>Train DL

>Teacher training for Data Literacy & Computer Science competences

> D3.1 DL and AI teaching methodologies and primary teacher education formats research summary

train-dl.eu

Vilnius University

1. Executive summary

This document provides an overview of the results of the analysis carried out at this stage (D3.1 DL and AI teaching methodologies and primary teacher education formats research summary). The aim of this review is to better understand and clarify the current approaches to teaching DI and DL and to analyse the teaching materials provided in primary education. This information will be used in the following phases of WP3.

In the Train DL project, WP3 draws heavily on the experience and results of WP2, since WP2 is responsible for secondary education and WP3 for primary education. This was also the case in this activity, mainly drawing on WP2 for training activities and methodologies on data literacy and artificial intelligence. In addition, a variety of different sources were explored for teaching artificial intelligence in both primary and secondary education, mainly based on existing online learning practices, but also on a literature review: books, articles, reports. In addition to these sources, a number of practical examples from other countries were used to show what is currently being applied in AI training in primary education. Vilnius University also has experience in developing practical tasks related to data literacy education in primary education. Vilnius University organises a computational thinking challenge - Bebras. It is aimed at both primary and secondary school students and is conducted in many countries around the world. Below we will look in more detail at the sources and experiences studied, as well as other activities such as workshops and conferences.

2. Literature, learning Initiatives and Experiences overview

The books, articles and report on artificial intelligence for children have been reviewed, not all of them focus on primary education, but as there is a lack of learning material for primary education, we analysed some secondary school level material which could be adopted for primary level. Below is a list of several of the sources reviewed, with a brief description:

- *Lane, D. (2021). Machine Learning for Kids: A Project-Based Introduction to Artificial Intelligence. USA: No Starch Press. A companion to the website (https://machinelearningforkids.co.uk/#!/about), the book provides a practical introduction to artificial intelligence and exercises based on the Scratch block programming environment. The book is aimed at students aged 12-14.*

- *Gallenbacher, J. (2021). Abenteuer Informatik. IT zum Anfassen für alle von 9 bis 99 – vom Navi bis Social Media, Springer, Berlin, Heidelberg. The book describes various computer technologies and presents them all through non-computer based techniques.*

- *Kahn, K., Megasari, R., Piantari, E., & Junaeti, E. (2018). AI programming by children using Snap! block programming in a developing country. Thirteenth European Conference on Technology Enhanced Learning, 11082. The paper presents AI*

Co-funded by the Erasmus+ Programme of the European Union

programming learning process with high school and vocational school children with Snap! (it has AI cloud services) in Indonesia.

- *Kahn, K., & Winters, N. (2021). Constructionism and AI: A history and possible futures. British Journal of Educational Technology, 52(3), 1130-1142. The article presents history of AI teaching and relationship with constructionism, that first try outs to teach children AI started in 1970ies with Logo.*

- *Zhou, X., Van Brummelen, J., & Lin, P. (2020). Designing AI learning experiences for K-12: emerging works, future opportunities and a design framework. arXiv preprint arXiv:2009.10228. The article focuses on these RQ connected with AI: An analysis of how existing work applies general AI literacy competencies and design considerations; A design framework for designers and researchers creating K-12 AI education tools; A reference chart for educators selecting AI educational tools to suit the needs of their classrooms.*

- *Kahn, K., & Winters, N. (2021). Learning by enhancing half-baked AI projects. KI-Künstliche Intelligenz, 35(2), 201-205. Article presents developed thirty sample artificial intelligence (AI) programs in a form suitable for enhancement by non-expert programmers. The projects are implemented in the Snap! blocks language and can be run in modern web browsers.*

- *B. Sakulkueakulsuk et al., "Kids making AI: Integrating Machine Learning, Gamification, and Social Context in STEM Education," 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE), 2018, pp. 1005-1010, doi: 10.1109/TALE.2018.8615249. The paper presents an agricultural based AI challenge that fostered students to learn the process of creating machine learning models in the form of a game with the emphasis on the Four P's of Creative Learning (Projects, Passion, Play, and Peers). Our goal is to come up with an innovative education model that encourages the students to connect the emerging technological solutions such as AI with the pressing real-world problems in the playful environment.*

- *Stefania Druga, Sarah T. Vu, Eesh Likhith, and Tammy Qiu. 2019. Inclusive AI literacy for kids around the world. In Proceedings of FabLearn 2019 (FL2019). Association for Computing Machinery, New York, NY, USA, 104–111. DOI:https://doi.org/10.1145/3311890.3311904. The paper focuses on primary school children. The authors observed how 102 children (7-12 years old), from four different countries (U.S.A, Germany, Denmark, and Sweden), imagine smart devices and toys of the future and how they perceive current AI technologies.*

- *Dohn, N.B., Kafai, Y., Mørch, A. et al. (2022). Survey: Artificial Intelligence, Computational Thinking and Learning. Künstl Intell. Authors of the article argue on this idea that: significance of computational thinking as regards artificial intelligence on three counts: (i) Human developers use computational thinking to create and develop artificial intelligence systems, (ii) understanding how humans learn can enrich artificial intelligence systems, and (iii) such enriched systems will be explainable.*

Co-funded by the Erasmus+ Programme of the European Union

- *Tuomi, I. The Impact of Artificial Intelligence on Learning, Teaching, and Education. Policies for the future, Eds. Cabrera, M., Vuorikari, R & Punie, Y., EUR 29442 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-97257-7, doi:10.2760/12297, JRC113226. The report presents the current state of the art in artificial intelligence (AI) and its potential impact for learning, teaching, and education. It provides conceptual foundations for well-informed policy-oriented work, research, and forward-looking activities that address the opportunities and challenges created by recent developments in AI.*

Both in the sources cited, and in the project partners pilot workshop rely on non-computer-based activities for teaching AI. This is particularly attractive and relevant for children in primary education, as such activities make it easier for them to understand how AI works. Talking to colleagues in other countries (Portugal, Switzerland, Finland, Germany), we can see that they are also using such activities in their AI training. These include card games where you have to identify certain characteristics. The Swiss educational experience with food cards, which have to be identified by certain characteristics. There are also Beaver tasks on cards, which is very handy and attractive for younger children. One of the most popular games that we have adopted from the experience of the project partners, also shared by a Portuguese school, is a checkers-based game that uses a 3x3 board of boxes to pit humans against computers and uses rules to demonstrate the process of how artificial intelligence learns. In Portugal, the game is integrated with technology, with children first having to make their own game board and then play. The picture shows a game board from a Portuguese school:

Figure 1 Wooden game table from Portugal school

Co-funded by the Erasmus+ Programme of the European Union

We have also explored a range of interactive online activities to introduce artificial intelligence, in addition to the previously mentioned Scratch and Snap!, here are some of the educational initiatives we have explored:

- ***Minecraft: Education Edition**, has prepared a series of lessons in the Minecraft game environment, designed to introduce artificial intelligence through various activities, including block programming.*
- ***Machine learning for kids**, free tool introduces machine learning by providing hands-on experiences for training machine learning systems and building things with them.*
- ***STEMpedia,** AI learning companion for kids to explore the world of Artificial Intelligence & robotics in an interactive and playful way.*
- ***Elements of AI** -The Elements of AI is a series of free online courses created by Reaktor and the University of Helsinki. We want to encourage as broad a group of people as possible to learn what AI is, what can (and can't) be done with AI, and how to start creating AI methods. The courses combine theory with practical exercises and can be completed at your own pace.*
- ***AI Experiments with Google**- is example for simple experiments that helps to understand machine learning and AI better.*
- ***AI activity on CS Unplugged**- present activity to understand AI without using computers.*
- ***Kids in data** - KiD - an interactive data literacy workshop platform, helping young children to learn about data and visualizations through games*
- ***Tuva Labs** - Powerful Data, Graphing, and Statistical Tools to Empower Students to Investigate, Model, and Explain the World.*
- ***Bebras tasks** – Tasks from the Bebras Challenge for the different aspects of Computer Science and Computational thinking. A group of tasks focuses on digital literacy*

3. Workshops, conferences and academic work

Most of the sources and examples we have looked at are aimed at secondary school-age children, and only a few focus on primary school-age children. All the activities that focus on primary age children are based on a variety of games. Based on the experience of our partners, we participated in their pilot workshop for IT teachers in Berlin and adapted their gamified activities for our primary teachers. Due to the COVID-19 situation in the world, we were very limited in organizing events, but we managed to organize one pilot workshop in a regional school. As all the material and research focuses on the development of students' knowledge of artificial

Co-funded by the Erasmus+ Programme of the European Union

intelligence, the pilot workshop was essential for us to find out how teachers will understand the topic. Below is a photo from the pilot workshop:

Figure 2 Pilot workshop for teachers about AI and DL in Druskininkai, Lithuania

Primary school teachers do not have a background in IT. This problem was also observed during the pilot workshops. This is a very important finding, because in the next stages, when developing the training material, we must not only make sure that the tasks are attractive and understandable for children, but also that there is methodological guidance material for teachers, not only on AI or data literacy topics, but also on the general computer science basics that are related to these topics.

In addition to these workshops, we also had the opportunity to give presentations at two conferences, one of which was organised by Vilnius University, a live conference attended by primary school teachers from six schools. The teachers were very interested in the topic and invited us to come to their schools to run workshops. Due to the corona situation, the workshops in these schools are planned for April. Another conference was organised by the Education Department of Šiauliai City Municipality, which was held remotely and attended by about 180 teachers from different schools in the region. After the presentation, there was also a great deal of interest in the topic, with a variety of AI-related movies offered by the teachers as one of the teaching alternatives.

Furthermore, future IT teachers have already been introduced to artificial intelligence in didactic lectures on computer science. They have also used the aforementioned gamification activities to introduce artificial intelligence to the pupils in their practice. One of the university students further refined the gamification activity (see image below).

Co-funded by the Erasmus+ Programme of the European Union

Figure 3 Improved game-based activity introducing AI

Two students have chosen to write their final theses on artificial intelligence for their pedagogical studies. The chosen thesis topics are:

- *Innovations in School: AI, ML and Neural Networks*
- *Teaching AI through the use of board games*

Their research on artificial intelligence will be finalised in May and the results will be relevant for the next phases of the project.

Conclusions

The findings of the study show that, both from a practical point of view and from the sources analysed, game-based unplugged activities are very effective for the development of understanding of artificial intelligence in primary education. Another very important aspect in the development of the methodological material is to keep in mind to complement it with general knowledge of computer science related to the topics of AI and DL, since primary school teachers do not have a computer science background.

References

1. *Computer Science Education Research Group at the University of Canterbury (2021). Artificial Intelligence. The Intelligent Piece of Paper. https://classic.csunplugged.org/activities/community-activities/artificial-intelligence/*
2. *Dohn, N.B., Kafai, Y., Mørch, A. et al. (2022). Survey: Artificial Intelligence, Computational Thinking and Learning. Künstl Intell.*
3. *Gallenbacher, J. (2021). Abenteuer Informatik. IT zum Anfassen für alle von 9 bis 99 – vom Navi bis Social Media, Springer, Berlin, Heidelberg.*
4. *Google (2021). AI Experiments. https://experiments.withgoogle.com/collection/ai*

Co-funded by the Erasmus+ Programme of the European Union

5. *Kahn, K., Megasari, R., Piantari, E., & Junaeti, E. (2018). AI programming by children using Snap! block programming in a developing country. Thirteenth European Conference on Technology Enhanced Learning, 11082.*
6. *Kahn, K., & Winters, N. (2021). Constructionism and AI: A history and possible futures. British Journal of Educational Technology, 52(3), 1130-1142.*
7. *Kahn, K., & Winters, N. (2021). Learning by enhancing half-baked AI projects. KI-Künstliche Intelligenz, 35(2), 201-205.*
8. *Kids in Data (2020). https://kidsindata.com/*
9. *Lane, D. (2021). Machine Learning for Kids: A Project-Based Introduction to Artificial Intelligence. USA: No Starch Press.*
10. *Machine learning for kids (2021) About. https://machinelearningforkids.co.uk/#!/about*
11. *Minecraft: Education Edition (2021). UNIT 9: AI. https://education.minecraft.net/en-us/lessons/unit-9-ai*
12. *Sakulkueakulsuk B. et al. (2018), "Kids making AI: Integrating Machine Learning, Gamification, and Social Context in STEM Education," 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE), 2018, pp. 1005-1010, doi: 10.1109/TALE.2018.8615249.*
13. *Stefania Druga, Sarah T. Vu, Eesh Likhith, and Tammy Qiu. 2019. Inclusive AI literacy for kids around the world. In Proceedings of FabLearn 2019 (FL2019). Association for Computing Machinery, New York, NY, USA, 104–111. DOI:https://doi.org/10.1145/3311890.3311904.*
14. *STEMpedia (2021). Artificial Intelligence for Kids. https://learn.thestempedia.com/courses/artificial-intelligence-for-kids/*
15. *The University of Helsinki & Reaktor Education (2021). Elements of AI. https://www.elementsofai.com/*
16. *Tuomi, I. The Impact of Artificial Intelligence on Learning, Teaching, and Education. Policies for the future, Eds. Cabrera, M., Vuorikari, R & Punie, Y., EUR 29442 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-97257-7, doi:10.2760/12297, JRC113226.*
17. *Tuva Labs (2021). Interactive Tools for Teaching, Learning, and Assessment. https://tuvalabs.com/*
18. *Vilnius University (2021) Bebras International Challenge on Informatics and Computational Thinking. https://www.bebras.org/*
19. *Zhou, X., Van Brummelen, J., & Lin, P. (2020). Designing AI learning experiences for K-12: emerging works, future opportunities and a design framework. arXiv preprint arXiv:2009.10228.*

Co-funded by the Erasmus+ Programme of the European Union