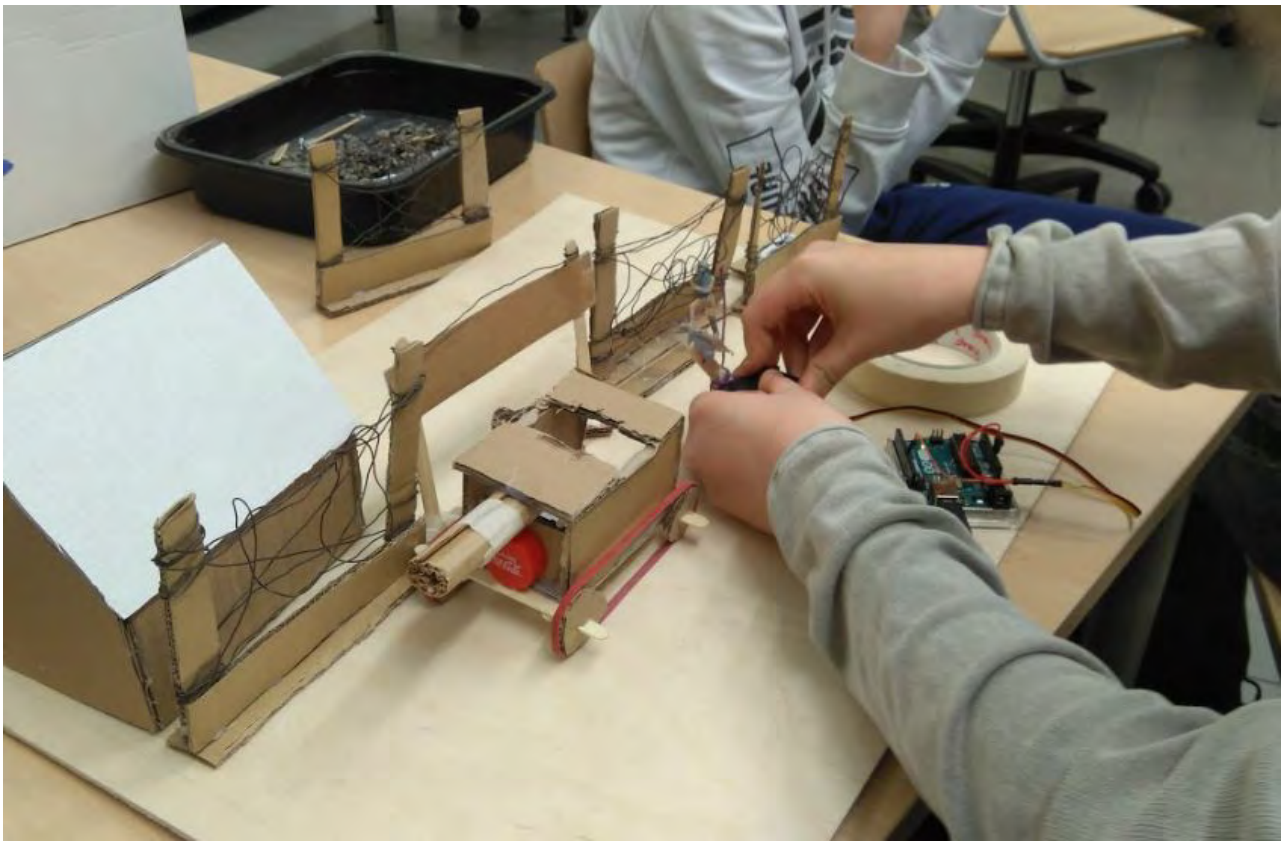
We recommend that you join the eCraft2Learn user group as over time it will provide a valuable source of inspiration, ideas and community support.

Access CREATE Connect and join the eCraft2Learn project group at: https://connect.createeducation.com/

Please refer to Teacher Guide 9 Collaborating and sharing in the eCraft2Learn connected community at: https://project.ecraft2learn.eu/collaborating-sharing-ecraft2learn-connected-community/

Impacts from the pilots

The main aim of the inquiry from the pilots was the impact of the eCraft2Learn methodologies on teachers and students when performing different projects. In addition, eCraft2Learn was also interested in drawing in recommendations for teachers that could support the development of a sound pedagogical methodology. To answer the questions, several analyses were performed on qualitative data (19 teacher and 43 student interviews, 469 student diary entries, 113 teacher diary entries and 154 student questionnaires) as well as quantitative data sets (student questionnaires, observation sheets, teacher diaries). The single analysis of these data gave valuable insights on the impact of the pilots. In combination, they allowed to extract similarities and differences, but also complemented each other.



A summary of the impacts is detailed in the is section, the full detailed analysis is available in Project Report D5.4 at: https://project.ecraft2learn.eu/wp-content/uploads/2019/01/D5.4-Impact-of-the-Pilots-on-Learners-Report.pdf

IMPACT ON KNOWLEDGE AND ABILITIES

The eCraft2Learn pilots included more long-term project work compared to the normal school work. These projects helped students to develop skills in planning and testing as well as recovering after a failure and finding ways to cope with challenges and difficulties. Students reported in the final questionnaires that they now feel more comfortable than before the pilots to work with electronics, make and create things, program and solve problems. **Teachers also** outlined that they have observed **improvements on students' collaboration skills, methodological skills, creativity, programming and robotics.**

In both sites, **the more students gained experience in making, electronics and programming, the more comfortable they were than before to tackle and solve problems.** The close connection between problem solving and making was also reported by teachers in their interviews.

Some students (in particular introverted students) **improved their self-confidence and courage** when taking over responsibility in working with electronics. Several teachers mentioned that they were surprised about the performance and abilities of the students and mentioned that they saw new sides of their students (change of view of students abilities and competencies).

It can be said that eCraft2Learn projects increased students' level of digital competency in multiple areas and on different levels. Still, all teachers agreed that all students got at least familiar with these technological skills even though some of them acquired greater skills than others.

IMPACT ON MOTIVATION

Students showed **increased motivation to find solutions** in emerging problems.

The **connection to real life examples or problems as well as the enabling of individual working style enhances the motivation of students.** Interesting in this respect is the fact that the arts and visual aspect of the project especially had impact on girls' motivation and interest towards the project.

Students with lower time management skills were in danger of losing motivation. Consequently one important task of the coach is to lead the time management of teams. Another task that is also vital for students' motivation is the provision of support by the coach in a timely manner. That is considered to decrease the frustration level of students as well.

In both countries in formal as well as informal settings, students had a **positive learning experience** on the project as a majority of the students had liked the project.

IMPACT ON ROLES, WORKING STYLE AND ATTITUDE

The eCraft2Learn teaching/learning approach requires a change of the role of teacher (acting as coach) AND students (acting increasingly self-driven and self-determined). Thus, not all students could develop their self-regulatory skills in a limited time frame. It has been argued that this change requires some time to adapt accordingly from both target groups, teachers and students.

When investigating which dimensions had the biggest effect on the students' overall liking of the project, the correlation matrix indicated these variables being **innovativeness, problem solving, collaboration** and **creativity** in both informal and formal contexts. **Thus, the more students experienced being able to be innovative, collaborative and creative, and the more comfortable they felt after the project to tackle and solve problems than before, the more positive was their experience of the project.**

The project **did not change teachers' basic attitude towards technology** but their role instead: the more the teacher acts as coach, the better students can act self-driven. Especially those teachers that were not familiar with the concept of coaching reported positive impacts in relation to the potential of their students, own perception of technology as well as on learning concepts of children.

It was observed that many students are proud of their work and **enjoyed presenting and sharing their work** on different occasions. The students gained much more feedback on their work during the eCraft2Learn project than during the normal school lessons which had a positive influence on their self-confidence and self-esteem.

Several teachers agreed that the project **decreased students hesitations and fear towards technology** and provided a new way to see technology, while others were of the opinion that student do not fear technology at all.

The teachers found that eCraft2Learn pilots are a great way to **open a new perspective** for students. Many students mentioned that the pilots had an impact on their options, perspectives and/or interest in general.

Teachers and students highly valued their involvement in **hands-on activities and showed strong sense of ownership** of the final artifacts, explaining every aspect of the technical solution and the related STEAM concepts.

IMPACT ON THE LEARNING ECOSYSTEM

There is c**onflict between the open nature** of the eCraft2Learn learning intervention and the **timely predefined school sessions** (i.e. by the Greek Ministry of Education). Several teachers struggle with the amount of hours needed to complete a project and to acquire knowledge to a specific topic (issue of time and efficiency). Due to restrictions of the curriculum the projects need to be very carefully timed and smartly solve this issue (ie. by integrating the eCraft2Learn workshop in 'the free and creative zone').

According to teachers students have better results if the level of pre-knowledge and abilities is mixed. Consequently it is recommended to **mix the students** according to their academic achievement.

Moreover, the support from their peers and the **teamwork encouraged students to make things and tackle problems and resulted in them feeling more competent** with these skills. Students who reported being more confident in solving problems had also been able to be innovative, creative and test and try out things.

Students who **collaborated with each other on planning, coordinating and sharing activities, felt being able to be creative and test things.** One important finding was that the informal site answers had in general less correlations between variables than the formal site. Innovativeness was included in all variables in the formal site but in the informal site only in overall liking and problem solving.

The own preferred way of working did not correlate in the informal setting with any other variable but **in the school setting** the correlations indicated that students willingly chose to work collaborating with others during the pilots and therefore **preferred working in teams**. In addition, **if students in school could do things the way they preferred**, they experienced **being able to be creative and test things.**

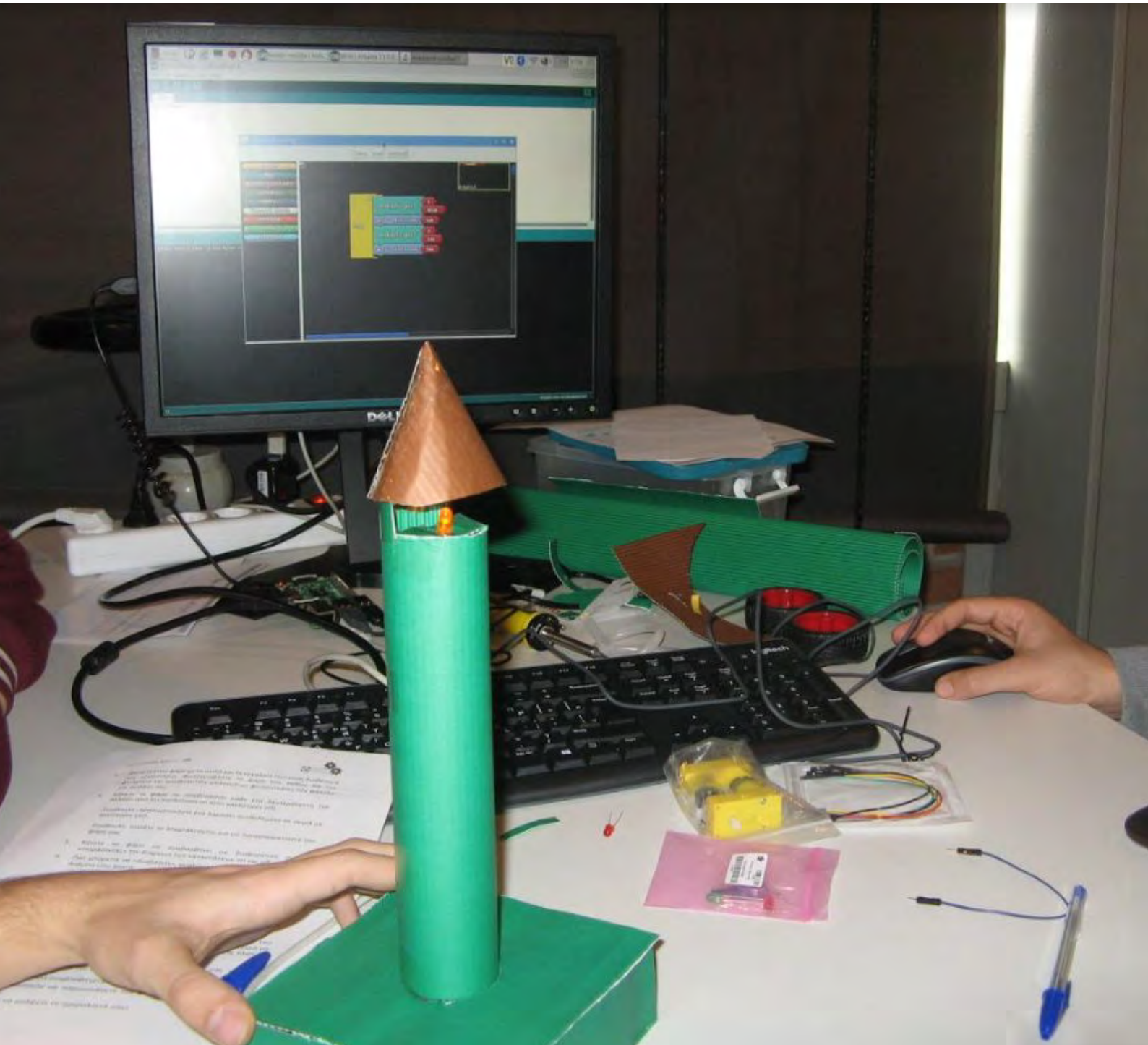
The ideal setting for these type of projects are **supported by different teachers as well as by the headmaster.** A smooth integration into the curriculum is to be preferred. Also the volunteer participation of the students is vital.

Teachers quote that the **learning analytics is necessary** and useful for the day-to-day school environment.

Students that have **worked with AR, are printing** their objects **earlier and are more self-confident** in comparison to students that have not used the AR.

Teachers emphasized that students learn different (or rather additional) things than at regular school classes. They observed students' different approaches to the project and several teachers emphasized that teaching technology in this way works the best for the younger students because they can think from their perspective how to implement it.

As positive aspect to the learning has been mentioned that the project allows students to **learn and create in a tangible way.** Students learn by a trial and error process from which they get valuable lessons, feeling also the success. "That's probably the best thing in it. Many things will be better remembered when students are practicing and experimenting themselves" (Finnish teacher). Also, for students with special needs, hands-on making is a suitable and great way to learn.



eCraft2Learn project recommendations

A number of recommendations have been made in the “Impact of learners” project report based on the feedback data from the pilots. These are:

- Integrate and foster digital hands-on activities in classroom as well as in informal learning settings - it allows students to learn and create in a tangible way as well as foster their creativity and problem solving.

- Re-think the role as teacher and rather act as a facilitator or coach - it will improve your relationship to your students and will ease the different learning of your students.

- Consider that this change of adaptation to a new role and behavior requires some time also for the students - students will learn to work independently, self-directed and self-driven.

- Support your students by setting time frames. Many of them will have difficulties to steer their timing in the first projects.

- Promote a change in attitude and performing the activities under the premise that failing is not equal to ‘not learned’ something - it will help the students to understand that failing is a chance to improving

- Exploit different ways of sharing and presenting- it will support students to gain new skills of collaboration, idea generation and entrepreneurship.

- Invest some time and get familiar with different pedagogical teaching methods and the technology (i.e. within a training) - it will support teachers to feel more confident and handling their new role as coach and facilitator.

- Ideally, organize the sessions in longer working periods - it will support the feeling of continuity of the project work and sense the “flow” in the work.

- Organize the setup of your projects at one place - it will ease the organization and will save time.

- Seek support and communicate with an experienced community group that is well-versed - the group might have valuable tips and tricks for your student groups.

- Seek support from other stakeholders in your learning environment (director, other teachers, parents, local industry or SME’s) - it might enrich the work of the students to a great extend.

- Foster projects that have connection to real life - it will have a positive influence on the students motivation and eases to make partnerships with stakeholders.

- Mix the students in teams according to their pre-knowledge and abilities - it will help them to learn from each other and to achieve better learning results.

- Provide support only if needed but in time - it will support the self-confidence of the students, avoiding frustration.

In addition to these, further detailed recommendations can be accessed in Project Report D5.6 Section 5 at: https://project.ecraft2learn.eu/wp-content/uploads/2019/02/D5.6_Claims-validation-final-conclusions-and-recommendations-report.pdf

Learn more

You can learn more about the project and access all the project documentation at: https://project.ecraft2learn.eu/

You can access all of the project videos on the eCraft2Learn YouTube channel at: https://www.youtube.com/channel/UCwbD52gv0F9N7l2sQ6jFmBw

Follow us on Twitter at: https://twitter.com/eCraft2Learn

Join our community to connect with other eCraft2Learn educators and share ideas, projects and good practice at: https://connect.createeducation.com/

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