Education and Awareness for Artificial Intelligence

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Abstract. The increasing digitization and automation processes in daily life through the use of Artificial Intelligence (AI) pose great challenges for society and education. These range from building awareness, increasing acceptance, and teaching the foundations of this important and disruptive technology, to fostering a meaningful, creative usage, an assessment of threats, opportunities, and potentials as well as allowing an informed discussion about the technology. This paper presents the 2-year international AI education and awareness project 'ENARIS' which addressed these challenges on various levels. On the one hand, the project fostered young people's interest in AI and facilitated a basic technical understanding. In this context, the integration of teachers, using a train-the-trainer approach and providing ready-to-use, open educational resources based on sound didactic concepts was an essential factor. On the other hand, the project aimed at strengthening awareness regarding social, economic, and technical aspects and potentials of AI among the general public, including school students, children, parents or working persons by conducting open and easily-accessible workshops. In the first project stage, online pre-surveys were conducted to analyze the needs within the target groups. Based on the results, AI ready-to-use prototype learning modules were developed. Following the principles of constructionism, a combination of different teaching methods including unplugged and plugged activities was used. The second project stage dealt with implementing and evaluating pilot workshops using quantitative pre- and post-tests as well as qualitative measures. Results indicate that, a) the ready-to-use teaching material, train-the-trainer workshops and AI topics covered were well received and that, b) a significant positive impact regarding the awareness and general knowledge about AI was achieved.

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1 Introduction

Artificial Intelligence (AI) is already part of our daily life and the working world. To ensure a sustainable and responsible usage of this disruptive technology, young people with a sufficient understanding of AI and skills for using these new technologies are required. Stimulating enthusiasm as well as facilitating a basic understanding has to be done at an early age in order to foster AI literacy. According to Long & Magerko AI literacy can be defined as *"a set of competencies that enables individuals to critically evaluate AI technologies; communicate and collaborate effectively with AI; and use AI as a tool online, at home, and in the workplace"* [14]. Fostering AI literacy goes hand in hand with fostering awareness and general knowledge about AI, providing a sound basis for young peoples' decision to pursue a career in an AI-related sector and enabling social and economic participation.

This paper presents methods and results of the international project 'ENARIS' *(Education and Awareness for Intelligent Systems)* which aimed to foster AI awareness and a general understanding of AI concepts. The project lasted two years, 472 teachers and young people were trained and 73 workshops for teachers, school students and the public were held and empirically evaluated (pre-survey among target groups, pilot implementations, stakeholder reviews, pre-/post-tests of workshops). In order to ensure versatile access to the thematic blocks, researchers from the fields of computer science as well as the humanities with a focus on ethics and art were involved in the development of the content.

The remainder of the papers is structured as follows: Sect. 2 provides an overview of related literature, Sect. 3 discusses the applied didactic methodology and also provides an overview of the AI learning modules developed. Section 5 presents evaluation methods and results, while conclusions, limitations and future work are discussed in Sect. 6.

2 Related Work

Traditionally, teaching AI concepts has mostly been done at the university level. Nevertheless, in recent years AI education at K-12 level has become a major topic and is still evolving [12]. For instance, the *AI4K12* [2] initiative focuses on the development of AI education guidelines and centers its concepts around the *Five Big Ideas in AI* (perception, representation and reasoning, learning, natural interaction, societal impact) [22]. Additionally, an online repository provides supporting material for teaching AI at K-12 level. The initiative *Elements of AI* [8] provides a free e-learning course, covering foundations of AI in an easy comprehensible form and targeting a general audience. An example for fostering AI skills through unplugged activities is the project *AI Unplugged* [18]. It provides a collection of paper-and-pencil activities to teach decision trees, deep

learning, reinforcement learning, problem-solving using search and the Turing Test. In her paper, Kasinidou presents an ongoing project which investigates how people perceive and comprehend AI across various segments of the public, including children and adults [13].

An extensive discussion of further existing AI K-12 initiatives and projects along four dimensions (formal/informal education, cooperation between AI and education research and teachers, level of AI education - from broad to specific, concepts and tools for teaching AI to youngsters) can be found in the article by Steinbauer, et al. [20]. The study by Casal-Otero, et al. [5] provides an overview of how AI is currently integrated into K-12 education. In this context, Tenório, et al. also conducted a bibliometric analysis, investigating the publications in the area of AI literacy from 1989 to 2021 [21]. The article by Olari & Romeike analyzes the correlation between AI and data literacy skills within current educational frameworks [16].

Compared to already existing projects and initiatives, the project presented in this paper follows a hybrid learning approach with a strong focus on educators (teachers, trainers) which acted as multipliers later on. Within project duration, ready-to-use, freely available teaching material was developed (open educational resources). In addition, in-person (face-to-face) and virtual train-the-trainer courses and workshops for young people were conducted. Finally, the project not only addressed teachers and educators, but also the broad general public by developing and conducting workshops 'for everybody'.

3 Methodology

3.1 Pre-survey

In the beginning of the project, a needs analysis (pre-survey), in the form of two separate online questionnaires, one for teachers and one for the general public, was conducted. The survey was divided into three sections corresponding to AI topics and concepts, teaching material as well as personal information. In sum, the pre-survey comprised 65 Likert scale questions and five free text questions to allow remarks and personal opinions. The survey questions were written in English and translated into German and Hungarian (the official languages of the two project countries). The surveys were then distributed using *LimeSurvey* and *Google Forms*. The teacher survey was sent to school educators in Austria and Hungary, to which 143 teachers replied. The survey focusing on the general public was conducted mostly in a science center in Hungary and comprised 82 responses. The needs analysis revealed that the most interesting type of learning material to use are short and independent thematic units which include interactive elements like tutorials and simulations in combination with age-appropriate explanations of technical concepts. Participants highlighted their strong interest in the topics *social impact of AI* and *machine learning*. Furthermore, the results indicate a general interest in the AI topic. In this context, 52% of the participants of the teacher survey stated that they are currently teaching AI in school or are

planning to do so in the future[1]. In a further step, it was therefore also necessary to consider how the interest of the other 48% could be raised in order to teach AI related topics in the classroom.

3.2 Didactic Methods

Based on these results, teaching material in a modular form was created. The aim was to help teachers to incorporate AI related topics into their classes and to design and implement workshops to foster a more basic understanding for the technology as well as to strengthen awareness for AI. In order to ensure versatile access to the thematic blocks and consequently also ensure interest of a higher number of teachers from different subjects, researchers from the fields of computer science as well as the humanities with a focus on ethics and art were involved in the development of the content. This interdisciplinary approach during development is also intended to reflect and promote cross-disciplinary collaboration in different subjects and school project work. In addition, through these multifaceted approaches and enclosed detailed theoretical information materials, uncertain teachers who lacked the necessary know-how or connection possibilities in their subject should be introduced to the topic with a low entry bar. In order to interest the greatest possible number of students in the topic, to initiate learning processes in the sense of a participatory fairness and to open up inclusive learning spaces, the majority of the materials were designed in a differentiated way and opportunities for individualized access were created. Based on the differentiation according to Finkelstein, Sharma, and Furlonger (2019), the learning objectives are basically the same for all students, but collaborative exercises, additional materials in different media variants, and different degrees of complexity in the questions and tasks are provided [9]. In addition, the use of digital as well as unplugged exercises should enable these materials to be used independently of the school's equipment [4]. To provide an immersive learning experience, improve the learning efficiency and motivation, gamifying elements such as scoring, competition and storytelling and the resulting slipping into roles were used [19]. In addition to this approach of using constructivist principles [17], there has also been an emphasis on the 21st century skills [10], especially on the 4Cs, creativity, critical thinking, collaboration, and communication so that students should be given the opportunity to share their thoughts, questions, ideas and solutions on different topics concerning AI.

4 Implementation

4.1 Learning Modules

Initially, three prototype modules were created, building on the findings of the pre-survey (see Sect. 3.1). These modules focused on the topics *AI Basic*, *Ethics* and *Supervised Learning*. The prototype modules were qualitatively evaluated

[1] Further details regarding the survey and the results are available upon request.

within the scope of a pilot review workshop with teachers (further details, see Sect. 5).

In general, each module consists of a structured lesson plan containing content for two to four hours and includes hands-on activities as well as material for theoretical input. Furthermore, a written summary of the subject, in the form of a teacher guide, is included to provide the required knowledge as well as references for further research. The following paragraph provides an overview of the different modules.

AI Basics. While all modules are mostly independent of each other, there is some knowledge that relates to most modules. This module includes a basic definition of AI as well as common terminology like algorithms and data, as well as an overview of the vast field of AI. Therefore, this module acts as a natural starting point and ensures that other modules do not need to reconsider these basics. In addition, this module is designed for a duration of only one to two hours. Thus, it can be covered before any others easily.

Ethics. In this module, the students learn a critical approach to AI and the need for ethical guidelines. Among other things, they learn to formulate and test their own robot laws, reflect on their own and common viewpoints on data bias, and transfer thought experiments, such as the trolley problem, to the current difficulties of autonomous driving.

Supervised Learning. In addition to the basics of what a supervised learning model is and the meaning of training by using data, this module includes chapters about overfitting and underfitting as well as possibilities and limitations of supervised learning algorithms. On the practical side, students have to create their own model to differentiate between pictures of cats and dogs. Finally, they have to train a real model to recognize directions and use this final model to control a game of snake.

Chatbots - Natural Language Processing. In this module, different types of chatbots are illustrated through various practical, gamified exercises. The students learn what chatbots are and how they work. The authentic imitation of human speech, associated problems and the Turing Test are addressed.

Reinforcement Learning. In this module, basic content regarding reinforcement learning (RL) is covered in the form of small educational games. In addition, students learn about the basic RL-process and decision making based on Q-values.

Computer Vision. Here, the most striking differences between human and machine visual perception are identified. It is intended to elaborate on how a computer stores and processes visual information and where the limits and possibilities lie. The students work with practical hands-on examples and develop a face recognition algorithm using the visual programming language *Scratch*.

Neural Networks. In this slightly more challenging module, students learn the basic structure and operation of neural networks and how they can be used practically by testing simulations from the module materials.

Art and Artificial Intelligence. This module deals less with the technical functioning of image-generating applications, but focuses more on the ethical

and socially relevant issues. Students discuss copyright issues, definitions of creativity and art, and whether an AI is even capable of making art. In this context, students test easily accessible image generation applications.

AI and Manipulation in Social Media. The topic of manipulation by AI is examined from two sides in these materials. On the one hand, the handling of one's own private data, which are used by companies to generate customized advertising, is discussed by evaluating the student's own data on social media by themselves. On the other hand, the topic of deepfake is taken up, how they are developed and what damage they can cause. As a consolidation, deepfakes can be created with the help of commonly used applications.

AI and Environment. In project lessons, the students reflect on their individual energy consumption and detect digital "climate killers" in their everyday life and in the development of novel AI technologies. In a further step, students reflect on current environmental and climate problems caused through the use of technologies in the form of an ideas laboratory, where they sketch and discuss solutions based on AI.

All modules are published under the creative commons BY-SA license and can be found on the project website[2].

4.2 Regular Implementations

During the 2-year project duration, 472 persons (203 teachers and 269 school students) were trained, and 73 workshops were held. Figure 1 provides an overview of these regular implementations.

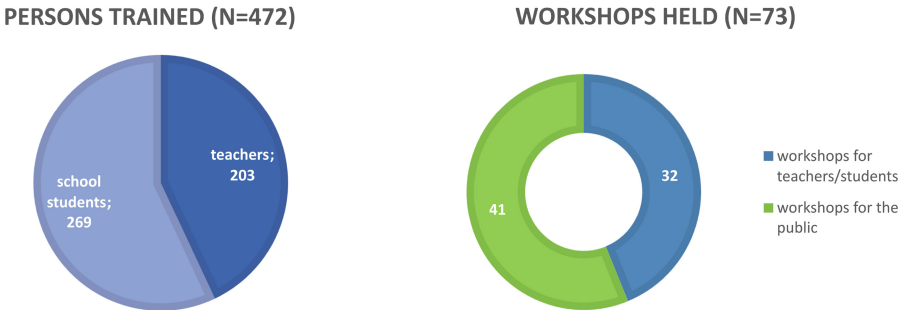

Fig. 1. Number of teachers and school students trained (left) and workshops held (right)

[2] Teaching material on ENARIS project website: https://enaris.org/material/en.

5 Evaluation Methods and Results

A combination of well-grounded quantitative and qualitative evaluation methods were used [7,15] throughout the project.

After conducting and analyzing the quantitative **pre-survey** (details and findings were described in Sect. 3.1) and developing three prototype learning modules (as discussed in Sect. 4.1), a **pilot review workshop** was held with four selected secondary school teachers, acting as external experts. The workshop started with a hands-on session, where teachers extensively tested the three prototype modules. Afterwards, each teacher was interviewed by the project researchers using a semi-structured interview approach [11]. Summarizing the results, the prototype modules were received positively. A specific critique addressed the way of providing the modules to the public. Therefore, the publication method was changed from offline documents to a website, with the option to download everything for offline use and printing.

Furthermore, two **stakeholder review workshops** with public education authorities and representatives from the industrial sector from each project country were conducted at the midway point of the project. In the workshops quantitative methods (i.e. World-Cafe, discussion) were applied to gather feedback from the stakeholders in order to ensure an alignment with educational and economic strategies as well as maximizing an adoption of the project outputs. In this context, the stakeholders specifically recommended matching the modules with the competence frameworks for national school curricula[3]. Based on the findings of the pilot workshop and the data from the stakeholder review workshops, the modules were adapted and served as templates for all subsequently developed modules.

In order to evaluate the impact on participants' awareness and general knowledge of AI, quantitative **pre- and post-tests** were conducted before and after a workshop. The instrument applied was a six-item true/false questionnaire based on the questionnaire used in the national survey called *America Needs AI Literacy Now* which was conducted in the US in 2021 with over 1500 participants [1,6]. Questions were translated from English to German and Hungarian (by native speakers) and covered the areas *artificial versus human intelligence*, *AI in everyday life* as well as *limitations and societal aspects of AI*[4].

Pre- and post-test data was collected during seven representative pilot-workshops for the general public (comprising young people as well as working persons), with in total 57 participants. In order to ease the participation (e.g. using smartphones) as well as to apply a gamification approach, the online tool *AhaSlides* was used to perform the tests [3]. No personal data (like age or gender) was collected, ensuring participants' anonymity. The data gathered was analyzed using inferential statistical procedures (paired-samples t-test) [7].

[3] As a first step, this recommendation was implemented in Austria for the curriculum 'Digital Basic Education'; see https://enaris.org/material/de/education.html.

[4] The six-item questionnaire will be provided upon request.

Compared to the results of the pre-tests (M = 52.83, SD = 22.88), participants showed a significant gain in AI awareness/knowledge after the workshops (post-tests; M = 74.85, SD = 21.62; t(56) = 7.29; p < .001). The effect size (measured by Cohen's d) was calculated with d = 0.97, indicating a large effect (see Fig. 2, right picture). An improvement could be observed for each of the six questions (as shown in Fig. 2, left picture). These results indicate that the workshops had a positive effect on participants' awareness and general knowledge of AI.

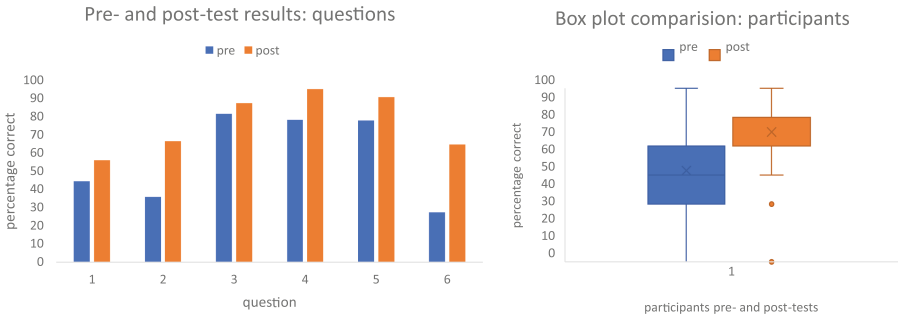

Fig. 2. Pre- and post-test results of the AI questionnaire (n = 57); analyzed by questions (left) and by participants (right)

6 Conclusion and Outlook

Artificial Intelligence (AI) has become increasingly important, having an influence on many aspects of our lives. The emergence of large language models (like ChatGPT) in the recent months brought AI into the spotlight, igniting curiosity and discussions worldwide. Recognizing the need to foster a basic technical understanding of AI and raise awareness about its implications, the AI education and awareness project 'ENARIS' presented in this paper was initiated, implemented and empirically evaluated (pre-survey among target groups, pilot implementations, stakeholder review workshops, pre-/post-tests). The results of these evaluations were encouraging, highlighting the significance of such activities and projects in enhancing AI awareness and general knowledge among young people, teachers and the general public. The quantitative data - though limited by a relatively small sample size - demonstrated a significant improvement of participants' awareness and general knowledge of AI. The qualitative data revealed a positive perception of the overall project concept and the developed learning modules. The next steps comprise the implementation of further workshops for trainers and teachers (acting as multipliers) as well as the further development of the learning modules (since new AI tools and applications literally emerge every week). Due to the open-source nature of the project, we also count on the active involvement of the community. Finally, we plan a more comprehensive evaluation, comprising a larger sample size as well as a more extensive AI knowledge test (which is currently being developed).

By providing open educational resources, based on sound didactic concepts, by applying a train-the-trainer approach, by integrating stakeholders in the review process, and finally, by conducting AI workshops for teachers, school students and the general public, we envision a sustainable positive impact of the project on the understanding and usage of AI as well as on fostering a more informed and AI-aware society.

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