HORIZON 2020

Educational Robotics for STEM

Rapports

Informations projet

ER4STEM

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Make scientific and technological careers attractive

to young students, and forster sustainable

Periodic Reporting for period 2 - ER4STEM (Educational Robotics for STEM)

Période du rapport: 2017-01-01 au 2018-09-30

Résumé du contexte et des objectifs généraux du projet

ER4STEM aimed to ignite and maintain children's curiosity in science, technology, engineering and mathematics with educational robotics. The domain of robotics represents a multidisciplinary and highly innovative field encompassing physics, maths, informatics and even industrial design as well as social sciences. Moreover, due to various application domains, teamwork, creativity and

entrepreneurial skills are required for the design, programming and innovative exploitation of robots and robotic services. Children are fascinated by such autonomous machines. This fascination and the variety of fields and topics covered make robotics a powerful idea to engage with. Young girls as well as boys can easily connect robots to their personal interests and share their ideas through these tangible artefacts. ER4STEM will refine, unify and enhance current European approaches to STEM education through robotics in one open operational and conceptual framework.

The concept is founded on three important pillars of constructionism: 1. engaging with powerful ideas, 2. Building on personal interests, and 3. learning through making (or presenting ideas with tangible artefacts). The ER4STEM framework coherently offers students aged 7 to 18 as well as their educators' different perspectives and approaches to find their interests and strengths in robotics to pursue STEM careers through robotics and semi-autonomous smart devices. At the same time students learn about technology (e.g. circuits), about a domain (e.g. math) and acquire skills (e.g. collaborating, coding).

Travail effectué depuis le début du projet jusqu'à la fin de la période considérée dans le rapport et principaux résultats atteints jusqu'à présent

The ER4STEM project has demonstrated the importance of providing students with multiple ways to engage in educational robotics activities (particularly through the creative arts) and the value of an integrated STEM approach (where students engage with multiple knowledge domains) both for learning and for engagement. When it comes to engaging girls, teamwork is a particularly valuable approach and the project sheds light on the complexity of team formation and development in this context, whether mixed or single sex teams.

The research examined the outcomes of the robotics experiences for students, as well as looking at the activities in action, which informed the development of the ER4STEM Framework. The ER4STEM Framework sets out connections between 21st century skills, robotics, STEM and pedagogy, with practical guidelines (and tools) on how to design educational robotics activities both in and outside school for use by others (e.g. teachers). Through design-based research, workshops and conferences were iteratively developed, informed by an in-depth understanding of what works and what is needed for successful educational robotics experiences.

The project generated pedagogical tools informed by theory, practice & research for the teaching of STEM subjects through robotics activities. A generic curriculum was developed, linking subject domains, technologies, use cases and powerful ideas. And last but not least, we created an educational robotics repository where all of this and more could be found, used and improved on by teachers, academics, researchers and practitioners in the field of educational robotics. Several scientific publications were written for disseminating ER4STEM in the academic world, as well as conference presentations and keynote presentations. The project results have also been presented at numerous events to non-academic audiences (such as teacher events)I and was further disseminated through a number of social media networks. A sustainable partnership with SCIENTIX was established throughout the project including international events and with national SCIENTIX ambassadors.

Progrès au-delà de l'état des connaissances et impact potentiel prévu (y compris l'impact socio-économique et les conséquences sociétales plus larges du projet jusqu'à présent)

The ER4STEM project was highly successful, exceeding many of its aims. That success is down to the hard work, commitment and ambition of all project partners. Over 4500 young people between the ages of 6 and 19 years old participated in ER4STEM activities across Europe. We have created an activity plan template for use by teachers and those interested in running robotics workshops, which provide pedagogic guidance on the design of the workshops. This activity plan template has been used in the design of workshops by project partners and teachers to create integrated STEM workshops involving robots. Activities created foster positive attitudes towards STEM subjects, teamwork, creativity, critical thinking, reflection and other 21st Century skills. These activities are available for free in the er4stem.eu repository, for anyone to use and edit for their context. The ER4STEM evaluation is the first large scale collection and analysis of qualitative data on educational robotics activities in action. Prior to this, the majority of research has focused on quantitative measures of attitudes and learning outcomes, without examining the processes which learners engage in with the robots and with each other. By observing workshops and conferences in action, it has been possible to draw out design principles for successful workshop design and uncover the most effective aspects of workshops in developing young people's interest in STEM and essential 21st Century Skills such as teamwork and creativity. This has been disseminated through scientific and non-scientific events and publications are in progress.

Bringing these activity plans together is the ER4STEM curriculum, which provides multiple routes through which to engage in educational robotics activities in STEM. It provides both structure and flexibility. It spans multiple ages, multiple technologies and we believe it to be the first of its kind. Providing multiple ways for young people to engage with robotics was a key aim of the ER4STEM project. The ER4STEM curriculum and repository illustrate various ways to inspire young people in STEM through robotics, importantly providing multiple examples of the use of creative arts. Finally, ER4STEM was one of six finalists for the European Digital Skills in Education Award (2018) from 102 applications. This clearly shows the importance of the achievements of this project.

Two new robotics tools were created during the project for use by young people. The first tool, Hedgehog, an educational robotics controller, facilitates the control of robots for students of different age levels through both textual and visual programming support. For advanced students, Hedgehog's open source ecosystem allows delving into subjects such as microcontroller programming or cooperative robots as well. Hedgehog has been used in numerous workshops and also in robotics competitions with great success. The second tool, SLurtle world, a 3D virtual world environment which is run on a school's network (ensuring security). In the virtual world, students are represented as avatars, through which they can act and interact with each other, programme SLurtles to construct objects and programme those objects to be interactive.

The project repository, <u>https://repository.er4stem.com/home</u> will stay active and open for educators, teachers, parents and robotics enthusiasts to access all the great results of the projects. This legacy of the project will be a more nuanced and research informed approach to the design of educational robotics activities. Teachers will be able to use the project outcomes to design their own activities and continue to inspire young people within STEM through robotics.



ER4STEM Workshop with children and their robot creation.

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