What Are the Effects of the Artificial Intelligence Pilot Program on 4th Grade Students' Knowledge, Skills, and Dispositions?

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Abstract.

Artificial Intelligence is altering the world, and this has started affecting the sector of education. This increased interest in the last few years has led educational institutes across the world to integrate Artificial Intelligence in their curriculum and programs. Research has shown the impact of AI in education suggesting that educators should prepare students to understand this new technology now, in their everyday life, but also in their future careers. However, Artificial Intelligence is still a term that needs to be clearly defined, and because this is a new concept, we, educators, are not aware yet of the ways of implementation in the classrooms. This highlights the need to determine the approach and more specifically the level of readiness and familiarity as well as the learning objectives according to students' profiles and needs. This paper presents the implementation of a pilot program of Artificial Intelligence in the Elementary School of American Community Schools of Athens and more specifically in Grade 4 Technology classes. The goal of this implementation was to investigate the effects of this program on students' knowledge, skills, and dispositions. During Technology classes, students were exposed to the concept of Artificial Intelligence. The implementation contributed to the increase of students' knowledge and level of familiarity with AI suggesting that the development of the learning design should focus on understanding and connecting AI to everyday life through multimedia resources and hands-on learning activities.

Keywords: artificial intelligence, education, implementation, technology class, elementary school

1. Introduction

Artificial Intelligence is gaining ground and attracting the interest of a large variety of industries and sectors around the world, with education being a prominent example. This increased interest in the concept of AI is also reflected by the rising number of papers published in the topics ''AI'' and ''Education'' from Web of Science and Google scholar. Regarding the nature and impact of Artificial Intelligence in the education field, the literature review shows that the term "Artificial Intelligence" is defined as a field of study in Computer Science and as a theory, it is related to terms of machines, machine learning, and human reasoning (Chen, et all, 2020).

Although Artificial Intelligence has been defined in many ways, all definitions show that it is connected to machines and their ability to perform tasks that require human-like abilities. Regarding the techniques for Artificial Intelligence scenarios, it is supported that Artificial Intelligence could support the following: assessment of students and schools, grading and evaluation of papers and exams, personalize intelligent teaching, smart school as well as online and mobile remote education (Han, X., et al., 2018). Research has shown the impact of AI on education suggesting that educational institutes and teachers should prepare students to understand this new technology in their everyday life, but also in their future careers. According to JRC science for policy report, AI implications for society and the economy cannot fully be understood yet, but it is highlighted that AI can create new ways of teaching and learning. (Tuomi, The Impact of Artificial Intelligence on Learning, Teaching, and Education). Initiatives connecting AI with education include the design of AI + Curriculum for Primary and Secondary Schools in Qingdao (Han, X., et al., 2018), the development of AI curriculum guidelines by the AI4K12 collaboration (Touretzky et al. 2019) as well as the development of UNESCO IITE policy brief on Artificial Intelligence in education (UNESCO IITE, 2020). All these initiatives stress the great importance of educating the students to be prepared to understand AI and how to use it in a world with increased human-computer interactions. In response to this need, experts and educators from all around the world have entered into a dialogue sharing their insights and exploring resources. An indicative example is the handbook "Teaching AI" which offers educators many ways to approach AI and try out new concepts in the classrooms and provides lesson ideas, activities and tools for exploring AI with students (Zimmerman, 2018).

Introduction

American Community Schools of Athens (ACS Athens) which is a student-centered international school, is developing an Artificial Intelligence framework. Projects related to AI have started being implemented in High School aiming at investigating high school students' perceptions, awareness and prior knowledge about Artificial Intelligence and Machine Learning (Karampelas, A., 2021).

I am the Technology Teacher in the Elementary School and the idea of this pilot program was born last year when I was part of the AI team at ACS Athens where we were developing the AI framework. Discussions with other members of the team, teachers, AI projects being implemented in High School, and further research from my part inspired me to explore and introduce Artificial Intelligence to the Elementary School, and more specifically in Grade 4. The implementation of this pilot program and the data collected (level of familiarity, engagement, knowledge and skills) will be valuable for better understanding Artificial Intelligence and its connections with pedagogical aspects. The following section describes the methods, learning activities, data collected and analysis.

Methods and student sample

The duration of this pilot program's implementation was a month, and more specifically four weeks taking place during Grade 4 Technology classes. Grade 4 consisted of 4 sections

(homeroom classrooms) with a total number of 61 students. In this paper, those groups are named: Group 1, Group 2, Group 3, and Group 4. Students' prior knowledge, dispositions, and level of familiarity with Artificial Intelligence were collected and compared to those after the interventions. Students were exposed to materials related to Artificial Intelligence in an effort to build their knowledge about machines, machine learning, training data as well as experience Artificial Intelligence working on the activities assigned.

A prior/ post assessment model was used to collect students' knowledge, and level of familiarity with Artificial Intelligence. In the first part of the action research, students were asked to share their prior knowledge and dispositions about Artificial Intelligence. Comments and thoughts were collected. Then, students got a first insight into Artificial Intelligence by being exposed to educational videos on "Machine Learning" and "How AI Works" and participating in whole group discussions. Examples of classification were presented so students could understand how a machine classifies objects, in other words, data. After that, Google AI experiments (Quick, Draw! and AI Duet) were used so students would start exploring machine learning, through drawings and music. Working on the Quick, Draw! activity, students were asked to draw something specific, and then, a neural network tried to guess what the students were drawing. In this way, students had the chance to experience how a machine learning model learns and uses patterns. The AI Duet activity allowed students to play a duet with the computer through machine learning. Students were prompted to play some notes using the keyboard and the computer responded to their melody. Students were able to understand that a neural network had been trained and learned about musical concepts by building a map of notes and timings.

Exploring Artificial Intelligence applications in their lives was the next step. A poster with AI applications in our everyday life was presented and explained. During the whole group discussion, students were prompted and encouraged to identify and share personal experiences by providing some examples of their everyday life. A table with all the applications was used to collect students' votes. For the last part, students were encouraged to use AI to make the world a better place by training their data. Students were provided with the steps on how to access their accounts on the code.org platform and work on the online activity "AI for Oceans". Students were asked to classify objects and expand training data. In more detail, first students classified objects as either "fish" or "not fish" to attempt to remove trash from the ocean. Then, students expanded their training data set to include other sea creatures that belong in the water. In the second part of the activity, students chose their own labels to apply to images of randomly generated fish. This training data was used for a machine learning model that then was to label new images on its own. In other words, students who consistently labeled things correctly, saw an ocean full of different types of sea creatures, without many (or any) other objects.

Results

The pre/post assessment model revealed changes in students' knowledge and level of familiarity after the implementation of the pilot program. Before and after their exposure to AI,

students were asked to share their knowledge about AI by writing any words or phrases that according to them were related to it. The themes/ comments identified in these responses are summarised in Figure 1. Before the implementation of this action research, only 36 comments related to AI were collected with the participation of ¼ of the total number of students. The

common comments collected include "robots" (10 comments), "machines" (5 comments), "machines learn with experience" (4 comments) and "machines learn with patterns" (4 comments). After the implementation, 213 comments were collected with the participation of all the students. Apart from the increased number of the students' participation, which shows a higher level of familiarity, other words and phrases were also suggested. For instance, "programming" and "actions" (40 comments each), "machines" (58 comments), "machines learn with patterns" (30 patterns).

Figure 1: Pre/ Post Students' Comments about AI
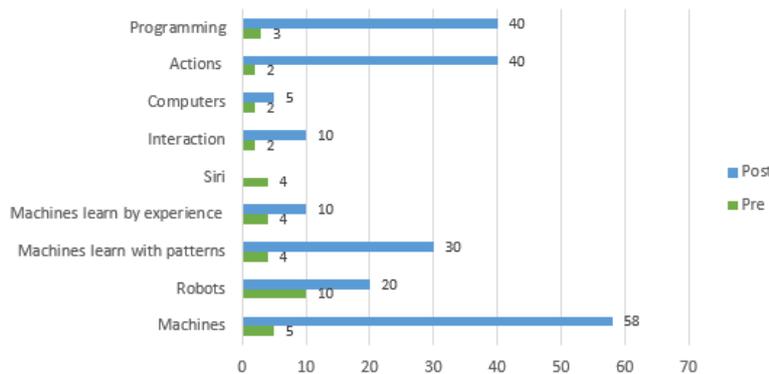
Regarding students' experience with Artificial Intelligence, both activities, Quick, Draw! and AI Duet certainly raised students' interest and motivation and stimulated their curiosity. While working on the Quick, Draw! activity, students were able to understand that this machine learning model uses drawings that other people had submitted, so it can now guess their drawing by paying attention not only to what they were drawing, but also to how they drew it (such as the shapes, the lines, and the directions). The AI Duet was another simple tool that allowed them to use their creativity to explore machine learning. Both activities made students wonder and think about the patterns that each of those models use. They also realized that even though machine learning was not always working successfully, the more they played with it, the more the machine would learn.

Regarding the AI applications' in their everyday life, the table below (Figure 2) illustrates some of the main examples that students gave. Some of them include the following applications: Siri/ Alexa/ Google Assistant, Face Recognition, Netflix Recommendations, Google Search and Google Predictive Searches, and Social Media/ Youtube. All the groups voted the category of Social Media/ Youtube as the most frequent AI application in their lives. The second most frequent AI application that students identified was Google Search/ Google Predictive Searches. However, the votes of Group 2 contain some fundamental differences since they chose Voice Recognition as the second most frequent AI application they use.

Figure 2: AI Applications in students' everyday life by Group

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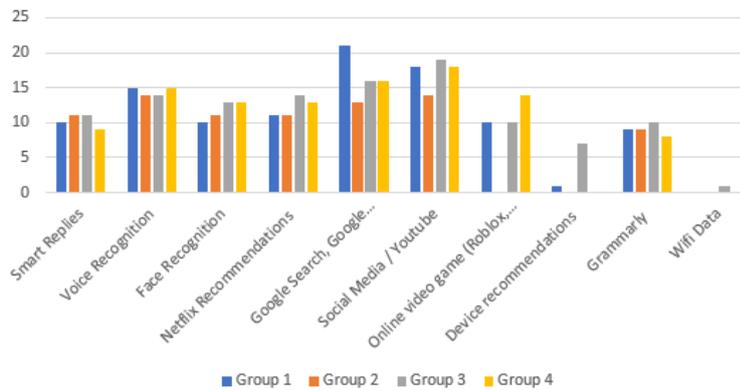
In more detail, it can be seen from the data in Figure 3 that the categories of Google Searches/ Google Predictive Searches (M=16.5) and Social Media/ Youtube (M=17.25) reported significantly more votes than the other eight categories. What is interesting about the data in those tables is that the last three categories (Device Recommendations, Grammarly, and Wifi Data) were suggested and added by the students themselves. This is a surprising result outcome which shows that a few students were familiar with Artificial Intelligence and its applications.

Figure 3: AI Applications in students' everyday life by Group

	Smart Replies	Voice Recognition	Face Recognition	Netflic Recommendations	Google Search Predictive Searches	Social Media/ Youtube	Online Video Games	Device Recommendations	Grammarly	Wifi Data
AVERAGE	10.25	14.5	11.75	12.25	16.5	17.25	11.33	4	9	1

Regarding students' exposure to Artificial Intelligence through exploration and hands- on activities, the AI for oceans activity was proved very helpful and effective while training and testing a machine learning model. It was observed that students were able to understand as well as show understanding of what classification is by classifying objects and expanding training data. After this introduction of AI, students were asked to share once again their knowledge about AI by writing any words or phrases that, according to them, were related to it. As mentioned above (Figure 3), statistically more students were willing to express their ideas and more comments were collected. This shows that the level of their familiarity with AI was significantly higher.

Discussion

This paper introduces the design and implementation of an AI pilot program. This pilot program of AI implementation in Grade 4 Technology classes was an effort to explore students'

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knowledge, skills, and level of familiarity with AI as well as assess the activities used. The findings suggest that students in Grade 4 are ready to be exposed to the concepts of AI since they demonstrate basic technology and cognitive abilities and exhibit high-quality digital skills. In other words, they are equipped to understand more in-depth technologies such as AI. From these results, it is clear that this pilot program gave students the opportunity to not only gain a first insight into AI, but also generate interests. Students were encouraged and guided to acquaint themselves with the world of Artificial Intelligence, so they can later reflect on the prevalence of Artificial Intelligence in their lives and think broadly about potential future innovations. Due to the fact that this initiative is original, the results of this pilot program cannot be compared with others since the implementation of AI in elementary school, and especially in the specific grade level, is still at an early stage.

Regarding the limitations of this research, it could be argued that more resources and materials could be collected and used if time allowed the extension of the program. However, companies and educational institutes around the world are developing and enriching the learning resources, so hopefully, this network will be expanded and grown in the near future. Another limitation that could be mentioned is that that the current pilot program paid more attention to the AI exploration through hands-on activities rather than in-depth knowledge and relevant algorithms. However, this was a conscious choice by taking into consideration the students' readiness and cognitive development at this age. Perhaps, more focus on the technical aspect of AI could be paid on a higher grade level.

2. Conclusion

Acknowledgment

The main conclusion that can be drawn is that students in Grade 4 were ready to explore AI and were able to be exposed to the fundamentals of this concept. They also demonstrated an understanding of how AI works by identifying examples of AI in their everyday life and training data through online activities. The results suggest that the learning resources mentioned in this paper could be used in an elementary classroom in an effort to introduce AI concepts. This also provides a good starting point for discussion and further research. In future work, investigating ways to introduce aspects of AI in elementary classrooms might prove important.

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