

Craft- and Project-based Making for STEAM Learning

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ABSTRACT

Science, technology, engineering, arts and math (STEAM) learning is a promising way to engage learners, both males and females in the process of inquiry in order to become active makers, designers and innovators. A learning ecosystem that integrates a suitable pedagogical approach as well as technological tools could facilitate this process.

This workshop includes presentations by the eCraft2Learn project funded by the European Union's Horizon 2020 Framework, keynote speakers Sylvia Martinez and Gary Stager as well as interventions from the participant researchers and teachers. During the workshop, we will explore the idea of fostering the link between sciences, technology, engineering, and math with arts, in order to encourage the inclusive participation of students with all levels of technical skills and also to reduce the technology-triggered gender divide.

The eCraft2Learn learning ecosystem will be described from its pedagogical underpinnings to the technical implementations that support the pedagogical approach including a unified user interface and a large set of tools for ideation, planning, creating, programming, and sharing. Within the eCraft2Learn learning ecosystem, support has been developed to enable children to create AI programs that rely upon cloud services [1], learning analytics provides guidance to teachers and coaches [2] [3], and a badge system fosters personalised learning path and self-regulation through gamification. Results from pilot studies will be shared.

Presentations from participating international researchers that are working on *making for learning* will take place, as well as hands-on activities and demonstrations involving the entire audience.

CCS CONCEPTS

- **Social and professional topics** → **Computational thinking**;
- *Social and professional topics* → *K-12 education*

KEYWORDS

Craft- and project-based pedagogy, *making*, digital fabrication, comprehensive education

1 INTRODUCTION

The workshop will provide a space for teachers, practitioners and researchers to create synergies and share lessons learnt on the inclusion of digital fabrication and making into educational arena.

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The day will have a strong STEAM learning flavour, with emphasis on the role of arts (the 'A' in STEAM) and on how digital fabrication and making is deployed through craft- and project-based, hands-on pedagogical approaches. These approaches to STEAM learning will be analysed from three different perspectives: tools and technologies used for *making* in schools (e.g., Arduino, Raspberry Pi, electronic components including sensors, LEDs, modelling software, 3D printers, etc.), pedagogical practices underlying the process of *making* in education and lessons learnt from real implementations. The eCraft2Learn project brings together these perspectives through the development of suitable pedagogical practices for STEAM learning through *making* and digital fabrication. With this we aim at using digital fabrication and *making* to close the gap between the ICT skills normally learnt at schools and increasing digital literacy demands of the rapidly advancing digital society.

With this in mind, the eCraft2Learn project is implementing cross-disciplinary project-based pedagogies within an educational ecosystem that provides a suitable framework for multi-disciplinary use and making of technological artefacts. The pedagogical framework encompasses 5 stages of craft- and project-based *making*: ideation, planning, creation, programming and sharing [4]. Within the eCraft2Learn educational ecosystem students have the opportunity to repeatedly explore the underlying mechanism for some scientific phenomena. An analogy to this is the learning process undertaken by a toddler who repeatedly asks "why" but instead of a parent (or in our case a teacher) answering the child, the child themselves explores the answers to those questions with software and tools. This learning ecosystem allows for seamless integration of art and natural sciences subjects, for instance, into technical subjects, through the combination of digital technologies and project-based learning methodologies.

The workshop will also see a keynote speech given by Sylvia Martinez and Gary Stager, experts on the topic of bringing the maker movement into the educational arena, as well as hands-on activities, practical advice and lessons learnt from their over 20 years' experience bringing technology to education in the USA. Furthermore, Matthias Ehlenz and Hans-Peter Kühn will also share their experiences with the Deutsche JuniorAkademien (German Junior Academies) Program, empowering gifted children to foster their creativity and innovative thinking through *making*.

2 WORKSHOP STRUCTURE

Morning session – keynote and presentations

- Registration (09:30 – 10:00)
- Introduction to the workshop – interactive activity among participants (10:00 – 10:10)
- Keynote lecture – Q&A (10:10 – 11:10)

- eCraft2Learn – lessons learnt and topics related to technical and pedagogic research on *making* and digital fabrication for STEAM learning (11:10 – 11:45)
- Empowerment by *Making* – experiences with the Deutsche JuniorAkademien (11:45 – 12:05)

Lunch break (12:05 – 13:05)

Afternoon session – hands-on activities

- Hands-on experiences with the eCraft2Learn ecosystem and its pedagogical integration with technologies for *making* – group work using Raspberry Pis/laptops, Arduinos, electronics, and AI-extensions to the Snap! Visual programming language, through the pedagogical framework of the project. Participants will experience first-hand completing a simple project which involves using electronic components, visual programming, and crafts. Flash lessons will be given on the use of electronics. Two levels of difficulties will be available according to how fast the participants progress with developing the task (13:05 – 15:35)

Coffee Break – free networking (15:30 – 16:00)

- Wrap up – task outcome presentations by the audience. Tips and best practices to take away, what have we learnt and where to find help. Invitation to the eCraft2Learn open community (16:00 – 16:45)
- Cultural and networking activity (16:45 – 17:30)

2.1 Pre-workshop Plans

The call for participation will be distributed among eCraft2Learn project members' networks from 12 organisations spread over 6 European countries. Invitation to teachers from schools in the region will also be distributed. The eCraft2Learn project website (<https://project.ecraft2learn.eu/consortium-events/koli-calling-workshop/>) as well as the Koli Calling International Conference on Computing Education Research website will advertise the workshop (<https://www.kolicalling.fi/index.php/ecraft-workshop>).

2.2 Post-workshop Plans

A workshop description will be published in the conference proceedings. There will be a session during the main conference where the workshop outcomes will be shared with the audience. We are also exploring the possibility of a special issue of the Springer open access journal *Research and Practice in Technology Enhanced Learning* based upon this and an earlier workshop contributions.

3 CALL FOR PARTICIPATION

We encourage submissions about research, design, field deployment and work in progress on STEAM education, digital fabrication and making. **Particular interest is given to the role of Arts in STEAM learning.** Papers must be formatted according to the ACM conference proceedings and must not exceed 4-pages. Authors are encouraged to present their work as videos, demos or hands-on activities. Accepted work will be made available to the entire community through the Koli Calling 18 conference website. Possible presentation topics include (but are not limited to):

- Gender perspectives in digital fabrication and making
- The 'A' in STEAM, Craft-based projects
- Maker movement in schools
- Physical computing, RPi and Arduino programming
- STEAM in the context of formal and informal learning
- AI programming by children
- Learning analytics
- 3D printing and design in education

The full-day workshop will split the time equally between theoretical aspects of making in educational settings including eCraft2Learn project reports, participant presentations and discussions (morning session) and hands-on exercises from the eCraft2Learn project (afternoon session).

4 ORGANISERS

Dr. Calkin Suero Montero is the H2020 eCraft2Learn project coordinator and senior researcher at edTech group, School of Computing, University of Eastern Finland. Dr. Suero Montero received her PhD in computer science from Hokkaido University, Japan. Her main research interests are related to Human Language Technologies (HLT) applications such as conversational system; designing and implementing algorithms for text-based Affective Computing; investigating the social acceptance of novel human-computer interactions, such as gesture-based mobile interactions designs; and computer supported collaborative work in educational settings.

Prof. Kati Mäkitalo is Professor of Educational Sciences, especially focusing early learning and teaching at the Faculty of Education, University of Oulu. Her research focuses student teachers' learning, especially attitudes towards using ICT in teaching and learning as well as technical, pedagogical, and content knowledge (TPACK/TPB) of student teachers. Further, she is interested in collaborative knowledge and shared understanding building, inquiry-based learning approaches, help-seeking processes, STEAM, maker education, designing supportive learning environments and innovative pedagogical practices using ICT in different educational levels.

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