Irish National Evaluation Report

AI4T –DELIVERABLE D3.3

DEIRDRE BUTLER

Work Package 3:

Evaluation

Deliverable D3.3

National Evaluation Report

Ireland

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ABSTRACT	This report presents the quantitative and qualitative evaluation of the impact of the AI4T professional learning pathway in France. The first parts are dedicated to introducing the intervention – which is the AI4T professional learning pathway, and the experimental design detailing: the recruitment and randomisation procedures, the theoretical framework of the evaluation and the instruments used for data collection. The sample is then described, and elements are provided on data processing, along with verifications regarding the experiment's internal and external validity. The results are then outlined in three parts, first the teachers' results, then the school leaders' and finally the students. A bigger focus is given to teachers as they are the main target of the AI4T project. After detailing their reactions to the professional learning pathway, the report delves into the three main outcomes of the experiment: teachers' knowledge, perceptions and use of AI. Both the initial state and the impact of the intervention are presented for each outcome. Additional analyses on the heterogeneity of the impact of the intervention depending on teachers' engagement in the MOOC, teachers' self-efficacy for integrating technologies into the classroom, and teachers' subject are then outlined. The final part highlights the takeaways from teachers and school leaders which could inform educational policies on AI. It focuses on their needs regarding professional learning, tool development and ethical safeguards.
KEYWORDS	Artificial intelligence, experimentation, evaluation, impact study, professional learning, teachers

Dissemination level		
PU	Public	**X**
PP	Restricted to project partner (including the Commission)	
RE	Restricted to a group defined by the consortium (including the Commission)	
CO	Confidential, only for members of the consortium (including the Commission)	

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Introduction

In recent years, the rapid development of new technologies based on Artificial Intelligence (AI) has prompted a crucial discussion on its implications for education. At the European level, the Digital Education Action Plan 2021–27 emphasised the necessity of developing students' AI skills and providing ethical guidelines on the topic.

Funded by the European Commission, the Artificial Intelligence for and by Teachers (AI4T) project was a three-year experiment to explore and support the use of AI in education. It consisted of producing, implementing and evaluating professional learning activities with the goal of acculturating teachers to AI. The project was conducted in five countries: France, Slovenia, Italy, Ireland and Luxemburg. Seventeen partners, including education ministries, evaluators and research labs took part in the project, under the coordination of France Education Internationale (FEI).

The AI4T intervention was built around two common online resources specifically developed for the project: the AI4T massive open online course (MOOC) created under the coordination of the Institut National de Recherche en Sciences et Technologies du Numérique (Inria) and the textbook *AI for Teachers: An Open Textbook* under the coordination of the Université de Nantes. Both resources received contributions from the consortium partners. In each country, professional learning pathways with common learning objectives but varied formats (online platforms, webinars, face-to-face sessions) were then developed.

Following a pilot phase conducted in 2021-2022 in a small sample of schools, the intervention took place during the 2022–23 school year. The programme was aimed at maths, science and language teachers with students aged 15 to 17 years. Of all the participating schools, half were randomly chosen within each country so that the teachers would engage in the professional learning pathway during the experimentation year. The teachers in the remaining schools served as a control group and were given access to the resources only after the end of the experimentation period.

The findings presented in this report are based on questionnaires administered to teachers, school leaders and students, as well as interviews carried out with teachers. Based on the data collected, this report will address the four evaluation questions formulated at the beginning of the project.

1) *Was the professional learning experience conducive to teachers' learning of AI?*
2) *Was the professional learning experience conducive to changing teachers' perceptions of AI?*
3) *Was the professional learning experience conducive to modifying teachers' use or behavioural intentions of using AI?*
4) *What are some key factors that can account for the impact of the intervention?*

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1. Intervention

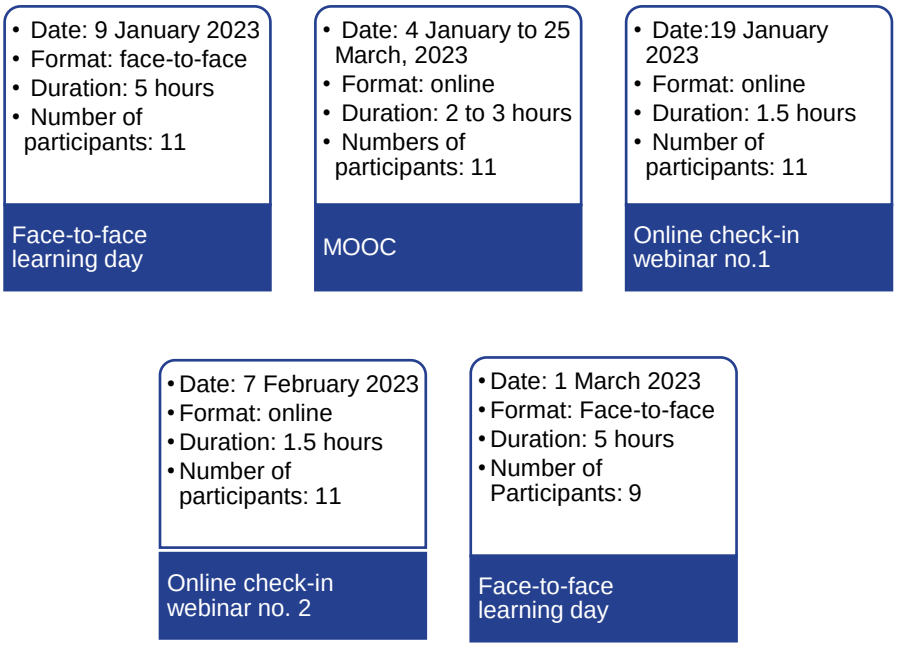
The AI4T intervention revolved around two common online resources translated for all five participating countries. The first resource was the AI4T MOOC under the coordination of the Inria. A textbook entitled *AI for Teachers: An Open Textbook* was also developed under the coordination of the Université de Nantes as a resource for more experienced users and trainers.

Finally, a set of common learning outcomes was established for the professional learning pathways in all countries:

1. Being able to express one's understanding and attitude towards AI and discuss it.
2. Being able to understand the basic principles of AI systems.
3. Being aware of AI educational applications and key considerations when identifying, assessing and selecting an AI for teaching, learning and assessment.
4. Being aware of legal considerations when using AI in educational settings.
5. Being aware of ethical considerations when using AI in educational settings.
6. Being aware of generic AI tools and being able to reflect on their impact on education and critically consider the possibilities for AI tools in education.

In Ireland, the professional learning pathway took place from January to March, 2023, and followed a hybrid format.

Figure 1. AI4T professional learning pathway (intervention group) in Ireland



The teachers in the intervention group in Ireland had access to the AI4T MOOC on a dedicated Moodle platform from January to March, 2023, while the teachers in the control group had access from April to June, 2023. The link to the textbook was provided in the MOOC as an additional resource. The textbook was used as a resource for the facilitators initially and provided for the intervention group at the end of the intervention. The learning materials were complemented with two webinars (online) and two face-to-face sessions. The first session was at the beginning of January and introduced the AI4T project and

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professional learning pathway, explored AI use cases from industry and education, and engaged in activities centred on understanding machine learning and the ethical considerations of AI in education. There were also some short demonstrations of Duolingo (free version for schools) and Photomath. During the two online webinars the content of the MOOC was discussed and facilitated by a member of the PDST facilitation team to deepen understandings of the MOOC content and discuss usage of the AI tools being used in the classrooms (Duolingo and Photomath). The second face-to-face session in March focused on reviewing the content and format of the professional learning pathway and considered the role of AI technologies, as they are presently used and their potential use in society and education particularly Gen Ai as a response to its growing prominence.

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2. Experimental design

2.1 Recruitment and randomisation

Between the 7 and 21 November, 2022, an open call for expressions of interest was circulated in social media and professional networks to teachers to participate in the AI4T. Seventy-nine teachers (38 mathematics teachers, 41 French teachers) from 64 different post-primary schools (representative of all school types) nationwide initially volunteered to take part in the project.

To assign teachers and schools to the control and intervention groups, a stratification procedure was followed by the evaluation team (see Appendix 1). The randomisation took place before the administration of the baseline questionnaire for teachers, but schools were not informed which schools had been assigned to the control or intervention groups. With the cooperation of the PDST, the teachers were randomised at the school level. Following the recommendations of Banerjee and Duflo (2017), the chosen method for the randomisation was stratification. Specifically, schools were split into eight groups (strata) based on their DEIS status (DEIS/non-DEIS), size (700 or fewer enrolled students/more than 700 enrolled students) and subject taught by teachers registered to take part in the project (most registered teachers taught Maths/most registered teachers taught French, or equal numbers of teachers taught Maths and French). Schools within each stratum were initially randomly assigned to the control and intervention groups. Assignment to the control and intervention groups was completed at the school level, meaning that teachers from the same school were assigned to the same group. However, in one school where five teachers registered their interest to take part in the project, only two were assigned to the intervention group. This decision was made because it was highly unlikely that the school would be able to accommodate all five teachers to engage with the intervention group activities during teaching time. Consequently, although there were only 64 schools in total, this adjustment meant there were 29 schools in the control group and 36 schools in the intervention group. This resulted in 39 teachers assigned to the control group and 40 teachers assigned to the intervention group.

However, further modifications needed to be implemented before the baseline questionnaire could be made available, due to many schools' inability to participate because of teacher shortages. Consequently, decisions were taken in consultation with the PDST to balance the demographic compositions of the schools assigned to the two groups and account for potential further dropouts from the intervention group. The sample is not assumed to be representative of the general population of teachers and due to the large dropout rate, it was not possible to have a true randomised controlled design. As the numbers within the intervention group were relatively small, all the teachers were invited to participate in the recorded interviews. This process also ensured that we had a variety of school types included. The evaluation team did not have access to the schools or teachers' names, or other identifiers, as anonymised codes were assigned by the PDST to each school and teacher. The students also used the code that had been assigned to their teacher (see WP1_D1.2 Report on the experimentation phase for full details as to how this process was conducted).

The intervention group received access to the AI4T professional learning pathway from January to March, 2023, while the control group was granted access to the online learning resources from April to June, 2023.

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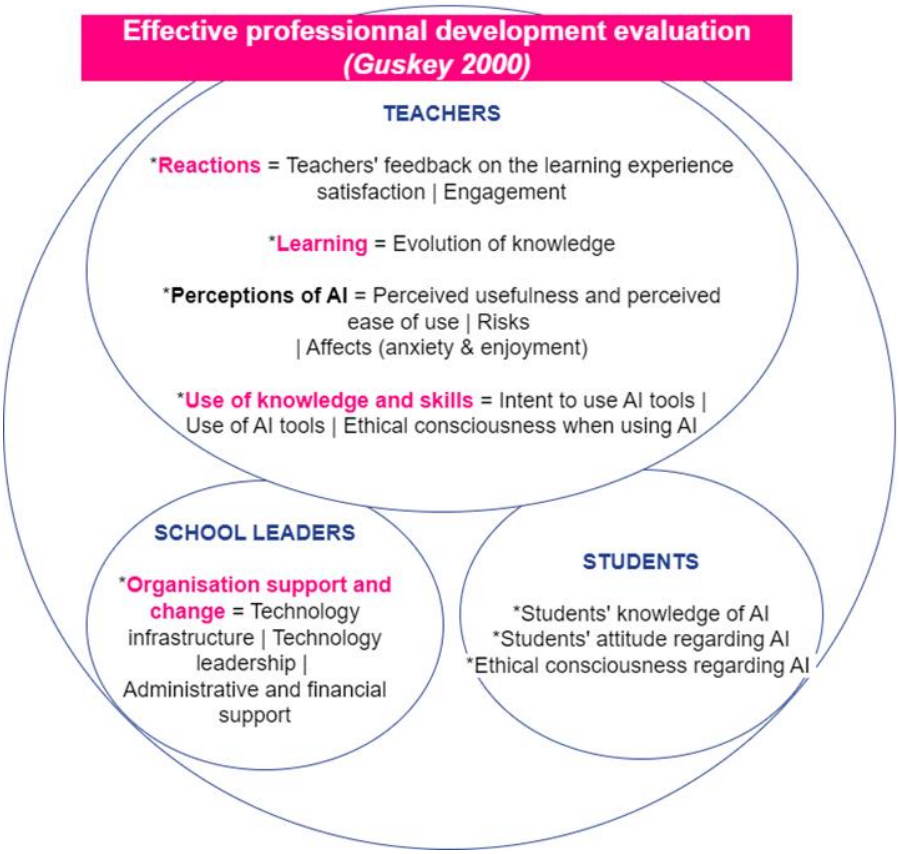
2.2 Theoretical framework

AI4T started as a pioneer project on AI in education, tackling a relatively unexplored topic. To refine the evaluation questions identified at the beginning of the project, we adopted a theoretical framework drawing from the existing literature on AI, but also on digital technologies and professional development evaluation. Specifically, we drew upon Guskey's work as a foundational framework (2000). According to Guskey, an effective evaluation of professional development requires the collection and analysis of five critical levels of information: 1) participants' reactions, 2) participants' learning, 3) organisation support and change, 4) participants' use of new knowledge and skills, and 5) student learning outcomes.

For each level the evaluation team created robust indicators adapted from existing scales and tested them during the pilot phase of the project.

Figure 2. Theoretical framework for the evaluation of the AI4T professional learning pathway



Participants' reactions were assessed through the measure of their engagement in, and satisfaction with, the professional learning pathway. The level of engagement in the professional learning pathway was measured through the behavioural, cognitive, social and emotional connections that the participants made with the course content, the instructors and the other learners. While the behavioural engagement corresponds to learners' observable actions such as taking notes, cognitive engagement corresponds to participants' mental investment in the learning process. Social engagement refers to both learner-

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instructor and learner-learner interactions, when emotional engagement centres on emotional connections with the professional learning pathway (enjoyment, interest, etc.). The engagement scale was adapted from Deng et al. (2020a & 2000b) and the satisfaction scale from Yennek (2014).

The measure of **participants' learning** was based on the content of the AI4T MOOC and additional reports on AI (European Commission, 2019; Samoili *et al.*, 2020; Fengchun *et al*., 2021). We also consulted experts on AI in education from within and outside of the consortium to review the questions and their interpretation. To measure participants' learning, we asked them to self-assess their knowledge of AI, indicate their level of familiarity with AI technologies, answer questions about how AI works, and identify tools that contain AI.

Data on **organisation support and change** was collected through school leaders. Guskey (2000) recommends assessing whether the organisation's policies and characteristics are compatible with the implementation of the envisioned change. To address the integration of AI, we assessed the technology infrastructure and technology leadership (Anderson & Dexter, 2005) of the schools. Access to technological equipment is sometimes described as the first-order barrier for technology integration, in comparison to the second-order barrier that is teachers' beliefs (Ertmer *et al*., 2012). We also assessed the administrative and financial support provided to teachers for their participation in the professional learning pathway.

Given the specific context of the project, which centres on changing teachers' **perceptions of AI** and encouraging the integration of AI tools into classrooms, the measure of **participants' use of knowledge and skills** was extensively developed by incorporating into the framework the Technology Acceptance Model (Davis *et al.*, 1989), described by Scherer *et al.* (2019) as follows:

> *In the literature, the question is repeatedly put forward as to what variables determine technology integration in education. Measuring user acceptance of technology is a way of determining the teacher's intentions toward using new technologies in their educational practice. Over the last decades, a series of models have been proposed to describe the mechanism behind and factors affecting technology adoption. […] Despite the variety of models, the TAM has dominated the research landscape as the most commonly used model to describe use intentions and actual technology use.* (Abstract)

This model identifies two main variables — 'perceived ease of use' and 'perceived usefulness'—that determine behavioural intention to use, and the actual use of a technology. We adapted the original scale from Davis *et al.* (1989) to measure the perceived ease of use of AI. To measure the perceived utility of AI, we created items specific to the teaching profession, which enabled us to gain information about the specific pedagogical functions (identified by André Tricot, Cnesco, 2020) for which teachers perceived AI to be the most useful. In order to counterbalance the positive concept of 'perceived utility', we also surveyed participants on the 'risks' posed by AI, based on elements identified by Schiff (2021) and Remian (2019).

Some versions of the TAM also contain the concept 'attitude', whose definition and scope often varies (Njiku *et al.*, 2019). We took a particular interest in one of the sub-dimensions of attitude, namely, 'affects'. Affects regarding AI are prominent in the AI literature (Wang & Wang, 2019; Cave *et al.*, 2019), are of interest to the AI4T partners, and can also impact the use of a technology (Février *et al.*, 2011). We therefore measured AI anxiety by adapting items from the Wang and Wang scale (2019), and AI enjoyment by generating items based on existing scales on computer enjoyment (Christensen & Knezek, 2009; Noiwan *et al.*, 2005).

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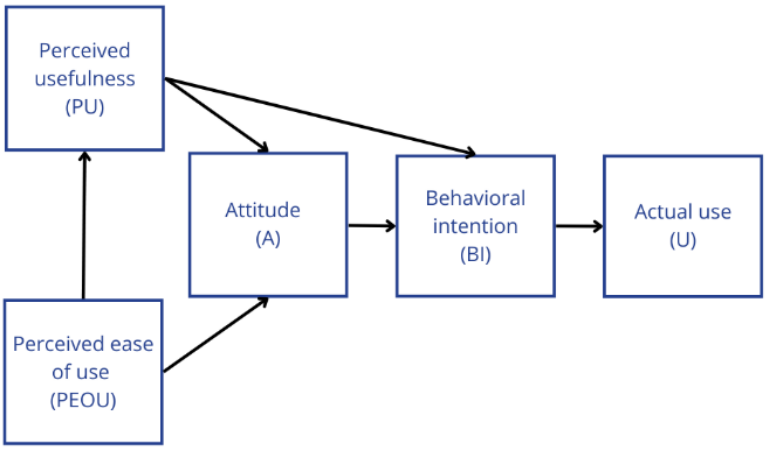
Figure 3. Technology Acceptance Model developed by Davis *et al.* (1989)



Both behavioural intentions to use AI and **use of AI** were measured in accordance with the TAM. We also characterised the types of use by asking about the frequencies, the tools and the tasks done with the tools. Finally, we measured participants' ethical consciousness when using AI by utilising items from a subscale on ethics in the AI literacy scale (Wang *et al.*, 2022).

Due to the characteristics of the AI4T professional learning pathway—objectives, length and content—and the focus on teachers, we did not measure **student** learning outcomes, but instead gathered context information on students' knowledge, attitude and ethical concerns regarding AI. We created an attitude scale towards AI in education based on the conceptualisation of attitude by Njiku *et al.* (2019) and on existing scales on attitude towards AI (Suh & Ahn, 2022; Schepman & Rodway, 2020). For the ethical concern scale, we carried out a literature review to include the main concerns mentioned in the literature on AI in education (Jang *et al.*, 2022; Remian, 2019; Schiff, 2021; Akgun & Greenhow, 2021; European Commission, 2022; Holmes *et al.*, 2021).

2.3 Evaluation instruments

The evaluation of the AI4T intervention is both quantitative and qualitative. The main data was collected through questionnaires and interviews. Ethical approval for the Irish team to engage in this research was granted by Dublin City University's research committee (reference letter – DCUREC/2022/179).

Online questionnaires were administered to teachers, students and school principals. Teachers were asked to respond to baseline and endline questionnaires, administered at the beginning and end of the intervention, while school principals and students were only surveyed at the end. For the administration of the questionnaires, the education ministry sent the questionnaire links to teachers and school leaders using their school email addresses. They were also given individual evaluation identity numbers, necessary to access the questionnaires. For students, the questionnaire was administered in class under the supervision of a school staff member. Students from one class were all asked to enter the same number, which was their teacher's evaluation identity number. The evaluation team did not have access to the personal data of the teachers, principals or students (e.g., name, school, etc.).

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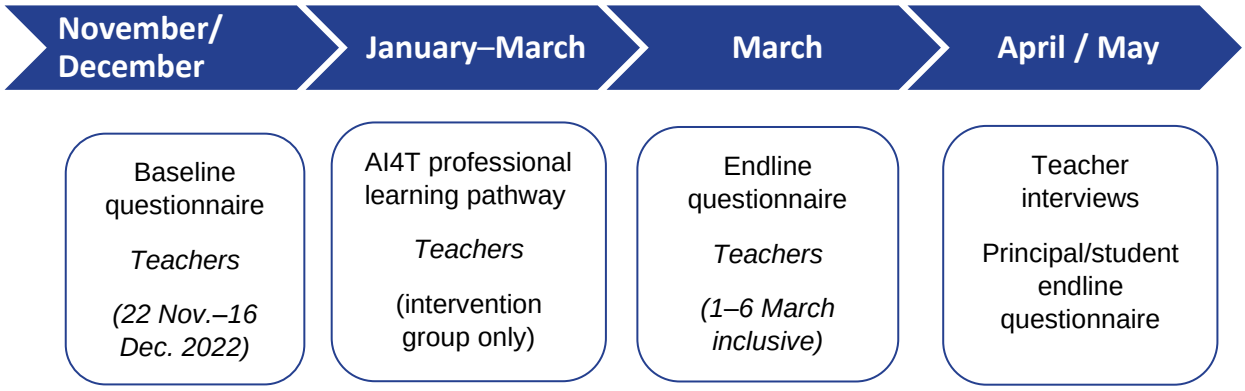
The teacher questionnaires covered the main outcomes regarding teachers' knowledge, perceptions and use of AI. In the baseline questionnaire, teachers were also asked to provide information on their background (sex, teaching experience, etc.). In the endline one, teachers who had participated were asked questions about their engagement and satisfaction with the intervention. Through the school leader questionnaire, data was collected on the general characteristics and technical infrastructure of the school, and on the administrative and financial support for teachers' professional learning and integration of AI in the school. Finally, students were surveyed on their understanding of AI, attitude towards AI, and ethical concerns regarding AI. The questionnaires (i.e., Teacher Baseline and Endline, School Leader and Student – AI4T Deliverable D2.3) can be accessed on the AI4T website.[1] Semi-structured interviews (see Appendix 2 – Interview Guide) were conducted online using Zoom with nine teachers from the intervention group. The interviews took place from the 17th to 21st April inclusive after the administration of the endline questionnaires, and were all conducted by the principal investigator (Prof. Deirdre Butler) of the evaluation team.

The interviews focused on the teachers' experience of the professional learning activities and AI tools. They covered the dimensions addressed in the questionnaires to provide a better understanding of the responses given by the participants. The teachers were also asked about their expectations and recommendations regarding AI policies.

Figure 4. Calendar of the evaluation of the AI4T intervention



[1] https://www.ai4t.eu/

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3. Data

3.1 Questionnaire data

Due to the administration method that allowed for multiple responses coming from a single participant, the first step of the data cleaning process was to remove duplicates, identifiable thanks to the evaluation numbers entered by participants. When a single participant answered several times, we kept the most complete answer and if several answers had the same level of completion, we kept the first one. Incomplete answers were kept if the participant had completed at least the first module of outcomes.

The participants' evaluation numbers, which were specific to the country, and the country entered by participants was checked. In the teacher, school leader and student questionnaires, there was no inconsistency between these two variables.

Data from the questionnaires was analysed using descriptive statistics' techniques. The statistical analysis was conducted in SPSS (version 29). Findings related to the teachers are discussed in Sections 4 and 5. Findings in relation to the student data are outlined in Section 6. However, due to the small number of school leader responses, it was decided to include just a short summary of these in the appendices (see Appendix 3). The low response rate from school principals is very understandable considering the project content, and the fact the professional learning pathway was focused on teacher understanding and use of AI. In addition, there was a teacher supply crisis during this period and the timing of the questionnaire was problematic; it was one the busiest times of the school year (e.g., oral and practical state examinations were underway, coupled with end of year school exams).

3.2 Interview data

Interviews were conducted with nine teachers from the intervention group who had participated in the AI4T professional learning pathway and completed the baseline and endline questionnaires. Thematic analysis of the qualitative data was carried out, following the six-stage process outlined by Braun and Clark (2006):

1. Familiarisation: The data was collected via Zoom; thus, the researcher was provided with an audio transcript of each interview. In order to make each transcript usable, the researcher listened to the audio and amended the transcript to fix any errors. In doing so he started to gain familiarity with the data. This process took approximately five times as long as the length of each transcript.

2. Coding: The researcher then went through each transcript one by one, assigning labels (or 'codes') to each chunk of data. For example, in the extract shown below, the code *unclear learning intentions* was assigned to the piece of text from "I suppose …" to "... use it in the classroom". The coding process was inductive, in that the researcher was not guided by any preconceived ideas (gathered from previously read literature) as to what information was likely to be in the data. The online software Taguette was used to code the data (once the coding had been completed and analysed the project documentation was deleted from this software's server). Examples of this tagging process for two of the codes ('unclear learning intentions' and 'benefits of multiple subjects') are included in the appendices (see Appendices 4 & 5).

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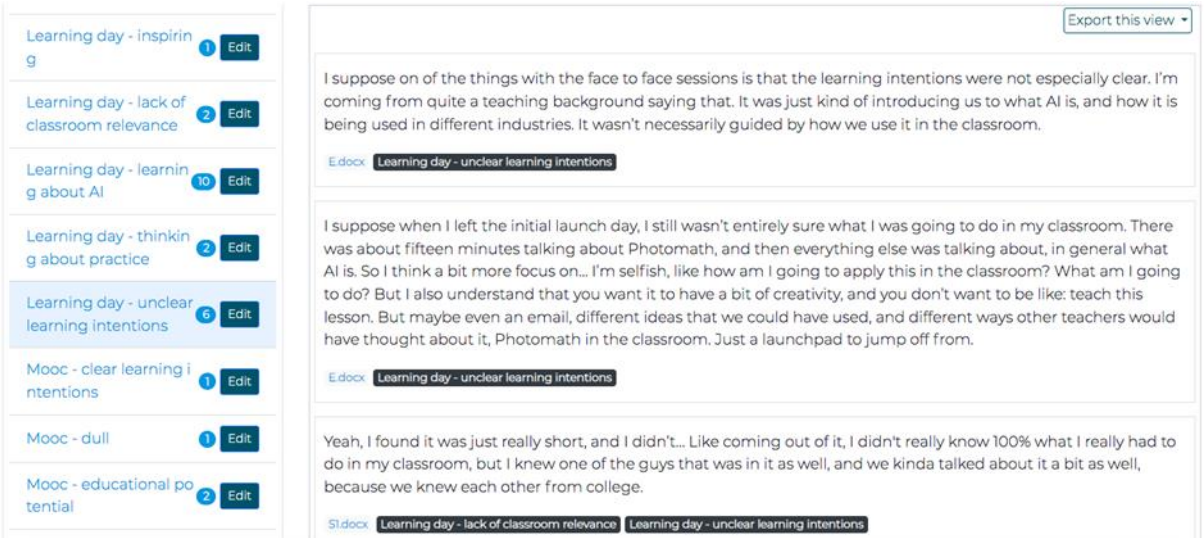
Figure 5. How labels (or 'codes') were assigned to each chunk of data

3. Theme identification: From the initial coding process, a total of 81 codes were identified across the nine transcripts (see Appendix 6 – Codebook). These codes were then organised into themes in an iterative process, informed by the different aims of the research process as outlined in the Teacher Interview Guide (see Appendix 2), which contained the following sections: *AI4T professional learning experience, Impact of the professional learning experience on the knowledge and understanding of AI,* and *Experience or use of AI.* These sections are mirrored in how the themes are organised. The extract noted above, which recurred six times across the interviews (see Figure 6), was classified within the theme *Learning days – negatives.*

Figure 6. Example of classification within a theme



4. Theme review: The researcher reviewed the themes to ensure they captured the data in the clearest way possible. At this point, some minor changes were made, for example, the sub-theme *data protection concerns* was deemed to be too narrow, and did not reflect the extent to which participants spoke about this issue. At this point, it was expanded to include information about how schools have a responsibility to think about data protection, and how participants expressed ambivalence about the need to use digital tools in spite of the fact that they may collect data about students.

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5. Theme definition: The researcher then defined each theme in order to capture its 'essence'. In contrast to more latent forms of coding, in which the researcher attempts to uncover the deep meaning behind interviewees' remarks, this coding process was semantic, focusing almost exclusively on the literal meaning of what participants said. As such, the definition of each theme (for example, *Learning days – negatives*) was easily derived from the theme name (see Appendix 7 – Index of Themes).

6. Write up: In the final stage, the researcher wrote a summary of the themes, including quotes to illustrate each theme, and also developed theme maps to represent the material.

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4. Teachers' knowledge, perceptions and use of AI prior to engaging in the AI4T professional learning pathway

The reporting of the findings in relation to the teachers who participated in the AI4T project in Ireland is organised into two discrete sections in order to effectively capture a comprehensive understanding of teachers' knowledge, perceptions and use of AI, particularly in their classroom practice, in order to inform policy decisions relating to AI in education.

As there was a small number of teachers involved overall in the AI4T project in Ireland it was decided that in order to garner as broad an understanding as possible of their knowledge and perceptions about AI, before they embarked on the AI4T learning pathway, the responses of all the teachers (i.e., both control and intervention groups, a total of 24 teachers) who completed the baseline questionnaire should be analysed. These findings will be reported in this section.

However, to determine the possible effects of participating in the AI4T project, only the responses of those nine teachers who completed both the baseline and endline questionnaires, and who participated in the different elements of the professional learning experience, were included. These nine teachers were also interviewed in relation to their experiences of the AI4T project. This analysis is also included in the narrative which outlines the teachers' views on, and reactions to, the AI4T professional learning pathway, their learning about AI, their use of and intention to use AI, and their perception of AI. These findings will be reported in Section 5.

4.1 Teacher demographics

This section summarises the responses of all 24 teachers who completed the AI4T baseline questionnaire between the 22 November and 2 December, 2022, in Ireland. It must be noted that the sample is made up of volunteer teachers and, due to the nature of the project, we expect that these teachers have a greater than average interest in digital technologies.

Table 1. Teacher demographics

		n	*%*
Gender			
	Female	21	87.5
	Male	3	12.5
Teaching experience			
	Less than 10 years	11	45.8
	More than 10 but less than 20 years	8	33.3
	More than 20 years	5	20.8
Subject			
	Mathematics	13	54.2
	French	9	37.5
	Other	2	8.3
School type			
	Secondary school	14	58.3
	Community/comprehensive school	2	8.3
	Vocational/community (ETB) school	8	33.3

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The majority of teachers who participated in the survey were female (87.5%); 12.5% of teachers were male. Nearly half of the teachers (45.8%) reported having less than 10 years of teaching experience when they completed the survey. On average, teachers had 12.1 years of teaching experience with a standard deviation of 7.9. A little more than half of the teachers who participated in the survey teach mathematics (54.2%) and just over a third (37.5%) teach French. One teacher reported teaching both mathematics and French, while another reported teaching science. Most teachers who participated in the study teach in secondary or vocational schools (91.6%).

For the purposes of the survey, teachers were asked to indicate one of the class groups they were going to work with that year using the AI powered tools recommended by the AI4T project. This class was used by teachers as a reference during the completion of the questionnaire (see Table 2).

Table 2. Numbers/percentages of teachers who agreed with the following statements regarding their confidence in using digital technologies in class

	Minimum	*Maximum*	*Mean*	*SD*
How many students do you have in your class?	8	32	21.8	6.3
How many of your students (approximately) in that class have difficulties achieving prescribed goals for your subject?	2	15	6.7	3.2
How many times a week do you teach this class?	1	6	2.8	1.3

On average, teachers reported having about 22 students in their class, with class sizes ranging from 8 to 32 students. Teachers reported that, on average, almost seven students in their class have difficulties achieving the prescribed goals of the subject. Indeed, the number of students having difficulties could be almost 50% of the students in any one classroom, considering the maximum class size is 32 and those having difficulties could be as many as 15 students. What is interesting to note here is that only one of the 24 teachers surveyed taught in a DEIS[2] school. There were very small differences between maths (22.9) and French (22.3) and, similarly, small differences across the three school types.

Overall, teachers reported high levels of confidence about selecting and consistently using appropriate digital technologies in effective ways for teaching purposes in their classrooms (see Table 3).

However, confidence levels slightly decrease when using technologies for assigning and grading activities that include student use of these digital technologies, and for effectively monitoring their use by students. In addition, approximately one-third of teachers surveyed were aware that they were not using technologies to their full potential, as they did not agree with the statement that they understood the possibilities/capabilities of digital technologies well enough to maximise their use in the classroom.

[2] Delivering Equality of Opportunity In Schools, https://www.gov.ie/en/publication/a3c9e-extension-of-deis-to-further-schools/

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Table 3. Numbers/percentages of teachers who agreed with the following statements regarding their confidence in using digital technologies in class

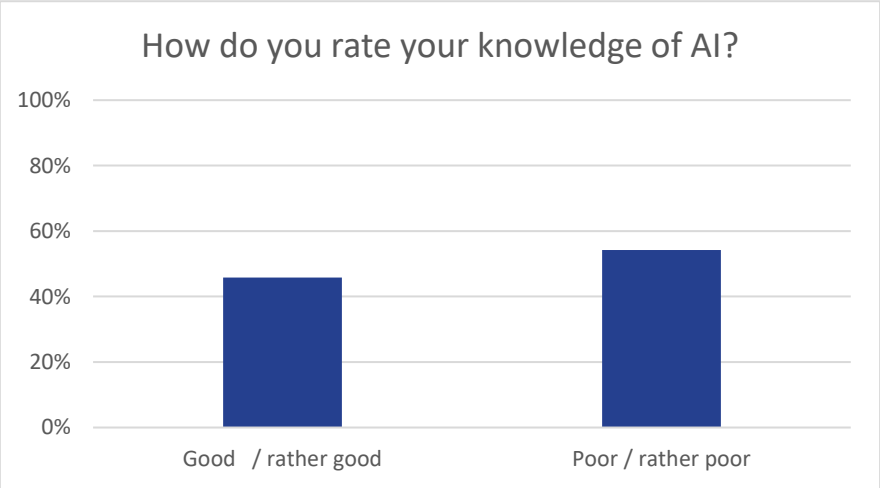
	n	*%*
I feel confident I can consistently use educational digital technologies in effective ways.	20	83.3
I feel confident about assigning and grading activities that include student use of digital technologies.	17	70.8
I feel confident I can effectively monitor student use of digital technologies in my classroom.	17	70.8
I feel confident that I understand the possibilities/capabilities of digital technologies well enough to maximise their use in my classroom.	16	66.7
I feel confident about selecting appropriate digital technologies for teaching.	20	83.3

Note. Categories "Strongly agree", "Agree" and "Generally agree" have been merged and the results are presented in this table.

4.2 Teachers' knowledge of AI

Not surprisingly, less than half of the teachers (n=11) rated their knowledge of AI as good or rather good.

Figure 7. Teacher perceptions of their knowledge of AI



Almost two-thirds of teachers (n=15) were able to give an example of an AI tool that could be used for an educational purpose.

Additionally, teachers were asked how they would describe AI (see Figure 8). Again, less than half (n=11) of the participants (45.8%) mentioned that AI is designed to achieve specific goals. While 15 participants (62.5%) identified that AI is a software, only five (33.3%) were able to identify a tool that definitely contains AI (e.g., Duolingo), and eight participants (53.3%) described a tool containing AI but did not give the specific name (e.g., "Selection of maths questions based on success in previous questions, similar to a recommendation algorithm"). In addition, seven (29.2%) mentioned that it imitates

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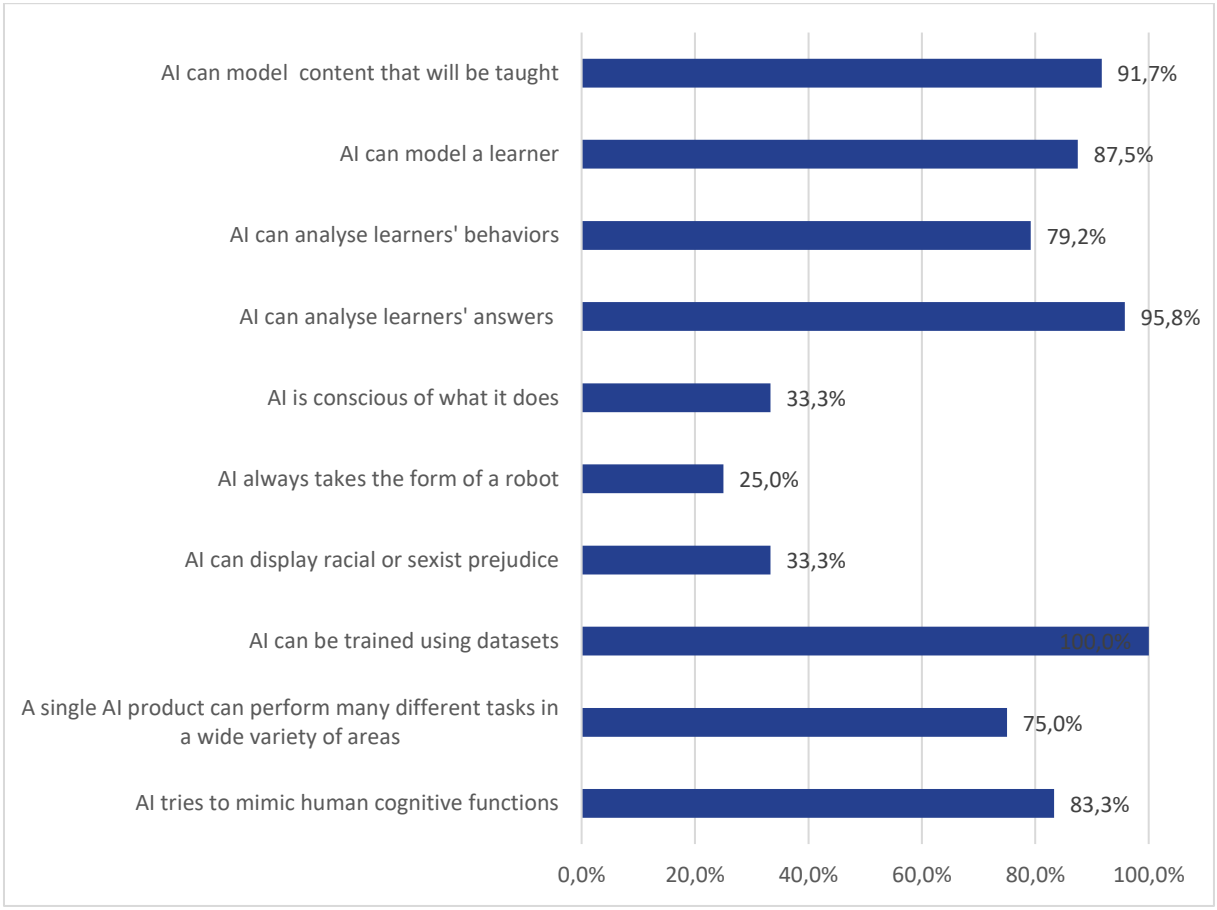
human cognition. Only one participant (4.2%) said that AI collects data, while two (8.3%) mentioned that it processes data, three (12.5%) that it adapts, and four (16.7%) that it learns.

Finally, only two participants (8.3%) mentioned that AI can make decisions.

This appraisal of their knowledge of AI by the teachers surveyed was further exemplified in their open-ended responses to the question asking them to describe AI. While all 24 participants correctly identified at least one element of AI in their definition, 13 of the 24 participants (54.2%) gave a definition that incorporated two correct elements, a single participant gave a definition that incorporated three elements, while a further two participants gave definitions which incorporated four components—"Using regression models to allow software to accurately predict outcomes/make decisions based on given datasets, and consistently refine those decisions/predictions based on new information"—i.e., AI is a software, it makes decisions, it processes data, and it adapts.

Figure 8. Percentages of teachers who believe the following statements are true when talking about AI as it exists today



Note. Categories "I am very confident it is true", "I am pretty confident it is true" and "I am not confident, but I think it is true" have been merged and the results are presented in this figure.

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Some of the teachers' poor knowledge of AI was particularly evident in their lack of understanding that AI can display racial or sexist prejudice, and the misconception that AI is conscious of what it does and always takes the form of a robot.

Table 4. Numbers/percentages of teachers who reported being familiar with the following AI technologies

	n	*%*
Machine learning	10	41.7
Neural network	5	20.8
Deep learning	7	29.2
Supervised learning	7	29.2
Reinforcement learning	8	33.3
NAL v-coding	1	4.2
Clustering	3	12.5

Note. Categories "Very familiar", "Familiar" and "Rather familiar" have been merged and the results are presented in this table.

Teachers were also asked to indicate their level of familiarity with a number of AI technologies (see Table 4). Except for machine learning, for which a considerable number of teachers reported high levels of familiarity, teachers were not familiar with most of the AI technologies in the list provided to them.

Table 5. Numbers/percentages of teachers who believe that the following technologies fall under the umbrella of AI

	n	*%*
Automatic translator (e.g., Deepl, Google Translate, etc.)	16	66.7
Recommender system (e.g., product recommendations on Amazon)	21	87.5
Slideshow software (Microsoft PowerPoint, Prezi, Google Slides, etc.)	7	29.2
Intelligent tutoring system	21	87.5
Spreadsheet (e.g., Excel, Google Sheets, etc.)	10	41.7
Automated essay grading software	21	87.5
Digital workspace	12	50.0
Interactive quiz software (Kahoot, Quizizz, etc.)	13	54.2

Note. Categories "I am very confident it does", "I am pretty confident it does" and "I am not confident, but I think it does" have been merged and the results are presented in this table.

Of the provided technologies, recommender systems (e.g., product recommendations on Amazon), intelligent tutoring systems and automated essay grading software were the ones that most teachers (87.5%) reported fall under the umbrella of AI. However, only two-thirds of teachers surveyed in the baseline questionnaire perceived automatic translators (e.g., Deepl, Google Translate, etc.) as part of AI technology (Table 5).

Table 6. Numbers/percentages of teachers who reported that the following descriptions could apply to an AI-based image recognition software

	n	*%*
It can recognise the image of a car without having received any data beforehand.	9	37.5
It can recognise the image of a car if it has seen other images that have been labelled as cars by humans.	22	91.7

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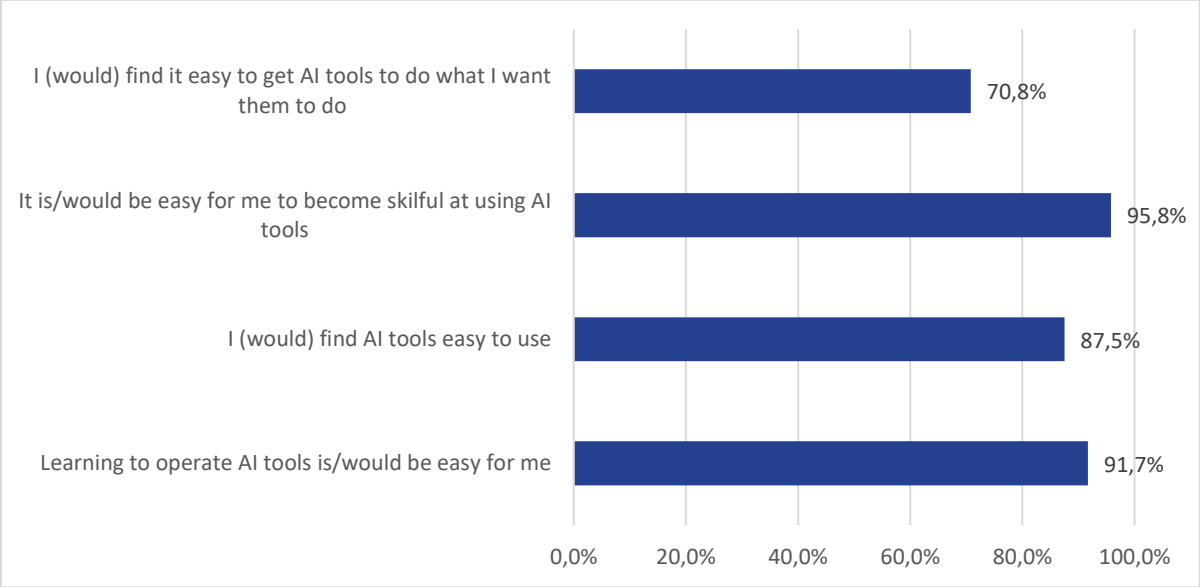
This lack of confidence about which software falls under the umbrella of AI and, indeed, how AI works is illustrated in the table above where nearly all the teachers surveyed agreed that an AI-based image recognition software can recognise the image of a car if it has seen other images that have been labelled as cars by humans. Yet nearly 40% of them also indicated that it could recognise the image of a car without having received any data beforehand (Table 6).

4.3 Teachers' perceptions

The vast majority of the teachers believed that they would find learning about and using AI tools easy, and that they would become skilful at using these tools. However, some of them were less confident that they would find it easy to get the AI tools to do what they wanted them to do.

Figure 9. Percentages of teachers who agreed with the provided statements regarding the use of AI in their work



Note. Categories "Strongly agree", "Agree" and "Generally agree" have been merged and the results are presented in this figure.

Nevertheless, while they were confident in their own ability to learn to use these tools, it is interesting to note the range of emotions teachers expressed when asked to report what emotions come to mind when they think about AI. Of the 19 who mentioned emotions (or a lack thereof), the most commonly mentioned ones were fear, worry and excitement, with six participants (31.6%) mentioning these (once all in the same response). After this, the most frequently mentioned emotions were curiosity, by four teachers (21.1%); hope, by three (15.8%); and interest, by two (10.5%). Additionally, three participants (15.8%) reported feeling no emotions about AI (e.g., "No strong emotions come to mind"). Emotions that were not contained in the classification framework were also described: eagerness (twice), and relief, confusion, stress, wariness and anxiety (all mentioned once).

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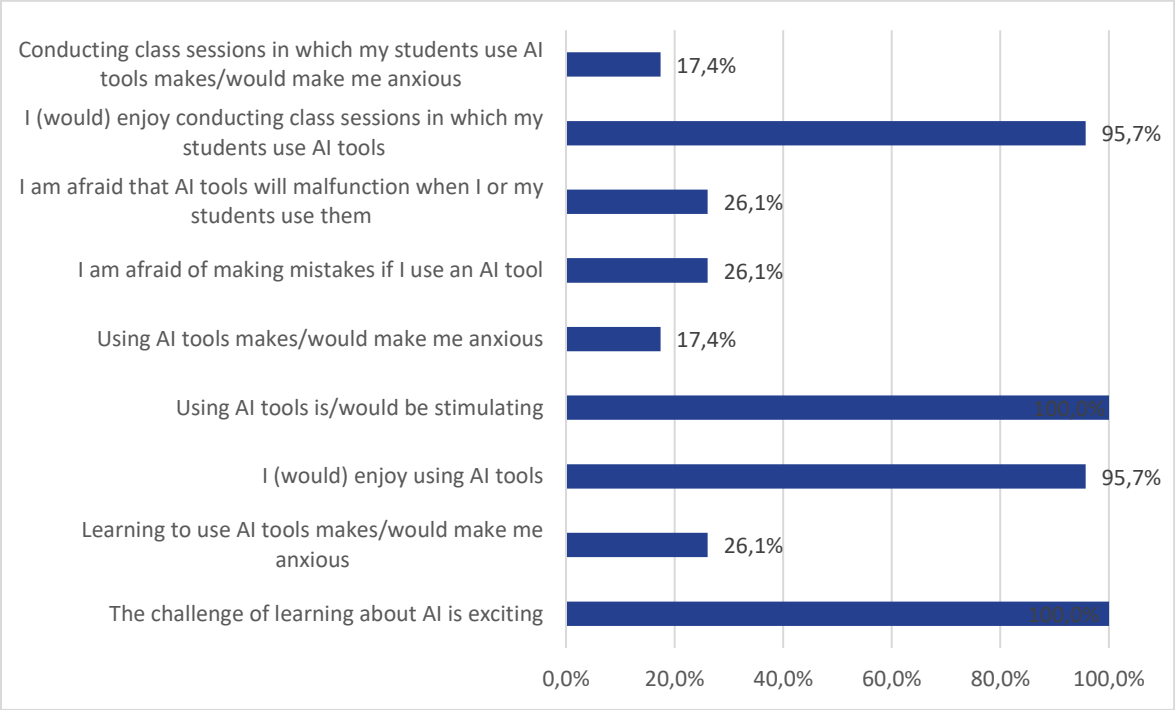
Figure 10. Percentages of teachers who agreed with the provided statements regarding the use of AI in their work



Note. Categories "Strongly agree", "Agree" and "Generally agree" have been merged and the results are presented in this figure.

All respondents agreed that learning and using AI in their classroom would be exciting and stimulating (see Figure 10). Most teachers also reported that they would enjoy using and conducting class sessions with AI tools. Only a few teachers reported that such practices would make them anxious. When probed by the open-ended question to elaborate on why the use of AI by them or their students makes/would make them anxious, six participants out of 24 (25%) responded. Of these responses, five were related to the teacher not being able to master the tool or use it correctly (e.g., "If I do not fully understand how to fix the problem if the tool does not work/If the students understand it better than me/If I break it for everyone!"). The other response was to do with the tool not working ("Just in case it doesn't work or becomes too time consuming").

While all teachers agreed that AI would be useful in their work, it is interesting to see the range and variation in what they believed AI could help them with relating to their own work and classroom practice (see Figure 11).

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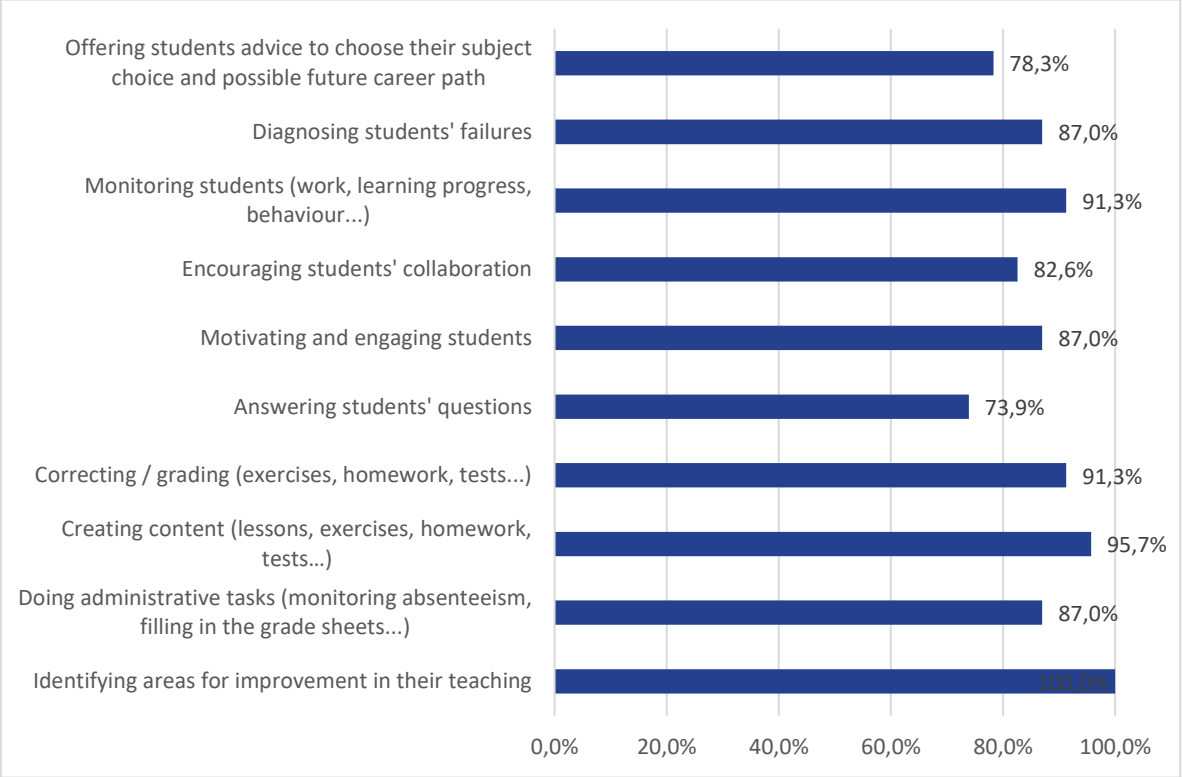
Figure 11. Percentages of teachers who agreed that AI tools can help them with the following activities



Note. Categories “Strongly agree”, “Agree” and “Generally agree” have been merged and the results are presented in this figure.

Most teachers agree that AI tools can help them with all mentioned activities. All respondents agreed that AI can help them identify areas for improvement in their teaching. In addition, more than 90% of respondents agreed that AI can help them with creating content, correcting/grading and monitoring students.

Teachers were also asked to report if there are other domains they believe AI could benefit them in their job, or in education in general. However, 18 participants out of 24 (75%) did not submit a response. Of the six who did respond, two were not analysable, while three participants wrote functions that were already mentioned in the questionnaire (completing assessments, monitoring students, and helping with administrative tasks). The remaining participant mentioned individualised learning pathways for students (“To help students focus, as they can see what they need to do in order to improve and get better grades, e.g., Athena Tracker is great for this”).

As illustrated in Figure 12, most teachers agree that an increase in the use of AI tools in their schools will have a positive impact on teaching and learning (e.g., teaching quality will increase, students’ academic success will improve, teachers will have more time to focus on student learning, and teaching will be personalised to each student’s needs). Fewer teachers reported that they are concerned about the negative consequences of the use of AI (e.g., the teaching profession will be devalued, teachers will be progressively replaced with AI, relationships between teachers and students will be impoverished, education will be dehumanised, private companies will have an increasing influence on schooling,

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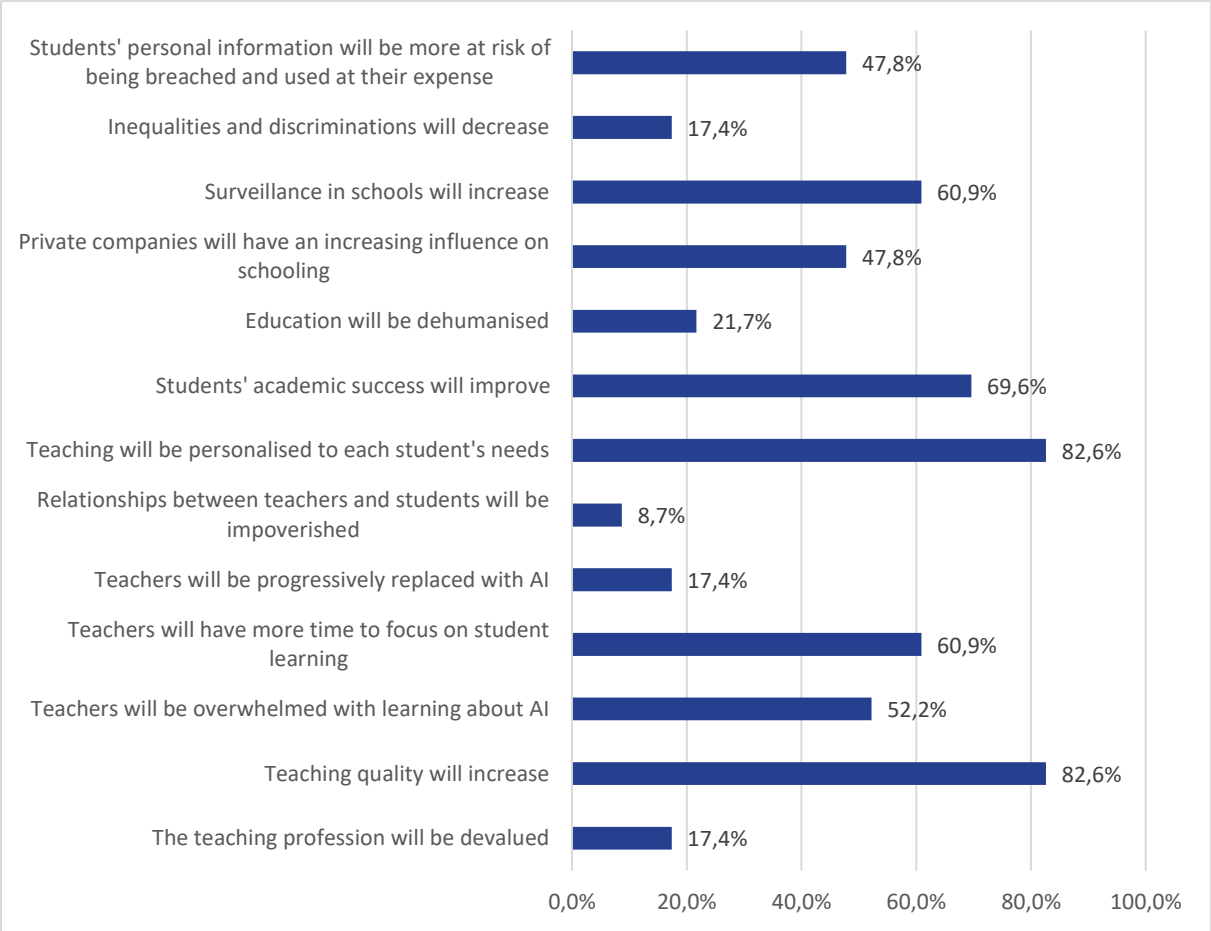
students' personal information will be more at risk of being breached and used at their expense). Almost half of teachers are concerned that if the use of AI in schools increases, teachers will be overwhelmed with learning about AI.

Figure 12. What teachers believe an increase in the use of AI in their school will impact on



Note. Categories "Strongly agree", "Agree" and "Generally agree" have been merged and the results are presented in this figure.

In the open responses (six teachers out of 24 responded) about the potential consequences of AI in education, some other concerns were raised, including less connection with the real world (two responses) or that some skills would no longer be learnt or taught (one response). Others were concerned about data protection issues "and what is being done with the information" particularly the "ownership of any student data collected". Just one teacher expressed concern that this data collection could "lead to the micromanaging of teachers or the monitoring of teachers to determine the most effective teachers and the potential knock-on effect of that on the profession".

4.4 Teachers' intention to use AI and use of AI

The majority of teachers (70%) indicated that they ask their students to use digital technologies in class at least once a week. However, less than 20% reported using AI educational or generic tools to

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teach and less than 10% asked their students to use them. Indeed, more than 25% of teachers reported never using any AI educational or generic tools to teach, and 33% never asked their students to use them.

Table 7. Teacher responses on the frequency of using technologies in class

This school year, how frequently did you …	More than once a week		Once a week		At least once a month		Less than once a month		Never	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Use educational AI tools to teach	4	16.7	7	29.2	5	20.8	2	8.3	6	25.0
Use generic AI tools to teach	4	16.7	2	8.3	6	25.0	5	20.8	7	29.2
Ask your students to use educational AI tools	4	16.7	2	8.3	6	25.0	4	16.7	8	33.3
Ask your students to use generic AI tools	2	8.3	3	12.5	4	16.7	7	29.2	8	33.3
Ask your students to use digital technologies	10	41.7	7	29.2	6	25.0	0	0.0	1	4.2

As illustrated in Table 7, search engines (e.g., Google) were found to be the most commonly used AI tool with most teachers (83.3%) indicating that they use them for their work, and they ask students to use them as well. Some teachers indicated that they use these tools but they do not ask students to use them, while only one teacher reported that they do not use such tools for their work nor ask their students to use them.

Automatic translators are also being used in one way or another by most teachers (72.8%).

The remainder of the listed AI tools are not being used by most of the participating teachers, nor their students.

Encouragingly, some participants reported already using the tools being considered for use by teachers participating in the AI4T project, namely, Duolingo and Photomath. Three of the language teachers asked their students to use Duolingo and a further two used Duolingo for their own work and asked their students to use it. Similarly, one of the maths teachers reported using Photomath for their own work, another asked their students to use this tool, and a further two reported using the tool for their own work as well as also asking their students to use it.

Teachers were also asked to report if there are other AI tools (not provided in the list) that they use for teaching or that they have their students use. However, 15 out of 24 participants (62.5%) did not submit a response, while a further participant submitted a response that was not analysable. Of the eight who did submit a response, six mentioned online quiz tools such as Quizlet or Blooket. One mentioned Seneca Learning, while another mentioned Google Classroom.

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Table 8. Numbers/percentages of teachers who have used the following AI tools for teaching and learning this school year

	I use this tool for my work		I ask my students to use this tool		I use this tool for my work AND I ask my students to use it		I do not use this tool for my work nor ask my students to use it	
	n	*%*	*n*	*%*	*n*	*%*	*n*	*%*
Search engines (Google, Bing, Yahoo, etc.)	3	12.5	0	0.0	20	83.3	1	4.2
Automatic translators (Deepl, Linguee, Google Translate, etc.)	3	27.3	0	0.0	5	45.5	3	27.3
Intelligent personal assistant (Alexa, Siri, Cortana, etc.)	2	8.3	0	0.0	0	0.0	22	91.7
Duolingo for schools	0	0.0	3	27.3	2	18.2	6	54.5
Adaptiv'Lang	0	0.0	0	0.0	0	0.0	11	100.0
CheckMath	1	6.7	1	6.7	0	0.0	13	86.7
Photomath	1	6.7	1	6.7	2	13.3	11	73.3

In addition, teachers were asked to report if they plan to use any new AI tools that they had not already discussed. Only a single participant out of 24 mentioned a new AI tool that had not already been listed in the questionnaire (i.e., Wolfram Alpha). Two participants mentioned tools which were not relevant, either because they were not specific enough or they did not contain AI (e.g., Google Calendar).

However, despite the apparent limited knowledge of AI technologies and their use in the classrooms of some teachers, the vast majority of teachers reported that they plan to use AI tools as well as get their students to use them during and after class for their work (Table 9).

Table 9. Numbers/percentages of teachers who reported that in the next five years they plan to use AI in the following settings

	n	*%*
Use AI tools for their work outside the classroom (e.g., planning, assessment)	24	100.0
Use AI tools during class sessions	23	95.8
Ask your students to use AI tools	23	95.8

Note. Categories “Yes” and “Probably yes” have been merged and the results are presented in this table.

What is a concern, however, is the teachers’ lack of awareness around important issues, such as security and privacy, when using AI technologies. There were mixed patterns in the responses indicating perhaps that the teachers may lack understanding and have some misconceptions relating to privacy, information security issues, and the ethical use of AI tools (see Figure 13).

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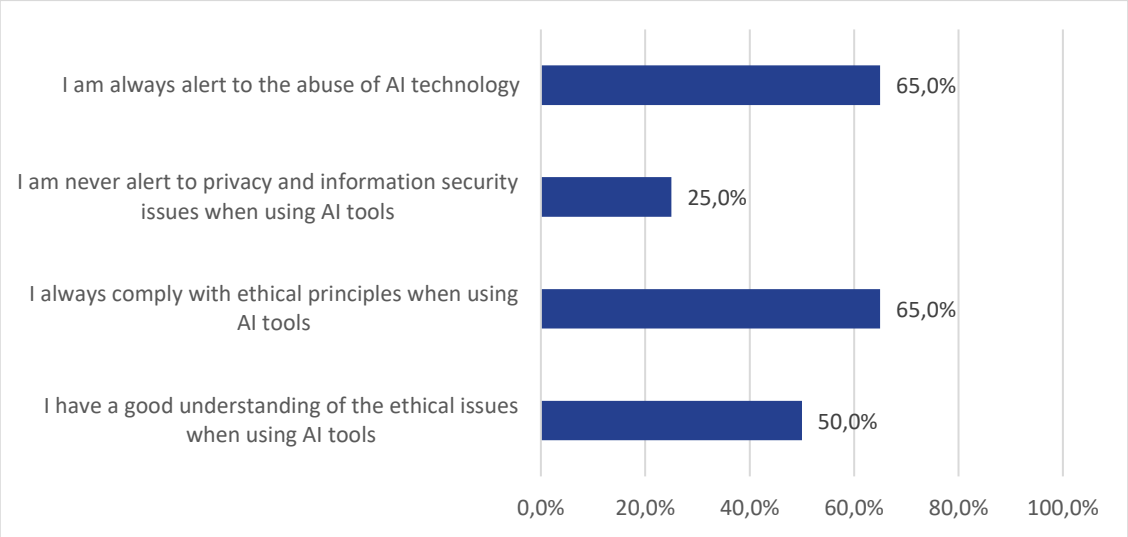
Figure 13. Teachers' awareness of AI ethical, security and other issues



Note. Categories "Strongly agree", "Agree" and "Generally agree" have been merged and the results are presented in this figure.

The majority of teachers reported complying with ethical principles when using AI (65%) and being alert to the abuse of this technology (65%). However, only half of the teachers reported that they have a good understanding of the ethical issues of AI, while one-fourth of them reported that they are never alert to privacy and information security issues when using AI tools.

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5. Teacher results – Intervention group

This section summarises the responses of the nine teachers who had access to the AI4T professional learning pathway (intervention group) and participated both in the baseline and endline AI4T questionnaires. Focusing on this particular group enables us to examine what, if any, changes were observed in these teachers' knowledge of AI, their use of AI technologies, and their perceptions of AI as a result of participating in the AI4T professional learning pathway.

5.1 Teacher demographics

The majority of teachers in the intervention group who accessed the AI4T professional learning pathway and took part in both surveys, before and after the completion of the programme, were female (88.9%).

Most teachers (88.8%) reported having less than 20 years of teaching experience when they completed the survey. On average, teachers had 11.9 years of teaching experience with a standard deviation of 7.6. Just over half of the teachers reported teaching mathematics (55.6%) while one-third teach French. One teacher reported teaching both mathematics and French.

Similarly, a little more than half of the teachers who participated in the AI4T professional learning pathway teach in secondary school (55.6%) and 33.3% were teaching in a vocational/community (ETB) school.

Table 10. Teacher demographics

		n	*%*
Gender			
	Female	8	88.9
	Male	1	11.1
Teaching experience			
	Less than 10 years	4	44.4
	More than 10 but less than 20 years	4	44.4
	More than 20 years	1	11.1
Subject			
	Mathematics	5	55.6
	French	3	33.3
	Other	1	11.1
School type			
	Secondary school	5	55.6
	Community/comprehensive school	1	11.1
	Vocational/community (ETB) school	3	33.3

For the purposes of the survey, teachers were asked to indicate one of the class groups they were going to work with that year using the AI powered tools recommended by the AI4T project. This class was used by teachers as a reference during the completion of the questionnaire.

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Table 11. Class size and frequency

	Minimum	*Maximum*	*Mean*	*SD*
How many students do you have in your class?	14	29	22.0	5.8
How many of your students (approximately) in that class have difficulties achieving prescribed goals for your subject?	3	9	6.1	1.8
How many times a week do you teach this class?	1	5	3.1	1.2

On average, teachers reported having 22 students in their class, with class sizes ranging from 14 to 29 students. Teachers reported that, on average, about six students (c. 25%) in their class have difficulties achieving the prescribed goals of the subject.

Table 12. Numbers/percentages of teachers who agreed with the following statements regarding their confidence in using digital technologies in class

	n	*%*
I feel confident I can consistently use educational digital technologies in effective ways.	7	77.8
I feel confident about assigning and grading activities that include student use of digital technologies.	6	66.7
I feel confident I can effectively monitor student use of digital technologies in my classroom.	7	77.8
I feel confident that I understand the possibilities/capabilities of digital technologies well enough to maximise their use in my classroom.	5	55.6
I feel confident about selecting appropriate digital technologies for teaching.	6	66.7

Note. Categories “Strongly agree”, “Agree” and “Generally agree” have been merged and the results are presented in this table.

Overall, most teachers reported high levels of confidence in using digital technologies for teaching purposes in their classrooms.

5.2 Teachers’ reaction to the AI4T professional learning pathway

This section focuses on the teachers’ experience in relation to the AI4T professional learning pathway. Teacher responses from the endline questionnaire, as well as the analysis of teacher interviews, form the corpus of data used to outline the findings.

Seven of the nine teachers completed this section of the questionnaire. The other two teachers who were in the intervention group appear to have misinterpreted the filter question (“Did you have access to the AI4T professional learning pathway?”) and answered “no”. These teachers did participate in the various elements (MOOC, webinars, textbook, face-to-face sessions) of the professional learning programme so perhaps did not realise the phrase ‘AI4T learning pathway’ was referring to the combination of these elements, or they may have thought it referred to completing all the elements. Consequently, the questions in relation to the professional learning pathway were not visible to them.

What is encouraging is that the majority of the teachers who did complete this section on the professional learning pathway stated that it had “completely” or “for the most part” met their expectations.

Table 13. Teacher responses on whether the AI4T professional learning experience met their expectations

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	n	*%*
Completely	3	42.9
Pretty much/for the most part	3	42.9
Somewhat/a little	1	14.3
Not at all	0	0.0

As the AI4T professional learning pathway consisted of four different elements, it is interesting to see how the teachers engaged with each of the parts (Table 14).

Table 14. Numbers/percentages of teachers who completed the following parts of the AI4T professional learning pathway

	Yes, entirely		**Yes, partially**		**No**	
	n	*%*	*n*	*%*	*n*	*%*
MOOC	7	100.0	0	0.0	0	0.0
AI for Teachers: An Open Textbook	3	42.9	1	14.3	3	42.9
Online webinar(s)	5	71.4	1	14.3	1	14.3
Face-to-face session	7	100.0	0	0.0	0	0.0

Most teachers entirely or partially completed all four parts of the AI4T professional learning pathway. All seven teachers completed the MOOC and attended the face-to-face sessions, with the majority of them (71.4%) participating in the online webinars. The lower engagement rate with the online textbook (42.9%) are due to the late introduction of the book as part of the professional learning pathway. Teachers did not have access to it until they had completed the MOOC, but it was used by the facilitators of the pathway for their professional learning about AI. They also used sections of it as content during the online webinars when supporting the teachers (Table 14).

Table 15. Numbers/percentages of teachers who reported being satisfied with the following parts of the AI4T professional learning pathway

	n	*%*
MOOC	7	100.0
AI for Teachers: An Open Textbook	3	75.0
Online webinar(s)	6	85.7
Face-to-face sessions	7	100.0

In addition, almost all of them reported being “satisfied” or “very satisfied” with the different elements of the AI4T professional learning pathway (i.e., the MOOC, the open textbook, the online webinars and the face-to-face sessions, which the teachers referred to as “learning days”, as this was the term used by the Professional Development Services for Teachers who organised these face-to-face events). During the interviews all the teachers spoke about the positives and negatives of these individual components.

An overview of this is outlined in Figure 14 and a summary of each of the main points raised by the teachers is outlined below.

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a) Learning days

Positive comments about the learning days related to the fact that participants were able to learn about AI, both in education and society at large.

> Indicative comment: "I probably found the learning day at the beginning super interesting, because it kind of helped me understand what it was that they were explaining. I didn't properly understand what AI was, and that was really interesting and focusing, to realise I was probably doing lots of the stuff anyway but didn't have the label for it to know that's what I was doing, or that's what the kids were using."

The teachers were also positive about the engagement and motivation they felt as a result of participating in the learning days.

> Indicative comment: "I found everyone, with regards to the trainers, very good as well. Very helpful, very friendly. They made you want to take part, and this was welcoming when we arrived every time and any contact we had via email was always very nice and helpful."

Finally, participants were very positive about how the learning days gave them the chance to exchange ideas with their peers about the use of AI in the classroom. These comments particularly related to the learning day that took place at the end of the programme.

> Indicative comment: "And then the last day, one of the activities we did was a walking debate, and that was, it was, great again to have the point of view of everybody else, and to see why people agreed with certain statements. We kind of … sometimes you're stuck in your own opinions, and then somebody else kind of explains their opinion about it, and you're thinking, oh, yeah, I can see that now. I wouldn't have seen it beforehand, but having the chat here, I can see how that could be a problem or how it's not a problem, you know."

Some critical feedback about the learning days related to the lack of clear learning intentions for the pathway, and how participants left the first day without a clear understanding of how they were supposed to implement AI in the classroom.

> Indicative comment: "I suppose when I left the initial launch day, I still wasn't entirely sure what I was going to do in my classroom. There was about fifteen minutes talking about Photomath, and then everything else was talking about, in general, what AI is. So, I think a bit more focus on … I'm selfish, like how am I going to apply this in the classroom? What am I going to do?"

Relatedly, some participants also spoke about how the information they learnt about AI in the learning day (particularly the first day) was not relevant to their classroom practice.

> Indicative comment: "And the first day I found it was very interesting, but I found that there wasn't much towards the AI that we would be using in the class, and it was just, I suppose, like most of it, it was really good to know about it, but I'd rather if there was a lot more, maybe like, could be a half an hour or an hour on what we would actually be doing in our classrooms."

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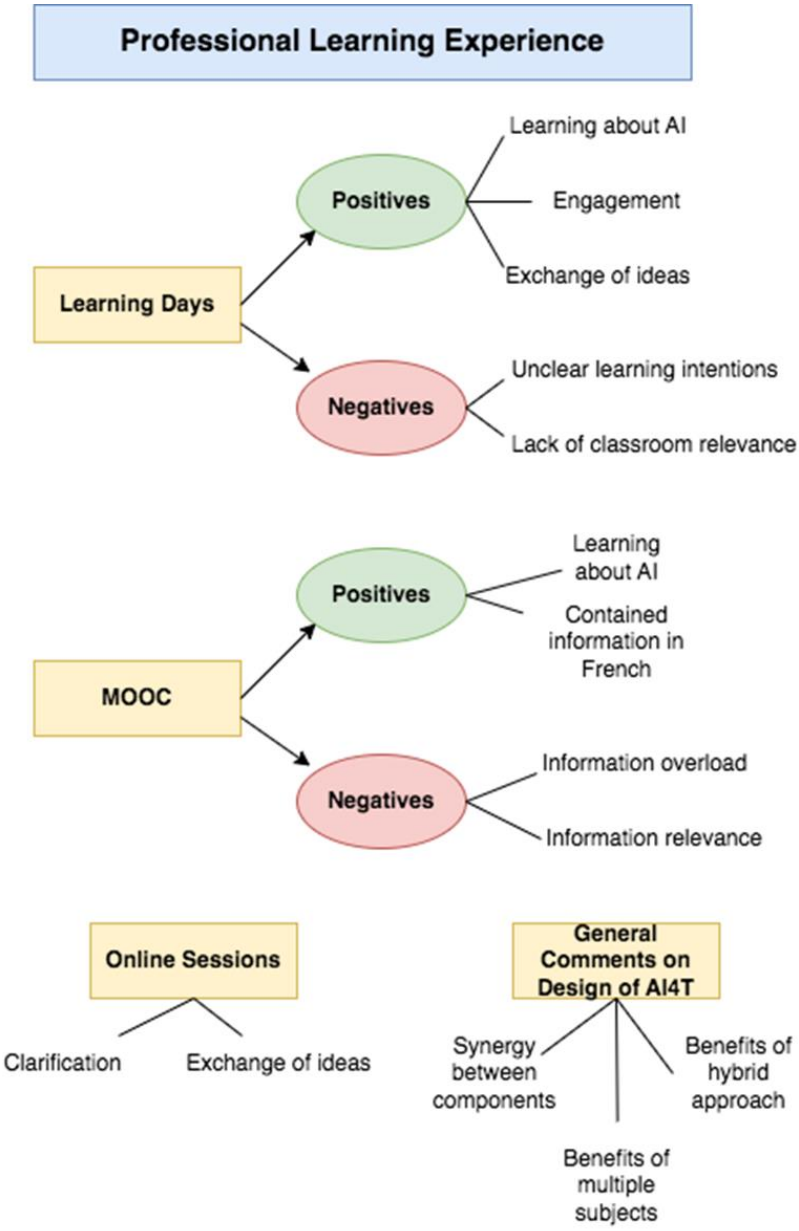
Figure 14: Teachers' feedback relating to the AI4T professional learning pathway



b) MOOC

Participants remarked positively on how the MOOC taught them information about AI, both in education and in other aspects of life.

> Indicative comment: "And the fact that it started years ago, you know, like in that MOOC when they were talking about the different stages in machine learning and the other ones which I forget the names of, but like it's that it's been around for so many years, and like, I didn't realise how long it's been around, you know, it dates back the first … the fact that the first

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> people who were thinking about, maybe, and some sort of robots, or something that could do things for you dates back to the nineteenth century, it's incredible."

However, many participants had negative things to say about the MOOC. Many of these comments related to the idea of 'information overload'.

> Indicative comment: "I found it was almost too much at times. I remember that at one point there was a very large graph that you had to click on images, and I think it was to do with the – is it a history of AI through the ages, or something like that. I thought that was a lot of information to digest at once. Right afterwards there was a quiz, and to be honest, I said this during my face-to-face day, that a lot of it I was just almost guessing, because I literally had just looked at it, and I was supposed to be tested on it, and I hadn't really had time to consume it all. It was interesting but just, there was a lot of it, as I said, at times. Perhaps too much for the amount of time we were given, as well."

Relatedly, participants remarked negatively on the relevance of the information to their teaching.

> Indicative comment: "In the MOOC I think there was quite a lot of information, of very technical information about AI that, maybe, I don't think was very relevant to me."

c) Online seminars

In general, participants spoke a lot less about the online sessions than both the MOOC and the learning days. Many commented that the sessions were useful in terms of clarifying what they were expected to do in the classroom.

> Indicative comment: "Just to see that we are going on the right path, and we are kind of using the app properly. Because, as I said, I missed the first one, so I kind of was like, oh, what am I actually really doing? And then the second one. I was kind of like, okay, I'm doing it properly in the classroom."

Participants also discussed that the sessions were useful for exchanging ideas about the project and its implementation in their school.

> Indicative comment: "But then when we had the follow-up meetings, then I could hear what my colleagues were doing, what we were struggling with, and from then on it was much easier to gauge what everyone else was doing and what I could do too."

d) General feedback on the design of the AI4T professional learning pathway

As well as speaking about specific components of the AI4T course, participants spoke about various aspects of the overall course structure. Many remarked that the different components complemented each other.

> Indicative comment: "So I think that there was a lot in the MOOC, of course, and I think what the learning day did is that it really helped highlight the important things out of the MOOC. It really helped to cement that. So, hand in hand, I think they went quite well [together]."

Some participants spoke positively about the fact that teachers from both maths and French were included in the pathway.

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> Indicative comment: "And I know that it was quite a different spread of interests and experience. But also it was very good to have a different subject as well, and understanding how a humanities subject would bring in this technology, and their concerns. So having colleagues there from different schools and different experiences, focused the learning on all classes. Not just your own specific context."

Finally, participants were also positive about the hybrid approach to the programme.

> Indicative comment: "I think hybrid is always the way to go. Especially when you're … it was good to have little groups in the meeting, different people, what different people were doing, and then we could kind of bounce different ideas off each other. But also it's good that you can go online at 9pm and do a bit of work. So it's kind of the best of both worlds."

What is particularly interesting is how engaged these teachers were with the AI4T learning pathway. They all stated they enjoyed taking part and were inspired to expand their knowledge of AI. This is evident by their behaviour as they set aside regular time to work on the AI4T professional learning elements, contributed regularly to the course discussions, and shared learning materials with others who took part in the AI4T pathway. In addition, it is evident they invested time in understanding the content as the majority of the teachers indicated that if they had trouble understanding a concept or an example presented in the AI4T professional learning materials, they went over it again until they understood it and they even tried to get more information about things that puzzled them (Table 16).

Table 16. Numbers/percentages of teachers who agreed with the following statements regarding how they approached the AI4T professional learning pathway

	n	*%*
I have set aside a regular time to work on the AI4T professional learning elements.	7	100.0
When I had trouble understanding a concept or an example presented in the AI4T professional learning materials, I went over it again until I understood it.	6	85.7
I tried to get further information when I encountered something in the AI4T professional learning materials that puzzled me.	5	71.4
I often responded to the questions of others who took part in the AI4T professional learning pathway.	5	71.4
I contributed regularly to course discussions that were part of the AI4T professional pathway.	7	100.0
I shared learning material with others who took part in the AI4T professional learning pathway.	7	100.0
I enjoyed taking part in the AI4T professional learning pathway.	7	100.0
I found the AI4T professional learning pathway interesting.	7	100.0
I was inspired to expand my knowledge of AI as I engaged in the AI4T professional learning pathway.	7	100.0

Note. Categories "Strongly agree", "Agree" and "Generally agree" have been merged and the results are presented in this table.

All the teachers indicated that the design of the AI4T professional learning pathway with the combination of different elements worked particularly well. The different elements coupled with the excellent quality of facilitation during the pathway (e.g., the pedagogical team was very responsive to participants' questions) enabled them to take an active role in the pathway, including sharing their professional experiences with the other participants.

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Table 17. Numbers/percentages of teachers who agreed with the following statements regarding the AI4T professional learning pathway

	n	*%*
The AI4T professional learning experience positively influenced my ability to be efficient in my work.	7	100.0
The AI4T professional learning experience had great practical value for my work.	6	85.7
The AI4T professional learning experience helped me improve my professional skills.	7	100.0
The AI4T professional learning pathway was appropriate for my subject.	6	85.7
The activities and the way the content was taught enabled me to take an active role in the AI4T professional learning pathway.	7	100.0
The activities and the way the content was taught enabled me to share professional experiences with the other participants.	7	100.0
The facilitation of the AI4T professional learning experience was of great quality.	7	100.0
The pedagogical team was very responsive to participants' questions.	7	100.0
In my opinion, the content delivered was relevant to the programme of the AI4T professional learning pathway.	7	100.0

Note. Categories "Strongly agree", "Agree" and "Generally agree" have been merged.

They all also stated that the AI4T professional learning pathway helped them to improve their professional skills, as well as be efficient in their work. In addition, most of the teachers indicated that the pathway had great practical value for their work and was appropriate for their subject.

None of the teachers reported any bugs in the online materials or lack of support from their school administration, and there was only one teacher who reported experiencing an issue with a lack of equipment (computer, internet connection) that hindered their participation in the AI4T professional learning pathway (see Table 18).

> Indicative comment: "And then I think also I don't think our school is rare in that we don't have internet access all the time. It seems mad, but it's true. I've met other colleagues in the same boat, so having something that isn't going to take up a lot of bandwidth, having offline versions that classes can use, even if the weather is shocking."

However, the others commented in the interview that their school had sufficient technological infrastructure to use the necessary tools.

> Indicative comment: "Well we're very lucky here, because we have very good wi-fi. We have lots of devices in terms of laptops. Students have their phones. We are allowed to use the phones in class for education purposes, so no, there's very little, unless there was a big ban on anything computer wise. I don't think there's anything that would prevent us, no."

Table 18. Numbers/percentages of teachers who reported that the following obstacles hindered their participation in the AI4T professional learning pathway

	n	*%*
Lack of equipment (computer, internet connection, etc.)	1	14.3
Lack of room available to engage with the online materials	0	0.0
Bugs in the online materials	0	0.0
Lack of support from your school administration	0	0.0

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To conclude, all teachers stated that engaging with the AI4T professional learning pathway had modified their perception and improved their knowledge of AI in education and led them to use more AI in their work as a teacher (see Table 19). Only two out of the seven teachers (29%) who completed the endline questionnaire reported that they had looked for professional learning resources on AI outside the AI4T project during the school year. This perhaps is not surprising considering the time they had devoted to the AI4T project and the busy schedules and work commitments of these teachers, as well as the lack of specific policy initiatives and funding from the Ministry that AI is to be used for teaching and learning. AI is mentioned in the Digital Strategy for Schools (DSS) which runs to 2027 (DE, 2022) but there has been no implementation plan launched to date.

Table 19. Numbers/percentages of teachers who agreed with the following statements about the AI4T professional learning experience

	n	*%*
It has modified my perception of AI in education.	7	100.0
It has improved my knowledge of AI in education.	7	100.0
It has led me to use more AI in my work as a teacher.	7	100.0

Note. Categories "Strongly agree" and "Agree" have been merged and the results are presented in this table.

What is encouraging is that all teachers reported that they would recommend the AI4T professional learning materials to their colleagues. Finally, all teachers reported that they intend to develop their knowledge and skills regarding AI in education and to continue to exchange with participants of the project on the topic of AI in education.

5.3 Teachers' knowledge of AI

The number of teachers who rated their knowledge of AI as "good" or "rather good" was considerably higher after the completion of the AI4T learning pathway, as indicated in the below table (i.e., the percentage doubled from 44.4% to 88.9%). Also, after the completion of the programme, all teachers reported being able to give an example of an AI tool that could be used for an educational purpose. Of these nine participants, eight (88.9%) correctly identified at least one AI tool, most commonly Photomath and Duolingo. A single participant named a different AI tool (Microsoft Teams Analytics) than those that had been used by the teachers in their classrooms during the AI4T project.

Table 20: Knowledge of artificial intelligence (AI)

		Baseline		***Endline***	
		n	***%***	***n***	***%***
How do you rate your knowledge of AI?					
	Good/rather good	4	44.4	8	88.9
	Poor/rather poor	5	55.6	1	11.1
Can you give an example of an AI tool that could be used for an educational purpose?					
	Yes	6	66.7	9	100.0
	No	3	33.3	0	0.0

However, rather than just naming tools, what is interesting to examine are the teachers' definitions of what they understand AI to be. In the answers participants provided in the endline survey, two out of

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nine (22.2%) failed to identify a single correct definitional element of AI. Of the seven participants who mentioned at least one correct element, three identified two elements and one person identified three elements. A single participant gave a definition that correctly identified four elements of AI—"software that is able to learn from our input to adjust and respond better to our cues"—that it is a software, that it learns, that it adjusts and that it processes data.

Just three participants (33.3%) mentioned that AI is a software, while two (22.2%) explained that AI replicates human intelligence. Most telling was that only two participants (22.2%) said that AI collects data, and one participant (11.1%) gave the opinion that AI processes data. This is interesting when one considers that four participants (44.4%) mentioned that AI is designed to address or achieve specific goals, but how can it do this if it doesn't collect data to illustrate that it has achieved these goals. The questionable understandings of how AI actually works is evident when one considers that only two participants (22.2%) mentioned that AI adapts, and one (11.1%) said that it learns. Yet no one mentioned that it makes decisions.

A close examination of these responses illustrates clearly that we need to consider more carefully the design of future learning activities connected to teachers' everyday classroom practice to enable them to understand the main ideas of AI (i.e., that AI is a software, that it learns, that it adjusts and that it processes data) and to be able to define what it is clearly and be able to point to examples in classroom practice.

However, what is encouraging is that there is evidence to illustrate that the teachers' level of understanding about AI developed as a result of engaging with the professional learning pathway. Participants spoke at length about how taking part in the course affected their knowledge about AI and their practices regarding AI, both within and outside the classroom. Firstly, they remarked on how the AI4T pathway increased their **awareness of AI**.

> Indicative comment: "I was probably using tools without knowing they were powered by AI. Yeah, even though it does make sense. Because I'm on the iPad, or the computer, 90% of the time when it comes to schoolwork. I've been using it without really thinking, oh, yeah, that's AI."

Relatedly, many also remarked how participating in the course had made them **understand how common/ubiquitous AI is** in various aspects of their lives (both personal and professional).

> Indicative comment: "It's everywhere, it's actually everywhere, like even anytime you turn on a device, it's AI, and we don't realise it really. And when you see AI on the news, or you know, it's always this scary thing but when you sit down and think about this, you're actually using it every single day and you're not worried about it, and you're not panicking."

Interviewees also remarked that participating in the AI4T pathway had made them more **interested in learning about AI**.

> Indicative comment: "Yes, and also kind of tap into the articles online, you know, whereas before, I probably would have thought, oh, that's too techy, you know. It's too techy for me. Whereas now definitely it has sparked the interest for me, definitely."

It is apparent that after the completion of the AI4T programme teachers reported higher levels of familiarity with more AI technologies (see Figure 15).

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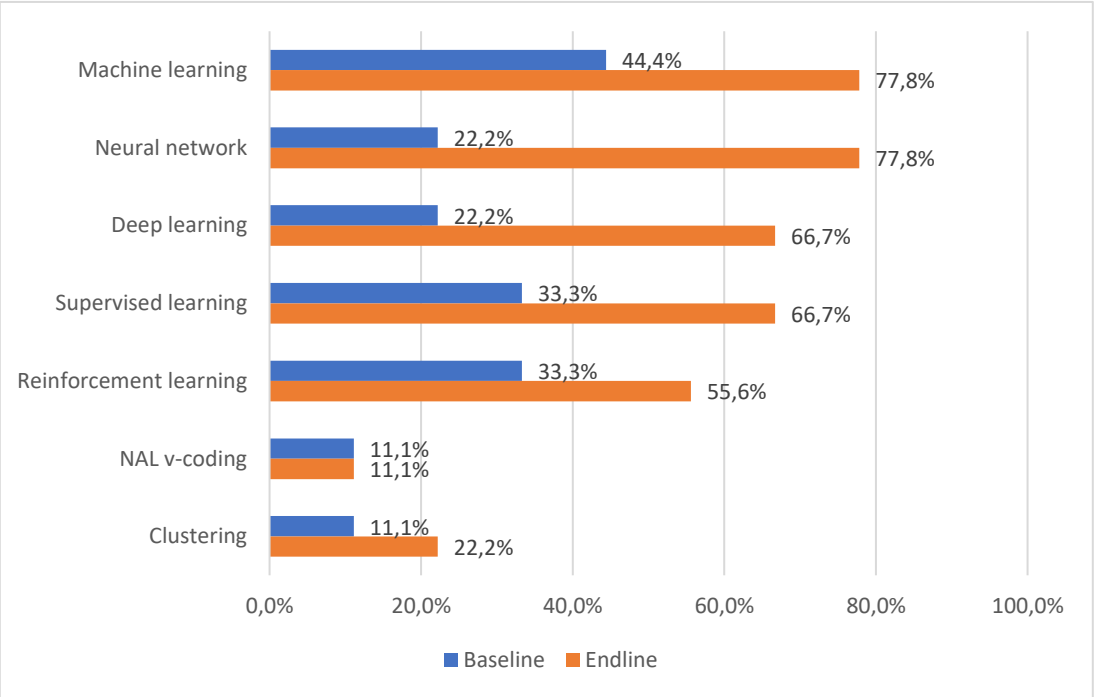
Figure 15. Percentages of teachers who reported being familiar with the following AI technologies



Note. Categories "Very familiar", "Familiar" and "Rather familiar" have been merged and the results are presented in this figure.

While there are no large differences in the percentages of teachers, who believe the provided statements about AI are true, between the baseline and the endline surveys, what is of particular importance is that the category where the largest difference is observed has to do with racial and sexual prejudices. While in the baseline survey, only 22.2% of teachers reported that AI can display racial or sexist prejudice, this percentage increased to 66.7% after the completion of the AI4T programme (Table 21). This increased awareness of teachers of the possibility of AI bias is of the utmost importance and one of the central tenets to be aware of when choosing and using AI technologies.

Table 21. Numbers/percentages of teachers who believe the following statements are true when talking about AI as it exists today

	Baseline		Endline	
	n	***%***	***n***	***%***
AI tries to mimic human cognitive functions.	8	88.9	8	88.9
A single AI product can perform many different tasks in a wide variety of areas.	6	66.7	8	88.9
AI can be trained using datasets.	9	100.0	9	100.0
AI can display racial or sexist prejudice.	2	22.2	6	66.7
AI always takes the form of a robot.	1	11.1	1	11.1
AI is conscious of what it does.	3	33.3	2	22.2
AI can analyse learners' answers.	9	100.0	9	100.0
AI can analyse learners' behaviours.	8	88.9	9	100.0
AI can model a learner.	8	88.9	9	100.0
AI can model content that will be taught.	8	88.9	8	88.9

Note. Categories "I am very confident it is true", "I am pretty confident it is true" and "I am not confident, but I think it is true" have been merged and the results are presented in this table.

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In addition, a considerably larger proportion of teachers were able to identify that the provided range of technologies fall under the umbrella of AI.

Table 22. Numbers/percentages of teachers who reported that the following technologies fall under the umbrella of AI

	Baseline		Endline	
	n	*%*	*n*	*%*
Automatic translator (e.g., Deepl, Google Translate, etc.)	4	44.4	9	100.0
Recommender system (e.g., product recommendations on Amazon)	7	77.8	9	100.0
Slideshow software (Microsoft PowerPoint, Prezi, Google Slides, etc.)	2	22.2	6	66.7
Intelligent tutoring system	8	88.9	9	100.0
Spreadsheet (e.g., Excel, Google Sheets, etc.)	5	55.6	7	77.8
Automated essay grading software	7	77.8	9	100.0
Digital workspace	6	66.7	7	77.8
Interactive quiz software (Kahoot, Quizizz, etc.)	5	55.6	7	77.8

Note. Categories “I am very confident it is true”, “I am pretty confident it is true” and “I am not confident, but I think it is true” have been merged and the results are presented in this table.

The misconception previously evident in some of the teachers’ responses in relation to the ability of AI to recognise an image without data training has now been resolved as after completing the AIT4 learning pathway, teachers identified that AI cannot recognise an image without having received any data beforehand.

Table 23. Numbers/percentages of teachers who reported that the following descriptions could apply to an AI-based image recognition software

	Baseline		Endline	
	n	*%*	*n*	*%*
It can recognise the image of a car without having received any data beforehand.	5	55.6%	0	0.0%
It can recognise the image of a car if it has seen other images that have been labelled as cars by humans.	9	100.0%	9	100.0%

5.4 Teachers’ perceptions of AI

Most teachers reported that they would be able to learn how to use AI easily. There are not large differences in teachers’ responses before and after their participation in the AI4T programme.

Table 24. Numbers/percentages of teachers who agreed with the following statements regarding the use of AI in their work

	Baseline		Endline	
	n	*%*	*n*	*%*
Learning to operate AI tools is/would be easy for me.	8	88.9	9	100.0
I (would) find AI tools easy to use.	8	88.9	9	100.0
It is/would be easy for me to become skilful at using AI tools.	9	100.0	8	88.9
I (would) find it easy to get AI tools to do what I want them to do.	5	55.6	6	66.7

Note. Categories “Strongly agree”, “Agree” and “Generally agree” have been merged and the results are presented in this table.

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When asked to report what emotions come to mind when they think about AI, what is encouraging is that overall teachers are positively disposed to AI. Three participants out of nine (33.3%) discussed something other than emotion. Of the six participants who mentioned specific emotions, the most commonly cited were excitement (5/6, 83.3%), followed by apprehension and joy (each with 2/6, 33.3%). There was one mention each for curiosity, fear/worry, fun and interest.

Table 25. Numbers/percentages of teachers who agree with the following statements regarding the use of AI in their work

	Baseline		Endline	
	n	***%***	***n***	***%***
The challenge of learning about AI is exciting.	9	100.0	7	77.8
Learning to use AI tools makes/would make me anxious.	4	44.4	3	33.3
I (would) enjoy using AI tools.	9	100.0	8	88.9
Using AI tools is/would be stimulating.	9	100.0	9	100.0
Using AI tools makes/would make me anxious.	1	11.1	1	11.1
I am afraid of making mistakes if I use an AI tool.	1	11.1	2	22.2
I am afraid that AI tools will malfunction when I or my students use them.	2	22.2	4	44.4
I (would) enjoy conducting class sessions in which my students use AI tools.	8	88.9	7	77.8
Conducting class sessions in which my students use AI tools makes/would make me anxious.	2	22.2	2	22.2

Note. Categories “Strongly agree”, “Agree” and “Generally agree” have been merged and the results are presented in this table.

As illustrated in Table 25, most respondents agreed that learning and using AI in their classroom would be enjoyable (100%/88.9%) exciting (100%/77%) and stimulating (100%/100%), both before and after their participation in the AI4T pathway (with some less positive responses after the completion of the programme). Most teachers also reported that they would enjoy using and conducting class sessions with AI tools. Only a few teachers reported that such practices would make them anxious, particularly if the AI tools malfunctioned when they or their students were using them (22%/44%). When the teachers were invited to share further why the use of AI by them or their students makes or would make them anxious, just three participants out of nine responded. Of these responses, two were to do with activity management (e.g., “I would need to consider how the AI would fit into the lesson”), while the other was to do with the teacher’s need to master the tool (e.g., “Would like to be more knowledgeable about it”).

Table 26. Numbers/percentages of teachers who agreed that AI tools can help teachers with the following activities

	Baseline		Endline	
	n	***%***	***n***	***%***
Identifying areas for improvement in their teaching	9	100.0	8	88.9
Doing administrative tasks (monitoring absenteeism, filling in the grade sheets, etc.)	7	77.8	8	88.9
Creating content (lessons, exercises, homework, tests, etc.)	8	88.9	7	77.8
Correcting/grading (exercises, homework, tests, etc.)	8	88.9	7	77.8
Answering students’ questions	6	66.7	5	55.6
Motivating and engaging students	9	100.0	4	44.4
Encouraging students’ collaboration	8	88.9	4	44.4
Monitoring students (work, learning progress, behaviour, etc.)	9	100.0	8	88.9
Diagnosing students’ failures	8	88.9	8	88.9
Offering students advice to choose their subject choice and possible future career path	7	77.8	6	66.7

Note. Categories “Strongly agree”, “Agree” and “Generally agree” have been merged and the results are presented in this table.

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While the teachers agreed that AI tools can help them with most of the provided activities, after the completion of the AI4T programme, they seem to have slightly lower expectations in relation to what AI tools can help them with (see Table 26). Interestingly, the greatest drop in expectations was in relation to motivating and encouraging students (100%/44%) and encouraging student collaboration (88.9%/44.4%). Perhaps this was to do with their increased understanding of how AI tools function leading to more realistic expectations of what AI is capable of doing. Or it could be related to their own experiences of the AI tools they had used in their classrooms during the AI4T project and/or their students' responses to the use of these AI tools. These questions would be interesting avenues to pursue in future studies.

When asked to report if there are other domains in which they think AI can benefit them in their job, or in education in general, it was apparent that perhaps this was something they had not previously considered in any great depth. Six out of nine participants (66.7%) did not submit a response and of the three who did respond, one mentioned collecting data about students, while another participant mentioned "monitoring whole school data" (both already included in the questionnaire). The final participant mentioned interpreting teaching and learning styles ("I suppose if AI can interpret my teaching style or my students' learning style then that would make my job easier").

Moving from a classroom focus to considering the impact of the use of AI in their schools, prior to completing the AI4T programme, most teachers agreed that an increase in the use of AI tools in their schools would have a positive impact on some elements of teaching and learning (e.g., teaching quality will increase, students' academic success will improve, and teaching will be personalised to each student's needs).

Table 27. Numbers/percentages of teachers who agreed that an increase in the use of AI in their school will impact the following

	Baseline		Endline	
	n	*%*	*n*	*%*
The teaching profession will be devalued	1	11.1	1	11.1
Teaching quality will increase	6	66.7	2	22.2
Teachers will be overwhelmed with learning about AI	6	66.7	4	44.4
Teachers will have more time to focus on student learning	3	33.3	5	55.6
Teachers will be progressively replaced with AI	2	22.2	2	22.2
Relationships between teachers and students will be impoverished	2	22.2	3	33.3
Teaching will be personalised to each student's needs	8	88.9	4	44.4
Student academic success will improve	7	77.8	5	55.6
Education will be dehumanised	3	33.3	3	33.3
Private companies will have an increasing influence on schooling	4	44.4	5	55.6
Surveillance in schools will increase	6	66.7	7	77.8
Inequalities and discrimination will decrease	3	33.3	0	0.0
Students' personal information will be more at risk of being breached and used at their expense	6	66.7	6	66.7

Note. Categories "Strongly agree", "Agree" and "Generally agree" have been merged and the results are presented in this table.

In contrast, after completion of the AI4T programme, fewer teachers reported that they expect such outcomes (Table 27), particularly in relation to an increase in teaching quality (66.7% v. 22.2%) and personalisation of teaching to each student's needs (88.9% v. 44.4%), coupled with less teachers agreeing that student academic success will improve (77.8% v. 55.6%). However, there was an increase in the belief that the use of AI would enable teachers to have more time to focus on student learning. Teacher expectations regarding the negative consequences of the use of AI (e.g., the teaching

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profession will be devalued and education will be dehumanised) remained relatively stable after the completion of the AI4T programme.

5.5 Teachers' use of AI and intention to use AI

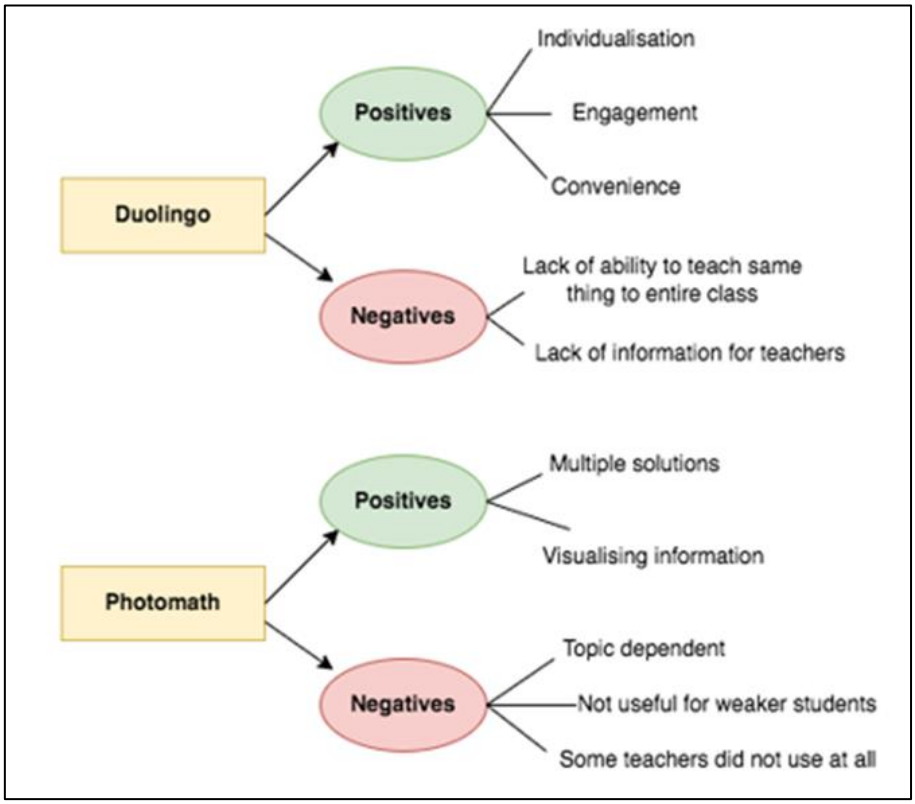
Besides developing their knowledge on AI, there was an increase in teachers' reported use of AI tools (both generic and educational) to teach. In addition, there was a corresponding increase in asking their students to use educational AI tools (Table 28).

Table 28. Numbers/percentages of teachers who reported doing the following at least once a month

	Baseline		Endline	
This school year, how frequently did you …	***n***	***%***	***n***	***%***
Use educational AI tools to teach	6	66.7	9	100.0
Use generic AI tools to teach	3	33.3	7	77.8
Ask your students to use educational AI tools	3	33.3	7	77.8
Ask your students to use generic AI tools	4	44.4	5	55.6
Ask your students to use digital technologies	8	88.9	9	100.0

The teachers confidently spoke about the advantages and disadvantages of specific AI tools they had used in the classroom. Due to the nature of the AI4T pathway, participants frequently discussed both Duolingo and Photomath. (See Appendix 8 for a more detailed overview of teachers' interview feedback on Duolingo and Photomath and the other AI tools they mentioned.)

Figure 16. Positive and negative aspects of Duolingo and Photomath identified by teachers



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They outlined individualisation as a key benefit, how the design of the software (specifically, its resemblance to a game) increased student engagement, and the convenience of the software for the students (e.g., how students can log on for a short amount of time anywhere they are able to use their phone and complete a short language lesson).

> Indicative comment: "I suppose it's [Duolingo] for everybody. It depends, you know … it's for any level, so you can start from the very beginning, and you can advance to advanced, you know, and it helps you … I suppose that's where the AI comes in, in that it helps, you know, find your level and helps you jump to what's suitable for you, as a student."

> Indicative comment: "Because it's gamified, it's on their phone. It's just the idea of the game. … So it is an app that students enjoy."

However, shortcomings such as specific content or topic limitation, lack of teacher support materials, and lack of data on student progress were also highlighted.

Teachers were able to identify other AI powered software they were using in their classroom practice. For example, they outlined how the use of ChatGPT was useful for planning, expressing frustration at the need for very specific prompts but how this also helped them to clarify their own thoughts.

> Indicative comment: "For the rubrics, for example, it's helped me to know what I am about really. Because I have to be specific. And I have to know what I want before being able to ask ChatGPT. It just saved a bit of time so instead of typing everything I was able to copy and paste it."

In addition, they expressed concern about the possibility of students using it for cheating but also pointed to the benefit of students having to understand the need for clarity and how to use the tool to be able to leverage it in their own learning.

> Indicative comment: "But I think a lot of teachers would be scared, you know, because again, it's quite difficult to know if a student has actually written that themselves."

> Indicative comment: "… with the likes of ChatGPT it's very specific. So you do need to be extremely specific – what you type in as to what exactly you're looking for. So even to teach them that, being very specific with regards to what they're looking for, to try and narrow it down."

In addition, some of the teachers spoke at length about Microsoft Teams and were very positive about the ability it gives them to monitor student progress through the analytics function, and how they used the software to provide individualised work to students.

Other AI powered tools the teachers mentioned that they found useful for their students were Immersive Reader and Reading Progress.

> Indicative comment: "And Immersive Reader is a help as well for them to link what they hear with what they see. So it's really helpful for that, because in languages very often what you hear is not necessarily what you see. So that's very helpful for students."

> Indicative comment: "Reading Progress, I think, for languages, for English, for English as an additional language (EAL). Reading Progress is brilliant because the student can work individually at their pace … You can choose different passages for different students. You can choose the level the students are reading. At the end they get the reading coach. So, the reading coach picks out I think it's the five words that the student has struggled with most and

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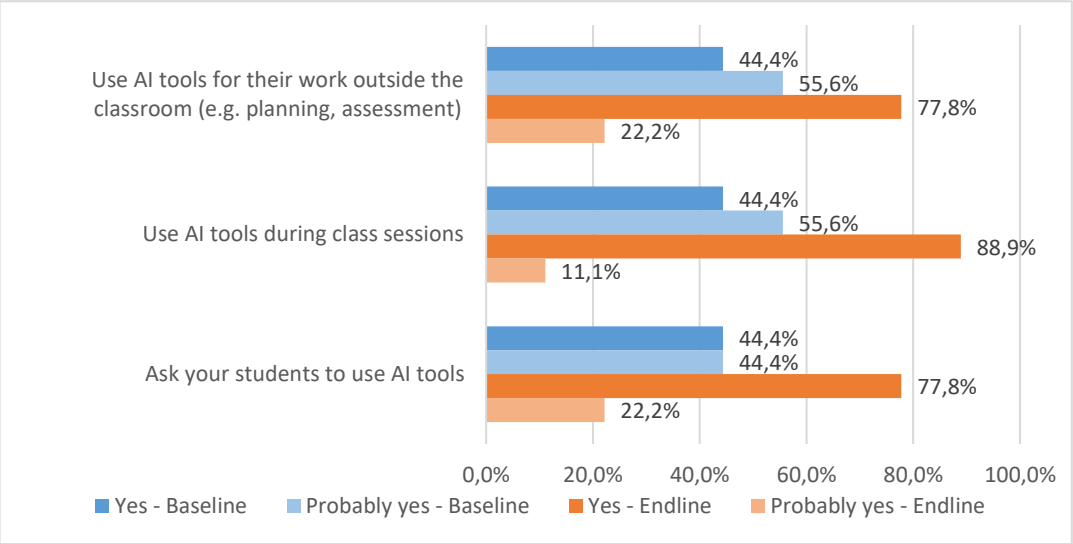
they get them to repeat the words until they get it right. And yeah, I think Reading Progress is a very good tool."

Overall, teachers were positive about using AI tools in the next five years for work both in and outside the classroom (see Figure 17). After the completion of the AI4T programme, teachers provided more positive responses with most of them reporting that they will use AI tools in the future, selecting "Yes" as opposed to "Probably yes". Encouragingly, this use of AI tools was not only for preparation and planning but also for during class sessions, and asking students to use such tools.

Figure 17. Teacher responses on whether they plan to use AI in the following settings in the next five years



However, when the teachers were asked if they plan to use any new AI tools not already mentioned, they were not able to name particular tools. One participant mentioned Photomath and Seneca Learning, while another one gave a general statement ("I am waiting for better tools to be developed!") but did not mention any specific tool. The other six participants (out of nine) did not respond to this question.

What is of great significance is that participating in the course resulted in many teachers **reflecting on their pedagogical approach** in the classroom.

> Indicative comment: "It's always good to move out of your own world, and your own experiences, and your own classroom. And find out different ways of teaching. And even if you're going 'I'm not going to be using Photomath every day', or whatever AI technology, it's a good time to reflect on your own practice, and how you can build on that practice. And how different people are building on their practice. So I think personally it has helped me reflect more on my own teaching. And it's also helped me understand a bit more about how I could use AI in assessment, and things like that."

Teachers also spoke about how the course prompted them to have **discussions with colleagues** about the use of AI in the classroom.

> Indicative comment: "And I'm saying to the French teachers, I'm doing this AI thing, I think they thought I was programming, or I was doing something really convoluted. I think their expectations were a little bit different from the reality. But I suppose maybe the more we talk about it the more people will understand, actually, you're using it all the time. And I'm not sure,

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> I think it's not specific to one subject. It'll take us a while to get everyone to understand that it's in all subjects. It's not just going to be for, you know, the maths or science teacher."

In addition, participation in the AI4T project caused them to think about whether their **roles as teachers are likely to change** in the future due to AI. Some teachers were confident that such a change would take place, while others maintained that the core principles of teaching would remain the same.

> Indicative comment: "We as teachers need to [change]? Yes, definitely, because already I feel we could become more facilitators, you know, in a classroom. So how can we do that effectively, or will there be more kind of co-teaching involved in it? Or yeah, will somebody be on a screen? I don't know."

> Indicative comment: "And then sometimes I utterly know it won't, because I set the temperature in my room. My kids are used to me, and we do our own thing our own way, and it doesn't really matter like what I did eighteen, twenty years ago. Probably fundamentally what I did eighteen, twenty years ago is identical to what I'm doing now. But different stages, different software, different programmes come and go. But the bottom line is the feeling I give them and the sense of confidence I give them. It's what I'm really teaching them personally, and that's a human, a human does that rather than anything else."

Finally, participants discussed how the AI4T project had made them aware of skills that students are likely to need in the future as AI becomes more prominent, particularly **analytical skills**.

> Indicative comment: "… maybe we need to teach the kids how to critically analyse what's coming back from these things, to make them more … to adjust it to make it more correct or more pertinent to what they need."

What is particularly encouraging is that after completing the AI4T programme, teachers show higher levels of understanding and awareness of ethical, privacy and security issues when using AI tools (Table 29). This greater awareness is a necessity particularly considering their stated intention to use more AI tools for teaching and learning in the future.

Table 29. Numbers/percentages of teachers who agreed with the provided statement about their awareness of AI ethical, security and other issues

	Baseline		Endline	
	n	***%***	***n***	***%***
I have a good understanding of the ethical issues when using AI tools.	3	33.3	8	88.9
I always comply with ethical principles when using AI tools.	5	55.6	7	77.8
I am never alert to privacy and information security issues when using AI tools.	2	22.2	1	11.1
I am always alert to the abuse of AI technology.	3	33.3	5	55.6

Note. Categories "Strongly agree", "Agree" and "Generally agree" have been merged and the results are presented in this table.

During the interviews all the participants spoke at length about how the AI4T project had made them aware of how companies may be collecting and storing **data** on students. They spoke about data concerns not only in general terms, but also how **schools have a responsibility to be aware** of what data is collected on students.

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> Indicative comment: “But I think the AI project definitely made me more aware that people absolutely have to be aware of what’s being gathered on them. What I’ve learned is that your data is your own, and that you should be able to control your personal data. Before the project I probably wouldn’t have thought about it like that.”

> Indicative comment: “Whether the data is ethical or not, I can’t say that’s ever [been] a conversation, but I think it definitely should be. It’s not, but it probably should be part of the school’s IT policy. But in my school it’s currently not. The IT policy is quite a few years old. So I think it’s definitely due an update.”

Relatedly, interviewees frequently expressed concern that the problem of data collection was too big for them to deal with, and they did not have the **ability to combat data protection concerns**.

> Indicative comment: “I think a lot of it is out of our control, but you know, we also … Even though we’ve been asked to do all our work online. And when you put online, you no longer own it. You know it belongs to the school, and it belongs to everything else. So there’s a much bigger conversation to be had there I suppose, you know, than AI. It’s the data. It’s who owns what, it’s, you know, at what point do you lose ownership of it, etc. But a lot of it is when you sign your contract, that you’re starting, you’re signing up for all of it. So it’s out of your control.”

Ultimately, many teachers expressed ambivalence about data collection: the AI4T project had made them more aware of the fact data may be collected on students, but they recognised that completely stopping the use of digital tools powered by AI was not the correct approach either.

> Indicative comment: “So it’s about the use of your time, so you have that conundrum: OK it can really help with assessment, and can help learning, but you have to be really careful about the data that’s being shared. So it’s a balancing act.”

In addition, the range of AI tools available made it difficult to determine which ones they should use (AI overload).

> Indicative comment: “But I personally feel we’re a bit bamboozled by the range of things that are on offer. There’s nearly too many things, and it’s very hard to hone in on what you can use.”

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6. Student results

For policy makers to be able to plan effectively for the use of AI in education, it is useful and advisable to comprehend how students understand AI, how AI is used, their attitudes towards AI, and their understanding of ethical issues in relation to AI. Findings reported in this section are based on the questionnaire responses from students who attended the classes of teachers from both the control and intervention groups who were part of the AI4T project in Ireland.

In total, 92 students from seven classes in seven schools completed the baseline questionnaire. The teachers of four of those classes were part of the intervention group (n=35); the other three classes belonged to the control group (n=57). Three out of the seven teachers whose students took the survey teach French (n=63), while the other four teach maths (n=29).

6.1 Student demographics

There were almost equal numbers of male and female students participating in the survey; a small number of students selected “Other” or “Prefer not to say”. The students were all aged between 14 and 17 years; most of them were over 14 and less than 16 years of age (84.8%).

Table 30. Student demographics

		n	*%*
Gender			
	Female	43	46.7
	Male	42	45.7
	Other	2	2.2
	Prefer not to say	5	5.4
Age			
	14–15 years old	29	31.5
	15–16 years old	49	53.3
	16–17 years old	14	15.2

Students answered several socio-economically related questions, i.e., parental education, home possessions and number of books at home, factors that are often used as proxies for socio-economic status (Table 31).

Overall, students reported high levels of education for their parents. Interestingly enough, many of the students who answered the question regarding their parents’ education indicated that the parent with the higher level of education in their household has either a master’s or doctorate degree (29.3%). A further 26.1% of students (n=24) reported that their parents’ highest level of education is a college or further education diploma, while the same number of students (n=24) reported that they did not know their parents’ level of education. Very few students reported that their parents have a bachelor's degree, finished upper-secondary education, have the Leaving Certificate or Junior Certificate, or finished primary or post-primary school. This may account for the large number of students who reported that they did not know the level of their parents’ education.

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Table 31. Socio-economic indicators – education and possessions of students' parents

		n	*%*
Parent education			
	Master's degree or doctorate	27	29.3
	Bachelor's degree	8	8.7
	College/further education diploma	24	26.1
	Finished upper-secondary education, Leaving Certificate	4	4.3
	Junior Certificate	4	4.3
	Finished primary or post-primary but no Junior Certificate	1	1.1
	I don't know	24	26.1
Home possessions			
	A computer or tablet	91	98.9
	An internet connection	91	98.9
	Your own mobile phone	91	98.9
Books at home			
	None or very few (0–10 books)	4	4.3
	Enough to fill one shelf (11–25 books)	17	18.5
	Enough to fill one bookcase (26–100 books)	20	21.7
	Enough to fill two bookcases (101–200 books)	15	16.3
	Enough to fill three or more bookcases (more than 200)	36	39.1

Apart from one student, all the others reported that they have a computer or laptop, internet connection and their own mobile phone (98.9%). Finally, most students indicated that they have more than 100 books at home (55.4%), with nearly 40% of them indicating there are more than 200 books (39.1%) in their home.

Students were also asked to indicate how good they think they are at school. Most students indicated that they think their performance at school is good (n=53; 57%). Only one student reported that their performance is low, while the remaining students (n=38; 41%) stated their performance is average.

6.2 Student knowledge of AI

Most students indicated they know fairly well what AI is (51.1%), while a considerable number said they definitely know what AI is (23.9%). However, just over 20% of students reported knowing very little and four students (4.3%) indicated they do not know anything about AI.

Table 32. Knowledge of artificial intelligence (AI)

Do you know what AI is?	*n*	*%*
Definitely	22	23.9
Pretty much	47	51.1
A little	19	20.7
Not at all	4	4.3

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Students were also asked about their understanding of artificial intelligence through the question: “How would you define AI?” Their open-ended responses were analysed with the aim of understanding how students define and comprehend AI, identifying common themes in their understanding, and evaluating the depth of their knowledge and awareness of AI concepts.

Of the 92 student responses that were collected, 90 were analysed; two responses were excluded from the analysis because they included rich, extended definitions which seemed likely to have been generated by AI tools, rather than written by the students themselves.

Student responses were categorised according to six pre-defined themes; five related to the understanding of AI (as smart devices/software, as digital assistance, as human-like intelligence, as an autonomous learning system, and how it collects/processes data) and the sixth was used to categorise responses that were unclear, ambiguous or expressed a lack of knowledge or understanding of AI. Most responses fit clearly into a single category; however, 11.1% of responses were more nuanced and contained more than one theme.

Over one-fifth (21.1%) of student responses included descriptions of AI as software or smart devices. For example, “a software that can do something without human assistance”. These responses frequently included more than one theme. Other examples are:

> *“An AI is a robot that is online, programmed to help people.”*
> *“AI is a robot that can learn from past conversations with people without needing to be reprogrammed.”*
> *“AI stands for artificial intelligence. It is a computer programme that creates new code based off information received to better adapt to its role. For example, ChatGPT is AI.”*

The most common theme in student responses was AI as digital assistance, for example, students described AI as computer programmes or digital assistants that answer questions and help people to learn or achieve goals. Some responses also referred to AI completing tasks that would previously have been completed by humans. The theme of AI as digital assistance was evident in 27.8% of student responses, some examples of which are:

> *“A computer or a programme that answers questions you give it by looking at the best answer for it.”*
> *“Programmes which help us with learning.”*
> *“Machines doing things that humans would have done in the past.”*

Just under a quarter of students (23.3%) gave definitions of AI that described it as human-like intelligence, referring to aspects of human cognition such as thinking, reasoning, learning, planning and problem solving. Examples of such responses include:

> *“Computers that think.”*
> *“Artificial intelligence is a code made to mimic human reactions and processes, able to have independent thought.”*
> *“Artificial intelligence is software created by humans to mimic the human intelligence or mind. A sort of manmade intelligence.”*

The proportion of student responses referring to AI as an autonomous learning system was 11.1%. Some of these responses directly addressed this theme, for example: “It is a programme that can

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learn by itself." Others were more detailed and tended to include references to AI's ability to adjust, adapt or react to information, for example:

> *"Artificial intelligence is a set code that has set responses or learns from the responses of other things to learn and generate its own response/knowledge."*
> *"Computers that can learn from their mistakes and adjust to specialise in specific tasks."*

In 11.1% of student responses, AI was represented as a system that collects, processes or analyses data, and/or has the ability to perceive its environment. Examples of such responses include:

> *"AI or artificial intelligence is a machine that can gather information and use it to learn, adapt or give answers."*
> *"Artificial intelligence can use data from different online connections to give answers and responses."*
> *"A computer/automated system that has some form of 'self-awareness' which (for example) can understand phrases or know where it is."*

Responses that were ambiguous or unclear, or indicated a lack of understanding, were equally as common as those that defined AI as human-like intelligence (23.3%). Of the unclear/inadequate responses, about half simply said "artificial intelligence", which does not demonstrate any understanding of the concept. However, these students may have simply misunderstood the question thinking that they just had to give the name of the acronym AI. Other responses in this category included, for example, "Don't know" and "Not sure if I could give a full definition".

When their understanding of AI was probed further, asking them to indicate what technologies fall under the umbrella of AI, it emerged that the majority of students could clearly identify some technologies that leverage AI, such as automatic translators (80.4%), image recognition software (85.9%), and search engines (75%). However, they were less sure if AI was used in technologies such as digital workspaces (34.8%) and spreadsheets (21.7%).

Table 33. Numbers/percentages of students who believe that the following technologies fall under the umbrella of AI

	Yes		No		Don't know	
	n	***%***	***n***	***%***	***n***	***%***
Automatic translator (e.g., Deepl, Google Translate, etc.)	47	80.4	8	8.7	10	10.9
Slideshow software (Microsoft PowerPoint, Prezi, Google Slides, etc.)	21	22.8	57	62.0	14	15.2
Spreadsheet (Excel, Google Sheets, etc.)	19	20.7	53	57.6	20	21.7
Digital workspace	35	38.0	25	27.2	32	34.8
Image recognition system (Google Lens, software that recognises faces on pictures/videos)	19	85.9	4	4.3	9	9.8
Search engine	69	75.0	11	12.0	12	13.0

6.3 Student use of AI

Most students reported that they quite often (once or more than once a week) use AI tools that are either generic (80%) or designed specifically for education (65%).

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Table 34. Student responses on the frequency of using AI tools this year and with the teacher engaged in the AI4T project

	AI tools that are not designed specifically for education (such as search engines, automatic translators and intelligent personal assistants)		**AI tools designed specifically for education (such as Photomath, Duolingo for schools, Kwyk and Grammarly)**	
	n	***%***	***n***	***%***
More than once a week	51	56.0	35	38.5
Once a week	22	24.2	24	26.4
At least once a month	13	14.3	18	19.8
Less than once a month	3	3.3	12	13.2
Never	2	2.2	2	2.2

When asked to discuss the tools that the teacher who engaged in the AI4T project used with them, most students reported that they used search engines (e.g., Google, Bing and Yahoo). This finding was consistent both for the maths and the language (i.e., French) groups (82.8%; 87.3% respectively).

Photomath was another commonly used tool by the maths group (62.1%), while automatic translators (69.8%) and Duolingo for schools (95.2%) were popular among students in the language group.

Identification of these tools (i.e., Photomath and Duolingo) is not surprising as they were the tools chosen for use in the AI4T project. What is encouraging is the high percentage of students who reported using these tools with their teachers who were participating in the AI4T project.

Table 35. Numbers/percentages of students who have used the following tools this year with the teacher engaged in the project

		n	***%***
Students of maths teachers			
	Search engines (Google, Bing, Yahoo, etc.)	24	82.8
	Intelligent personal assistant (Alexa, Siri, Cortana, etc.)	5	17.2
	Photomath	18	62.1
Students of language teachers			
	Search engines (Google, Bing, Yahoo, etc.)	55	87.3
	Automatic translator (Deepl, Linguee, Google Translate, etc.)	44	69.8
	Intelligent personal assistant (Alexa, Siri, Cortana, etc.)	10	15.9
	Duolingo for schools	60	95.2

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6.4 Student attitude towards AI

Overall, most students reported positive attitudes towards AI; however, many students also have significant concerns about it. A very high proportion of the student sample is impressed by what AI can do (87.8%) and they believe that, in general, AI would be useful in education (82.2%), particularly the possibility that teaching will be more personalised to each student's needs (70%). A large proportion of students think AI is exciting (66.7%), they plan to use AI for learning in the near future (63.3%), and are interested in discovering new tools for learning (64.4%).

Table 36. Numbers/percentages of students who agreed with the following statements regarding AI

	n	*%*
I am impressed by what AI can do	79	87.8
AI is exciting	60	66.7
I am interested in discovering new AI tools for learning	58	64.4
I want to use AI more in class	51	56.7
I plan to use AI for learning in the near future	57	63.3
I think in general AI would be useful for education	74	82.2
I think that, with AI, teaching will be more personalised to each student's needs	63	70.0
I think the use of AI will increase teaching quality	42	46.7
AI worries me	48	53.3
I have an instinctive dislike for AI	17	18.9
I think the use of AI will dehumanise education	39	43.3
I think the use of AI will increase inequalities and discrimination	17	18.9
I think the use of AI will lead to a greater risk of students' personal information being breached and used at their expense	44	48.9

Note. Categories "Strongly agree" and "Agree" have been merged and the results are presented in this table.

At the same time, though, a significant proportion of students have negative feelings or beliefs about AI, with over half indicating that it worries them (53.3%) and nearly a fifth going so far as to say that they have an instinctive dislike for AI (18.9%). In addition, a considerable number of students believe that AI can dehumanise education (43.3%) and that it might lead to a greater risk of students' personal information being breached and used at their expense (48.9%). Less than 20% of students think that AI will increase inequalities and discrimination, which is somewhat worrying as it indicates they may not understand how AI models are trained and developed, and have not considered the possibility of bias in the data that is used for these purposes. However, as indicated in the next section concerning ethics, they are aware of the public debates that are taking place in relation to these topics.

6.5 Student ethical awareness and worries regarding AI

Most students reported that they have heard about many of the debates concerning AI, which were presented to them. Specifically, most students were aware of the debates on AI transparency (59.1%), decision-making (59.1%), privacy violations (72.7%), and the use of AI for illegitimate intents (69.3%).

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Table 37. Numbers/percentages of pupils who have heard of the following debates about AI

	n	*%*
On AI transparency (e.g., should users know when they interact with an AI and should they understand how AI makes decisions)	52	59.1
About who is responsible when AI makes decisions for humans	52	59.1
On potential discrimination perpetuated by AI tools	32	36.4
On potential privacy violations due to data collection by AI tools	64	72.7
On the potential use of AI for illegitimate intents (e.g., the risk of excessive monitoring of student activity or use of their personal data against their interests)	61	69.3

Fewer students reported being aware of the debate on potential discrimination perpetuated by AI tools (36.4%), which is in keeping with their responses in the previous section when less than 20% indicated that they think AI will increase inequalities and discrimination.

To conclude, overall, most students expressed concerns about many aspects of AI (see Table 38). They were especially concerned about the potential loss of privacy due to the collection of data (67.8%). More than half of students had concerns about the transparency of AI (57.5%), the potential use of AI for illegitimate intents (56.3%), and the difficulty in attributing responsibility when AI makes decisions for humans (54%).

Table 38. Numbers/percentages of pupils who are concerned about the following issues

	Definitely/pretty much		**A little**		**Not at all**	
	n	*%*	*n*	*%*	*n*	*%*
AI transparency	50	57.5	25	28.7	12	13.8
The difficulty of attributing responsibility when AI makes decisions for humans	47	54.0	29	33.3	11	12.6
Potential discriminations perpetuated by AI tools	36	41.4	35	40.2	16	18.4
The potential loss of privacy due to the collection of data by AI tools	59	67.8	24	27.6	4	4.6
The potential use of AI for illegitimate intents	49	56.3	25	28.7	13	14.9

In keeping with other results, they were less definite in expressing their concern about potential discriminations perpetuated by AI tools (41.4% reported being definitely/pretty much concerned, while 40.2% were a little concerned). This may relate perhaps to their lack of knowledge about how data sets are used and trained to make decisions with the potential for bias being present.

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7. Takeaways from teachers

7.1 On professional learning about AI

Although teachers stated that they intend to use AI tools in their classroom practice, their responses illustrate clearly that we need to consider more carefully the design of future learning activities connected to teachers' everyday classroom activities to enable them to understand the main ideas of AI (i.e., that AI is a software that learns, that it adjusts, and that it processes data) and to be able to define clearly what it is and to point to examples in classroom practice.

In short, teachers need to be supported through a range of focused professional learning pathways to enable them to develop an understanding of how to effectively use existing and future AI powered tools in their classroom.

It is also necessary for developers to work with teachers to create more appropriate educational AI tools.

7.2 On AI tools

Teachers expressed how it was important for schools to have an organised and coordinated approach to the use of AI tools. Specifically, they recommended conducting cost-benefit analyses of AI tools, having a dedicated AI policy, and encouraging staff professional learning about such tools.

> Indicative comment: "Maybe, how could it benefit the students and benefit the teachers, benefit their students' learning, like, see how their students could come on with it, and would it actually benefit them in a positive way."

> Indicative comment: "So I suppose that at the school management level, I think that there should definitely be in the school's IT policy, there should definitely be a school policy on digital technologies and AI, on what to use and how to use it."

> Indicative comment: "As I said, definitely get some training, whether it's to get someone into the school, for example, if you are using Microsoft, get someone from Microsoft to come in and tell you how to use it properly. If you're getting Apple, get someone from Apple in. You need to have someone who's an expert in the particular technology that you're bringing into school, because otherwise you won't use it to its full ability."

7.3 On ethics

Teachers emphasised the need for oversight of AI at the government level. This could include a framework for the use of AI in schools, provision of teacher professional learning sessions, and consultation with teachers or teachers' groups.

> Indicative comment: "Yeah, I think there should definitely be a set in stone AI policy for education. So there should be ... teachers shouldn't be worrying about what they're allowed or not allowed to do, using online tools. So I think there should definitely be a framework of the process, and what they can use these tools for. I think where people get frustrated about

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knowing what they are, what they are allowed to do, what they aren't allowed to do is when bad feelings start."

Indicative comment: "So I think teachers need to be trained up on the various technologies, I think, yeah, continuous professional learning is hugely important. Generally speaking, for all teachers, I think it's something that we should probably be doing on a regular basis."

Indicative comment: "Yes, I suppose there should be some sort of a formalised feedback system. If there was some, maybe a teachers' forum once per year, or something. So that's whoever it is, at a department level or a PDST level, etc., where you can give some sort of feedback, because a lot goes on in the classroom. I suppose it's difficult for the Department to get all of that info back in for themselves."

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Appendices

1. Stratification Process

Table A1. Stratification variables: School DEIS status, school size and subject (composition of mathematics and French participating teachers within each school)

DEIS status	School size	Subject	Stratum	No. of schools (No. of students)	No. of schools assigned to Control Group (No. of students)	No. of schools assigned to Intervention Group (No. of students)
DEIS	700 students or less	More French or 50% - 50%	1	3	1	2
		More Maths	2	6	3	3
	More than 700 students	More French or 50% - 50%	3	2	1	1
		More Maths	4	2	1	1
Non-DEIS	700 students or less	More French or 50% - 50%	5	9	4	5
		More Maths	6	16	8	8
	More than 700 students	More French or 50% - 50%	7	11	5	7
		More Maths	8	15	6	9

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2. Teacher Interview Schedule

Personal information (5 minutes)

1) Tell me a bit about your professional experience.
   - What subject do you teach?
   - For how many years have you been teaching?
   - What do you like and dislike about your job?
   - Do you have a particular approach to teaching?
2) Tell me a bit about the class participating in the experiment.
   - How many students are there in your class?
   - Are your students more socially disadvantaged or privileged?
   - Are they academically high performing?
   - In terms of academic level, is your class rather homogeneous or heterogeneous?
   - Do you have students with special needs?
   - What kind of special needs?
   - Do they have special digital equipment to help them meet their needs?

Professional learning experience (10–15 minutes)

1) What was your experience of the AI4T professional learning pathway?
   - Could you please describe the professional learning pathway you received?
   - Were there variations in your commitment to the different elements of the professional learning pathway and, if so, why?
   - Did you have any issue following the professional learning pathway, such as time constraints or equipment problems?
   - Are you satisfied with the professional learning pathway, as a whole, and with each element (MOOC, textbook, online webinars, face-to-face sessions) in particular?
   - Did you enjoy the professional learning experience?
   - Which parts did you most and least enjoy?
   - Do you think it was adapted to your level of knowledge?
   - Do you think it was adapted to your professional needs?
2) What would you suggest to improve the AI4T professional learning experience or, more generally, professional learning for teachers about AI?
   - Should the professional learning pathway aim at other objectives?
   - Is there any content you would like to see implemented in the course?
   - Which pedagogical scenario would be better fitted for teacher professional learning regarding AI?
   - Do you prefer online, hybrid or face-to-face?
   - Are there aspects of the AI4T professional learning experience that you particularly appreciated and that should be included in future courses?

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Impact of the professional learning experience on knowledge and perceptions of AI (15–20 minutes)

1) Have you gained any personal benefits from the professional learning experience?
   - Which ones?
   - Was it worth your effort?
2) What have you learned about AI?
   - Do you feel like you understand better what AI is and how it works thanks to the professional learning pathway?
   - Is the concept of AI clear for you now?
   - Which tools or situations do you think about when you think about AI? [If not specific to the field of education What about AI for education?]
3) Has your engagement in the AI4T professional learning experience changed your perception of AI?
   - Are you more or less interested in AI now?
   - Do you discuss AI with your friends or colleagues?
   - In your opinion, what are the greatest benefits of using AI in schools?
   - Do you think AI applications that exist today bring added value to teaching?
4) What do you think are the greatest risks and preoccupations when it comes to using AI in schools?
   - Are you aware that some companies collect the data of users? Is this a problem according to you? And if so, why? [The interviewer can give an example of an AI tool used in education]
   - Do you think that teachers and students should be aware of the presence of AI in digital tools? And if so, why?
   - Do you think AI tools can be biased and what could be the consequences of this? [The interviewer can give examples of biases]
   - Do you think the development of AI could reinforce the role of economic interests in the field of education?
5) What message would you like to send to AI developers and policy makers with regards to ethics?

Experience of use of AI (10–20 minutes)

1) What is your experience of use of AI tools in your work?
   <u>If they have used AI tools</u>
   - Which AI tools have you used or made your students use?

- If they don't mention any tool, ask about:
- For language teachers: search engines, automatic translators, ChatGPT, Grammarly, Duolingo, intelligent personal assistants, etc.
- For mathematics teachers: search engines, Kwyk, Photomath, etc.
  - Did you use them before the training?
  - Has your way of using the tools changed since you have had the training?
  - For which pedagogical objectives do you use these tools?
  - Based on this experience, when do you find these tools relevant?
  - Were the tools easy to use?

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- If their students used AI: How did your students react to using these tools? Did you enjoy conducting class sessions in which AI was used or were you apprehensive? If you were apprehensive, what could be done to make this experience easier? Is your experience of the use of AI different from your experience with other digital tools?

<u>If they haven't used any AI tools</u>

- What are the main factors that prevent you from using AI? Examples: access, concerns, etc.
- Are there AI tools that you intend to use in the future? If so, for which pedagogical purpose? How could AI be developed to help you with your professional needs?

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3. School Leader Questionnaire Summary

This section summarised the responses of the four principals who completed the AI4T school leader questionnaire between 20 March and 6 April, 2023, in Ireland. The principals were asked questions about the school's technical infrastructure, the integration of AI in the school, and the support given to teachers as they engaged with the AI4T project and the AI4T learning pathway.

The average school size reported was 657.3 (SD=260.0) with values ranging from 341 to 898.

Table A2. Percentage of students in the school who have special needs, come from a socio-economically disadvantaged home and/or have a migrant background

	None	1% to 10%	11% to 30%	31% to 60%	Over 60%
Students with special needs	0	1	2	1	0
Students from socio-economically disadvantaged homes	0	1	1	2	0
Students who are immigrants or have a migrant background	1	1	1	1	0

School principals were asked to report the percentage of students in their school who have special needs, come from a socio-economically disadvantaged home and/or have a migrant background. None of the principals reported leading a school where more than 60% of the students had any of these characteristics. Two principals reported that between 31% and 60% of students in their school come from a socio-economically disadvantaged home, while two more principals reported that between 11% and 30% of their students have special needs.

An equal number of schools had or had not participated in other studies related to the use of digital technologies and AI during the last five years. None reported participating in AI-related studies.

All school principals reported that all teachers had access to a device that they could use both in the classroom for teaching and at home for their planning and preparation of school-related work. All teachers also had access to a multimedia projector or smartboard in all the classrooms in the school so could, if they wished, utilise them in their classroom learning and teaching activities.

Table A3. School principal responses regarding the number of digital devices available for student use in their school

	Minimum	*Maximum*	*Mean*	*SD*
Desktops	25	100	61.3	39.2
Laptops	90	150	108.8	28.4
Tablets	0	100	31.3	46.3
Total	120	350	201.3	103.3
No. of students per device	2.4	4.7	3.5	1.3

Although not all students had access to an individual device there were enough devices in the schools to enable students to use them in their learning at least in pairs or small groups. In addition, depending on the management of the devices it was possible for students to have individual access for some of their classroom learning activities.

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4. Coding Process – Tagging – Example 1: Learning day – unclear learning intentions

I suppose one of the things with the face-to-face sessions is that the learning intentions were not especially clear. I'm coming from quite a teaching background saying that. It was just kind of introducing us to what AI is, and how it is being used in different industries. It wasn't necessarily guided by how we use it in the classroom.
Document: E.docx **Tags:** Learning day – unclear learning intentions

I suppose when I left the initial launch day, I still wasn't entirely sure what I was going to do in my classroom. There was about fifteen minutes talking about Photomath, and then everything else was talking about, in general, what AI is. So, I think a bit more focus on … I'm selfish, like how am I going to apply this in the classroom? What am I going to do? But I also understand that you want it to have a bit of creativity, and you don't want to be like: teach this lesson. But maybe even an email, different ideas that we could have used, and different ways other teachers would have thought about it, Photomath in the classroom. Just a launchpad to jump off from.
Document: E.docx **Tags:** Learning day – unclear learning intentions

Yeah, I found it was just really short, and I didn't … like coming out of it, I didn't really know 100% what I really had to do in my classroom, but I knew one of the guys that was in it as well, and we kinda talked about it a bit as well, because we knew each other from college.
Document: S1.docx **Tags:** Learning day – unclear learning intentions; Learning day – lack of classroom relevance

To be honest, I liked the way that it was set up. After the first day I felt I was a bit, I suppose, unsure about what exactly was being asked of us, you know. There was lots of, you know, information from speakers, etc. And it was all very interesting information, but honestly, I left just not entirely knowing what I was meant to do when I got back to school.
Document: S2.docx **Tags:** Learning day – unclear learning intentions

I found them all useful, but I felt there should have been an additional talk that's saying: Listen, when you go back to school tomorrow, this is what we're asking you to do. And for it to be clear, because it wasn't clear. Somebody spoke about Photomath. They spoke … I heard about lots of AI technologies, but it wasn't like: this is what we're asking you to do. So I think that could have been just a little plainer to go back and just what the expectation was, ahead of the first check in.
Document: S2.docx **Tags:** Learning day – unclear learning intentions

I think I would restructure the first day, include the talks but have a bit more structure about the expectations of what teachers are asked to do.
Document: S2.docx **Tags:** Learning day – unclear learning intentions

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5. Coding Process – Tagging – Example 2: Benefits of multiple subjects in AI4T

So I think it was great to have different maths teachers. And I know that it was quite a different spread of interests and experience. But also it was very good to have a different subject as well, and understanding how a humanities subject would bring in this technology, and their concerns. So having colleagues there from different schools and different experiences focused the learning on all classes. Not just your own specific context.
Document: E.docx **Tags:** Benefit of multiple subjects in AI4T

D: That's interesting that you said not just maths teachers in the group … Were there aspects that the humanities people brought up that you hadn't thought about?
E: Yeah I think—maybe I'm generalising—but they would talk a lot more about the risks … We're very black and white in maths, it's like: You're right, three points, three out of five, done done done. Whereas it's a lot more like, can AI capture the language? Can it pronounce everything? And things like that. So being able to understand more subtle uses for AI, instead of being like, this is the answer. Did you get the answer?
Document: E.docx **Tags:** Benefit of multiple subjects in AI4T

No, I think it's beneficial, certainly, because oftentimes there are kinds of cross-curricular links, as you know yourself, in schools. And that's really important to be able to do that. And I found myself, I was coming back to the maths department in my own school and thinking, oh, have you tried this app, I just heard about it. And so, even if I couldn't use it, I was able to share that across the board so that others could share it, even though they weren't necessarily part of the project.
Document: R.docx **Tags:** Benefit of multiple subjects in AI4T; Learning day – exchange of ideas
Well, we didn't really kind of mix, or like you were talking to the language teachers as well, but say like there was no kind of overlap between the two things like … Yeah, it was kind of useful that they were there, but I didn't … there was no overlap in it, there wasn't anything there, you know.
Document: S1.docx **Tags:** Benefit of multiple subjects in AI4T

S: Well we kind of went through the ChatGPT at the end of the final session. There were ideas there from the language teachers that I wouldn't have thought about putting into it.
D: And what sort of things would you be thinking about?
S: Just like, say, some of them were putting in, maybe like, print out like a worksheet or … I can't think of exact ones. But I think one of them kind of put down like the age group of the students, whereas I probably put down the Irish curriculum instead of the age group of students, and it would have been better to put down the age group because you get more accurate answers from it.
Document: S1.docx **Tags:** ChatGPT – streamlining work; Benefit of multiple subjects in AI4T

It was just the fact that, the discussion between the facilitators and the other teachers. Other people's experiences—ways, maybe—that they were using apps that I hadn't considered. Now I was hearing lots from the languages as well, which wasn't so relevant to me. But at the same time I found it interesting, and I suppose I was hoping for a similar experience with the maths one.
Document: S2.docx **Tags:** Online meetings – exchange info; Benefit of multiple subjects in AI4T

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6. Codebook

The codebook contains all the codes that were assigned, a brief description of the code, how many times the code appeared, and the theme or sub-theme the code eventually became. Because the data are relatively simple this process was quite straightforward—some of the codes were collapsed together to become sub-themes, while some others which recurred a lot simply became the sub-themes.

Code	Description	No.	Theme/Sub-theme
AI can't address traditional teaching concerns	Lack of ability to solve pedagogical/classroom problems	1	*Reconsidering the role of the teacher*
AI images	Awareness that AI can be used to generate images	1	*Awareness of AI*
Awareness of AI	Participants discussing knowing more about AI as a result of the course	14	*Awareness of AI*
Barriers to using AI in schools	Focused mostly on how participants' schools did NOT have barriers to using AI	6	*School infrastructure*
Benefit of hybrid approach	Comments on how the use of online and in-person elements was beneficial	3	*General comments on design of AI4T*
Benefit of multiple subjects in AI4T	Or, lack of benefits	6	*General comments on design of AI4T*
Benefits of collecting/storing data	Teachers' comments about the need to collect data sometimes	1	*Ambivalence about data collection*
Changing role of teacher due to AI	Changes, but ALSO things that are likely to remain the same	14	*Reconsidering role of the teacher*
ChatGPT - awareness that students are using	Comments relating to the fact that students are probably using ChatGPT already	4	*ChatGPT - negatives*
ChatGPT - better capabilities	ChatGPT often better able to develop materials than teachers	3	*ChatGPT - positives*
ChatGPT - clarifying thoughts	ChatGPT makes teachers think about what they really want	1	*ChatGPT - positives*
ChatGPT - iterative process	The need to continually hone prompts	1	*ChatGPT - positives*
ChatGPT - need for specific prompts	Frustration at the need for extremely specific input information	4	*ChatGPT - negatives*
ChatGPT - streamlining work	ChatGPT faster at completing tasks than teachers	2	*ChatGPT - positives*
Connectivity of school	Comments (positive) about the connectivity of participants' school	5	*School infrastructure*
Cutting out admin duties	General remark about AI being useful for cutting out teacher admin	1	*Reconsidering the role of the teacher*
Data	Comments about how AI tools might collect data about students, either relating to a specific tool being discussed, or in a general sense	37	*Data protection concerns*
Duolingo - convenience	Duolingo easy for students to use for a few minutes at a time	6	*Duolingo - positives*
Duolingo - data protection	Concerns with Duolingo collecting student data	1	*Data protection concerns*
Duolingo - engagement	Students motivated to play Duolingo due to its design	5	*Duolingo - positives*
Duolingo - focused support	Duolingo gives a tailored learning pathways	3	*Duolingo - positives*
Duolingo - formative feedback	Duolingo gives tailored feedback which is used to individualise learning	3	*Duolingo - positives*

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Duolingo - individualisation	Duolingo specifically designed to be individualised	12	*Duolingo - positives*
Duolingo - lack of focused learning	Can't provide the whole class with detailed learning on specific topic	5	*Duolingo - negatives*
Duolingo - lack of information for teachers	Information to teachers only vague/not detailed enough	4	*Duolingo - negatives*
Duolingo - motivation	Duolingo makes students motivated to learn	6	*Duolingo - positives*
Duolingo - oversight	Teachers have some oversight of student progress	2	*Duolingo - positives*
Duolingo - revision	Duolingo allows students to revise aspects of language learning	3	*Duolingo - positives*
Feedback to developers	What would teachers say to app developers if they had the chance?	2	*Data protection concerns*
Future potential of AI	How AI might help change teaching in the future	5	*Reflecting on pedagogy*
General benefits of AI4T	What was good in general about the course	9	*Awareness of AI, general comments on design of AI4T*
Helping students with special needs	Use of Immersive Reader to help students with special needs	2	*Immersive Reader*
Increased interest in AI	Benefits of AI4T programme overall	2	*Interest in AI*
Knowledge of AI about us	Worry that AI tools have lots of information about us	1	*Data protection concerns*
Combat data protection concerns	Worry that teachers are powerless to stop tools collecting data	5	*Lack of ability to combat data protection concerns*
Lack of devices in schools	Potential barrier to using AI tools	2	*School infrastructure*
Learning day - engagement	Good engagement with AI as a result of the learning days	2	*Learning days - positives*
Learning day - exchange of ideas	Learning days allowed for exchange of ideas	12	*Learning days - positives*
Learning day – hands on	Learning days were practical	1	*Learning days - positives*
Learning day - inspiring	Learning days were inspiring	1	*Learning days - positives*
Learning day - lack of classroom relevance	Learning day content not related to classroom practices	2	*Learning days - negatives*
Learning day - learning about AI	Learning days taught participants about AI	10	*Learning days - positives*
Learning day - thinking about practice	Learning days caused teachers to reflect about their roles	2	*Reflecting on pedagogy*
Learning day - unclear learning intentions	Teachers were confused as to the point of the first learning day	6	*Learning days - positives*
MOOC - clear learning intentions	Found the MOOC to have an obvious learning intention	1	*MOOC - positives*
MOOC - dull	Found the MOOC boring	1	*MOOC - negatives*
MOOC - educational potential	MOOC showed how AI could be used in the classroom	2	*MOOC - positives*
MOOC - information overload	MOOC contained too much information	10	*MOOC - negatives*
MOOC - information relevance	MOOC contained information that was not relevant to teachers	7	*MOOC - negatives*
MOOC - learning about AI	MOOC taught teachers about AI	8	*MOOC - positives*
MOOC - positive experience	General positive remarks about MOOC	4	*MOOC - positives*
MOOC - self-directed learning	MOOC allowed teachers to direct their own learning	1	*MOOC - positives*

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Analytical skills	Students will need to develop skills in the future to cope with AI tools	10	*Recognition of the need for students to develop analytical skills*
Need for a government AI policy	Need for, and also content of	13	*Need for governance of AI - government level*
Need for student text-processing skills	Students may need to analyse large blocks of text given to them from AI tools	1	*Recognition of the need for students to develop analytical skills*
Online meetings - clarification	Allowed teachers to determine what they should be doing in their classrooms	4	*Online sessions*
Online meetings - exchange info	Meetings allowed teachers to discuss the project with other teachers	8	*Online sessions*
Overload of AI tools	Teachers overwhelmed by amount of AI tools on the market	2	*Awareness of the negative effects of AI*
Pedagogical approach	Teacher describing their approach in the classroom with AI tools	3	*Reflecting on pedagogy*
Photomath - future potential	Software might be more useful in the future	2	*Photomath - positives*
Photomath - lack of individualisation	Can't be used to give individualised learning paths	1	*Photomath - negatives*
Photomath - multiple solutions	Software can demonstrate more than one solution to a problem	6	*Photomath - positives*
Photomath - not good	General negative remark	1	*Photomath - negatives*
Photomath - not used in class	Concerns with Photomath meant it was not used	1	*Photomath - negatives*
Photomath - not useful for weaker students	Only beneficial for students already good at maths	3	*Photomath - negatives*
Photomath - student independence	Allows students to work alone	1	*Photomath - positives*
Photomath - topic dependent	Only useful for certain topics	5	*Photomath - negatives*
Photomath - visualising information	Visualising info such as graphs	2	*Photomath - positives*
Potential bias of AI	Concerns that AI could be biased	11	*Awareness of the negative effects of AI*
Reflecting on own practice	AI4T caused teachers to think about their own practice	2	*Reflecting on pedagogy*
School IT policy	Need for (and content of) school policy regarding use of AI	12	*Need for governance of AI - school level*
Social skills losing out	AI might cause students to lose social skills	1	
Staff discussions of AI	AI4T caused teachers to discuss AI with peers	6	*Staff discussions of AI*
Student awareness of AI	Or lack of awareness	14	*Data protection concerns*
Synergy between AI4T components	Remarks about the different aspects of AI4T course working well together	4	*General comments on design of AI4T*
Teams - encouragement	Teams encourage students to work	1	*Microsoft Teams*
Teams - individualisation	Teams allows for individualised learning pathways	3	*Microsoft Teams*
Teams - organisation	Teams helps teachers organise	1	*Microsoft Teams*
Teams - student analytics	Teams allowed teachers to monitor student progress	6	*Microsoft Teams*
Ubiquity of AI	AI4T allowed teachers to understand how much AI is in the world already	8	*Ubiquity of AI*
Use of AI tools other than those in AI4T	Mentioning other AI tools	12	*Microsoft Teams, Immersive Reader, Google Translate, Reading Progress*

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7. Index of Themes

1. Professional learning experience

a. Learning days
   - *Positives: learning about AI, engagement, exchange of ideas*
   - *Negatives: unclear learning intentions, lack of classroom relevance*

b. MOOC
   - *Positives: learning about AI, contained information in French*
   - *Negatives: information overload, information relevance*

c. Online sessions
   - *Clarification, exchanging ideas*

d. General comments on design of AI4T
   - *Synergy between components, benefits of multiple subjects, benefits of hybrid approach*

2. Impact of learning experience on knowledge and perceptions of AI

a. Personal effects of participation: *awareness of AI, ubiquity of AI, increased interest in AI*

b. Professional effects: *reflecting on pedagogy, encouraging discussions with staff members, reconsidering the role of the teacher, recognition of the need for students to develop analytical skills*

c. Increased awareness of the negative effects of AI: *data protection, lack of ability to combat data protection concerns, ambivalence about data collection, AI overload*

d. AI governance and infrastructure: *school level, school infrastructure, government level*

3. Experience and use of AI

a. Duolingo
   - *Positives: individualisation, engagement, convenience*
   - *Negatives: lack of ability to teach same thing to entire class, lack of information for teachers*

b. Photomath
   - *Positives: multiple solutions, visualising information*
   - *Negatives: very topic dependent, not useful for weaker students, some teachers did not use at all*

c. ChatGPT
   - *Positives: useful for planning lessons and developing materials, clarifying thoughts*
   - *Negatives: need for specific prompts, awareness of student use (maybe to cheat)*

d. Microsoft Teams
   - *Student analytics, individualisation*

e. Other AI tools mentioned
   - *Google Translate, Immersive Reader, Reading Progress*

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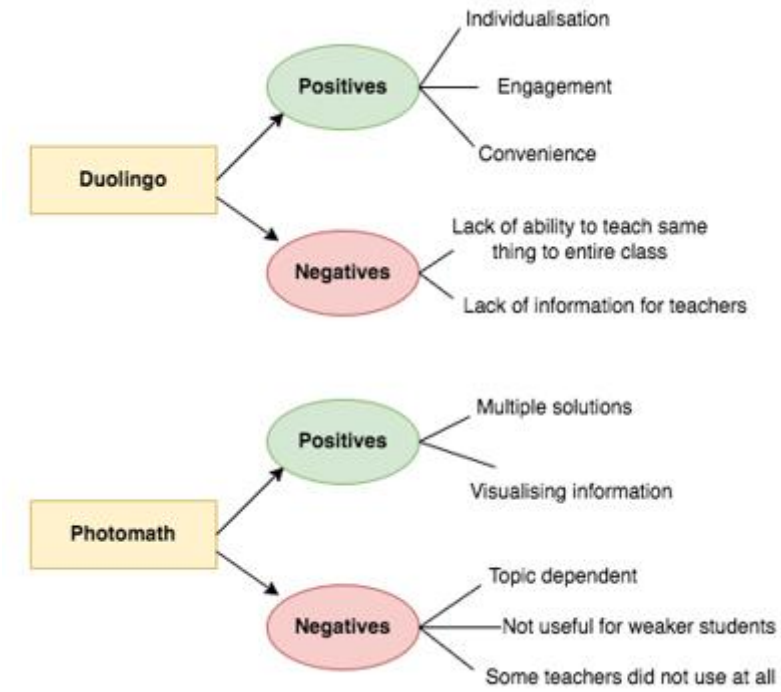
8. Experience and use of Duolingo and Photomath



Duolingo

Participants who used Duolingo in the classroom most frequently cited **individualisation** as a key benefit of the software.

> Indicative comment: "I suppose it's for everybody. It depends, you know … it's for any level, so you can start from the very beginning, and you can advance to advanced, you know, and it helps you … I suppose that's where the AI comes in, in that it helps, you know, find your level and helps you jump to what's suitable for you, as a student."

Participants also spoke about how the design of the software (specifically, its resemblance to a game) increased student **engagement** with language learning.

> Indicative comment: "Because it's gamified, it's on their phone. It's just the idea of the game. And some of them were already using Duolingo, with other languages even, you know. So it is an app that students enjoy."

Finally, participants also spoke about the **convenience** of the software for students, specifically how students can log on for a short amount of time anywhere they are able to use their phone, and complete a short language lesson.

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> Indicative comment: "Yeah, that it just becomes a good habit and, you know, it's only five minutes. It can be twenty minutes, it can be more. But you know, if they can just try and fit that into their typical day, you know."

Some participants spoke negatively about how the individualised nature of Duolingo meant it was difficult for them to use the app to **teach specific aspects of language to the whole class at once**.

Participants particularly spoke about the difficulty of using the app to teach grammar.

> Indicative comment: "But like I feel, maybe if I needed to practice the difference between *passe compose* and *imparfait*, I wasn't kind of getting a feel that I could send them into a section to work on that. So probably my own traditional way of looking at some of these things – it isn't going to do that necessarily. I don't know. Maybe I missed a step, or there was something I wasn't getting. But yeah, if you really wanted to drill a particular area, or grammar, I don't know."

Some participants also felt that the app did not give them **enough specific information** about students' progress.

> Indicative comment: "Well, for me in class, it doesn't really help. I can see … whether they have done the assignments on it, but, like I can't see exactly what they have to do in terms of topic or questions, and all this … I could have a student working on food, and then another student working on clothes. But I don't know – I can't see it. So that's the limit of Duolingo. As a teacher I can see that they have been using the app for the 20, 30, 50 XPs, that they have used it for an hour and a half or twenty minutes, but I don't know exactly what is the content of their learning path."

Photomath

In general, the participants who used Photomath as part of the AI4T project were less positive about it than those who used Duolingo. However, they did mention that it was useful for demonstrating **multiple solutions** to the same problem.

> Indicative comment: "So if they're going to be using it I need to say how do I teach them to use it well. So it's not just about finding the answer – look through the solution. Is there a different solution you can find? Are there different methods? So that you are always learning from it."

Participants also thought that Photomath was useful for visualising information.

> Indicative comment: "Yeah, I was saying like, when I did it in class, like we were solving simultaneous equations. You know just sort of showing how to solve it, but I then got onto the graphs. You know, here is a function. What does the graph look like? Here's an x function. Where does it cut the x-axis? Where does it cut the y-axis? And then look at the transformation. What happens if I add 3 to this, you know, what's happening graph-wise, and all that. So I think it's really good for that."

The most common negative remark about Photomath is that it is **only useful for specific topics** within maths. Participants felt it was useful for algebra, but less so for topics like statistics and probability.

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> Indicative comment: “It’ll answer the question. It’ll try to give you a step-by-step solution. On a basic run of the mill algebra question it’s very good. If it starts going into anything that’s wordy, it starts to struggle with how it interprets the question – it can start to struggle with them.”

Participants also discussed how Photomath was **not helpful for weaker students** in their class.

> Indicative comment: “What I found like say for the weaker students, if they’re kind of falling behind more than the middle of the road students, they’d kind of just look up the answer and write it down. That would be it, and they wouldn’t understand like where they actually got it from. So if you’re in a strong class, I think it would be useful to see, they could check their answers. But if you’re in a weaker class, I don’t think it’d be as useful for them.”

Finally, one participant mentioned that they felt the app was so weak that they **didn’t meaningfully use it** in their classroom at all.

> Indicative comment: “I think the main thing I would change – is there another app that can be used apart from Photomath? Because, you know, you are basing all of this on a really not great app. So if there was a better app, I think it would have been a lot easier to engage with it, and to see the benefits of it.”

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