



Artificial Intelligence Role in K12 Education

Agile Collection of Information

October 15, 2021





Artificial Intelligence Role in K12 Education – Agile Collection of Information is created as a set of three documents in which you may find additional information and resources:

- Report
- [Country cards](#)
- [Presentation](#)

All documents are available at European Schoolnet, and you may contact Lidija Kralj (lidija.kralj@eun.org) should you need one.

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Rue de Trèves, 61 - 1040 Brussels, Belgium

Author: Lidija Kralj

Editor: Patricia Wastiau

Designer: Jonatas Baptista

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Introduction

Artificial Intelligence in Education (AIEd) is one of the currently emerging fields in educational technology. Whilst it has been around for about 30 years with high expectations about its potential, it is still unclear how it can impact on teaching and learning, and how to make pedagogical advantage of it on a broader scale.

The educational community is facing the opportunity and challenge brought by the continuously developing artificial intelligence (AI) technologies, which can potentially and fundamentally change the structure, operation, and governance of educational institutes. Chatterjee and Bhattacharjee (2020) defined AI as computing systems capable of engaging in human-like processes such as adapting, learning, synthesizing, correcting and using of various data required for processing complex tasks.

The European Commission High Level Expert Group on Artificial Intelligence has proposed the following definition: Artificial intelligence (AI) systems are software (and possibly also hardware) systems designed by humans that, given a complex goal, act in the physical or digital dimension by perceiving their environment through data acquisition, interpreting the collected structured or unstructured data, reasoning on the knowledge or processing the information derived from this data and deciding the best action(s) to take to achieve the given goal. AI systems can adapt their behaviour by analysing how the environment is affected by their previous actions.

Artificial intelligence (AI) applications in education are more and more used by learners and educators nowadays and involve various tools and applications. AI-supported learning occurring in both traditional classes and workplaces by combining AI and various learning sciences aiming at stimulating and advancing the development of AI-driven educational applications featuring flexibility, personalization, and effectiveness but also bringing challenges like data privacy and ownership, bias in training data and other ethical issues. The most often AIEd applications are in adaptive systems and personalisation, assessment and evaluation, intelligent tutoring systems and profiling and prediction. In this report we use Baker and Smith (2019)'s categorization of AI in education (AIEd) applications that are available today: a) learner-oriented AIEd; b) instructor-oriented AIEd; and c) institutional system-oriented AIEd.

As stated in the European parliament resolution (2021) real objective of AI in education systems should be to make education as individualised as possible, offering students personalised academic paths in line with their strengths and weaknesses and didactic material tailored to their characteristics, while maintaining educational quality and the integrating principle of our education systems. AI has the potential to offer solutions for the day-to-day challenges of the education sector, such as monitoring learning difficulties, the automation of subject-specific content/knowledge,

reducing the administrative work of educators and educational institutions, freeing up time for their core teaching and learning activities.

After consultation with the Steering Committee, European Schoolnet conducted the survey about Artificial Intelligence (AI) role in K12 education in 2021. Seventeen countries answered the questionnaire: Belgium-nl, Croatia, Cyprus, Estonia, Finland, France, Greece, Hungary, Ireland, Lithuania, Luxembourg, Malta, Norway, Portugal, Republic of Serbia, Spain, Switzerland, and Turkey. The analysis of their answers has been followed-up by 13 interviews of experts from Croatia, Cyprus, Estonia, France, Hungary, Ireland, Lithuania, Malta, Norway, Portugal, Spain and Turkey.

The current state of AI in K12 education

AI is a topic receiving interest from policy makers in most countries, with diversity of areas of use under the spotlight. More than 30 pilot projects are already developing in twelve countries.

When asked about the current state of AI in K12 education debate in their country, most of the respondents (ES, FR, RS, FI, HR, NO, TR, LU) says that there is mild interest, five countries (MT, BE, IE, EL, PT) express significant interest; a minor one LT, CY, CH, EE, and Hungary stated that is not relevant topic.

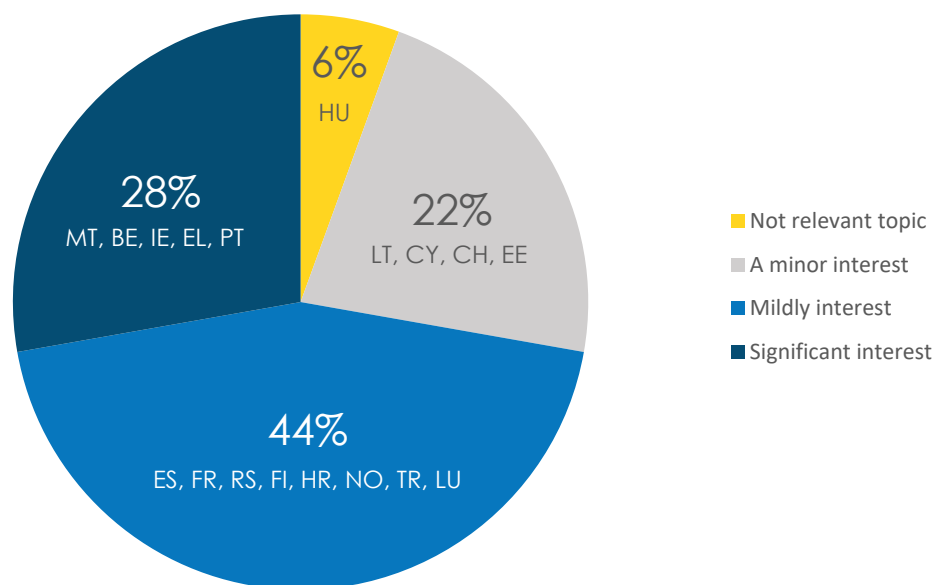


Figure 1. Current state of AI in K12 education debate

Table 1 below presenting the possible reasons for the use of AI in K12 education, highlights that most of the participants envision use of AI in *Increase support for students, Increase support for teachers and better student engagement*. *Improve teacher – student ratio* showed up as less significant reason for the use of AI. Malta additionally mentioned *Adaptive / personalised learning environment* and France *Advice and decision-making aids for the differentiation and personalisation of learning* as additional reasons.

Better student engagement	LT, FR, CY, RS, IE, FI, HR, EL, TR, PT
Improve teacher-student ratio	CY, TR
Increase support for students	MT, BE nl, FR, CY, IE, FI, HR, CH, NO, HU, EL, EE, PT, LU
Increase support for teachers	MT, ES, BE nl, FR, CY, IE, FI, HR, CH, EL, EE, PT, LU
Improve teaching quality	BE nl, CY, RS, IE, FI, HR, CH, NO, EL, PT

Table 1. Reasons for use of AI in K12 education

Most of the countries already have some projects or pilot projects connected with AI in K12 education; MT, ES, CY, NO, EL, EE, TR, PT, LU have 1 or 2 projects; France has 3 to 5 projects, and Belgium and Ireland have more than 6 projects; although LT, RS, HR, CH, HU declared no such projects, follow up interviews discovered some interesting projects in those countries too. You can find more information about projects connected with AI under titles *Examples* in next few chapters.

Regarding policy documents 7 countries do not have policies connected with AI in K12 education, 7 have them, and 3 are in the progress of developing such documents.

Although all countries express some level of interest and debate in their country state of readiness for the use of AI in K12 education showed that most of the countries started to experiment with AI in education; only France adopted AI as a core part of their education strategy, and Belgium and Malta adopted AI in some areas of education.

Have not started to consider AI in education	LT, CY, CH, HU, TR
Have started to experiment with AI in education	ES, RS, IE, FI, HR, NO, EL, EE, PT, LU
Have adopted AI in some areas of education	MT, BE nl
Have adopted AI as a core part of the education strategy	FR

Table 2. State of readiness for the use of AI in K12 education

National policies addressing AI and education developments are diverse, mostly education is mentioned in general AI strategy or AI is mentioned in digital education strategy, but more thematic and focused policy documents are expected during 2021 or early in 2022.

- General strategy mentioning AI
 - [Republic of Croatia National development strategy 2030](#)
- AI strategy in general
 - [Cyprus National Strategy on AI](#)
 - [AI Portugal 2030](#)

- [Lithuanian artificial intelligence strategy: a vision for the future](#)
- [Hungary's Artificial Intelligence Strategy 2020-2030](#)
- [AI for Flanders, AI4Belgium](#)
- [Malta's national AI strategy](#)
- [Spain National AI strategy](#)
- [France, AI for Humanity – Villani report](#)
- [Norway, National AI strategy](#)
- [Estonia's national AI strategy](#)
- [Strategy on Artificial Intelligence Development in Republic of Serbia for the period from 2020 to 2025](#)
- [Finland's Age of Artificial Intelligence](#)
- [Artificial intelligence: a strategic vision for Luxembourg](#)
- Integrated approach – Integrating the elements of AI into education or digital policies and strategies
 - [Turkey's education vision 2023](#)
 - [Ireland Digital Strategy for Schools 2015-2020](#)
 - [Spain National digital competence plan](#)
 - [Greece Digital Transformation Bible](#)
 - [Digital Switzerland strategy](#)
- Thematic approach – Focusing on AI and education
 - [Switzerland, Report on Artificial intelligence in education](#)

Learner-oriented AI

Artificial intelligence use for personalizing learning, tailoring content and learning process to students needs show as more advanced in most of the countries.

Baker and Smith (2019) approach educational AI tools from three different perspectives: a) learner-oriented AIEd; b) instructor-oriented AIEd; and c) institutional system-oriented AIEd. Learner-oriented AIEd enables students to study a subject domain in an adaptive or personalized learning management system, with the support of AI tutoring. AI could support student's learning by curating learning materials, diagnosing strengths, giving automated feedback, using academic data to monitor and guide students and adapt their learning path accordingly. AI combined with neuroscience research is already giving some insights on how learning takes place, and it is still expected to also progressively enable a high-level individualisation of learning (OECD, 2021).

Besides AI use in supporting student, several participants mentioned the importance of integration of fundamental AI learning into K-12 school curricula (including computational thinking, data and algorithm literacy, coding and statistics, creation of AI apps), which is recognized in international research too as a preparation to live and work with AI.

Regarding the presented scenarios of AI use by from and for students in participating countries more advanced use are to help students develop skills and knowledge in a more personalized and self-paced way and enabling the educational content to be tailored to student's level of understanding as they progress through it. The less advanced use concerns intelligent computer system, designed to help students to learn and helping students identify knowledge gaps and provide specialized support but differences among implementation of all mentioned scenarios are very little. Switzerland, Luxembourg and Spain answered that they do not have information about mentioned scenarios.

Figure 2 below presents the countries' answers to the question: *What is current situation in your country, are some of these scenarios present nationwide?*

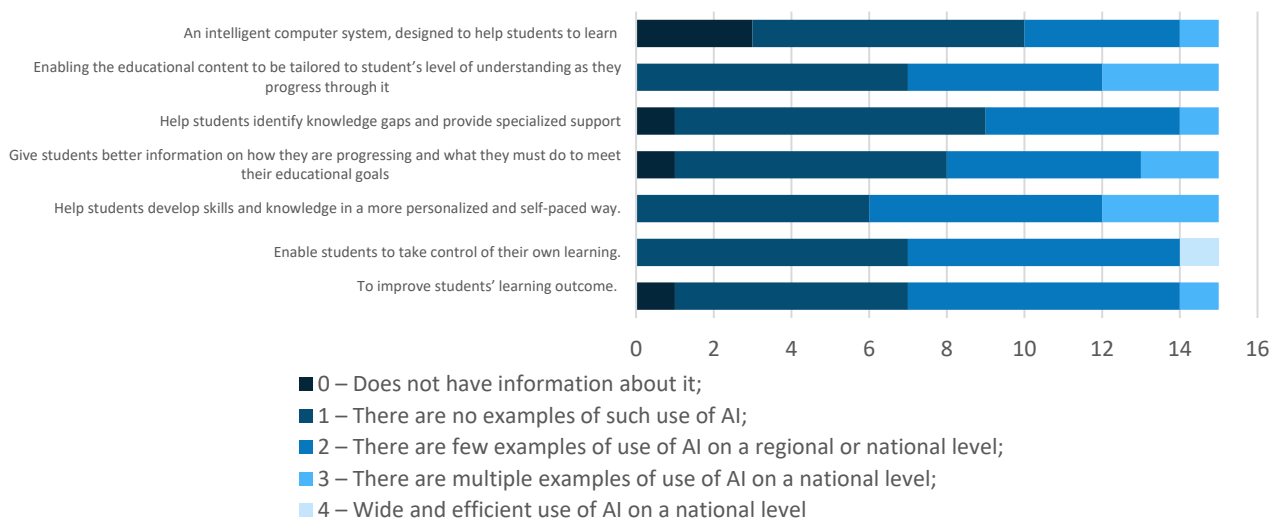


Figure 2. Current situation across countries – Learner-oriented AI scenarios present nation wide

Examples

Participating countries shared several scenarios of AI use for and from students in their education system, we could roughly group examples as:

- Learning resources about AI (green)
- Applications which use AI to personalize learning and monitor students' progress (blue)
- Chatbots or similar apps which support students in specific context (yellow)

In this collection, examples are mostly learning resources or personalized learning apps, but some of them belongs to both groups and we mention two supporting chatbots (Skilly and SomeBuddy).

Almost all learning resources mentioned in Table 3 below are created as part of international or national projects and shared under creative commons licenses or as open educational resources which mean they could be translated and reused in another educational context. Which aligns with EC recommendations that best practice should be promoted across the EU and support for their rollout provided.

<p>Artificial Intelligence for Children</p> <p>Book, learning resource created in Erasmus+ project</p> <ul style="list-style-type: none"> • Link • Turkey 	<p>AI School Challenge</p> <p>Attract students to learn basic information about the field of artificial intelligence</p> <ul style="list-style-type: none"> • Link • Croatia 	<p>EDUbox</p> <p>Learning resources about artificial Intelligence</p> <ul style="list-style-type: none"> • Link • Belgium
<p>Data Literacy</p> <p>Book for students. Knowledge centre for legal, ethical and societal aspects of artificial intelligence and data applications.</p> <ul style="list-style-type: none"> • Link • Belgium 	<p>KIKS</p> <p>Students learn to understand AI, with possibilities and limitations; how to have an impact on it</p> <ul style="list-style-type: none"> • Link • Belgium 	<p>LearnML Games</p> <p>ArtBot is a game for players of all ages which teaches the basics of Artificial Intelligence.</p> <ul style="list-style-type: none"> • Link • Malta
<p>i-Learn</p> <p>Online portal where software providers can make their digital applications for personalized learning available</p> <ul style="list-style-type: none"> • Link • Belgium 		<p>Lalilo</p> <p>Training: the pupil reads aloud and is given direct feedback on his reading in order to help him progress. Assessment: the pupil reads a text; no direct feedback is given to him. The result of this assessment is transmitted to the teacher and this result is used to improve the adaptive learning algorithm</p> <ul style="list-style-type: none"> • Link • France

<p style="text-align: center;">Kaligo</p> <p>A child reads, Kaligo analyses whether the reading is correct and provides feedback to the child to enable him to understand his mistakes and to value his achievements. A child completes a dictation, Kaligo analyses his production in real time. Feedback is given to the child and explicit teaching allows him to understand the rules of spelling. A teaching assistant helps the teacher in the preparation of the exercises, provides him with an analysis of the results of his class, allows remediation and memorization strategies and finally offers help with differentiation for children with specific needs.</p> <ul style="list-style-type: none"> • Link • France 	<p style="text-align: center;">Navi</p> <p>Navi recommends reading and writing activities adapted to the needs of your students, based on the learning traces. Artificial intelligence suggests the optimal content and completion dates for each student's memorization activities. Prepare differentiated activity sheets. This is possible thanks to the positions and the evaluations that you enter in Navi. They allow artificial intelligence to refine the memorization profile of each student. Navi is a prototype assistant based on artificial intelligence: the more you train it, the more relevant it becomes.</p> <ul style="list-style-type: none"> • Link • France 	<p style="text-align: center;">Adaptiv'Math</p> <p>Adaptiv'Math is a teaching assistant for teaching and learning mathematics. An initial diagnostic test makes it possible to constitute groups of students by profile. Exercise courses permanently adapted to each student, allowing them to progress at their own pace. A prior learning test and a fun reward system to motivate the student. A summary of each student's results to follow their progress, progress and results by skill. Support for formative assessment through initial and verification tests throughout the students' journey.</p> <ul style="list-style-type: none"> • Link • France
<p style="text-align: center;">Mathia</p> <p>Mathia is a Web and Mobile application built with and for schoolteachers and students. Immersive companion who aims to make the student actor of an educational game in which he is the protagonist and on which he progresses by accumulating stars. Students benefit from an innovative and engaging experience, combining voice assistant and 3D visualization tools, in particular promoting spatial representation in the context of geometry and pictorial or symbolic representation in counting exercises. For individual, group or collaborative classroom use.</p> <ul style="list-style-type: none"> • Link • France 	<p style="text-align: center;">Smart Enseigno</p> <p>Smart Enseigno offers students varied learning activities in mathematics, as close as possible to their needs. Smart Teaching is designed in such a way that the learning times realized using the so-called "learning" paths with assistance constitute a continuous formative evaluation, as close as possible to the needs of the students. If the teacher wishes, this collected data can be used by Smart Teacher to suggest remedial courses or to better perceive the state of knowledge of his students at a given time.</p> <ul style="list-style-type: none"> • Link • France 	<p style="text-align: center;">FinEduAI</p> <p>Artificial intelligence on a high school student's learning path. AI tutor "My Artificial Life Time Intelligence Tutor" is being developed, which uses Big data collected by suitable learning platforms for self-development. This information is used to make big data visual for the learner and the teacher. The aim is to co-operate significantly with Finnish universities as well and to develop new ways and contents of learning that utilize artificial intelligence, for example by studying the adaptability of artificial intelligence in learning and assessment.</p> <ul style="list-style-type: none"> • Link • Finland
<p style="text-align: center;">SomeBuddy</p> <p>Web app where users can report cyberbullying or harassment online and receive a tailor-made response including legal advice and psychological first aid.</p> <ul style="list-style-type: none"> • Link • Finland 	<p style="text-align: center;">Chatbot Skilly</p> <p>Chatbot prepared for students in virtual environment used for remote teaching and learning (Teams) as practical example of AI</p> <ul style="list-style-type: none"> • Cyprus 	

Table 3. Examples of learner-oriented AI resources and apps

Instructor-oriented AI

Artificial intelligence use for monitoring students' performance and identifying struggling students so teachers can then adapt their teaching show as more advanced in many participating countries.

An instructor-oriented AI can automate tasks such as administrative procedures, assessments, plagiarism detection, and provision of feedback. These systems can also help teachers monitor students' learning progress so that intervention could be provided proactively. Teacher-facing systems are used to support the teacher and reduce his or her workload, provide insight into the learning progress of students so that the teacher can proactively offer support and guidance where needed (Holmes, 2020).

AI assistant can provide the teachers with a summary of the individual progress of each student, the type of participation each of them has had in their work and information about the learning style of each student, so that the teachers can intervene when they consider it convenient. When talking about assessment and evaluation applications supported by AI typical use are automated grading, automated feedback providing, evaluation of student understanding, engagement and academic integrity (UNESCO, OECD, 2021).

Regarding the presented scenarios of AI use by and for teachers in participating countries more advanced are about monitoring the performance of students so teachers can then adapt their teaching and identifying students struggling with a particular topic. The less advanced are about AI-enabled plagiarism detection and AI-enabled conversational robot (teacher or assistant chatbot). Switzerland, Luxembourg and Spain answered that they do not have information about mentioned scenarios.

Figure 3 below presents the countries' answers to the question: *What is current situation in your country, are some of these scenarios present nationwide?*

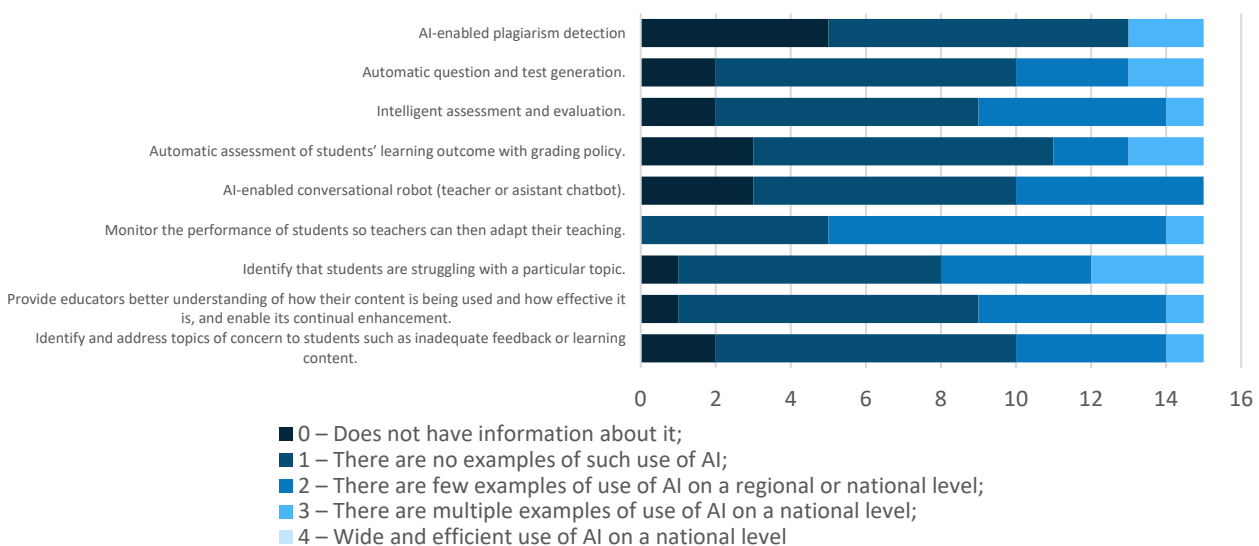


Figure 3. Current situation across countries – Instructor-oriented AI scenarios present nation wide

Examples

Participating countries shared several scenarios of AI use for and by teachers in their education system, we could roughly group examples as:

- Professional development and teacher training about AI (green)
- Teaching and learning resources about AI (yellow)
- Resources about ethics and transparency of AI (blue)

As you could see in the previous set of examples many of the learner-facing applications deal with the teacher-facing functions too. All of six French applications (Navi, Kaligo, Latio, Adaptiv'Math, Mathia, Smart Enseigno) have built-in teacher assistants which helps the teacher in the preparation of the exercises provides monitoring and analysis of the students and class progress and results, offers differentiation for children with specific needs, support for formative assessment, suggests the optimal content and completion dates for each student.

It is significant that among professional development for teachers are also resources about ethics and transparency of AI which enable teachers to understand possibility, limitations, and risk of AI in education and also to recognize the balance between protective and facilitative development of AI in order to help ensure the best outcomes for all stakeholders. More resources focused on AI ethics are mentioned under system-oriented AI. Collected examples from participating countries show the importance of teacher's role in the development of AI as stated by European Parliament, UNESCO, and OECD.

<p>Artificial Intelligence and its applications in learning</p>	<p>FATE – The Winter School</p>	<p>CyCAT</p>
<p>Teacher Training Program for the Development of Digital Competence</p> <ul style="list-style-type: none"> • Link • Cyprus 	<p>Fairness, Accountability, Transparency and Ethics in AI – Series of Seminars on Algorithmic Transparency</p> <ul style="list-style-type: none"> • Link • Cyprus 	<p>Cyprus Center for Algorithmic Transparency; EU-H2020 funded Twinning project</p> <ul style="list-style-type: none"> • Link • Cyprus
<p>Will AI transform the school as we know it?</p>	<p>Artificial Intelligence with Intelligence</p>	<p>AI4T</p>
<p>MOOC, Identify potentialities and implications of the use of Artificial Intelligence in the area of Education</p> <ul style="list-style-type: none"> • Link • Portugal 	<p>MOOC, A training available to everyone from 7 to 107 years old to question, experiment and understand what Artificial Intelligence is</p> <ul style="list-style-type: none"> • Link • France 	<p>Artificial Intelligence for and by teachers, training on artificial intelligence, educational resource, awareness, Erasmus+ KA3 project</p> <ul style="list-style-type: none"> • Link • France, Slovenia, Italy, Ireland, Luxembourg

<p>School of Computational Thinking and Artificial Intelligence</p>	<p>KlasCement</p>	<p>Smart School 2025</p>
<p>Open educational resources and training for teachers</p> <ul style="list-style-type: none"> • Link • Spain 	<p>Educational materials for teachers for all ages and subjects</p> <ul style="list-style-type: none"> • Link • Belgium 	<p>Project about artificial intelligence, Computer Vision and Big Data</p> <ul style="list-style-type: none"> • Link • Luxembourg
<p>Introduction to Artificial Intelligence Concepts</p>	<p>Artificial Intelligence Education for Children</p>	<p>EDUbox</p>
<p>AI Guidebook for Teachers</p> <ul style="list-style-type: none"> • Link • Turkey 	<p>Lesson plans and learning resources for children Erasmus+ KA201 project</p> <ul style="list-style-type: none"> • Link • Turkey 	<p>Artificial Intelligence learning resources for teachers and students</p> <ul style="list-style-type: none"> • Link • Belgium
<p>Scoilnet</p>	<p>AI in Education</p>	<p>Learn ML</p>
<p>Resources on AI for teachers and students</p> <ul style="list-style-type: none"> • Link • Ireland 	<p>A Practical Guide for Teachers and Young People</p> <ul style="list-style-type: none"> • Link • Malta 	<p>Teaching and learning computational thinking, Artificial Intelligence and Machine Learning, Erasmus+ project</p> <ul style="list-style-type: none"> • Link • Malta
<p>Sch.gr</p>	<p>Educational technology compass</p>	<p>The Data & Society Knowledge Center</p>
<p>The Panhellenic School Network educational resources</p> <ul style="list-style-type: none"> • Link • Greece 	<p>Additional overview of technological trends related to education with expert recommendations on Artificial intelligence</p> <ul style="list-style-type: none"> • Link • Estonia 	<p>Knowledge centre for legal, ethical and societal aspects of artificial intelligence and data applications.</p> <ul style="list-style-type: none"> • Link • Belgium

Table 4. Examples of instructor-oriented AI resources and apps

Institutional system-oriented AI

Artificial intelligence use on system level shows adjust teaching strategies, smart content and learning pathways according to students' learning effectiveness as more advanced in the most of the countries.

On the education system level artificial intelligence tools can provide useful insights to administrators and decision-makers, like enrolment and attrition patterns across disciplines or schools, smart learning analytics, etc. Significant developments in last five years moved education systems closer to personalised learning especially one device per student and learning analytics availability. The continuous use of technology in classrooms and further integration of technology into day-to-day school practices allows students to follow personalized learning path supported with power of data and development in the field of learning analytics. Learning technologies that include learning analytics and AI techniques have started to be used at scale in schools providing information for all stakeholders: students, teachers, parents, school, and education system (European Parliament, OECD 2021).

Regarding the presented scenarios of AI use on the system level in participating countries more advanced are about smart content, learning pathway, and recommendation, and adjusting teaching strategies and teaching materials design according to students' learning effectiveness and the less advanced is about evaluating students' learning behaviour with good learning strategy. Switzerland, Luxembourg and Spain answered that they do not have information about mentioned scenarios.

Figure 4 below presents the countries' answers to the question: *What is current situation in your country, are some of these scenarios present nationwide?*

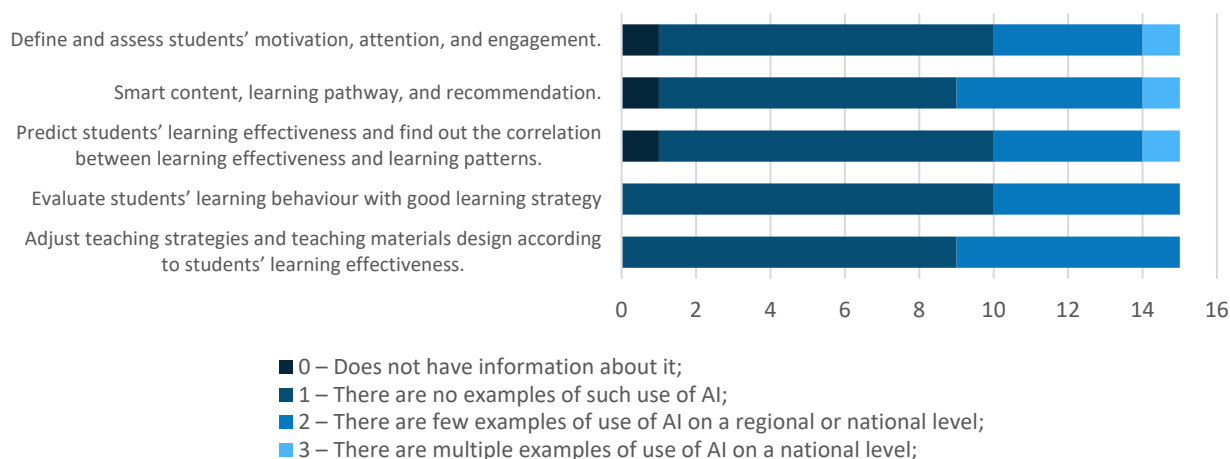


Figure 4. Current situation across countries – Institutional system-oriented AI scenarios present nation

Examples

Education is usually fragmented learning ecosystem which is challenging for all stakeholders and makes learning analytics on school or national level very complex. A school may use several different artificially intelligent technologies, a student sometimes uses five or six different technologies within a single class. Those are major obstacles to integration and interoperability. Developing integration between AIED learning technologies, may reduce inefficiency improve students' learning experiences and enable learning analytics on a higher level.

The goal of learning analytics is to use the data coming from education to better understand and make inferences on learners and the contexts which they learn from. Learning analytics and educational data mining apply the methods of machine learning/data science to education, with methods and problems emerging specific to education (OECD, 2021).

Interoperability challenge could be recognized in examples collected for this report, the Estonian project is trying to create an interoperable application ecosystem and Norway use to connect more and more education services to their single sign-on page. Several levels of learning analytics are visible in examples, from data collection and analysis in single application towards wider analysis on school cluster or even national level. It is very interesting and encouraging that implementations are backed up with research and dialogues about legal, ethical, and societal aspects of data collection, analysis, and use of AI in learning analytics.

Insights	Analizler	DIMA-LT 202
Insights in Microsoft Teams uses at-a-glance data views to help you catch up on all your students' Teams activity, from assignment turn-in to engagement in class conversations. <ul style="list-style-type: none"> • Cyprus 	Learning analytics, exams research reports <ul style="list-style-type: none"> • Link • Turkey 	Artificial intelligence in schools: scenarios for the development of learning analytics through modernization general education in Lithuania. Learning analytics application monitoring and its search for ways to develop. <ul style="list-style-type: none"> • Lithuania
Moral Machine Ethics in Artificial Intelligence <ul style="list-style-type: none"> • Link • Spain 	TRANSFORM-ED 2021 Solutions for the use of artificial intelligence and digital technologies to improve the quality of education in response to COVID-19 <ul style="list-style-type: none"> • Link • Lithuania 	The Data & Society Knowledge Center Knowledge centre for legal, ethical and societal aspects of artificial intelligence and data applications. <ul style="list-style-type: none"> • Link • Belgium

AuroraAI	Learning analytics	Éducation, numérique et recherche
<p>Towards a human centric society – national artificial intelligence programme. A concept for human-centric and ethical society in the age of artificial intelligence AuroraAI service model A service model for creating a human centric service market around a selected life-event or business activity</p> <ul style="list-style-type: none"> • Link • Finland 	<p>Learning analytics and such technology are highlighted in the national digitization strategy. Activity data for Assessment and Adaptation. Involve several suppliers, municipalities and schools</p> <p>Framework for learning analytics. The goal of the framework is to support adaptive learning and recommendation of relevant learning resources.</p> <p>Feide – a service for unified identity management in the Norwegian education sector; single sign on page with more than 600 available services</p> <ul style="list-style-type: none"> • Link • Norway 	<p>Monitoring and dissemination of research on digital technology in education. Thematic groups of research-action between researchers and teacher-trainers.</p> <ul style="list-style-type: none"> • Link • France
Delta	Data analytics and interoperability	KlasCement
<p>The CARNET Delta Learning Analytics and Educational Data Mining Information System covers the measurement, collection, analysis and reporting of student data and their contexts to understand learning and the environment in which learning takes place. Learning analytics is used to predict, personalize, and intervene when students need help, visualize learning information, and create systems to predict student achievement. Available with nationwide accounts: AAI for student and teachers or e-resident for parents. Dashboards: students, teachers, parents, school or system level</p> <ul style="list-style-type: none"> • Croatia 	<p>Vision of data analytics and interoperability in education. The creation of an interoperable application ecosystem (data factory) will take place in collaboration with existing webmasters and developers, starting with smaller experiments to learn from and lessons learned. Improving the traceability of web use</p> <p>Improving content discoverability, Development of analytical applications, Improving the usability of content</p> <ul style="list-style-type: none"> • Link • Estonia 	<p>Artificial intelligence is used to support them in their work and to increase the consistency of the metadata. Integration in process: a recommender system for learning resources. The first recommends learning resources, based on the profile of the newly registered user. This recommender shows items used by teachers with similar profiles on that date. The second works with a collaborative filtering system and targets more experienced users. This recommender shows items downloaded on that date by teachers with similar interests (using similar resources).</p> <ul style="list-style-type: none"> • Link • Belgium

Table 5. Examples of system-oriented AI resources and apps

Challenges and possibilities

All countries recognize challenges in artificial intelligence use in education and possibilities that lay in collaboration and sharing expertise.

When asked what are the challenges for teachers in developing or acquiring the necessary skill sets for an AI-enabled education the most frequent answers are about the lack of suitable training programs for them to take (MT, ES, FR, CY, RS, FI, HU, HR, CH, EL, EE, PT, LU); and the lack of time (MT, ES, FR, CY, IE, FI, TR, PT, LU) and They have no interest (LT, MT, CY, FI, HU, EL).

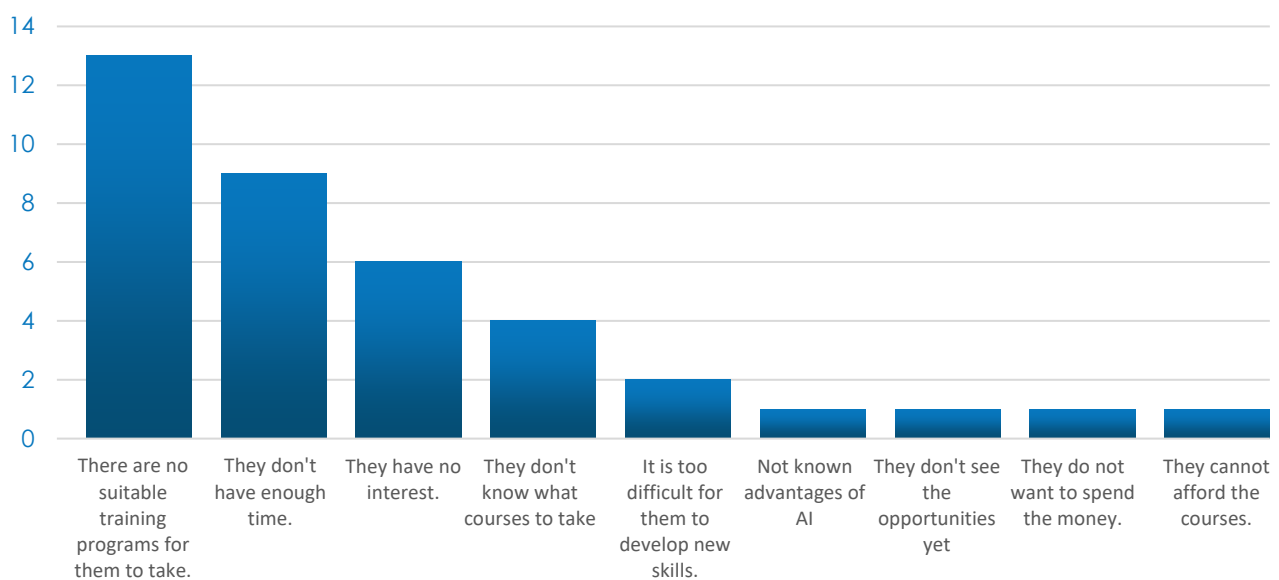


Figure 5. Challenges for teachers

When asked what the challenges on the country level are for an AI-enabled education, participants answered:

- There is not enough money for a such initiative (9)
- There are no experts in AI education area (5)
- There is no interest (1)
- It is too difficult (1)

With additional comments:

- No clear initiatives to support educational processes
- There is no initiative at the national level yet
- Still very early adoption of AI in the field of education, the technology is not widely available yet
- We do not have a national platform for digital adaptive learning, assessments, examinations, etc. yet. Hence, we still lack the barebones structure required for an AI-enabled education.

Regarding the level of specialized analytics model, most of the countries show that there is a space for acquiring more powerful analytics supported with AI having in mind ethics and social repercussions. The future of learning analytics lays in augmented analytics, which applies machine learning and natural language processes to identify patterns that humans might miss, and in predictive analytics, which focus on machine, learning techniques that predict future outcomes based on historical data. Actual feedback is that participants consider their country has learning analytics and reporting tools (6 countries), simple end-user tools such as Excel (2), low-level learning analytics (5), augmented learning analytics, business intelligence, machine learning tools, and predictive systems (1).

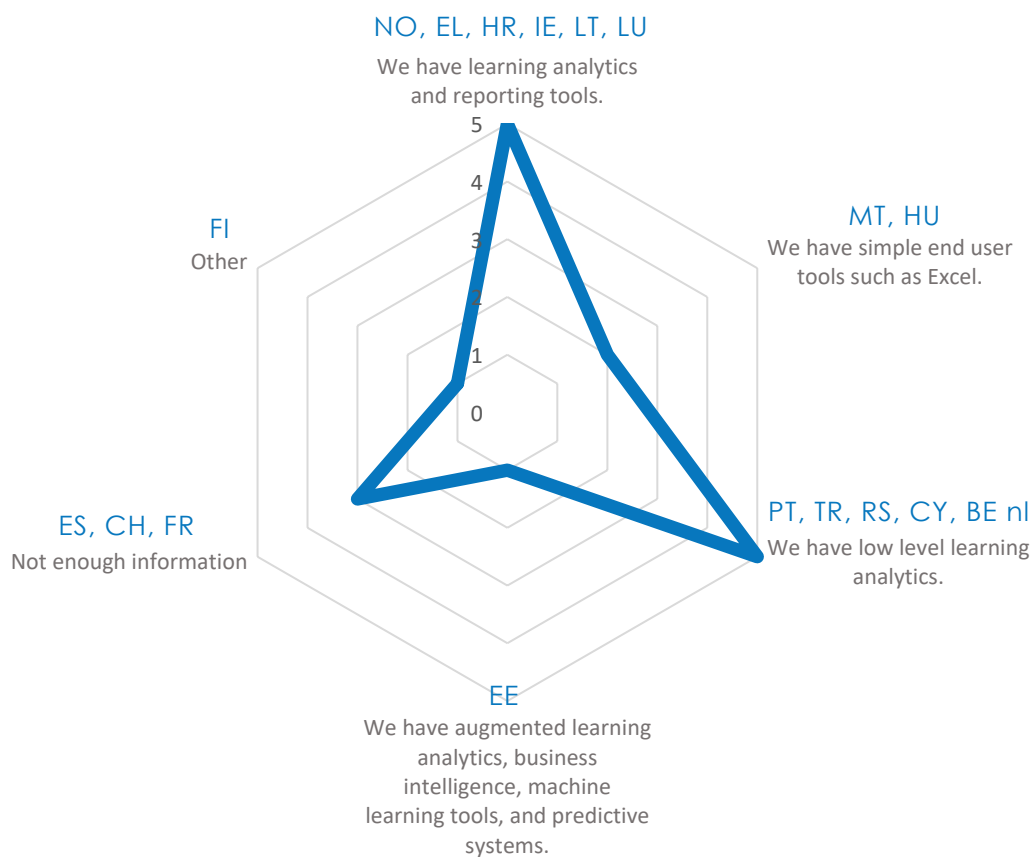


Figure 6. Level of specialized analytics model

Most of the countries expressed interest in support from the European Schoolnet in sharing the expertise of successful implementation of AI and development of vision and strategy on why and how to use AI for education system improvement.

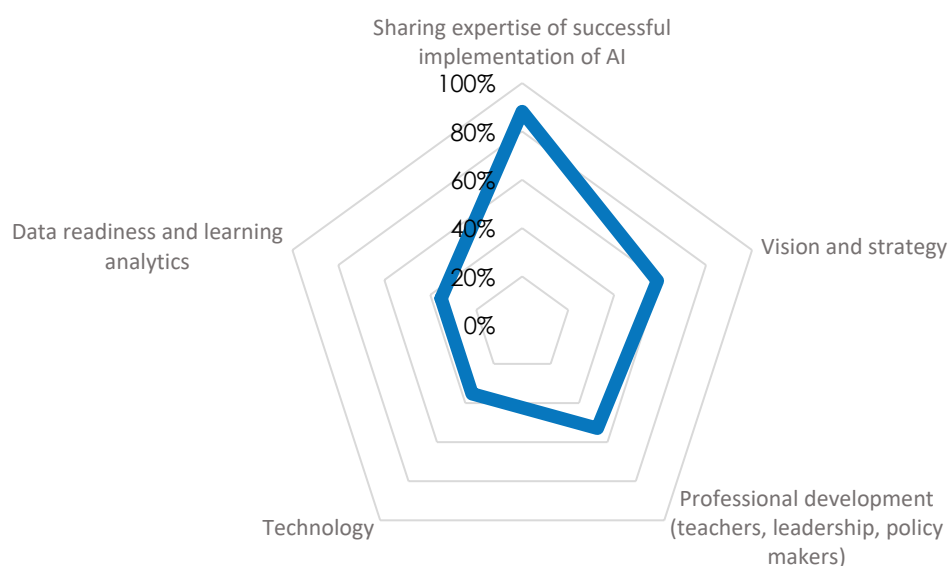


Figure 7. Areas in which European Schoolnet could help countries in further development of AI in education

Ethics and Risks

In education, as in all other areas, development and use of AI should be guided by the ethical principles of transparency, explainability, fairness, accountability, and responsibility (European Parliament, 2021). AI systems and their decisions should be explained in a manner adapted to the stakeholder concerned having in mind that education and educational opportunities are a fundamental right for everyone so AI should have embedded principles of ethics, privacy and security by design.

The first concern regarding AI use is privacy and data governance because the education system generates a huge amount of data mostly from minors which calls for extra caution while taking into account the quality and integrity of the data and ensuring legitimised access to data. All stakeholders must be mindful of the legal issues and ethical risks related to data ownership, data privacy, and data availability for the public good.

Education has considerable influence in shaping people's beliefs and values and are a fundamental tool for combatting discrimination and gender stereotypes. As gender inequalities, stereotypes and discrimination can be created and replicated through the AI-powered application therefore an ethical and regulatory framework must be in place ahead of implementing AI solutions as it could have multiple negative implications, from the marginalization of vulnerable groups, the exacerbation of prejudice and discrimination to the risks of doing harm by the scaling-up of bad pedagogical practices (European Parliament, 2021).

The application of AI in education could be intrusive and de-humanising: intrusive because some applications require continual monitoring of student actions, gestures and emotions; de-humanising

because some AI requires students to fit into prescriptive methods of teaching, with minimal human interaction, following automated learning pathways (UNESCO, 2021). AI is good at reading and predicting human emotions, algorithms can recognise emotions, analyse the words that people use, the tone of voice, facial expressions and movement patterns. That also means AI is powerful at influencing human emotions, catching and holding attention, encouraging certain behaviours or even manipulating decisions. European parliament recommends that the Commission and the Member States ban automated biometric identification, such as facial recognition for educational and cultural purposes.

UNESCO recommendations for ethical questions:

- What criteria should be considered in defining and continuously updating the ethical boundaries of the collection and use of learners' data?
- How might schools, students, and teachers opt-out from, or challenge, their representation in large datasets?
- What are the ethical implications of not being able to easily interrogate how AI makes decisions (using multi-level neural networks)?
- What are the ethical obligations of private organizations (product developers) and public authorities (schools and universities involved in research)?
- How does the transient nature of students' interests and emotions as well as the complexity of the learning process impact on the interpretation of data and ethics of AI applied in educational contexts?

Equity

AI technologies may have the potential to advance inclusion and equity in education using solutions such as speech recognition and transcription, virtual assistants, and digital representations of physical objects, early detection of dyslexia, artificial voices for people who are unable to speak, augmented reality applications to help deaf children read by translating texts into sign languages, diagnose specific learning difficulties and personalize learning pathways etc (UNESCO, 2021).

The use of AI in education systems brings a wide range of possibilities, opportunities, and tools for making it more innovative, inclusive, efficient, and increasingly effective by introducing new high-quality learning methods that are personalised and student centric. But AI could also be a source of inequity and a missed opportunity if developers of artificially intelligent educational technologies do not pay attention to individuals with special needs ensuring that AI tools and opportunities are available for all social groups, especially people with disabilities, historically underserved and underrepresented populations, including ethnic/racial minorities and linguistic minorities (OECD, 2021).

Fostering diversity, AI systems should be accessible to all and involve relevant stakeholders throughout their entire life circle.

Potential to be confirmed and recommendations

All examples mentioned in this report lead us towards the idea of the powerful and immersive use of AI in education in near future. Interactive dialogues discussing the role of data, learning analytics, and AI in education will help in achieving innovations beyond the current state and learn how to grasp the endless possibilities AI offers education, as well as how to mitigate the risks associated to it.

Some of the potential use of AI in education by UNESCO:

1. AI-driven lifelong learning companions
2. AI-enabled continuous assessment
3. AI-enabled record of lifelong learning achievements
4. AI-powered teaching assistants
5. AI-driven discussion forum monitoring
6. AI-human 'dual teacher' model

But bright future of AI in education must be ensured with the establishment of AI-specific criteria based on independent and rigorous pedagogical research and methodologies, providing evidence-based guidance that allows all stakeholders to navigate among offerings of AI-based technologies.

UNESCO emphasize the importance of supporting interdisciplinary approach to research, innovation, and analysis on the effects of AI on learning practices and outcomes, and on the emergence and validation of new forms of learning, creation of multi-stakeholder partnerships and mobilization of resources to reduce the AI divide and increase investment in the application of AI in education

OECD Recommendation for AIED development and use:

1. Govern ethics by design, transparency and data protection
2. Improving learning technologies with public-private partnership
3. Engaging teachers and education professionals in R&D

Interactive dialogues discussing the role of data, learning analytics, and AI in education will help us in achieving innovations beyond the current state and learn how to grasp the endless socially beneficial and pedagogically justified opportunities AI could offer to education.

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Appendixes

1. [Country cards](#)
2. [Presentation](#)



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European Schoolnet – EUN Partnership AISBL
Rue de Trèves 61, B-1040 Brussels
+32 (0)2 790 75 75