The Children's Congress at the JKU Linz: Young Researchers and Interdisciplinary Projects

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Abstract

At the Children's Congress pupils can slip into the role of researchers. Their task is to solve a real world problem by using strategies from the STEAM field. In this process the pupils are supported by teachers, students of the teacher education and students of the Honors Program from the STEAM department at the Johannes Kepler University Linz. They work together in interdisciplinary projects, where mathematical problem-solving gets combined with arts, and two of the basic concepts of computer science: computational thinking and development of creative (digital) products. The products and results are presented at a final event by the pupils themselves.

Introduction

The Children's Congress was developed in 2016 by one of the authors at her previous university [2]. In 2018 the Children's Congress started as an annual event at the Johannes Kepler University Linz. At these events teachers, university students of the STEAM teacher education, university students of the STEAM Honors program and pupils (grade 1-8) work together. The main goal is to show the pupils and students the broad field of STEAM and what possibilities interdisciplinarity or transdisciplinarity work offer. The pupils pose problem-based research questions, inspired form everyday life, try to solve them, report on their projects and present them as well as the developed products at an appropriate event.

To solve these tasks the pupils need a deep understanding of the problem, planning and structural skills, creativity and the ability to reflect and think in an interdisciplinary way [1]. Especially for gifted pupils this process allows to unfold their potential, because it's not that the gifted pupils think faster, they think differently [4]. The Children's Congress in Linz offers a different kind of tasks and learning possibilities to motivate the pupils and strengthen their interests and abilities in the STEAM field.

From the first Idea to the Product

The Children's Congress is not a single event but a project with three parts, where teacher pre- and in-service training as well as regular school lessons are embedded. Before the project starts, the teachers apply with their pupils for the Children's Congress. The teachers are then invited to the *Kick-Off*. The *Kick-Off* is the first meeting, where teachers and university students discuss project ideas and build teams. Furthermore, the teachers participate in workshops, where they get an introduction to the computational thinking concepts that should be integrated in the projects [2, 3]. The second part is the *Preparation Phase*, with individual work at the participants own schools for about four months. The aim is to develop creative products using digital technologies and/or computer science concepts and techniques such as modeling, encryption or logic operators in combination with math and arts. The project teams consist of 1-2 teachers, 1-2 university students and a class or group of primary or lower secondary school pupils. As part of the preparation, every project team visits at least one workshop in the JKU COOL Lab (a teaching-learning lab) [3]. Here they get a deeper understanding of computer science concepts like mentioned before and they can get in contact

with technologies they might want to use for their projects. The JKU COOL Lab provides the students with 3D-printers, a variety of robots, computers, datalogger equipment, chemistry sets etc. To further prepare, the university students come to the school to work together with the pupils and teachers. The last part is the *Children's Congress* itself, the final event, where the pupils present the projects and the developed products to the other project teams and a jury, who award a prize for the best three projects.

The Children's Congress 2018

The theme of the first congress at the university in Linz was "Understanding our World". Every congress has a main topic that is very general and open so that it can be related to every school subject and elaborated. A total of 165 pupils worked with 9 teachers and 16 students on their projects. The participating pupils were from 8 different schools in Upper Austria and from grades 2 to 8. An overview about the projects and the participating pupils can be seen in table 1.

Table 1: *The Projects at the Children's Congress at the Johannes Kepler University Linz in 2018*

Project Title	Pupils	Grade
Alternative Languages	18	2
Fingerprint Recognition	21	5
Lego World	20	7+8
Modelling and Algorithm in Mathematics	23	8
Plastic Analysis made easy	16	8
Showing Emotions	23	7
Tiny Town	24	7
What lives and flourishes in the meadows	20	5

Most of the project ideas were developed during the *Kick-Off*. All of teachers that had applied for the Children's Congress came to this event with some ideas or problems that their pupils had discussed beforehand. The students at the *Kick-Off* all needed cooperative school projects for their studies, but it was optional for them if they choose one of the projects from the Children's Congress or not. The main task at the *Kick-Off* was to create project teams that were interested in working with the same topics to utilize the collective expertise. The research questions themselves were developed by the pupils afterwards in the *Preparation Phase*. This phase, where all of the project members worked together amounted to 10 to 20 hours per team in total. The time that was spent by the pupils, students and teachers in total for the project was between 20 and 50 hours per person.

In the *Alternative Languages* project the students researched about the different languages spoken in the world. In addition, different language-like methods of communication such as pictures (emojis) or signs (binary number system) were used. This project was accomplished by the youngest participants of the Children's Congress 2018 in Linz. They were all very motivated and took part in the project with many ideas. At the end they developed their own art- and mathematically-based secret language and sang a coded song at the congress.

The *Fingerprint Recognition* project is about the storage and recognition of fingerprints. It explores the characteristics of a fingerprint, how to write them down as a list, how to set up an algorithm to compare them and how to use that data further. The pupils started by making their own fingerprints with ink, scaling them up and finding characteristics. Then they tried different artistic and mathematical approaches to find out how it is possible to compare fingerprints. They described this process of reducing a complex problem to the easiest possible solution as very inspiring. Especially the experience of not having one right solution for a problem was completely new. At the end they used a procedure based on describing characteristics with angles and points and comparing the different fingerprints by using these descriptions.

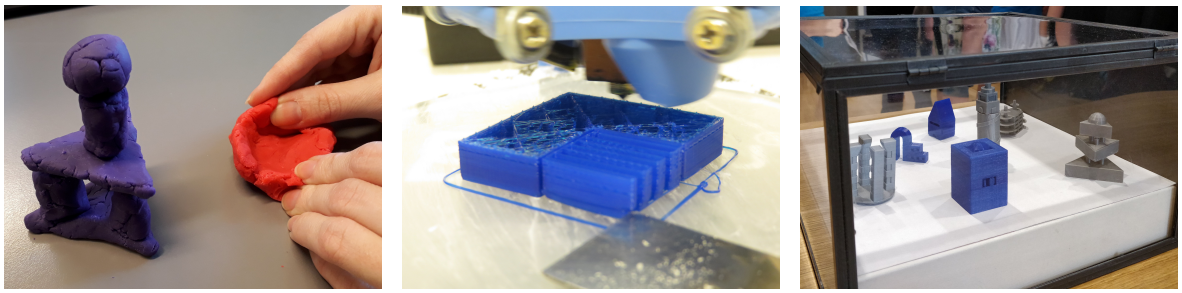
The *Lego World* project showed the challenges of a robot living on the earth and reacting to its surroundings. In arts and handicraft the pupils designed different environments like a maze (Figure 1a), a city (Figure 1b) and a cratered landscape (Figure 1c). In computer science they taught the robot how to react and to "live" under these circumstances. This was the winning project of the children's congress. The teachers and students reported that the pupils even used a lot of their spare time and came to school in the weekends to exceed their goals and find even more challenging environments.

(a) **(b)** **(c)**

Figure 1: *Lego World project: The Lego robot interacts and finds its way through (a) a maze, (b) a city landscape with streets and (c) a cratered landscape*

In *Modelling and Algorithm in Mathematics* the students formulated the question: "How can we use computer science concepts of modelling and algorithm to get a better understanding in Mathematics?" They described several mathematical rules and procedures by using flow charts and activity diagrams.

Plastic Analysis made easy combined ideas from arts, chemistry, computer science, mathematics and physics. The main question was how to determine the plastic type of a given sample. The students started to do research about the different plastic types and how to identify them. They described their results and ideas with decision diagrams and developed a smart phone app based on that. The pupils described the process of having a real life problem and trying to find the simplest solution for it as very motivating and challenging.



(a) **(b)** **(c)**

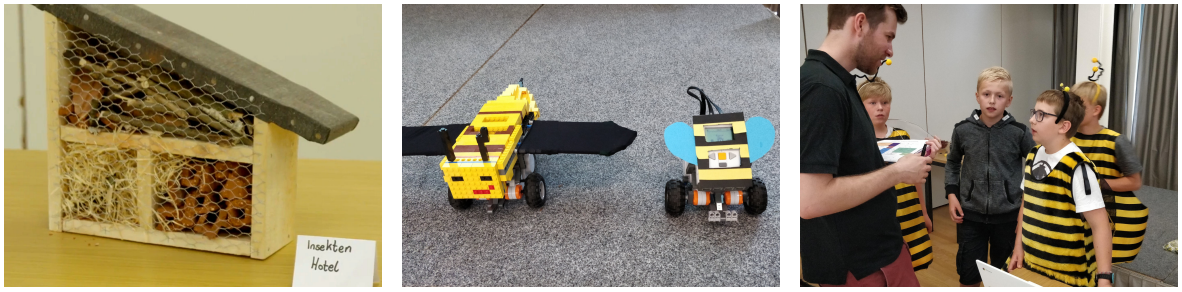
Figure 2: *Tiny Town project: (a) modelling of buildings with plastic modeling mass, (b) 3D-printing of the town, (c) Tiny Town buildings*

In the *Showing Emotions* project the pupils discussed the definitions of emotions. They explained how it is possible to recognize and differentiate between different emotions and how the human body reacts on it (posture, breathing, blood pressure, etc.). The pupils did research on how colors are connected to feelings and emotions, which effects pictures can have on emotions and how sounds can change emotions. They created their own sounds, edited them with computer software and created a database to share sounds that express or change emotions. This project combined the school subjects arts, computer science, media education, media design and music education. The result of their project was a multi medial presentation with pictures, sounds

and videos about emotions.

The *Tiny Town* is a 3d printed city with different buildings in miniature format (Figure 2c). The aim was to promote creativity and basic education in computer science and digital education. First the students drew and designed different kinds of buildings, did research about architecture, city planning and realization possibilities. In this process they used plastic modeling mass to get a first idea of possible buildings and the challenges and limitations of their construction (Figure 2a). They decided to print the town with a 3d printer (Figure 2b), researched the different technologies and modelled the city with computer software. The modeling and scaling of the different buildings strengthened the pupils artistic and mathematical skills.

In the *What lives and flourishes in the meadows* project the students started with exactly this question and did research on it. Besides this theoretical part they also started to seek out meadows to collect and take pictures of flowers and animals there. The students decided to focus on the bees and their lives. They constructed insect hotels (Figure 3a), learned more about their lives, read and wrote texts, made their own honey, described the flight behavior of the bees and programmed this with Lego robots to show it (Figure 3b). The pupils dressed as bees (Figure 3c) presented all their results at the Children's Congress and did an interactive quiz with the audience about its knowledge of bees.



(a) **(b)** **(c)**

Figure 3: *What lives and flourishes in the meadows project: (a) an insect hotel, (b) the bee lego robots, (c) the bee presentation*

Summary

The first Children's Congress in Linz got very positive feedback. The main goal of combining mathematical problem-solving with basic computer science concepts and arts, while working with interdisciplinary problems was successfully reached by all participating projects. The congress itself was described as a very inspiring event with lots of ideas on how to combine the STEAM subjects in interdisciplinary projects both in everyday classes and for project assignments.

References

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[4] B. M. Shore and L. Kanevsky. "Thinking Processes: Being and Becoming Gifted." *International Handbook for Research and Development on Giftedness and Talent*, pp.133-148, 1993.