The Children's Congress: A Benefit to All Levels of Schooling by Strengthening Computational Thinking

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***Abstract*—The Children's Congress is an event, developed to meet a demand for strengthening computational thinking and to increase the interest in STEAM subjects. This congress brings teachers, university students and pupils together to work interdisciplinary on real-life problems. During these proceedings, the pupils slip into the role of researchers and scientists, supported by their teachers, university staff and university students. In every project team, at least one student from the Honors program of the Johannes Kepler University in Linz takes part. This support helps the pupils both in their projects and in their personal development, through mentoring by the talent students of the university. To find out more about these benefits and to improve the congress for the next years the Honors students were asked to give feedback after the congress. In these interviews, the Honors students described the Children's Congress as a very inspiring and motivating project for all the participants. The results show that the students experienced a lot of appreciation through the work with the pupils, and that they faced many new challenges. They see many benefits for the pupils, starting from the increasing academical knowledge to skills like team- and time management. Furthermore, the benefit of getting used to computational thinking was described. Besides the advantages for the pupils, benefits for teachers were mentioned. Overall, the results show that the Children's Congress successfully combines computational thinking, real-life problems, interdisciplinarity, project work and mentoring, benefitting all participants involved.**

***Index Terms*—computational thinking, STEAM education, interdisciplinarity, mentoring programs, gifted education**

I. Introduction

When we think about digital education, the first thing that comes to mind is the computer. Nowadays, pupils have integrated digital devices in their everyday life, such as mobile phones, apps and wearables. So, it should go without saying that we must strengthen the pupils' technological understanding and furthermore show them possible ethical outcomes or co-occurring social aspects of digital life. Subsequently, Jeanette Wing defines the term "Computational Thinking" as a fundamental skill for everyone. It is best described as a problem-solving process with distinctive problem-solving techniques and general intellectual practices. It covers solving problems, designing systems, and understanding human behavior by drawing on the concepts of computers [1].

Before 2002, digital education policies in the European Union aimed to improve infrastructures in schools [2]. The EU ICT Cluster study from 2010 shows that the ratio between digital devices and the number of learners decreased significantly. Additionally, the reliability and the speed of internet connections increased throughout the European Union [3]. Second-generation digital education policies (from 2002 on-wards) focused more on educational modernization and transformed the terminology from "e-learning" to "educational innovation". In 2011, all European countries had digital education policies in place, either as standalone policies or as part of a national ICT strategy. The strategic weight of these policies remained on nurturing students' digital competences, justified by future economic benefits [4]. What this all amounts to is that computational thinking is on the rise, likewise in European schools.

Computational methods and models give pupils the courage to solve problems and design systems that no one would be capable of tackling alone [1]. By adding those concepts to the pupil's understanding of their everyday life, we aim to increase interest in informatics, correct possible misconceptions and work against still existing fears and inhibitions concerning computer science and technology [5].

The Children´s Congress was developed in 2016 and is held as an event to show pupils the diversity of the STEAM field. Pupils decide on a real-life problem and try to find solutions through computational thinking, with the help of teachers, students and university staff. In 2018 a total amount of 165 pupils with 9 teachers and 16 students worked on 8 different projects at the Children's Congress in Linz (Austria). Out of the 16 participating students, 10 students were part of the Honors Program at the Johannes Kepler University Linz.

The Honors Programs is designed for gifted university students who have the motivation and ability to work more than their regular programs offer. This includes not only academic challenges but also aspects to broaden their personal development and their interdisciplinary thinking. The Honors Program participants receive individual support and soft skills training, gain experience and competences in scientific work and

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research and develop their creativity. This is done by letting the students carry out individual projects that deepen their areas of expertise with complementary subject areas, broadening their horizons. They can interact with other participants and get in touch with top executives at the Johannes Kepler University who will talk about their research, their careers and share their personal experiences. Besides their own scientific training the students also support younger gifted students with their projects. One example of their tutoring work is the Children's Congress at the university. In this annual event participating children can slip into the roles as researchers and present the results of their projects accomplished with the help of the Honors students. The projects stand out due to their creative ways of implementing computational thinking across the STEAM subjects. Besides supporting the pupils with their academic competences, the Honors students show the children how to embrace and utilize their giftedness.

After the congress all participants were asked for feedback about their experiences. In this paper the results of the Honors Program participants will be examined. With their answers the following questions will be clari1fied:

- How do the Honors students describe and evaluate the work with the pupils and teachers for the Children's Congress and the Children's Congress itself?
- Which impacts do the Honors students describe that the Children's Congress has on the pupils, on the teachers and on themselves?
- Which role does computational thinking play in the projects from the perspective of the Honors students?

II. The Children's Congress

A. Background

The Children's Congress is a concept developed in 2016 by one of the authors at her previous university [5]. Launching in 2018 in Linz, this project is planned as a yearly, three-staged event. The main goal of the Children's Congress is to show pupils and students the broadness of the STEAM field, and to spark the pupils' creativity and curiosity within the field, by using computational thinking to find solutions to real-life problems. The event is held by the Johannes Kepler University in Linz, where the congress itself is hosted.

The Children's Congress is held for pupils from 2nd to 8th grade from schools in Upper Austria. They are tasked with finding a real-life problem and a solution to this, utilizing a variety of the STEAM field's many subjects such as arts, biology, computer science or mathematics. With the focus on computational thinking, the pupils find a problem and develop a solution. The pupils then present their problems, findings and solutions at the final event of the Children's Congress to each other, as well as to a jury, that selects a winning project.

Finding and working with real-life problems is a hard task that demands a deep understanding of the problem, as well as a good awareness of how to work towards a solution. To make sure that all participants, pupils, students and teachers alike, are well prepared for this process, the Children's Congress is established as a three-stage event. Therefore, all participants should work with computational thinking concepts within the STEAM subjects in a problem-based manner.

B. Aims and Contents

The Children's Congress aims to inspire pupils, students and teachers to work with computational thinking, as well as promoting the concept of working in an inter- or transdisciplinary way [6]. It is a core value of the Children's Congress that the project should challenge and benefit everyone involved. This unique aim sets the event apart from other learning activities by focusing not only on the pupils but also on in-service training for the pupils' teachers and for gifted students at the Johannes Kepler University in Linz. Focusing on the learning outcome for all participants shapes the Children's Congress culture and form. This resulted, among other things, in the three staged structure of the event.

The three stages consist of the kick-off event, the preparation phase and the congress itself. The three stages help to ensure the learning outcome of all participants, by giving the teachers, students and pupils time and opportunities to interact, challenge each other and give the students the opportunity for mentoring the pupils in their work as scientists and researchers.

The kick-off event is the first meeting between the students of the Honors Program and the teachers they will work with. At the kick-off event the research questions are chosen, and the students pick which of the projects they can see themselves in. It is important that the students get to choose a project where they can use their current knowledge to assist the pupils and teachers. When the students have been paired with the teachers and pupils, their work within the teams begin and they help the pupils to further define their research questions and provide suggestions to how the pupils can work towards finding solutions.

The second part is the preparation phase. The project groups will work towards producing a product that solves, prevents or helps with their specific problem. To further qualify the projects, the project teams participate in at least one workshop at the JKU COOL-Lab, a teaching-learning lab that hosts workshops about computational thinking for both pupils and teachers [7]. There they get introductions to computer science concepts such as modeling, logic, encryption, encoding etc. In this progress the pupils, students and teachers will get training in computational thinking to make sure that they have the necessary skills and understanding that is necessary to work within the project as a team in the following months. This is a keystone in the Children's Congress and is essential for the learning outcome for everyone - pupils, students and their teachers. During the preparation phase, the students visit the pupils and teachers at their schools, and work alongside them on their projects. There the students get to practice both their academic and their soft skills, such as communication, cooperation and mentoring.

The last part is the congress itself. The pupils present the projects to each other and for the judging committee. Both the problem, the process and the final product is presented and explained in seven to ten-minute presentations. The pupils switch between presenting and observing presentations. In the end, the best projects of the primary and secondary schools receive awards.

After the event, all participants are asked to give feedback to help evaluate the Children's Congress to improve it for the following years.

III. Methodology

In total 16 university students supported the children and the teachers in the development of their projects. 10 out of these 16 were part of the Honors Program as described above. These 10 students were asked separately after the Children's Congress about their experiences. 5 of them are female, 5 are male. At the time of the interviews they were all between 18 and 20 years old and in their first year of their studies. They were all students of different subjects in the STEM field and had training in computational thinking in educational context.

IV. Results

A. Evaluation

The students worked in cooperation with the pupils and got support from the teachers of the schools and from professors of the university. Therefore, they had to balance expectations not only according to their own ambitions, but also within the expectations of the pupils, the teachers and their professors.

The students described the collaboration with the pupils as very good. When they were asked to estimate in percent how good the pupils cooperated in the class, most of the students chose values above 90%. The extent to what the pupils were involved in the project work and implementation was also described as very successful and when asked for a percentage most of the students described values above 95%, with three students saying 100%. One student said that it was amazing how independently and motivated the pupils worked at the project. They were very easy to handle, and it was a great experience to work with them. Another student also highlighted the good mood in the class and the good working environment. One student reported that the pupils even worked during the weekends because they were so motivated. Summing up, all students described their pupils as very motivated and noted that they did a lot of work on their own. None of the students described the pupils in the project in a negative fashion. Interestingly, the working processes during the projects has been observed as being very different between the various classes, that all selected different starting points. These starting points were chosen by the teachers: Group work, fieldtrip out into nature, fieldtrip to a museum, teacher talk, experiments at the university, research in the library, joint brainstorming session. In one class the teachers chose to let the pupils manage the whole project planning by themselves. Naturally, very different processes developed out of these various starting points. Though different, the students were all very happy and satisfied with the way their pupils took part in the projects.

The collaboration between students and teachers varied from short talks during classes, to five extra meetings, besides the mandatory program. All students were in contact with the teachers per e-mail and felt well prepared for the projects. The students that had no extra meetings with the teacher expressed that they had no need for it. When the students were asked to estimate the quality of the collaboration with the teachers in percentages, where 0% is poor and 100% is perfect, most of them stated values above 95% with two students saying 100%. One student highlighted that it was great to work alongside a teacher because every idea she had was taken up by the teacher which made her feel very appreciated. Three of the students also commended the teachers for their motivating and inspiring way of teaching. One student went on to say that in her opinion the teacher was the main reason for a successful project, not because he did everything, but because he could motivate the children throughout the project phase, and that he was always there for the pupils if they needed advise.

Collaboration with the university professors was rare, because the need for it was minimal. This was affirmed by every student. They had a kick-off meeting at the beginning, where the background and aims of the project was explained, and another meeting at a workshop about computational thinking. The students had the possibility of getting support by one of the authors who was the main responsible person of the Children's Congress and oversaw the computational thinking component in every project. In addition, the students could consult the coordinator of the Honors Program. Four of the students took the chance to get mentoring support by one of the two. The other students said it was not necessary. Regardless, all students answered that they felt well supported during the project even if they didn't take advantage of the extra offers provided to them.

When summarizing the whole cooperation of the project teams, all the students were satisfied. One student added that it was very inspiring to see the enthusiasm and cooperation of all parties and the joy from the progress of the project.

The specific tasks the students had in the project depended mainly on the teachers. Three of the students described their part as administrative work like keeping supervision, assisting with the use of technologies or support by creating a project plan. One student described himself as the "support person". Whenever there was a problem, the pupils came to him for help. He helped with finding a project idea, solving logistical problems and designing the program code. Two other students described their parts similarly without using the term "support person". The other students had a main part in the projects and did a lot of research with the kids, showing them how they could solve their respective problems. Therefore, the amount of time used in the preparation phase of the Children's Congress varied between 8 and 30 hours with those students describing themselves as the project leaders, working the most hours.

When the students evaluated the final event of the Children's Congress only, they stated several ideas to improve the next Children's Congress. Evaluating the final event with percentages from 0% for the worst to 100% for the best, most of them gave the event over 80%, the mean was around 80%. Nobody graded the event with 100%, and everybody had ideas for improvement. Six students said that the time management needed improvement, since there wasn't enough time to see each project and you had a fixed amount of time for each project, without opportunity to stay longer at a project that you found particularly interesting. Just one student said that the time given to see the projects was sufficient. One student stated that some classes didn't stick to the schedule, giving the presenting groups a disadvantage, because they had less time to show all aspects of their project.

Moreover, the students were asked if they would join the Children's Congress again. All of them said that they really enjoyed the work for the projects, but not all could see themselves doing exactly the same procedures again, even though they found the experience giving and were happy about having been a part of the Children's Congress. Some students would prefer to bring their own project ideas to the classes, so that the projects would fit better to their expertise.

In summary, all students were very positive about the collaboration and motivation of both pupils and teachers and appreciated the possibility to further collaborate and get mentoring by the professors.

B. Impacts

The students described several aspects in the Children's Congress project that had impact on the pupils, on the teachers and/or on themselves in their interviews.

The impacts on the pupils were all described as very positive. The academical benefits were described as significant. They learned a lot about their project topic and its surrounding fields by doing research and getting support from the teachers and students. The student working on a fingerprint topic told us that neither the pupils nor they would have been introduced to the issue of fingerprint recognitions in their regular classes. But after the project they all had a lot of knowledge about how to preserve a fingerprint, what is unique about fingerprints, how you could describe fingerprints and how you could compare two fingerprints. The students combined this knowledge with their background in arts, mathematics and computer science and recognized the advantages that interdisciplinary thinking brings. Another student saw the benefits in the practical and innovative use of technology and to raise the interest in STEM subjects.

At the Children's Congress itself the pupils could see the projects of the other groups and get in touch with different technologies and unique ideas. This is an additional contribution that wouldn't have been easy to realize in a regular classroom. The students were asked to estimate the growth of academical knowledge for the pupils in percentages from 0% to 100% where 0% stands for no grow and 100% for enormous growth. Again, most students chose a value above 80%. Besides increasing the academical knowledge the students also mentioned impacts that lead to increasing social or general skills. In addition, the students highlighted the benefits of getting in touch with unknown technologies and their impact in these early years of the pupils' time in the educational system. One student mentioned that nowadays the use of those technologies is essential and that pupils should get in touch with these technologies as soon as possible. Noting that working in groups on projects is not that common in the early years of education, one student saw a big advantage in practicing team management, time management as well as presentation skills. Another student described that the project work helped the class to strengthen their class community.

Another benefit mentioned was the sense of achievements. The students said that they felt like the pupils really enjoyed working with them. In these mentoring situations, the students could help with their expertise and the pupils felt like they really got support and were taken seriously. Especially in the settings where younger gifted students met older gifted students, the students could share not only academical knowledge, but also assistance and support in their personal development.

The students all thought that the teachers got new ideas for their regular classes. That could lead to benefits for the teachers but also to another impact of the pupils who would benefit from good ideas and new practices of modern teaching. One student stated that the teacher he worked with decided to start using robots every year to strengthen computational thinking.

Considering the impacts for the students themselves, it was surprising that none of the students had done a project with pupils before. Even in their time as pupils, there was no possibility to be a mentor for younger pupils at their schools. Besides the benefits for the pupils, this cooperation between younger and older students leads to a lot of experience and expertise for the mentors themselves. As mentioned before, this setting lets older gifted students meet with younger gifted students. The older students can learn a lot about the development of giftedness and can see how inspiring their way can be for younger students. This might cause motivation for their own academic work, as four of the students had to admit. One student mentioned that he saw himself in this group "craving for knowledge" and that he had to recap all of his experiences of being gifted in a school class. Also, as mentioned before, the students felt very appreciated by the teachers and pupils, by further increasing their own motivation. To see the enthusiasm and cooperation of all parties and the excitement surrounding the project was described as inspiring. One student stated that it was a real pleasure to meet and get to know the pupils, and that they have grown dear to him. At the Children's Congress he said that he was very surprised and proud of the project of his pupils. Another student added that she never stood in front of a class before and that she really enjoyed it when she could feel their interest and motivation. Five students described that it was really

challenging to explain difficult topics to children, because they had never worked with children before and only had academical discussions with peers or professors, but never as a mentor. Summing up this new experience of doing a project with younger gifted students was a new experience for the students who were used to deepen their academical knowledge in their specific field of studies. All students had to admit that working with a school class brings lots of challenges that they didn't expect - like how to handle different ideas or different interests of the pupils.

All students described the project as an experience with huge benefits that helped them to evolve both personally and as students and coming professionals. All students appreciated the possibility to participate and were happy that they chose to be a part of the project.

C. Computational Thinking

Some aspects were already mentioned in the paragraphs before, because the strengthening of computational thinking leads to benefits for pupils and teachers. This was also described by all the students involved. Surprisingly the students estimated the computer science part of their projects as quite low. The highest value a student stated was 60%, the mean was around 44%. Even though all projects were assigned to the subject computer science, the students discovered various other aspects in their projects. They listed different school subjects that contributed in their projects like arts, biology, chemistry, drama, ethics, handicraft, German, mathematics, physics or psychology. To find out more about their attitude towards interdisciplinarity, students were asked if they found the combination of subjects useful. Most of them described it as very effective, none of them thought that it is not.

Concerning the growth of computational thinking skills, most of the students said that the pupils´learning curve was steep. One student mentioned that it was very interesting watching the children handling their problems in the project and finding out that computer science was everywhere around them. The increase of computational thinking skills for the teachers were even described as bigger.

V. Conclusion

Summing up, the Children's Congress 2018 in Linz was very successful in strengthening computational thinking skills, motivating pupils for STEAM subjects and supporting gifted students at the university. The feedback from the students was very positive and they provided various suggestions for improvements, mainly about the final event. The students had different tasks in their projects ranging from support persons to the main responsible person for the project management. These scopes of tasks depended mostly on the corresponding teachers. In addition, the students described various challenges during the project phase. Especially the basic project work with such young pupils was new and challenging to them. They all admitted that the pupils, the teachers and they themselves learned a lot during the project phase. On the one hand the students increased their own academical knowledge and on the other hand trained social skills, which was also described as very fruitful. The students also noticed a steep learning curve in the aspects of computational thinking – for pupils as well as for teachers. But they didn't describe the importance of computer science as that big in their project.

VI. Outlook

The next paper plans to evaluate the pupils´feedback and their evaluation of the project. The Children's Congress should become an annual event at the university in Linz and therefore the evaluation plays an increasing role. The final event of the Children's Congress 2019 took place in June in Linz and was again a very inspiring experience for all participants. Because of the feedback of the students described in this paper and the feedback of the pupils that will be published soon, some changes were made to the concept. The evaluation of these changes and the Children's Congress 2019 in general is in progress. In the course of this the two Children's Congresses will also be compared.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Sara Hinterplattner and Jakob Skogø conducted the research, while Corinna Kröhn and Barbara Sabitzer took part in the organization, development and implementation of the Children´s Congress. All four authors wrote the paper together and approved the final version.

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