European Agency for Safety and Health at Work

Artificial intelligence and education – a teacher-centred approach to safety and health

Report

European Agency for Safety and Health at Work

Safety and health at work is everyone's concern. It's good for you. It's good for business.

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Executive Summary

Introduction

This report examines the opportunities and risks associated with the integration of new digital technologies for the health, safety and wellbeing of teachers in schools. This is viewed both from the perspective of occupational safety and health (OSH) and a pedagogical perspective.

A comprehensive overview of the possible risks and opportunities for teachers from the integration of technologies, in particular based on artificial intelligence (AI), is provided based on a systematic analysis. Suggestions are also given of potential measures for improving the health, safety and wellbeing of teachers in the digital age.

Background

The European Agency for Safety and Health at Work (EU-OSHA) has already submitted important findings for the education sector with the publication of 'Education - evidence from the European Survey of Enterprises on New and Emerging Risks (ESENER) (2022)', 'OSH Pulse - Occupational safety and health in post- pandemic workplaces (2022)' and the report 'Mental health at work after the COVID-19 pandemic (2024)'. Publications are also available from EU-OSHA specifically on the impact of artificial intelligence on OSH (2021; 2022 AIWM; 2022 AIWM Regulations). And, finally, the EU-OSHA campaign 'Safe and healthy work in the digital age 2023-2025', which is Europe-wide, provides the opportunity to further explore the topic of health, safety and wellbeing of teachers in the digital age.

A focus on teachers

So far, learners have been the primary focus when it comes to the integration of digital technologies in the education sector. Teachers have been viewed, if at all, first and foremost in their role as mediators and primarily as users of digital tools. With AI-based technologies making their way into schools, greater attention is now also being paid to teachers — now in their role as those responsible for deploying these technologies and for coping with their challenges.

The COVID-19 pandemic

The COVID-19 pandemic was the trigger for a global disruption in the education system and an ad hoc surge in digitalisation, bringing an increased mental load and stress for teachers. For teachers in particular, the pandemic also brought great uncertainty, increased workload and digital stress, with both cognitive and emotional elements. Schools were also tested as organisations. The 'digital maturity' of a school, that is, having a good digital infrastructure but above all technical and pedagogical support for teachers, and school processes focused on digital teaching and learning, contributed to lower loads and stresses being experienced by teachers.

Evidence of the following strains on the digital well-being of teachers during the COVID-19 pandemic has been provided by initial longitudinal studies: uncertainty; a high workload, in particular at the end of the pandemic; and the feeling of being undervalued as an occupational group. Resources emerged in the form of the availability of social support, the ability to determine one's own work (work autonomy) and the use of functional coping strategies. New and younger teachers and those with prior illnesses were identified as being particularly at risk. Institutional decisions at school level have a key role to play in the perceived wellbeing of teachers during the COVID-19 pandemic.

New challenges for teachers resulting from the use of AI-based digital technologies in schools

Both traditional digital technologies and AI-based technologies contribute to greater flexibility for teachers. Use of these technologies, however, also increases the demands placed on the technical competencies of teachers, on their media skills in terms of didactics and their social competencies. The use of learning analytics for teaching and learning also imposes new demands on teachers' competence. These are demands extending beyond technological knowledge, and concern their pedagogical and technological judgement. The development of generative AI (GenAI) and in particular the arrival of ChatGPT in schools means teachers are now also faced with a new uncertainty: GenAI independently generates new content that then has to be interpreted and its origin explained.

New risks and opportunities from the use of AI-based digital technologies for teachers

The six factors of workload, autonomy, professional development, ethics, regulative framework and costs are used as the basis for specifying the following main risks and potential for the use of AI-based digital technologies for the health, safety and wellbeing of teachers.

Risks

- Lack of transparency (and explainability) of AI systems increases the cognitive load.
- Digital control and surveillance using real-time data can affect mental health.
- Human–robot collaboration may result in interaction being removed from the work of teachers.
- A tendency towards acting in machine-readable form ('prompt engineering').
- An excessive trust in AI technology.

There are also general challenges inherent in technology, such as:

- bias problems inherent in AI;
- problems of 'hallucination';
- lack of technical reliability and accuracy of AI systems; and
- risk of misuse of AI.

Additionally, challenges for the teaching profession include:

- loss of specific skills;
- risk of deprofessionalisation;
- a lack of validation of AI-based systems for use in the education sector; and
- non-compliance with data protection when using AI-based technologies in the education sector.

Opportunities

To reduce teacher workload there is need for:

- reduction in workload for routine tasks, such as marking;
- support with lesson planning, e.g. course development;
- reduced amount of work and greater precision when grading;
- support with the development and implementation of alternative integrated learning scenarios, e.g. transdisciplinary approaches, vertical teaching, mixed classes;
- simplification of resource planning (task and time schedule) and optimisation of work organisation in the school; and
- involvement of AI-based systems in the school's risk assessment.

To expand the scope of action available to teachers, recognise that:

- autonomy is maximised when teachers maintain control in a transparent manner over their entire work process ('human-in-command' approach); and
- more time is needed for pedagogical tasks and own professional development as well as being creative or developing creativity.

To support teachers' professional development, aim at:

- easier access to professional development for teachers;
- greater flexibility in the use of further training and consultation services;
- enabling new forms of exchange between colleagues, e.g. via platforms and eCommunities; and
- enhancing of the teaching profession as a result of AI expertise.

Strategies and measures for minimising the risks and exploiting the opportunities for teachers

In order to use AI in the education sector, which is an area defined as a high-risk one (EU AI Act), a proactive strategy must be developed where the health, safety and wellbeing of teachers and learners are given the highest priority.

AI-based technologies must be introduced gradually into the education system. In doing so, the risks and opportunities of AI-based technologies in relation to the health, safety and wellbeing of teachers must be considered.

The development of an AI school strategy is a necessary prerequisite for the safe and healthy integration of AI-based technologies into teaching and school administration.

The concept of AI literacy must be expanded to include the aspects of health, safety and wellbeing of teachers and learners.

Measures must be offered to support teachers, for example, the self-management of wellbeing, socio-emotional support programmes, but also measures supporting role reward and to increase the attractiveness of the teaching profession.

1 Introduction

1.1 Research questions

What are the opportunities and risks associated with the integration of digital technologies in education and everyday school life in terms of the health, safety and wellbeing of teachers? How do teachers and educational establishments deal with the challenges they face as a result of rapid technological development?

Currently there are no simple or conclusive answers to these questions. Firstly, the rate of development of digital technologies is faster than the rate at which their integration within the education sector can be scientifically evaluated and conclusively assessed; secondly, the speed of integration of digital tools varies by country and educational facility; and thirdly, it is still unclear under which conditions digital technologies contribute to the quality of education and whether the use of new digital technologies has been tested for consistency with educational objectives.[1]

Whether the focus is on integration of digital technologies in education or even on digital education, attention has so far primarily been directed at the learners, in other words pupils and students. So far, teachers have been viewed, if at all, first and foremost in their role as mediators and therefore primarily as users of digital tools. Studies examining how digital technologies affect teachers' health, safety and wellbeing are rare.[2] This is also the case for studies addressing the proactive role for teachers in shaping related technological developments.[3]

This report focuses on the impact of digitalisation on teachers in general education schools. To explore the issue in greater depth, the subject is considered from both an educational as well as an occupational safety and health (OSH) perspective. Due to the speed of technological development, a distinction is drawn between the use of traditional digital technologies and teaching and learning technologies based on artificial intelligence (AI). The impact of traditional digital technologies on the health, safety and wellbeing of teachers is considered through the 'lens' of the COVID-19 pandemic; the integration of AI-based technologies in education, the potential they offer and the challenges they pose for teachers are analysed and discussed to the best of current knowledge. At the time of preparing this report, research on the impact of AI on the health, safety and wellbeing of teachers is not yet available.

1.2 Structure of the report

The report starts with a short description of the current state of use of digital technologies in the education sector in Europe (EU-27) (Chapter 2). Following this, a more in-depth look is taken at what triggered the global surge in digitalisation in the education sector, at the COVID-19 pandemic as a never-before-seen disruption to the education system, and at its impact on the health, safety and wellbeing of teachers (Chapter 3). Reference is made to key theoretical models as well as to the concepts of 'digital stress' and the 'digital wellbeing' of teachers (Chapter 4). The potential and risks for teachers associated with the use of digital technologies based on AI are analysed on the basis of six factors. Due to the dynamic nature of technological development, particularly in the area of AI, the description here must necessarily remain partially incomplete (Chapter 5). The seventh and final chapter provides recommendations for a teacher-centred approach to the integration of AI-based technologies in schools (Chapter 6).

[1] EU-OSHA has been working on systematically integrating (mainstreaming) occupational safety and health (OSH) into education since 2002. The guiding principle of mainstreaming OSH into education is that the integration of safety and health into the curricula and the working and learning environment of educational institutions contributes significantly to improving the quality of education. See: https://osha.europa.eu/en/themes/mainstreaming-osh-education

[2] Since 2020, there has been an ever-increasing number of publications dedicated to the impact of the COVID-19 pandemic specifically on the mental health of teachers. Digitalisation is not always mentioned in this context. See the literature study by Duarte Santiago et al. (2023). For the most recent literature study on the wellbeing of teachers, see Nwoko et al. (2023).

[3] See: Magnusson 2023; Giannini 2023.

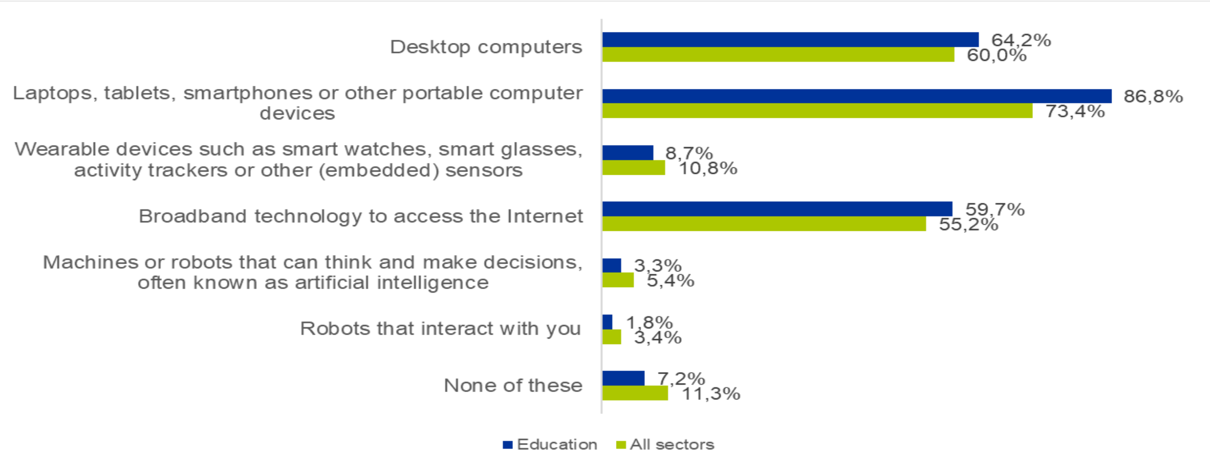
2 Digital technologies in the education sector in Europe

2.1 Current state of use of digital technologies in the education sector

According to the European Survey of Enterprises on New and Emerging Risks (ESENER), the use of digital technologies in the education sector is relatively high. Eighty-eight per cent of educational institutions use stationary PCs and 83% use laptops, smartphones and 'other mobile computer devices' (EU-OSHA 2022 ESENER Education, 67; cf. Vincent-Lancrin et al. 2019, 162). In the classroom, 'other mobile computer devices' include, for example, tablets, interactive whiteboards, e-books, smart phones and use of the internet as a means of exchanging data and information; they are also used as an element in the digital infrastructure of an educational facility (BitKom 2023; Mußmann et al. 2021, 98ff.). According to the ESENER study, use of the devices initially referred to above ranges from 71% in Sweden to 98% in Hungary, and in the case of mobile devices from 71% in Italy to 100% in Finland.

According to the European Agency for Safety and Health at Work's (EU-OSHA) OSH Pulse 2022 survey, 59.7% of facilities in the education sector have high-speed broadband internet access, which is above the comparative figure of 55.2% for other sectors.

Figure 1: Use of digital technologies by EU workers



Base: all respondents, EU-27 (n=25,683)

Source: EU-OSHA 2022 OSH Pulse

Alongside public administration and financial services, the education sector in Europe also has the highest prevalence of employees who occasionally or partly work remotely (Eurofound 2023, 52).

Differences however can be identified in the use of digital technologies for educational purposes between individual countries or groups of countries in Europe, for example between Scandinavian countries (with the exception of Norway) and eastern European countries (with the exception of Hungary and Estonia) (EU-OSHA 2022; ESENER 2019; Fraillon 2020, 190; see also UNESCO 2023 GEM, 69).

The figures however also document that while the use of digital technologies in educational facilities in the EU-27 is relatively widespread, there are still organisations where use of digital tools is not the norm (EU-OSHA 2022 ESENER Education, 67).

According to EU-OSHA's OSH Pulse 2022, use of AI-based technologies such as wearables and robots is still much less in evidence in the EU-27 as a whole, but particularly in the education sector: discussion regarding risks from use of these technologies to health, safety and wellbeing is somewhat disproportionate to their use. For example, according to the ESENER study from 2019, a usage rate of 8.7% for wearable devices compares to a value of 50% when it comes to discussion of the potential influence of smartwatches, smart glasses, activity trackers or other integrated sensors (cf. EU-OSHA ESENER Education 2022, 79; EU-OSHA 2022 AIWM, 15).

To date, there are very few examples of the use of so-called 'social robots' in schools in Europe: these include use for the early acquisition of a second language in a preschool setting in the Netherlands and the use of telepresence robots in Norway and France for pupils with long-term illnesses (OECD 2021, 145, 148; cf. Hein and Nathan-Roberts 2018; Anwar 2019).

2.2 Traditional digital technologies in school

Digital technologies have been used in schools since the 1980s which saw the emergence of personal computers and so-called e-learning in the form of 'programme-based learning' (Auswald 2023). In the mid-1990s, the World Wide Web was made accessible to the general public. Virtually all digital applications in the education sector are based on the internet. These include learning management systems (LMSs), open educational resources (OERs) and massive open online courses (MOOCs) (Weller 2020, 19).[4]

The internet enabled learning platforms to be integrated in teaching, such as the platform Moodle that was launched in 2002. Their LMSs gave teachers the opportunity to create and administer courses that pupils could work on independently. In the same year, the first OER was published. The OER approach means that training content is created with an open licence which means it is freely accessible and can be adapted. It is intended that content should also be free of charge and reusable.[5] This increases teachers' flexibility, but at the same time it also increases the demands on their technical and media competencies in relation to teaching methodology.

Around 2006, attention shifted from static websites, with the user taking more of a passive role, to so-called Web 2.0, where the user not only consumes the content and it is characterised by 'social interaction, user-generated content, and sharing'. Services for user-generated content such as YouTube, Flickr and blogs as well as Twitter (2006, named X since 2023) emerge. The metamorphosis of Web 2.0 into platforms supporting social media shifts the focus on to problems associated with this such as freedom of speech and abusive behaviour (Weller 2020, 91ff.). As a consequence, the emotional load and stress on teachers increases.

2.2.1 AI-based digital technologies in school

The subject of AI is also not new and is discussed from the very beginning in relation to a change in perceptions of human thinking, learning and knowledge.[6]

AI can be defined as 'computing systems which are capable of engaging in human-like processes such as learning, adapting, synthesising, self-correction, and use of data for complex processing tasks' (Salas-Pilco et al. 2022, 2 according to Popenici and Kerr 2017).[7]

2.2.2 Learning analytics

With learners spending increasing time in digital learning environments, interest grows in data generated, for example, as part of using an LMS. The development of so-called learning analytics (LA) dates back to 2011 when George Siemens organised the first LA conference. At this conference, LA was defined as 'the measurement, collection, analysis, and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environments in which it occurs'

[4] Sir Tim Berners-Lee invented the internet at CERN in 1989. By 2010 he had developed four technologies that made the internet work and remain the basis of it today: HTML; URL; HTTP; Web browser (Weller 2020, 15f.).

[5] The OpenCourseWare (OCW) Initiative was started in 2002 by MIT (Weller 2020, 77). To this day, the licensing issue is one of the critical obstacles to the use of digital technologies in school (see also EU 2023 Stakeholder Consultation Group on Digital Education Content in the EU). Owing to the rapid development and increasing provision of open (i.e. without access and admission restrictions), freely accessible online courses, which generally have a large number of participants, 2012 is described as the 'year of the MOOC's' (Weller 2020, 129). (Wikipedia accessed 27 February 2024).

[6] The question 'Can computers think?' has been discussed in this form since the 1950s. Alan M. Turing, English mathematician and leading computer theorist, sparked this debate with his article 'Computing Machinery and Intelligence' (Turing 1950). The term 'artificial intelligence' (AI) was coined in 1956 when Marvin Minsky and John McCarthy hosted the Dartmouth Summer Research Project on Artificial Intelligence (Sheikh et al. 2023). Seymour Papert was one of the first to address the impact of AI on education (Papert 1980; see also Bollmann 1988 and Bollmann 2001).

[7] The official and current definition of AI from the OECD is as follows: 'An AI system is a machine-based system that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence physical or virtual environments. Different AI systems vary in their levels of autonomy and adaptiveness after deployment.' https://oecd.ai/en/wonk/ai-system-definition-update

(Siemens 2013). This began the discussion that continues today around the understanding and impacts of the use of LA in the education sector. In 2012, Wolfgang Greller and Hendrik Drachsler developed the first comprehensive framework model for LA with six interdependent dimensions: stakeholders, objectives, data, instruments, external constraints, and internal limitations. This framework model addresses both pupils and teachers as well as the school as an institution. Pupils for example are able to compare their outcome with the overall outcome of a course or can receive personalised recommendations for appropriate learning resources, learning pathways or for peer students. Teachers can be provided with course monitoring systems informing them of gaps in knowledge for specific pupils and are able to make information available to support improved curriculum design and spontaneous adaptations. Schools can monitor the achievement of pupils in terms of drop-out and completion rates and in this way are able to evaluate courses and optimise course outcomes (Greller and Drachsler 2012, 46f.; see also: Ebner et al. 2020; Romero and Ventura 2020). The use of LA is intended to personalise the use of digital teaching and learning technology and to make teaching and the school more efficient.

In terms of external constraints relating to LA, Greller and Drachsler cite data protection law (e.g. compliance with General Data Protection Regulation (GDPR); Are pupils properly informed?) and ethical considerations (e.g. How great is the risk of misuse/incorrect use of the data? Do the pupils/teachers/school benefit from the data?). In terms of internal constraints of LA, they point to the competencies required of pupils/teachers/institution to interpret the results and to act accordingly and in order to understand the visualisation or presentation of the information. Last but not least, the authors refer to the ability to think critically. Do the pupils/teachers/school understand which data are being presented and which are not? How will they use this information? (Greller and Drachsler 2012, 45).

According to Greller and Drachsler, the use of LA for teaching and learning imposes specific new and higher-order demands on the competency and acceptance of teachers that extend beyond technical knowledge and concern their judgement: in order to turn LA into an effective tool for educational practice, it is important to recognise that LA culminates in the presentation of outcomes achieved on the basis of algorithms, outcomes that must be interpreted and critically assessed. This means that the assessment and grading of a pupil should not be based solely on the visualisation of log files from an LA system, the simplicity and attractive presentation of which may, for example, distract teachers from the full reality in terms of pedagogy. Data not included within the respective LA approach are just as important, if not more important in fact, than the dataset included.

Regardless of the necessary competencies, acceptance factors (such as the simplicity and usefulness of the system referred to above) can further influence the use or decision-making following an analysis process (Greller and Drachsler 2012, 51f.).

2.2.3 Intelligent tutoring systems

Based on the assumption that individual tuition is more effective than one individual teaching several people, ‘one-to-one computer-based tutoring continues to emerge as a practical alternative to one-to-one human tutoring’ (Sottilare et al. 2018, 226; see also WEF 2023).

The 1980s also saw an initial boom in intelligent tutoring systems (ITSs) in the education system. At the time, however, the use of ITSs was limited to specific areas of knowledge, in other words it was domain-specific.[8] An ITS uses a series of step-by-step tutorials to guide pupils individually through topics in structured courses such as mathematics and physics. The system uses the findings of experts and cognitive scientists dealing with the relevant subject, as well as data on each student’s individual misconceptions and performance, in order to produce a personalised course. ITSs are still criticised today for the fact that intelligent and adaptive tutoring systems such as these neglect aspects of collaborative and discovery learning and that personal contact between teachers and pupils lessens as a result of their use.

Then there is the issue that, in an ITS classroom, the teacher generally spends a lot of their time tracking pupils’ activities on their screen. The teacher is therefore unable to see what pupils are doing in the

[8] In the 1990s, interest in AI in the education sector was focused on expert systems. There was major interest in expert systems in particular in continuing vocational education and training. The automotive industry, for example, was anticipating a revolution in their initial and continuing education and training from expert systems. The problem in this case however was, on the one hand, developing a knowledge base from the knowledge of employees and, on the other, formalising the real-life experiences of employees.

room, which makes it difficult for them to decide where they should direct their attention. In order to resolve this problem, the ITS can be enhanced, for example, with augmented reality glasses that 'hover' over the pupils' heads and give the teacher detailed and continuous data on the learning progress of individual pupils (e.g. misunderstandings) or on their behaviour (e.g. lack of attention). The teacher can then react to this. This approach, however, raises issues relating to human rights, in particular the right to privacy. There is also a lack of solid evidence that ITSs, which are mostly commercial, are as effective as their developers claim (Kurni et al. 2023, 16f.).[9]

Stefan Küchemann et al. also draw attention to the high costs of developing ITSs (Küchemann 2023, 6). The further development and effective use of ITSs require leaps forward in the development of AI.

2.2.4 The AI boom

AI developed rapidly in the period from 2012 to 2020 — both in terms of pace of development as well as the processing of ever larger volumes of data.

In 2012, the processing of larger datasets was made possible through the use of artificial neural networks and of deep learning techniques that surpassed all previous AI techniques. Deep learning is a subcategory of machine learning. Deep learning is concerned with the development and application of deep neural networks, used for example in the education sector, in order to simulate and predict educational outcomes (see Steimers and Schneider 2022, 1).

The term generative AI (GenAI) has been used since 2016/2017. Generative means that content can be created with the help of AI. This content may be texts, but images, videos and audio, codes, 3D models and simulations (e.g. in the form of virtual reality or augmented reality) can also be produced. GenAI represents a revolution in machine learning (Kasneci 2023). OpenAI[10] and GPTn[11] are regarded as the most powerful models of GenAI. For GPT (generative pre-trained transformer), which is a large language model (LLM), algorithms are trained on the basis of large volumes of text data. They are able to generate human-like text responses and questions and they complete other natural language-based tasks with a high degree of accuracy.

Two key factors contribute to this. The first is the 'transformer' architecture, which enables the model to process contexts of words independently of their position in the sentence. The transformer makes it possible that natural language processes (NLP) no longer need to be processed sequentially. An LLM uses its earlier predictions as input for new predictions (automatic or auto-regressive) and the model learns from its own data.[12] Second, the use of pretraining, where the model is initially trained using the large dataset prior to the fine-tuning for a specific task, contributes to the greatest possible approximation to natural human language (Kasneci 2023, 2).

[9] Cf. with regard to the development of a Generalized Intelligent Framework for Tutoring (GIFT) by Sottilare et al. 2018. Since 2011, Robert A. Sottilare had been developing a largely domain-independent ITS encompassing interaction in groups, e.g. team training, teamwork and collaborative learning. For this, he used, among other things, the results of neurophysiological studies. Solitaire and his team may however have been pursuing a top-down model that was 'overtaken' by the development of generative AI and was therefore not further pursued. In a literature analysis on which the EU-OSHA Report 2022 AIWM is based, the paper by Sottilare et al. from 2018 was identified as the only article on AI with a reference to OSH.

[10] OpenAI, Inc. is a United States software company that has been researching AI since the end of 2015. Initially, the aim of OpenAI was to develop AI on an open source basis. To start with, OpenAI was run as a non-profit company. In 2019, the for-profit subsidiary OpenAI Global, LLC was established. (Wikipedia accessed 27 February 2024).

[11] GPTn Generative Pre-trained Transformer, where 'n' stands for the iteration 1,2,3. This is the first large language model (LLM) developed by OpenAI, which was released in 2018 (Kasneci et al. 2023, 4).

[12] A 'transformer' is a method enabling a computer to translate a sequence of symbols into another sequence of symbols. This can be used, for example, to translate text from one language into another. For this, a transformer is trained on a large volume of example data using machine learning before the trained model can then be used for the translation. Transformers are one of the deep learning architectures. Transformers were introduced in 2017 as part of the Neural Information Processing Systems conference. Before transformers were introduced, recurrent models were used in natural language processing (NLP). These models processed an input sequence sequentially. These methods were later enhanced by means of an attention mechanism. Transformers build on the attention mechanism and dispense with the recurrent structure. They achieve similar or better results in the transformation of sequences than recurrent models and require less computational effort. (Wikipedia accessed 27 February 2024) The attention mechanism improved the ability of auto-regressive language models (the model uses its previous predictions as input for new predictions) and self-supervised (the model learns from the data themself, rather than being explicitly provided with correct answers as in supervised learning) to handle long-range dependencies in natural-language texts (Kasneci 2023, 2).

The LLM ChatGPT-3 was the first easy-to-use tool for GenAI and was released to the general public on 30 November 2022. ChatGPT is able to create texts of all kinds on the basis of prompts or even become a chatbot.[13] This can be combined with a text-to-speech system and integrated in a social robot, which as a result acquires extensive natural language capabilities, or installed in search engines as Microsoft and Google have done (Bendel 2023). Language is becoming the universal interface for every AI model (Küchemann et al. 2023, 2).

With the aid of ChatGPT, it is possible to produce something technologically, the generation of which was previously the preserve of humans, namely language as the central basis for human creativity, and even to surpass humans in this regard: 'The example of ChatGPT shows that such technology can not only automate text creation but also increase human creativity' (Kasneci 2023; see also Gannini 2023, 2).[14] Texts and images however do emerge 'which are incorrect and unrealistic - referred to as hallucinating - or which harm individuals' (Bendel 2023).[15]

Developments in the area of AI have come thick and fast since 2022, which means innovation cycles are getting ever shorter. While the peak of LLM development seemed to have been reached with ChatGPT-3, the recent emergence of large multimodal foundation models (LMFMs), such as ChatGPT-4-Turbo from OpenAI and Gemini from Google, is forcing people to rethink and is bringing with it a series of new opportunities and challenges for education. LMFMs not only interact via written text with the user, they are also able to process spoken text, music, images and videos. This means GPT-4 is able to accept both text as well as images in its input requests. In this sense, it is multimodal (UNESCO 2023 - Guidance to GenAI, 11).[16]

The models represent a significant advancement compared to the first version of ChatGPT-3. This is not just due to the models' multi-modality but also their increased accuracy, faster reaction times (reactions in real time), and a more nuanced understanding of the context and subtleties of language. According to Küchemann et al., LMFMs could 'revolutionise' personalised learning by enabling customised learning experiences that adapt to individual needs and learning preferences (Küchemann et al. 2023, 2). The following 'capabilities' or functions are attributed to a multi-modal model: the capability to adapt to the depth of knowledge (from novice to enthusiast); to select the learning style (e.g. verbal, visual, active, intuitive, reflective); to define the communication style (e.g. formal, suitable for a layperson, storytelling, socratic); to adapt to the tone (e.g. encouraging, neutral, informative, friendly, humorous); and to determine the conceptual structure (e.g. deductive, inductive, analogue, causal) (VIWIS 2023).

However, Küchemann et al. also refer to the fact that considerable challenges also come along with these opportunities. Resorting to AI-supported education raises the issue of the accuracy and reliability of the information provided by these systems. The potential for inherent bias in AI algorithms remains a critical issue with LMFMs, and this problem may even be increased due to the complexity resulting from processing multiple input modalities. They also explain that the integration of AI-based technologies in the education sector will require a reassessment of teaching methods and curricula. This also requires the development of new competencies among teachers and pupils, as these tools now enable 'interactive learning', for example, in dialogue with personalised chatbots, and formative feedback, which means that the focus of these systems is no longer on transferring knowledge but on developing complex skills. Küchemann et al. view this as a key step towards the democratisation of education which ensures that learning opportunities are accessible and equitable. It is even more likely now, they add, that people who are illiterate will be able to use AI without even being able to read and write. Nevertheless, the issue of the digital gap and accessibility continues to be a problem as not all education facilities have the resources to implement and maintain this advanced technology (Küchemann et al. 2023, 2).

[13] Chatbot = a text-based dialogue system that lets you chat with a technical system. (Wikipedia accessed 27 February 2024).

[14] Does this mean that the debate being held since at least 1950 on the difference between human and machine creativity is settled? See in this regard the text-immanent discussion by Steimers and Schneider (2022, 15f.) on autonomy, determinism and the potential for a 'moral machine': 'A fully autonomous system would be a moral agent that has the ability to monitor and regulate its behaviour based on the harm its actions may cause or the duties it may neglect. … Looking at the capabilities of today's AI systems, only the level of operational morality can be implemented, so that the requirement for an autonomous system is not met. … The only exceptions are systems that are based on continuous learning and whose models can adapt further during operation'.

[15] This abuse however is not exclusive to AI (Kasneci 2023, 1).

[16] For an overview of alternative systems to ChatGPT or of tools based on this up to July 2023, see UNESCO 2023 Guidance for GenAI, 10. This also provides further information on image GenAI and music GenAI.

This is all 'incredibly stressful' for all those involved with such developments (Kleiber 2023). Conventional forms of communication and publication are also increasingly reaching their limits.[17] The mood spreading among those familiar with these technologies is similar to that at the time of the invention of the internet (Kleiber 2023).

In parallel with the hype, however, the understanding and explaining of AI-based processes are also reaching their limits. A distinct specialist field has now developed, so-called 'Explainable AI' (XAI).[18]

Over vast stretches of history, technologies created by humans fulfilled precisely those tasks for which they were developed and the mechanisms upon which these were based were well understood (Moinul Zaber 2024) — this still also applies to traditional digital technologies such as computers, the internet, learning platforms and the early forms of ITSs. The emergence of GenAI however has meant that the underlying mechanisms are becoming ever more opaque and the outcomes ever more unpredictable and unforeseeable. This raises important questions such as: Do teachers know what they are doing when they use ChatGPT to prepare lessons or for the semi-automatic grading of their pupils' work? Are teachers aware that, in this case, AI tools are making decisions? Even if they do know, do they believe that these tools are morally and ethically unbiased? If the AI-based systems fail or cause harm, are the teachers and school leaders then accountable? Are teachers and school leaders responsible for the risk assessment of AI-based technologies used in schools? (see Zaber 2024).

According to XAI, it is not sufficient to interpret an outcome such as information about gaps in knowledge acquired based on the use of LA or the level of a pupil's attention as identified using eye trackers. According to XAI, it must be possible for teachers to understand the process of how and why the system arrived at its result given an input. XAI therefore distinguishes between interpretability and explainability: interpretability is concerned with the degree of understanding of the cause of a decision; explainability however goes further and involves explaining the process of how AI arrived at an outcome. This is about predictive accuracy and comprehensibility, but also about human trust. XAI is therefore also calling for a reliable, 'ethical' AI.

In the discussions surrounding AI, these aspects are frequently summarised under the term 'transparency'. According to Steimers and Schneider (2022), however, the terms must be clearly differentiated from one another. Transparency is the feature of a system that describes the extent to which relevant information is passed on to participants via the system. Explainability describes the feature of an AI system for expressing key factors influencing the output of the AI system, and doing this in a manner that is understandable for humans (Steimers and Schneider 2022, 19). If XAI projects consider explanations to be part of wider social contexts, such as schools, then teachers and pupils should ideally also be involved in the co-creative explanation processes using AI.[19]

Transparency can be important as systems with a low degree of transparency may constitute risks in terms of fairness, security and accountability. Transparency is also a precondition for the reproducibility of the system's outputs and improves its quality assessment (Steimers and Schneider 2022, 19).

On the other hand, a high degree of transparency can also lead to confusion due to information overload. Steimers and Schneider therefore distinguish between users and experts: they explain that users must be informed about the nature of the system, but only about its basic functionality. Teachers therefore need information about the use of the system but also about its aims and its known limitations (Steimers and Schneider 2022, 19).

[17] This text, for example, will be outdated before it has even been completed.
[18] The discussion around Explainable AI was started by Adadi and Berrada in 2018 (Rong et al. 2023).
[19] Cf. Constructing Explainability: https://trr318.uni-paderborn.de/en/

3 The surge in digitalisation in the education sector due to the COVID-19 pandemic and its impact on teachers

3.1 Disruption of education

On a worldwide scale, the COVID-19 pandemic caused the greatest ever disruption in history to education systems (UNESCO 2022 REDS). Schools were closed in 102 countries around our globe with a further 11 countries experiencing regional closures. This caused abrupt changes to the work usually undertaken by teachers, meaning insufficient time for planning and careful implementation of measures (Herman et al. 2021, 483). Not only were educational tasks impacted but also the implementation of risk assessments and hygiene measures in light of the pandemic (Koestner et al. 2023).

The school closures in the 2020/2021 pandemic year also involved a so-called surge in digitalisation that led to a process of 'ad hoc digitalisation' in schools. This focused on technical solutions for ensuring teaching, remote learning, alternating instruction and acute crisis management (Mußmann et al. 2021, 3, 234).

The first representative study on the impact of digitalisation during the COVID-19 pandemic on the working conditions of teachers is that by Mußmann and Hardwig (2021). Early studies specifically on the psychological stress and strain on teachers during the COVID-19 pandemic are available, for example, from Panisoara et al. (2020), Herman et al. (2021) and Pressley et al. (2021). These are descriptive studies limited to the short time period from 2020 to 2021 and, with the exception of the study by Mußmann et al. (2021), cannot be considered as representative.

The studies provide key indications as to how the teaching profession coped with a crisis that had a profound impact on the education system, and also pointers for dealing with future pandemics and regarding sustainable strategies to help meet the challenges of such technological development in schools.

3.2 Ad hoc digitalisation

The ad hoc digitalisation in the 2020/2021 pandemic year meant an increase in the demands on teachers in terms of new additional requirements, but also excessive temporary demands resulting from improvisation and short-term additional requirements. Teachers faced an increased workload for example due to home-schooling, hybrid and alternating instruction, the transition from analogue to digital materials, varying digital competencies among pupils or differing equipment being available to pupils and as a result of increased communication via app, email and mobile devices. Of the 2,750 teachers surveyed by Mußmann et al. at 233 schools in Germany, 90% said that home-schooling increased their workload and 77% specified the increased need for communication with parents and pupils (Mußmann et al. 2021).

The surge in digitalisation caused by the COVID-19 pandemic also posed a challenge to school organisation: deficiencies in digital infrastructure instantly became clear (access to the WLAN; to a school or learning cloud; provision of sufficient digital end devices for use in teaching, rooms equipped to facilitate digital teaching and learning; support in the event of technical problems). Teachers frequently resorted to 'self-help' in this situation: 95% used their private electronic devices such as mobile devices, laptops or tablets or used them more frequently than previously for work and for teaching. Where digital technologies were available, these often could not be used due to technical failures; under-developed teaching materials and learning concepts also prevented the meaningful use of such technologies (Mußmann et al. 2021; EU-OSHA 2023 Event summary).

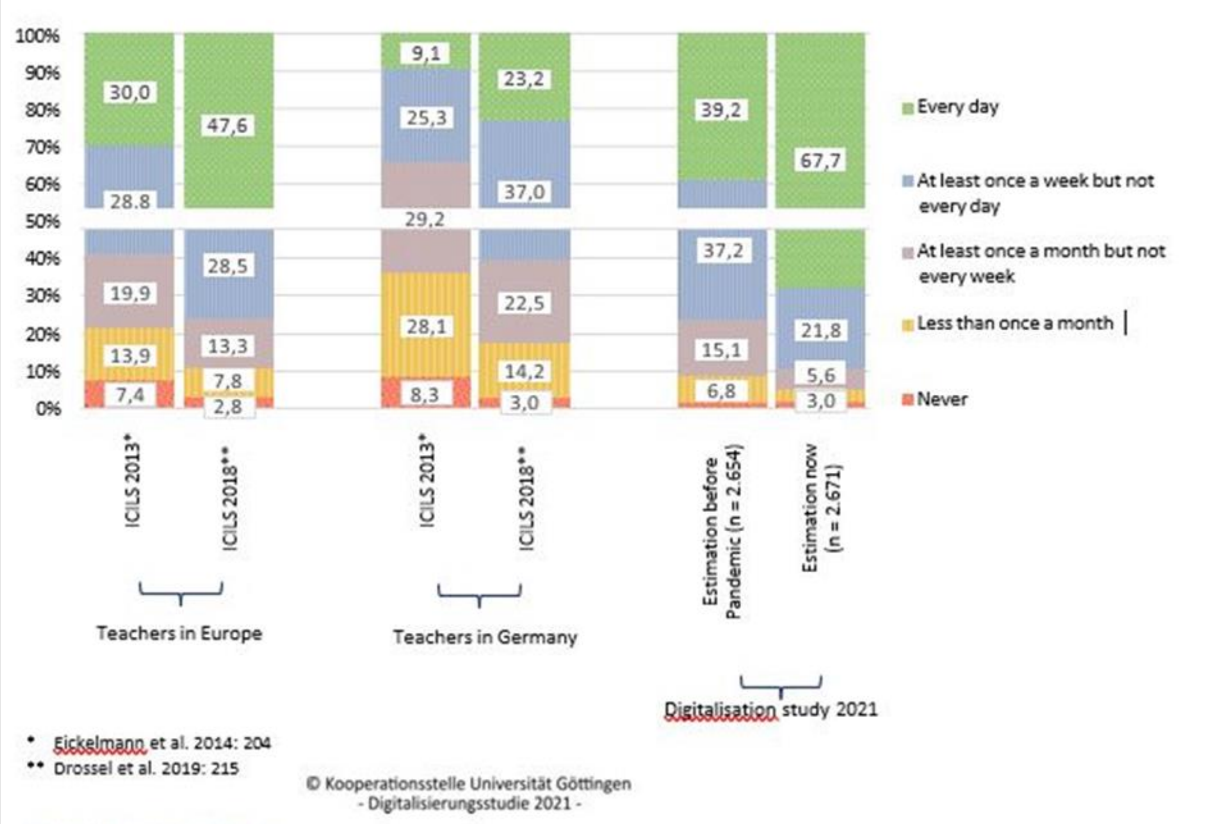
3.3 Rate of change in digitalisation

The first pandemic year also saw a high rate of change in digitalisation. This is shown by the fact that, compared to the ICILS study[20] base year of 2018, during which, for example, Germany's figure of 16%

[20] The International Computer and Information Literacy Study (ICILS) from the International Association for the Evaluation of Educational Achievement (IEA) records the digital literacy (Computer and Information Literacy, or CIL for short) of children and young people in year eight in those nations participating in the study using a sophisticated set of tools that has been developed internationally. The 'ICILS 2013 study' precedes the 'ICLS 2018 Study'. The 'ICILS 2023 study' is currently being conducted.

for portable digital devices for teachers was far below the European average of 41%, the German rate in 2020 rose to 38% and in 2021 to 48%, even though at that time devices were only available to all teachers in 18% of cases. This increased rate of change was also evident in the use of LMSs and in a marked increase in the usage intensity of digital technologies in the classroom (Mußmann et al. 2021).

Figure 2: Frequency of use of digital technologies in schools for teaching purposes (EU, Germany – 2013, 2018, 2021 - %)



Source: Hardwig (2023)

When comparing countries, it can be noted that growth was more frequent and greater if digital technologies had previously not been used so frequently in the educational facilities of a country; this contrasts with countries such as Denmark and Finland where digital technologies were already part of everyday life in schools before the pandemic (Strietholt et al. 2021, 2). For the years of the pandemic, progress in general can be identified at the level of school organisation in terms of development of a recognisable digital school strategy and the setting up of the digital infrastructure to support this, whereas in those countries where teachers already had more experience with the use of digital technologies, a sharp rise was seen in the use of digital technologies for collaboration among teachers (Strietholt et al. 2021, 19).

It is no surprise that teachers who were already using digital technologies before the COVID-19 pandemic also continued to do so during the pandemic: ‘During school closures, teachers who have used ICT before were at an advantage by being able to draw on their previous experience. On the other hand, this evidence suggests that teachers, who have not used ICT before the COVID-19 pandemic, do not manage to catch-up with their more experienced colleagues. Consequently, in times of crisis, it helps

As is already the case in the ICILS 2018 study, an additional module on the computational thinking (CT) literacy area is being added to the current study. This literacy area, for example, is relevant in the context of the use of algorithms and in many European countries is already established in teaching and learning processes. The results of ICILS 2023 will be published on 12 November 2024. For 2025, in-depth analyses, transfer of knowledge, and further practice-related results processing and feedback of specific findings to schools involved, are planned. The following countries/regions/cities took part in the ICILS study: Chile, Denmark, Finland, France, Germany, Italy, Kazakhstan, Republic of Korea, Luxembourg, Moscow, North Rhine-Westphalia, Portugal, United States and Uruguay.

if teachers are already familiar with using ICT. Strong correlations between the use of ICT by teachers in 2018 and again in 2020 were observed within all countries' (Strietholt et al. 2021, 2).

The surge in digitalisation therefore also meant that the urgent need for teacher training in the use of digital teaching and learning technologies became very obvious.

3.4 Impact of the surge in digitalisation on the working conditions of teachers

The teaching profession is, on the one hand, one of those occupations, such as medical doctors, social workers, prison officers and policemen, regarded as placing the greatest burden on physical and psychological wellbeing. It is assumed that the COVID-19 pandemic further increased the existing workloads of teachers as employees working on the front line of the pandemic (Herman et al. 2021, 483; Eurofound 2023, 22; see also: Nabe-Nielsen et al. 2022; Kotowski et al. 2022; EU-OSHA OSH Pulse 2022, 30).

This applies in particular to the factors of high workload, increased working time,[21] organisational obstacles, shortage of time and lack of technical support. However it also applies to even more complex work in terms of interaction under online conditions.

The teachers surveyed by Mußmann et al. (2021) said that on average they had clocked 29% more working hours during the 2020/2021 pandemic year. Members of the school leadership team said the impact was even greater and stated they worked for 50% more hours, an average of more than three hours of additional time per week (Mußmann et al. 2021, 35; cf. workload in the education sector under normal conditions in Eurofound 2023, 33).

The study by Mußmannet al. (2021) provides evidence for the period of the pandemic of a higher workload being involved in the organisation of pure online teaching compared to hybrid forms of teaching, most of all due to the organisational obstacles involved in implementing this entirely new task. Time shortages arose, for example, due to the unfamiliar requirement of having to provide written individual feedback to pupils. A lack of technical support adversely impacted on work processes (Mußmann et al. 2021, 168).

On the other hand, the teaching profession differs systematically from other occupations with a typical pattern emerging characterised by good availability of resources but also by very extreme stress (Mußmann et al. 2021, 203). Or as Keith C. Herman and colleagues succinctly put it in the American context: the teaching profession is a 'stressful profession under the best of circumstances' (Herman et al. 2021, 483).

3.5 The digital divide

The digitalisation of schools is not a uniform process but one that differs by school type and level of education, by school size and by the national context (EU-OSHA 2023 Event summary). Each school is also unique (EU-OSHA 2022 Better Schools; Mußmann et al. 2021, 87). Teachers also differ in terms of how they view themselves as a teacher and how they view their working conditions (Hascher and Waber 2021, 13).

The impact of digitalisation on the teaching profession is however not just a matter for individual stakeholders in the education sector — in this case teachers and school leaders — but a matter for school organisation as a whole. In the context of digitalisation, a distinction is therefore made between school types, each of which have a differing 'digital maturity'. What gave rise to the assigning of school types in line with how digital technologies have been integrated in the school was the finding that schools exist where, despite unfavourable contexts and despite the social situation of their pupil body, their pupils achieved above average results when testing digital competencies. In these schools, teachers gave a more favourable self-assessment of their own digital competencies and assessed the digital

[21] In a number of European countries teachers' working time is not clearly defined – it extends beyond teaching time and includes, for example, administrative tasks and the marking of exams. These tasks are not calculated within the formal working time and end up as 'invisible additional time' (EU-OSHA 2023 Event summary). Consequently, there is little compensatory time off and recovery time. This means that high workloads do not come with regular compensatory time off and recovery times, which can result in symptoms of exhaustion and other negative impacts on health (Mußmann et al. 2021, 165).

infrastructure more positively. A feature of the actions of the school leadership team at these schools was the integration of digital media being given a greater priority (Mußmann et al. 2021, 19; Eickelmann et al. 2019, 138; Pettersson 2018). These schools are designated ‘digitally optimal schools’ and differ from less effective schools based on three characteristics:

- The teachers are more satisfied with the digital infrastructure, although when considered purely quantitatively, they are not better equipped. However sufficient broadband and greater availability of the internet makes the technical infrastructure more usable.
- Better support is available, including both technical and educational support services.
- The school-based processes are geared towards digital teaching and learning. This means that further training enables teachers to deliver digital lessons more professionally, that a more intensive use of tools in terms of didactic methodology is identified in teaching and that pupils are also permitted to make greater use of digital media (Mußmann et al. 2021, 19f.; Eickelmann and Drossel 2020).

The degree of digital maturity of a school is therefore not just determined by the existence of digital technologies at a school, but by how digital technologies are introduced at the school and how teachers are supported in this process as key implementers of technology in the day-to-day administrative and educational activities.

Mußmann’s team of researchers diagnosed a ‘digital divide’ — between the schools nationally but also when compared internationally — that becomes evident in terms of the development and implementation of a digital strategy and the setting up of a digital infrastructure in schools. The study distinguishes between four types of schools: digital forerunners, digitally oriented schools, digitally average schools and digital latecomers (Mußmann et al. 2021, 75, 87).[22] Their study proves that more intensive use of digital potential at a school is not associated with an increase in digital stress: teachers at schools with a more developed digital strategy (digital forerunners) on average stated a slightly lower stress value than teachers at schools with a poor use of digital potential (digital latecomers). The differences are significant even if not very pronounced. According to Mußmann and Hardwig (2021), however, the clear direction indicated by this correlation is critical: a more highly developed digital school strategy and greater use of digital technologies in school tend to be associated with less digital stress. Digital stress is more likely to occur if schools trail behind with digitalisation and the resources for meeting the new demands are lacking (Mußmann et al. 2021, 218).

3.6 Impacts of the surge in digitalisation on the mental load and stress experienced by teachers

The sudden surge in digitalisation under the conditions imposed by the COVID-19 pandemic came with a huge amount of uncertainty for teachers. According to Herman et al. (2021), teachers were often uncertain of what their responsibilities were and how they were able to maintain the connection to pupils in order to support their learning. The process of switching over to learning platforms was often chaotic and frustrating, even under the best of circumstances. Uncertainty regarding the duration of school closures, the lack of training and preparation for online teaching, and the sudden nature of closures are cited in literature as factors that contributed to the stress of teachers. In some cases teachers were also regarded as essential workers who had to be on the ground in an infrastructure classified as critical, all of which further increased the stress and anxiety experienced by teachers. Subject to the premise that teachers’ wellbeing is related to the quality of their teaching and thus also influences that of pupils and also the quality of education, teachers’ wellbeing, in particular in emergency situations, is an important research theme (Herman et al. 2021, 483f.; cf. Klusmann et al. 2016; Wartenberg et al. 2023).

[22] For the systematic development of a digitally mature national school system, see Croatia and the example of the e-schools project (2015-2022): https://www.carnet.hr/en/projekt/e-skole-establishing-a-system-for-developing-digitally-mature-schools-pilot-project/. It is worth noting in that case, for example, that the Croatian Academic and Research Network (CARNET), the agency responsible for implementing the project, introduced an additional, lower level into the typology: The Croatian Framework for the Digital Maturity of Schools consists of five areas and five levels of the digital maturity of schools: Digitally unaware; Digital beginners; Digitally competent; Digitally advanced; Digitally mature. Cf. in this regard also Austria with respect to the development of the digital competencies of teachers.

Contrary to expectations, however, the studies by Herman et al. (2021), Pressley et al. (2021) and Panisoara et al. (2020) do not provide evidence of a rise in stress and anxiety of teachers as a result of the surge in digitalisation under the conditions imposed by the COVID-19 pandemic: 'Contrary to expectations, teachers reported significantly lower levels of stress and higher levels of coping, well-being, and job satisfaction after the start of the pandemic' (Herman et al. 2021, 490).[23] As regards the increase in stress and anxiety during the COVID-19 pandemic, however, Pressley et al. identify an exception: the group of teachers forced to teach exclusively online reported increased levels of anxiety and stress (Pressley et al. 2021, 373). Their higher level of anxiety may, for example, be due to a lack of online teaching experience, new approaches to the planning and delivery of teaching, the lack of engagement with pupils in a virtual environment or the use of the required new LMSs (Panisoara et al. 2020, 18).

The assumption that teachers, despite the disruption and associated uncertainties resulting from the COVID-19 pandemic and without the daily stress of face-to-face teaching, on the whole had less stress at work (Herman et al. 2021, 490) or, alternatively, much of the stresses and strains of the 'entirely normal madness of the school day' suddenly disappeared (Mußmann et al. 2021, 171), is confirmed by the study by Ahrens et al. (2021).[24]

3.7 Lessons from the pandemic

The following lessons can be drawn from analysing the influence of digital technologies on the safety, health and wellbeing of teachers under the conditions of the COVID-19 crisis:

- A digital strategy is required at school level that equips school leaders and teachers with the necessary resources for cushioning the load and stress resulting from the integration of digital technologies in the school day.
- A healthy and safe introduction of digital technologies in school is not solely dependent on technical equipment but requires technical, educational and social support for teachers and school leaders.
- A sense of self-efficacy in the integration of digital technologies in the school day (e.g. use of digital media in teaching, digital classroom management, digital communication with pupils and parents) requires, on the one hand, technological and educational knowledge, while on the other, necessary room for manoeuvre must be provided for the use of digital technologies in schools.
- A key component of a digital school strategy is professional development diversified by target group (e.g. for young teachers; for experienced teachers enthusiastic about technology; for IT coordinators; for school leaders by school level) and in new formats (e.g. in communities of practice, experimental labs, forums, networks).
- To ensure that changes and future crisis situations are dealt with in a proactive manner, teachers and school leaders need specific support in terms of positive coping strategies.[25]

The COVID-19 pandemic teaches us that something previously unthinkable can occur. It may not be sufficient to simply think in terms of a return to a 'new normal', representing only a minor change to the status quo existing before the pandemic. The pandemic can instead be interpreted as a rallying call to consider the digitalisation of education and its impacts on teachers in terms of further potential crises

[23] See by way of contrast EU-OSHA 2022 OSH Pulse. This survey is a representative survey following the COVID-19 pandemic. In terms of the experience of health problems, including stress, depression and anxiety, the education sector's value of 31% is the highest compared to other sectors.

[24] Ahrens and his team found an overall reduction of experienced daily hassles and '(e)ven more, we found a general increase in mental health, indicating that mental health functioning can also improve after exposure to adverse events, a phenomenon called psychosocial gain from adversity.' Ahrens et al. investigated if adjusting to the new circumstances 'may have deleterious effects on vulnerable groups, such as people with or at risk for depression or anxiety disorders'. They differentiated between three subgroups: 'a "resilient" group with initially improved mental health over time, a "recovered" group with an initially high mental dysfunction … followed by a quick return to baseline, and a "delayed dysfunction" group that showed a significant deterioration of mental health after … the assessment period. … Regarding perceived stress, the recovered group showed a reduction in initially high stress levels and loneliness after COVID-19 regulations started to be relaxed, while the vulnerable group displayed an exacerbation of stress levels at the same time' (Ahrens et al. 2021; 2, 5, 7).

[25] Coping = Employing specific psychological mechanisms or strategies (both cognitive and behavioural) to respond to a stressor is referred to as coping (Lazarus and Folkman 1984).

such as the next pandemic, climate crisis, increasing militarisation, geopolitical destabilisation and populist authoritarian regimes.

A structural model is introduced below. The model combines the three central theoretical models to explain the link between digitalisation and the health, safety and wellbeing of teachers. Following this, key factors relating to the occurrence of ‘digital stress’ and ‘digital wellbeing’ for teachers are explained.

4 Structural model addressing the impact of digitalisation on teacher wellbeing

4.1 Key theoretical models

Ion Ovidiu Panisoara and colleagues developed a comprehensive structural model and tested it based on data from 980 teachers between April and May 2020 during the outbreak of COVID-19 in Romania. For the first time, the structural model combines three theoretical models in the context of online teaching and its impact on teacher wellbeing: (1) self-determination theory; (2) Job-Demands-Resources model; and (3) Technology Acceptance model. The researchers derive five factors from these three theoretical models in order to explain the intention of teachers to continue with exclusively online teaching in an unstable working environment: technological educational knowledge; self-efficacy; intrinsic work motivation; extrinsic work motivation; occupational stress (i.e. burnout and technostress). This complements the understanding of the motivation and intention regarding online teaching by highlighting the direct and indirect affective responses to the technology, that is, the emotional dimension complements the cognitive dimension (Panisoara et al. 2020, 2; see also Scherer et al. 2019).

Panisoara et al. describe the theoretical models in the context of online teaching and its impact on the wellbeing of teachers as follows:

- **Self-determination theory (Deci and Ryan 2008)**

The self-efficacy of teachers has been shown to be a predictor of higher levels of commitment and lower levels of burnout.[26] A study found that an 8-month computer training programme for teachers on the theme of integrating computers into the classroom significantly reduced teachers' anxiety with regard to computers. This indicates that teachers' level of knowledge about the use of technology influences their fear of using it. Technological and educational knowledge has a key role in reducing teachers' technostress,[27] which suggests that improving teachers' technological and educational knowledge with support from the school is essential, as is increasing their self-efficacy when using computers. On the other hand, teachers who regard themselves as more digitally efficient and who receive better support from their institutions experience stronger positive emotions when they use digital resources in their teaching, and they are more motivated and more independent in their work. Intrinsic motivation is the factor in this case that has the key influence: if teachers take on online teaching because they find the method interesting, perceive it as a challenge for their personal development, and/or find it enjoyable, innovative, creative and successful, then this reduces occupational stress. By contrast, the requirement to teach online only due to the COVID-19 pandemic (extrinsic motivation) may lead to more occupational stress (e.g. fear of making mistakes when using online resources; not having sufficient capabilities and competencies for considering the design of virtual learning spaces; having only limited capabilities with regard to new information and communication technologies). In their study, Herman et al. establish the importance of the factor of self-efficacy as regards the health of teachers using the example of dealing with students with challenging behaviour in online lessons: the confidence teachers have in their ability to deal with pupil behaviour in an online setting correlated positively with managing conflict and teacher health, and negatively with stress (Herman et al. 2021, 489; cf. Pressley et al. 2021, 368: no correlation between student behaviour and stress when resources were available to teachers).

- **Job-demands-resources model (Demerouti et al. 2001)**

The relationship between occupation-specific requirements and performance in an educational context assumes that the health and well-being of employees is the 'result from a balance between positive (resources) and negative (demands) job characteristics' (Schaufeli and Taris 2014, 44). An extended job-demands-resources model that also takes into account the performance dimension describes burnout as something resulting from high work demands and poor resources (Demerouti et al. 2001, 502). A

[26] Burnout = emotional exhaustion (Panisoara et al. 2021, 6f., 19).

[27] Technostress or digital stress is caused by limiting environmental factors and the large number of technical tasks that, in connection with the technology used, cause stress (Panisoara et al. 2021, 7f., 19). Technostress or digital stress develops once the available resources and capabilities of an individual are no longer sufficient to cope in a healthy way with the demands imposed by the use of digital media and technologies. Various tools have been developed and validated in the academic literature to measure technostress (Ragu-Nathan et al. 2008; Ayyagari et al. 2011; Nimrod 2017; Mußmann et al. 2021, 70). The terms technostress and digital stress are used interchangeably in the literature.

high level of professional burnout among teachers can therefore be attributed in part to teachers having to familiarise themselves over a short space of time with the wide variety of forms of teaching supported by technology, and can also be attributed to demands resulting from working online with various digital tools, which can generate technostress. The study proves burnout and technostress have only a weak direct influence on teachers' willingness to continue teaching exclusively online. Here, burnout and technostress are defined as mediator variables/latent variables.

- **Technology acceptance model (Davis 1985)**

The technology acceptance model suggests that two attitudes — specifically the perceived user friendliness (i.e. intrinsic motivation) and perceived usefulness (i.e. extrinsic motivation) — provide the best predictors for the actual use of the system and for understanding behavioural intention over time. Due to its simplicity and parsimony, the technology acceptance model has been used extensively to predict intention to use various digital technologies such as MOOCs, mobile internet services or Facebook (cf. Scherer et al. 2020).

The preparedness for (continued and exclusive) use and the actual use of digital technologies in the classroom can therefore neither be derived directly from the availability of technological and educational knowledge nor directly from a teacher's high level of intrinsic or extrinsic motivation to use technology, instead it is derived from whether the use of digital technologies is associated with stress for the teacher or leads to their emotional exhaustion.

4.2 Impact of digital stress on teachers' health

A high level of digital stress brings with it a high risk of burnout in terms of emotional exhaustion. For teachers experiencing greater digital stress, burnout is more pronounced. There are also clear statistical correlations between the experience of technostress and a less favourable assessment of work–life balance and lower job satisfaction. Digital stress jeopardises both the health and wellbeing of teachers and compromises the attractiveness of the teaching profession (Mußmann et al. 2021, 227f.).

Four factors make a significant contribution to teachers experiencing more or less stress when using digital technologies: (1) digital competencies (a higher level of digital competence is associated with less stress); (2) IT affinity (own drive and expectation of gains result in reduced experience of technostress); (3) workload (teachers who report a generally higher level of stress from their work also experience greater technostress); and (4) support when using digital media and technologies (lack of school support is perceived subjectively as a stress and leads to experience of technostress) (Mußmann et al. 2021, 219ff.).

The lower stress levels among teachers for the pandemic year 2020/2021 established by the studies cited here are potentially due to the emergency situation of the pandemic. Mußmann et al. report that the pressure to cope with the unfamiliar situation is likely to have increased teachers' resources. This is because it does actually appear to be the case that: first, the operating culture within schools was experienced as more open, appreciative and collegial in the face of the challenges posed by the crisis; second, during the crises, there was a little more respect and less conflict in interactions between teaching colleagues and with parents and pupils (interactions were however also potentially more distanced); and third, there were more opportunities to take part in further training, to get involved and develop one's own knowledge and skills. Four, and contrary to expectations, barely any change is evident however in the assessment of creative scope, which in turn is probably due to the constraints of the pandemic and the accelerated, but in many cases more pragmatic 'ad hoc digitalisation'. If teachers have a few more resources, they actually do have more scope to cope with or to regulate stress. Five, at the very least, it can be stated that emotional stresses are reduced, probably due to the high proportion of home office working during distance learning and also due to the smaller class sizes during alternating instruction. And, six, the assumption that home-schooling from the 'home office' provided more opportunities overall for teachers to control the phases of work intensity themselves could also be confirmed (Mußmann et al. 2021, 203; see also Ahrens et al. 2021, 5).

It is possible, from the studies by Panisoara et al. (2020), Herman et al. (2021), and Mußmann et al. (2021), to identify a need for research into the resilience of teachers, teams and schools in crisis situations and into the development of resilience for dealing in proactive ways with changes currently being caused, and which will be caused in future, in particular by the introduction of AI-based digital technologies in schools (see also in this regard Schelvis et al. 2014).

4.3 Factors determining teachers' digital wellbeing

The literature shows no consensus on the definition of wellbeing and, in particular, on the wellbeing of teachers. Key anchor points for the development of the wellbeing of teachers concept are: firstly, the definition of health by the World Health Organisation (WHO) from 1946: 'Health is a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity';[28] and secondly, the concept of subjective wellbeing (SWB), which was developed by Ed Diener: 'SWB refers to the extent to which a person believes or feels that their life is going well' (Diener et al. 2018, 1; see also Diener 1984).[29] In their literature study covering the period from 2000 to 2019, Tina Hascher and Jennifer Waber propose defining teacher wellbeing as a 'positive imbalance' for the wellbeing of teachers concept. This is because: (1) 'positive components of well-being can coexist with negative components such as demands and stress' although (2) 'the experience of positive dimensions is significantly more pronounced than negative dimensions'. According to these authors, such a definition may help to avoid the misunderstanding of wellbeing of teachers 'as the mere absence of health problems, stress, strain or burnout symptoms' (Hascher and Waber 2021, 17).[30] The four-dimensional conceptual framework for wellbeing of teachers developed by Carine Viac and Pablo Fraser comprises physical and mental wellbeing, cognitive wellbeing, subjective wellbeing and social wellbeing, and is important and viable in this context. When preparing the teacher questionnaire for the 2021 PISA study, these dimensions were used as follows:

Table 1: Operationalisation of the conceptual framework for the assessment of teachers' wellbeing according to Viac and Fraser

Cognitive wellbeing	Ability to concentrate on one's work, and teacher self-efficacy.
Subjective wellbeing	Satisfaction with one's current job and with the teaching profession, frequency of moods and emotions with regard to job activities, purposefulness and satisfaction with life.
Physical and mental wellbeing	Frequency of psychosomatic symptoms, and number of school days missed due to these symptoms.
Social wellbeing	Social function of relationships with principals, colleagues and students, and feelings of trust.

Source: Hascher and Waber 2021, 17; Viac and Fraser 2020

Teacher wellbeing is defined accordingly by Viac and Fraser as 'the reaction of teachers to the cognitive, emotional, health-related and social conditions of their work and their occupation' (Viac and Fraser 2020, 18).

[28] Constitution of WHO from 1946: https://www.who.int/about/governance/constitution In 1984 WHO brought a new conception of health, not as a state, but in dynamic terms of resilience, in other words, as 'a resource for living'. This revised definition of health defined it as 'the extent to which an individual or group is able, to realize aspirations or satisfy needs and to change or cope with the environment'. https://www.publichealth.com.ng/world-health-organizationwho-definition-of-health/

[29] Ed Diener's work provided key impetus for wellbeing research from the perspective of work and organisational psychology (Hascher and Waber 2021, 2).

[30] For further literature studies on the wellbeing of teachers, see: Nwoko et al. 2023; Zhang et al. 2023; White and McCallum 2022; McCallum 2021; Na'imah et al. 2021.

5 Opportunities and risks for teachers from the use of AI-based digital technologies

Expansion in the use of AI-based technologies in schools, such as via the integration of LLMs into learning platforms, has at best been slow (Cukurova 2023, 152). However, in barely any other sector are the potential and risks of AI tools discussed as extensively as in the education sector (SWK 2024, 7 according to Fütterer et al. 2023).

Now, under the umbrella of GenAI, teachers as well as pupils are increasingly the focus of attention and being given equal consideration in discussion about the use of AI-based technologies in education (see for example: UNESCO 2021 AI and education; SURF 2022; Cukurova et al. 2023; Kasneci et al. 2023; Küchemann et al. 2023; Ng et al. 2023; UNESCO Guidance for GenAI 2023; EC 2023 AI Report; Bekiaridis and Graham 2024).

So far, figures from a 2021 UNESCO study are available on the status of the integration of AI into state-recognised curricula. According to this study, at this point in time, the following countries in Europe had taken steps to introduce AI curricula at primary and/or secondary level: Austria, Belgium, Bulgaria, Germany, Portugal and Serbia. Germany was given as a European example. At that time the country was in the process of developing state-recognised AI curriculum standards for primary and secondary education; China was cited internationally with its government already having developed standards for these three levels (HAI Report 2023, 260).[31]

According to the UNESCO study, the four topic areas to which most time was devoted in K-12 curricula were algorithms and programming (18%), AI technologies (14%), data literacy (12%) and application of AI to other domains (12%). By contrast, topics such as the ethics of AI and the social implications of AI only had figures of 7% and 5%, respectively (HAI Report 2023, 261). Austria is praised in the UNESCO report as an example where in 2021 the curriculum already included all of these dimensions.

5.1 GenAI opportunities and risks and the impact on health, safety and wellbeing of teachers

Achieving UN Sustainable Development Goal (SDG) 4 seems within reach with GenAI:[32] it seems possible to use AI to contribute to a world that provides general and equitable access to high-quality education at all levels (Cukurova 2022, 161). LLMs in particular 'represent a significant advancement in the field of AI. The underlying technology is key to further innovations and, despite critical views and even bans within communities and regions, large language models are here to stay' (Kasneci 2023, 1; see also EC 2023 AI Report, 22). The latest UNESCO report reminds us, however, that achieving SDG 4 with the help of GenAI comes with certain conditions: 'GenAI tools will not help address the fundamental challenges in education or the achievement of SDG 4 commitments unless such tools are made inclusively accessible (irrespective of gender, ethnicity, special educational needs, socio-economic status, geographic location, displacement status and so on), and if they do not by design advance equity, linguistic diversities and cultural pluralism' (UNESCO 2023 Guidance for GenAI, 24). Alongside the potential, GenAI also brings with it risks and challenges that have overtaken both the technical and political debates as well as the legal framework (UNESCO 2023 Guidance for GenAI, Summary).

5.2 Factor model

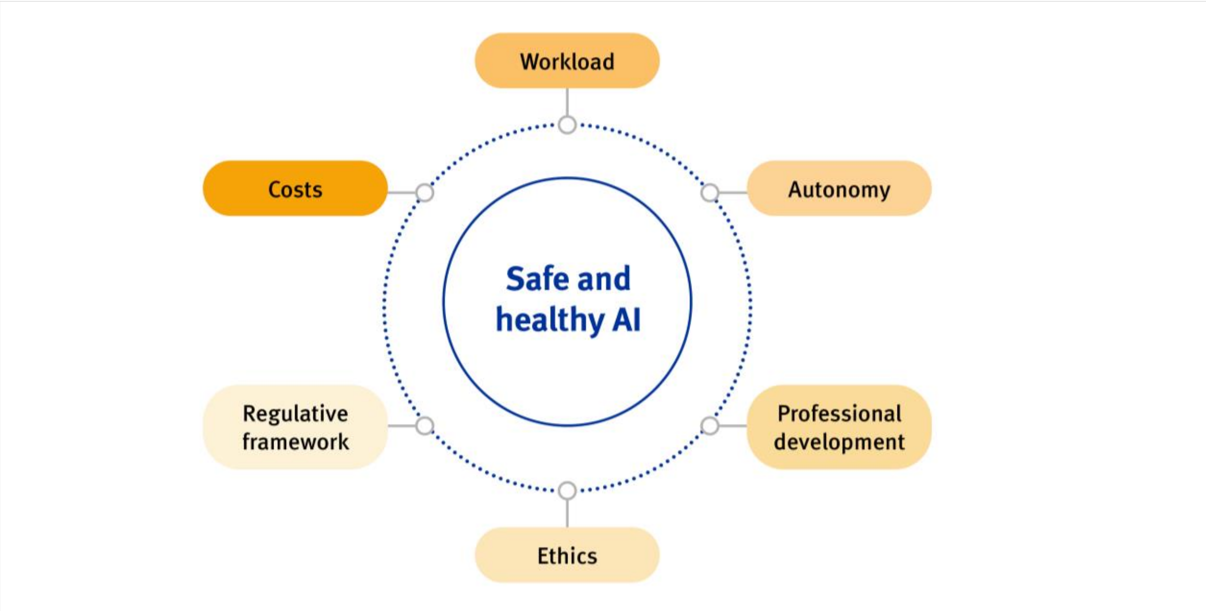
The following provides an overview of the opportunities and risks from using GenAI-based technologies in schools and their potential impact on the health, safety and wellbeing of teachers.

[31] In 2021, UNESCO released one of the most comprehensive reports to date on the international state of government-endorsed AI curricula. To gather information, UNESCO released two surveys: the first to representatives of 193 UNESCO member states and the second to over 10,000 private and third-sector actors. As part of these surveys, respondents were asked to report on the status of AI curricula for students in K-12 general education. According to the UNESCO report, Serbia has already endorsed and implemented certain kinds of K-12 AI curricula, but is also simultaneously in the process of developing others – thus it is listed under both categories (endorsed and implemented and in development) (UNESCO 2022 K-12 AI curricula).

[32] UN Sustainable Development Goal SDG 4 'Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all' is one of the 17 Global Sustainable Development goals of the United Nations that are to be achieved by 2030: https://en.unesco.org/education2030-sdg4/targets

The analysis is based on six factors: workload, autonomy, professional development, ethics, regulatory framework and costs.[33]

Figure 3: Factors ensuring safe and healthy use of GenAI-based educational technologies by and for teachers



5.2.1 Workload

Thesis

AI-based technologies increase the efficiency and effectiveness of educational work; counter-thesis: AI technologies are not facilitating less work, but worse jobs (Selwyn 2022, 162 according to Wajcman 2017).

The big 'AI promise', or the promise from the EdTech sector, is the reduction in the workload for teachers (Selwyn 2022, 123).

Opportunities

LLMs, such as ChatGPT, are able to support teachers as follows:

- In supporting learning processes, in this case pupils' writing and their responses. LLMs can provide tailored feedback and suggest materials geared to the specific needs of students (Kasneci 2023, 3, 5).[34] AI can also perform a corrective role with respect to the human weaknesses of teachers (Selwyn 2022, 153): the system knows the pupil better than the teacher (Selwyn 2021, 6).
- In lesson planning: 'Teachers can input to the models the corpus of document based on which they want to build a course. The output can be a course syllabus with short description of each topic. Language models can also generate questions and prompts that encourage the participation of people at different knowledge and ability levels, and elicit critical thinking and

[33] The analysis comes with the caveat that due to technological development and its speed and complexity, statements can only be made in relation to the present.

[34] Kasneci et al. also provide the following note with regard to 'lack of adaptability': 'Large language models are not able to adapt to the diverse needs of students and teachers, and may not be able to provide the level of personalisation required for effective learning. This is a limitation of the current technology, but it is conceivable that with more advanced models, the adaptability will increase' (Kasneci et al. 2023, 9). Currently, LLMs also face problems when solving word problems in mathematics. Discussion, however, is dominated by the 'promise of the next model'. This also applies to the reduction of bias and so-called hallucinations (Küchemann et al. 2023, 2).

problem-solving. Moreover, they can be used to generate targeted and personalized practice problems and quizzes, which can help to ensure that students are mastering the material' (Kasneci et al. 2023, 3).

- An LLM can provide help with researching and written tasks both at the syntactic level (e.g. recognising and correcting typos) and at the semantic level (e.g. highlighting grammatical inconsistencies and suggesting strategies for improvement). Suggestions on style improvements for specific topics as well as the summarising and breaking down of complex texts are also possible.
- When assessing and marking student performance, LLMs enable teachers to mark pupil work semi-automatically by highlighting the potential strengths and weaknesses of the relevant work. According to Kasneci et al. (2023), LLMs can be used to reduce the work involved in marking by up to 85%, and with a high degree of precision and improved quality, which is perceived as such by the students (Kasneci et al. 2023, 5; see also Christodoulou 2020, 4). Teachers can also use LLMs to check outcomes for plagiarism, which can help them to prevent cheating.
- When creating customised applications, teachers can tailor GenAI tools to their specific teaching requirement and use them for this purpose (Küchemann et al. 2023, 4).
- AI management systems mean that tasks can be allocated more easily, time planning can be improved and work organisation in schools can be optimised. They can also be used to provide information that can help identify OSH risks (EU-OSHA 2023 Press briefing, 8f.).

AI-based technologies, and in this case LLMs in particular, therefore have the potential to reduce the workload and stress on teachers by helping to save on time and effort, to relieve teachers from routine tasks and as a result allow them to focus more on other educational tasks besides teaching such as engaging the pupils, pupil observation and formative assessment (EC 2023 AI-Report, 25; Selwyn 2022, 153; Selwyn 2021, 353f.). According to the latest study from the World Economic Forum, the share of teachers' time reallocated as a result of AI from administration to supporting pupils with their learning is 20% to 30% (WEF 2023 according to McKinsey 2020).

Risks and challenges

Risks so far identified in relation to the workload for teachers as a result of using AI-based technologies are:

- ***Datafication*** – Instead of an incentive to be more efficient, the 'datafication' of school can be a source of extra work and indeed of extra hours of unseen stress 'behind the scenes' and of additional work (Selwyn 2021, 362). This serves to exacerbate the 'structural vulnerability' of teachers (Selwyn 2021, 355, 358; Selwyn 2022, 131).
- ***Fauxtomation*** – In this context, Neil Selwyn makes reference to Taylor (2018) and her term 'fauxtomation' which is a trend in the IT sector for developing online systems that purport to run automatically but which actually require a high level of unseen work by humans (Selwyn 2021, 365). 'While GenAI might help teachers … generate useful text and other outputs to support their work, it is not necessarily a straightforward process. It can take multiple iterations of a prompt before the desired output is achieved' (UNESCO 2023 Guidance on GenAI, 12).
- ***Blurring the work/private life boundaries*** – Increased 'unseen' work means a blurring of the boundaries between work and private life. At the same time, there is increasing pressure on pupils, parents and even teachers' own families, in the form of unpaid work, to produce 'usable' data (Selwyn 2021, 364).
- ***Increasing the pace of work*** – AI-based systems can contribute to an increase in the pace of work for teachers and thus generate stress (see also Eurofound 2023, 35).
- ***Increasing cognitive demands*** – The complexity, impenetrability, and resulting lack of explainability and predictability of GenAI increase the cognitive load. This includes the demand placed on teachers of having to distinguish between GenAI-generated products and human-generated products and the increased uncertainty associated with this (Giannini 2023, 2, 6). Küchemann et al. however draw attention to a reduced cognitive load in the use of LMFMs

compared to traditional programming; this could also develop 'computational thinking skills' (Küchemann et al. 2023, 6f.).

- ***Strengthening monitoring*** – 'Smart schools'[35] enable digital monitoring and surveillance not just of pupils but also of teachers using real-time data. This may exceed the extent of monitoring required and transgress legal regulations (EU-OSHA 2021 Policy brief AI; EU-OSHA 2023 OSH News).
- ***Isolation*** – Reduction of cooperative learning and support by using AI-based technologies resulting in the risk of isolation (EU-OSHA 2021 Policy brief AI; cf. Magnusson 2022, 4).
- ***Erosion of human relationships*** – Human collaboration changes into human–bot collaboration, e.g. by using 'generative twins' as teaching assistants (Küchemann et al. 2023, 7f.) Eurofound points out that algorithmic management can remove the human interaction element from work (Eurofound 2023, 37).

It should be noted that AI-based technologies, and here in particular LLMs, seem not to be 'a magic silver bullet for workload problems' (Christodoulou 2020, 2).

5.2.2 Autonomy

Thesis

AI-based technology supports teachers in their actual educational work; counter-thesis: the teacher is not replaced by a robot but works like a robot (Selwyn 2022, 135f.).

During the COVID-19 pandemic, no change in the scope for action available to teachers was observed (Mußmann et al. 2021, 200). But how does the use of GenAI impact the autonomy of teachers? What influence on the autonomy of teachers do AI-based systems have which function autonomously, or to a certain degree autonomously, and which not only support a teacher but also take on tasks that previously were the preserve of the teacher?[36]

Neil Selwyn distinguishes in this regard between institutional forms of AI (supporting the teacher) and the undertaking of tasks for the teacher by, for example, facial recognition systems, teacher assistance systems for detecting cheating, systems for automatically assessing essays, for NLP-based feedback, for supporting pupils with the help of chat bots or even using a holographic teacher (Selwyn 2022, 150, 174; see in this regard also OECD 2021).

Opportunities

- Maximised when teachers maintain control in a transparent manner over their entire work process.
- Teachers no longer have to perform non-creative, repetitive tasks that need doing on a daily basis.
- Teachers have more time for pedagogical tasks, for their own continuous professional development, and for being creative or developing their creativity (see EU-OSHA 2023 Press briefing, 8).
- The digital automation of education is an opportunity to use GenAI to provide 'high-quality' education in those locations where the challenges and deficits faced in the education sector are the greatest (Giannini 2023, 7).

Risks and challenges

- Reducing teachers' control over the content and direction of their work (Selwyn 2022, 161).

[35] Smart school = An educational environment that is replete with sensor technology that measures, monitors and regulates the building and all its occupants (Selwyn 2021, 6).

[36] Automation = Use of systems or technical procedures with some degree of autonomy, to perform physical or cognitive tasks that were previously, or could potentially be, carried out by a human. They can be embodied (robotics) or non-embodied (smart applications) (EU OSHA 2023 Press briefing, 8).

- Undermining the status and authority of teachers, even when more is demanded of them (disempowerment) (Giannini 2023, 7; cf. UNESCO 2023 Guidance on GenAI, 13).
- Accentuating the trend towards 'acting in a machine-readable form', e.g. in view of facial recognition and 'prompt engineering' (Selwyn et al. 2021, 17).
- Overconfidence from the teacher in AI-based technologies (EU-OSHA 2023 Press briefing, 8).
- Reduction in human situational awareness (the 'quick sideways glance', which can give the teacher an immediate impression of a person or situation; but also attentiveness/mindfulness may be lost with regard to unforeseeable negative impacts on the safety, health and wellbeing of pupils) (EU-OSHA 2023 Press briefing, 8).
- Loss of specific capabilities of a teacher such as the ability to assess outcomes fairly or write examination questions (see EU-OSHA 2023 Press briefing, 8).
- Reduction of teaching positions in the education sector due to the automation not only of cognitive but also of interactive processes (chatbots) (Guralnick 2024).
- Increasing the call for further automation of education by means of future opportunities to use AI: 'teacher-less schools, school-less education, and other dystopic visions' (Giannini 2023, 7).

The opportunities and the risks and challenges resulting from automation of the education system are dependent on which and how many functions of teaching activities are/can be automated, or on the degree of automation and control (see EU-OSHA 2023 Press briefing, 8). In general, a tension exists between the autonomy of a teacher and the degree of automation of the AI system (see Steimers and Schneider 2022, 13).

As a rule, a high degree of automation restricts the opportunities for control and influence and thus ultimately the autonomy of the individual, in this case the teacher. According to Steimers and Schneider, it must therefore be ensured that the human activity always takes priority when using an AI system, that is, the health, safety and wellbeing of teachers and learners are always at the heart of the application. For this purpose, the roles should be distributed appropriately and responsibly between humans and the AI system when the system is being developed. The best method for achieving this would be the appropriate involvement in the development of AI-based systems of teachers, students, education providers (e.g. schools) and those responsible for education policy. According to Steimers and Schneider, the degree of automation must also be appropriate to the context of the application, in this case an educational context, and it must offer the participants the necessary opportunities for control. If all this is taken into account, then this would ultimately result in AI that is geared towards humans (Steimers and Schneider 2022, 13).

The degree of automation can be divided into different levels. Anne Horvers and Inge Molenaar have adapted the six-level model of automation to teachers (Molenaar in OECD 2021, 60). In Table 2, however, the seven-level model as developed by Steimers and Schneider is used. Steimers and Schneider also introduce the distinction between heteronomous and autonomous systems. The table also shows how the degree of control by teachers reduces as the degree of automation increases (Steimers and Schneider 2022, 13).[37]

[37] Steimers and Schneider note the following in their paper submitted in January 2022: 'There is some confusion amongst the public, including developers, about the concept of autonomy in the context of AI systems. In general, it must be noted that it is not yet possible to produce artificial autonomous systems by technical means. AI systems as we find them today, can still all be classified as heteronomous systems. Heteronomous systems are distinguished from autonomous systems by being governed by external rules or the fact that they can be controlled by an external agent. In essence, this means that they are operated using rules that are defined or validated by humans. In contrast, an autonomous system is characterised by the fact that it is a system governed by its own rules and not subject to external control or oversight' (Steimers and Schneider 2022, 13).

Table 2: Description of the seven levels of automation of the work of teachers

System	Level of automation	Degree of control	Comments	Example
Autonomous	Autonomy.	Teacher out of the loop.	The system is capable of modifying its operation domain or its goals without external intervention, control or oversight.	ChatGPT 4 (Open AI). Gemini (Google). Llama (Meta).
Heteronomous	Full automation.	Teacher in the loop. Teacher out of the loop.	The system controls all tasks automatically, without external intervention.	Language learning technology (e.g. Alelo https://alelo.com).
	High automation.	Teacher control and monitoring is not required for specific tasks.	The system requests teacher control. The system controls most tasks automatically.	Intelligent Tutorial System (ITS) (e.g. MathSpring).
	Conditional automation.	Teacher monitors incidentally, but can resume control all time.	System signals when teacher control is needed; system controls broader set of tasks.	School notification system (e.g. emergency notification system DeskAlerts).
	Partial automation.	Teacher monitors technology; system remains under the control of an external agent.	System controls specific tasks.	Google classroom.
	Assistance.	Teacher has full control.	The system provides support; assists the teacher.	Teacher assistance (e.g. LMS, teacher dashboards).
	No automation.	Teacher only.		

Source: Molenaar 2021; Steimers and Schneider 2022

5.2.3 Professional development

Thesis

AI-based technologies contribute to expanding teachers' professional knowledge and their own capabilities; counter-thesis: AI-based technologies are leading to a deprofessionalisation of the teaching profession (Selwyn 2022, 162).

Under pressure from the rapid development in the area of AI and in particular from the development of GenAI, not only are the competency requirements for teachers increasing but also the demands on teachers and school leaders, whose role, and potentially the teaching profession itself, is changing (Ng et al., 2023; see also: EC 2023 AI Report, 8; SWK 2024, 15).

According to a UNESCO study from 2022, there are still only seven countries worldwide, of which only four are within Europe, that have AI training programmes for teachers: Finland, Georgia, Spain and Turkey (UNESCO 2023 Guidance on GenAI, 26; UNESCO 2022 K-12 AI curricula). According to the latest study from the European Commission's European Digital Education Hub (EDEH), Croatia, North

Macedonia and Serbia also offer professional development courses on AI in their national teacher training catalogues (EC 2023 AI Report, 27; for Croatia see CARNET[38]). Teacher-specific digital competences are a compulsory part of the curricula for initial teacher training at primary and lower secondary levels, and indeed for all teacher profiles, in only 15 education systems in the EU. In three further systems (Latvia, Luxembourg and Malta), digital competences are only compulsory for some teacher profiles (EC 2022, 62f.).

Education systems primarily support teachers in developing digital skills by setting standards. Approximately half of all countries around the world have established standards for the integration of digital technologies in teaching. The countries in Europe and North America lead the way in this regard (UNESCO 2023 GEM, 167). Europe has had a common standard specifically for education personnel since 2017: the European Framework for the Digital Competence of Educators (DigCompEdu). DigCompEdu is in turn based on the Digital Competence Framework for Citizens (DigComp). DigComp is regarded 'as the EU-wide framework for developing and measuring digital competence' (EC 2022 DigComp, 1).[39] DigComp 2.2 takes into account both the new and increased digital literacy requirements of citizens due to emerging technologies, such as AI, virtual and augmented reality, robotisation, the Internet of Things (IoT), datafication, and requirements resulting from new phenomena such as misinformation and disinformation, as well as the green and sustainable aspects of interaction with digital technologies (EC 2022 DigComp, 1).

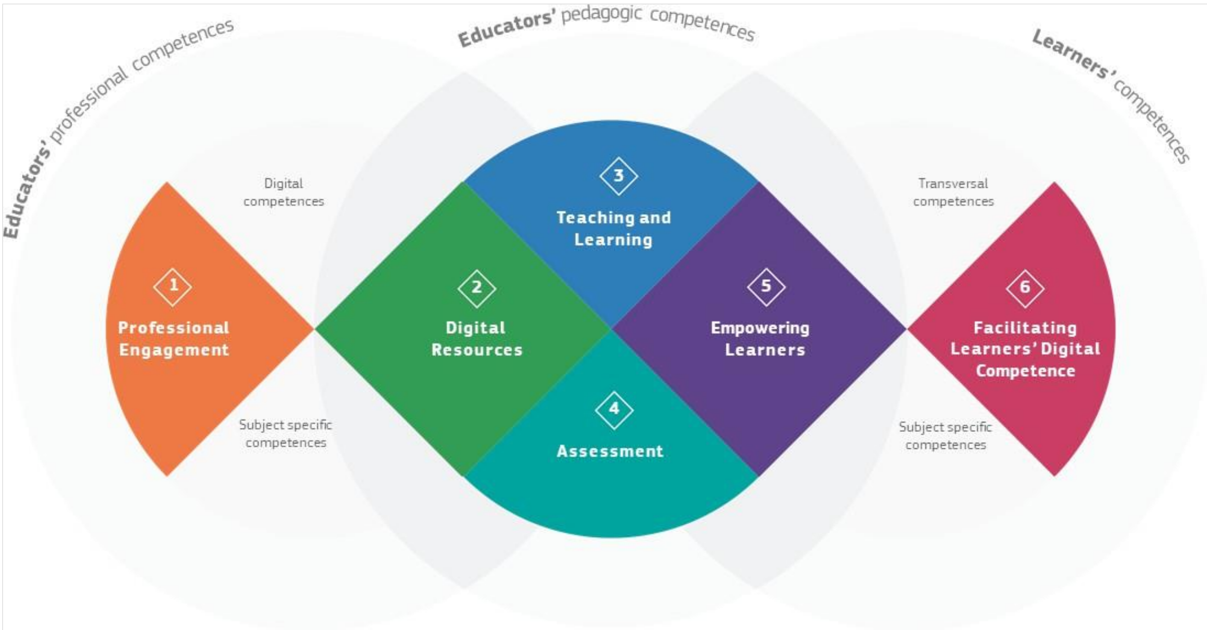
DigComp covers five competence areas: Information and data literacy; Communication and collaboration; Digital content creation; Safety; and Problem-solving. The first three areas are concerned with competencies linked to specific activities and uses. The fourth and fifth areas ('safety' and 'problem solving') are 'overarching' as they apply to any type of activity performed by digital means. (EC 2022 DigComp, 7)

DigCompEdu, that is, the 2017 standard specifically relating to educators, consists of six competence areas with a total of 22 competencies, each divided into six competence levels (Redecker and Punie 2017). The six competence areas are: Professional Engagement; Digital Resources; Teaching and Learning; Assessment; Empowering Learners; and Facilitating Learner's Digital Competence. The six-level progression model here extends from Newcomer to Pioneer.

[38] See https://www.carnet.hr/en/

[39] 'Digital competence involves the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society. It includes information and data literacy, communication and collaboration, media literacy, digital content creation (including programming), safety (including digital well-being and competences related to cybersecurity), intellectual property related questions, problem solving and critical thinking' (Council Recommendation on Key Competences for Lifelong Learning, 22 May 2018, ST 9009 2018 INIT. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018H0604(01)).

Figure 4: The six competence areas of DigCompEdu



Source: Redecker and Punie 2017; https://joint-research-centre.ec.europa.eu/digcompedu_en

In addition to the competencies of Information and media literacy, Digital communication and collaboration, Digital content creation and Digital problem-solving, the competence of Responsible use is also specified: the ability of the teacher '[t]o take measures to ensure learners' physical, psychological and social well-being while using digital technologies. To empower learners to manage risks and use digital technologies safely and responsibly'. In addition to data protection activities, this includes activities such as: to avoid health risks and threats to physical and psychological wellbeing while using digital technologies; to protect oneself and others from possible dangers in digital environments (e.g. cyberbullying); to be aware of digital technologies for social wellbeing and social inclusion; and to be aware of the environmental impact of digital technologies and their use (Redecker and Punie 2017, 84).

In particular, the increasing use of social media in peer communication is creating a greater need for teachers to receive training on the subject of cyberbullying. Teachers are often unaware of the risks of cyberbullying[40], and are themselves increasingly becoming victims of psychological violence by their pupils on the internet. There is a need for further training not only to educate students about the risks of cyberbullying and to teach them to behave responsibly not only in real life but also in virtual space, but also to train their own coping strategies to protect themselves and their own safety, health and wellbeing (Wolgast et al. 2022; Fernández-Alfaraz et al. 2023).

A supplement to DigCompEdu was published in January 2024, aligning specific AI competencies to the six competency areas of DigCompEdu (Bekiaridis and Graham 2024). The supplement was developed as part of the AI Pioneer project, the aim of which is to integrate AI into education, specifically in the areas of vocational education and adult education. For this purpose, a study was conducted in 2023 consisting of a literature review, a survey and interviews with stakeholders from various fields (AI, EdTech, consultants and policy development experts) (Bekiaridis and Graham 2024).

[40] Cyberbullying = an 'aggression that is intentionally and repeatedly carried out in an electronic context …against a person who cannot easily defend him- or herself' (Kowalski et al. 2014, 1073). Kowalski refers to a taxonomy of types of cyberbullying covering: flaming, harassment, outing and trickery, exclusion, impersonation, cyber-stalking, sexting. Cyberbullying can occure through diverse media: instant messaging, e-mail, text messages, web-pages, chat rooms, social networking sites, digital images, and online games. Cyberbullying has in common with traditional bullying: 1. It is an act of aggression; 2. it occurs among individuals with a power imbalance due to '·the fact that one person is more technologically savvy … Furthermore, the anonymity inherent in many cyberbullying situations may create a sense of powerlessness on the part of the victim'; 3. the behavior is often repeated. Bullying and cyberbullying are distinct from each other related to (a) the selfperception of the perpetrator as anonymus (deindividuation); (b) a higher accessibility of the victim (24/7); (c) a much greater potential audience (Kowalski et al. 2014, 1074, 1107).

The DigCompEdu supplement containing teacher competencies relating to AI includes, in the competence area 'Facilitating Learner's Digital Competence', the competence 'Teach Online Safety and Ethics' with the following activities:

- Integrate lessons on digital citizenship, focusing on ethical AI use, data privacy and security.
- Use real-life scenarios and role-playing activities to reinforce safe and responsible AI interactions (Bekiaridis and Graham 2024, 69).

The potential impacts of the integration of digital technologies in general and specifically of AI on the health, safety and wellbeing of teachers are not addressed in any of the standards or in the supplement.

In parallel with this development in Europe, UNESCO will launch both the AI competency framework for teachers (AI CFT) and the AI competency framework for school students (AI CFS) during UNESCO Digital Learning Week in early September 2024. The AI CFT currently comprises five thematic aspects: Human-centred Mindset; Ethics of AI; AI Foundations & Applications; AI Pedagogy; and AI for Professional Development with the three progression levels of 'Acquisition', 'Deepening' and 'Creation'.[41]

Opportunities for the professional development of teachers for and with AI[42]

- The integration of AI into education makes both initial and continuous education more accessible and flexible for teachers (UNESCO 2023 GEM, 172).
- AI-based apps can support teachers when planning courses, course modules and lessons (EC 2023 AI Report, 25).
- AI-based tools can help teachers to develop alternative integrated learning scenarios, e.g. transdisciplinary approaches, vertical teaching, mixed classes (EC 2023 AI REPORT, 27).
- AI-based technologies offer new forms of exchange between colleagues (e.g. European Education School Platform & eTwinning communities, EU Teacher Academies, peer-to-peer connections) (EC 2023 AI Report, 26; EC 2021 Eurydice, 3).
- AI, and particularly LLMs, can support teachers' professional development by providing resources, summaries and explanations of new teaching methods, technologies and materials. These can help teachers to stay up to date regarding the latest developments and techniques in the education sector and contribute to the effectiveness of their teaching. (Kasneci et al. 2023, 3).
- AI can help teachers identify risks of harassment on social media and cyberbullying by using algorithms and deep learning models to support the diagnosis of distracting behaviour of students (emotion recognition systems) (Airaksinen et al 2023; Thao et al. 2023; see also Dobbins et al. 2024 for a healtcare setting).
- AI-based technologies have a key role to play in identifying new trends and predicting future qualification requirements for teachers (Bekiaridis and Graham 2024, 10).
- Knowing about the current state of the integration of AI-based technologies in education can increase teachers' job satisfaction and motivation and provide them with opportunities for professional growth and development (EC 2023 AI REPORT, 24).

Risks and challenges

- Teachers have basic digital skills, but only limited AI-related skills (Kasneci et al. 2023, 6).
- Teachers pay little attention to topics such as data analytics, data protection and safety, data visualisation and big data (Gouseti et al. 2023, 19). Also, only 21% of countries refer to online safety as part of their teacher training (UNESCO 2023 GEM, 166 – according to the international Profiles Enhancing Education Reviews (PEER).[43]

[41] UNESCO Draft AI competency frameworks for teachers and school students:https://www.unesco.org/en/digital-education/ai-future-learning/competency-frameworks

[42] The European Commission's Digital Education Hub on AI distinguishes between competencies 'for, with and about AI' (EC 2023 AI Report, 8).

[43] International Profiles Enhancing Education Reviews (PEER): https://education-profiles.org

- Risk stemming from the use of facial recognition systems in schools (loss of privacy, constant and permanent surveillance, compulsory scanning, displacement of human judgement by automated decision-making processes) (Andrejevic and Selwyn 2019).
- Teachers have only minimal interest in creating digital content, in this case in particular in co-creation,[44] multimodal production[45] and remixing[46] as well as digital communication and collaboration.
- Even in the case of less sophisticated digital tools (e.g. spreadsheet analysis) which has been a curriculum requirement for 20 years, integration into teaching in a didactically appropriate way has so far not been implemented across the board by all teachers. This demonstrates the huge need for initial training and further professional development generally in the area of digital applications, to which LLM tools are now being added (SWK 2024, 15).
- There is a lack of continuing training programmes providing educators with AI-related skills. Programmes such as these should not only provide technical training in AI applications but should also incorporate pedagogical methods for integrating AI within teaching practice (Bekiaridis and Graham 2024, 12).
- Teachers need different levels of support depending on their prior knowledge and interests. Differentiated provision is therefore required (SWK 2024, 15). Among young teachers in particular there is huge need for ‘applying AI technologies in their teaching practices’ (Bekiaridis and Graham 2024, 34).
- Teachers tend to be more pragmatic in their acceptance of new digital technologies. The use of AI-based technologies in education focused solely on benefits, however, does not go far enough. What is needed are ‘critical digital literacies’ (Gouseti et al. 2023, 19). The constant development of AI means that the focus of education is shifting to not just using but also understanding and critically evaluating AI tools (Bekiaridis 2024, 10).
- The ‘critical digital literacies’ also include a creative approach to AI. This can get ignored when teachers are under pressure to adapt to technological developments and with AI-based school management.
- Realising the potential educational benefits of AI and of digital data in general requires the active and meaningful engagement of teachers and school leaders. This also includes collaboration between educational facilities, providers of AI technologies and industry partners to ensure that training is relevant and up to date with the latest advances in AI (EC 2023 AI REPORT, 8; see also SWK 2024, 15; Bekiaridis and Graham 2024, 12).
- GenAI technologies are currently being integrated into education systems without any controls, rules or regulations. Teachers face the challenge of using an entirely unknown technology for the purpose of education which evidently requires no validation and even leading technologists claim not to understand (Giannini 2023, 4f.).
- The use of GenAI is leading to an economisation of the teaching profession. The objective of teacher training is to increase the effectiveness of teachers so they become ‘more competitive and effective in their roles’ (EC 2023 AI REPORT, 24).
- Given AI-controlled technology in the classroom, it is yet to be determined whether, in the future, there will be any further need for highly qualified and well-paid professional teachers. ‘AI-driven classroom technology could well usher in an era of deprofessionalisation’ (Sewyl 2022, 162).

[44] Practices in which two or more people interact with each other to produce something, e.g. new goods and services, texts and media products for publishing, developing solutions to joint problems, and to create artistic compositions (Minna Lakkala in: Gouseti et al. 2021, DETECT, 18: https://www.detectproject.eu/).

[45] Multi-modality involves the production of works that contain two or more different forms of engagement, e.g. the combination of text, image, video and sound. An example in physical form would be a picture book, the combination of visuals and text, and sometimes objects to touch and feel. In digital forms, it could be, for example, the inclusion of video content within a news item, or the addition of an animal sound (Darren Mundy in: Gouseti et al. 2021, DETECT, 18: https://www.detectproject.eu/).

[46] Remixing means to take cultural artifacts, like stories, videos, pieces of artwork or photographs, and modify or combine them into new kinds of products (Minna Lakkala in: Gouseti et al. 2021, DETECT, 19: https://www.detectproject.eu/).

Teachers are the key to the integration of AI in schools and, consequently, in society. There are still gaps in this respect in both initial teacher training and ongoing professional development. A differentiated approach from newcomer to pioneer and which also applies to teachers is essential. A teacher-centred perspective focusing on the impact of AI on the health, safety and wellbeing of teachers must also complement the technology-centred perspective.

5.2.4 Ethics

Thesis

> *AI has disrupted education. Now it can be used for good (WEF 2023); counter-thesis: risk of ethical misuse is inherent to transformative digital technology (Kasneci et al. 2023, 3).*

In connection with the previous professional development factor, ethical considerations relating to the integration of AI-based technologies in education have emerged as one of the major challenges for teachers.

On 25 October 2022, the European Commission published specific 'Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for Educators'. The document is seen as a contribution to the EU's Digital Education Action Plan (2021-2027) and adds the ethical dimension to the action plan's first priority of 'Fostering the development of a high-performing digital education ecosystem'.[47]

The European AI strategy follows a human-centred approach to AI: AI is not an end in itself, but a tool that has to serve people with the ultimate aim of increasing the welfare of society and human wellbeing. The basic requirement for this is that the AI is trustworthy (EC 2019 Building Trust, 1f.).

The ethical guidelines specifically for the education sector are based on the 'Ethics Guidelines for Trustworthy AI' (2019), which were developed by the High-level expert group on artificial intelligence (AI HLEG) of the European Commission. This also includes an 'Assessment List for Trustworthy AI' (ALTAI) (2020) which is a practical tool for translating the ethical guidelines into a checklist for self-assessment.

The Trustworthy AI framework comprises the following:

- Three components: Trustworthy AI should be lawful, ethical and robust.
- Four ethical principles: Respect for human autonomy, Prevention of harm, Fairness and Explainability, although a certain tension exists between these principles (EC 2019 Ethics guidelines, 13).
- Seven requirements for the implementation of Trustworthy AI:
    1. human agency and oversight,
    2. technical robustness and safety,
    3. privacy and data governance,
    4. transparency,
    5. diversity, non-discrimination and fairness,
    6. societal and environmental wellbeing,
    7. accountability.
- An assessment for the operationalisation of the requirements (EC 2019 Ethics guidelines, in particular the figure on page 8).

The requirements referred to above are intended to apply to all AI systems. The appropriate and practical implementation of these requirements in a specific area or sector should, however, involve taking into account the specific context in which they are applied and following an impact-oriented approach in the process (EC 2019 Building Trust, 3; EC 2019 Ethics guidelines, 7).

[47] EU Digital Education Action Plan (2021-2027): https://education.ec.europa.eu/focus-topics/digital-education/action-plan

In the ethical guidelines for the education sector, the individual requirements for teachers and school leaders are as follows:

- **Human agency and oversight:** AI systems should support teachers' autonomy and their ability to make informed decisions in line with pedagogical objectives. A 'human-in-command' approach seems realistic here in order to ensure the necessary human oversight. The teacher has the opportunity to supervise the use of an AI system, as well as the ability to decide when and how the system should be used in a particular situation. The less supervision is possible, 'the more extensive testing and stricter governance is required' (EC 2019 Ethics guidelines, 16).
- **Transparency:** The teacher should be able to track the origin of the data and understand both the technical processes of an AI system and the human decisions combined with it. The teacher should be informed in an appropriate way about the capabilities and limitations of the system. In order to ensure compliance with basic rights, the teacher has the opportunity to decide against interaction with an AI system in favour of human interaction (see EC 2019 Ethics guidelines, 18).
- **Diversity, non-discrimination and fairness:** Teachers must ensure equal access to AI systems by means of inclusion and equal treatment. They must obtain information regarding whether the datasets used contain unintentional bias and therefore may result in prejudice against, and discrimination of, certain groups or individuals and potentially increase prejudice and marginalisation. Teachers must be involved in the development of trustworthy AI systems and in their implementation once a system has been introduced (see EC 2019 Ethics guidelines, 18f.).
- **Societal and environmental wellbeing:** Teachers should be aware that the omnipresence of social AI systems (e.g. chatbots, avatars) can change notions of social capacity to act or influence social relationships and ties. In this way, AI systems can 'be used to enhance social skills, they can equally contribute to their deterioration. This could also affect people's physical and mental well-being. The effects of these systems must therefore be carefully monitored and considered' (EC 2019 Ethics guidelines, 19).
- **Accountability:** Schools must put measures in place to ensure responsibility and accountability for AI systems and their output both before and after their implementation (see EC 2019 Ethics guidelines, 19).

Opportunities: how AI can be used for good in education

- AI improves access to education and expands opportunities for participation (e.g. for children and students with mental and physical disabilities) (Selwyn 2022, 154).[48]
- Using multimodality and multilingualism, AI enables fair access to education and therefore helps to develop inclusive learning environments (Kasneci et al. 2023, 9; Küchemann et al. 2023, 2).[49]
- AI-based school management systems enable improved deployment of 'strong teachers to the schools that need them most' and in this way help to reduce the digital divide between schools and socio-economic inequalities between pupils (see EC 2022, 63).
- If handled sensibly by the teacher, the challenges resulting from AI can be instructive in learning and educational scenarios in 'acquaint[ing] students early on with potential societal biases, and risks of AI application' (Kasneci et al. 2023, 3).
- The human-centred approach and ethical guidelines for trustworthy AI provide an appropriate (non-technical) basis for addressing the impact of AI on the psychological and physical health and wellbeing of teachers.

[48] For instance robots that teach autistic children social skills could help them develop: https://www.technologyreview.com/2020/02/26/916719/ai-robots-teach-autistic-kids-social-skills-development/ (see also EC 2019 Ethics guidelines, 19).

[49] 'LLMs are totally inclusive', Björn Fromman, a teacher at a school in Berlin with 80% of pupils who do not have German as their native language (SWK Talk 2024).

- AI promotes the further development of the teaching profession and enhances the occupation of teacher: teachers as experts and guardians of AI for good.
- The ethical guidelines for AI are the guiding principles for the ongoing development of a specific GPT model for education (EdGPT) that incorporates in its design aspects of health, safety and wellbeing of teachers, school leaders and students (for EdGPT see UNESCO Guidance for GenAI 2023, 13, 25).

Risks and challenges

The following key risks are associated with the use of AI, and in particular GenAI and GPT models:

- The bias problem: The bias problem is inherent in GenAI systems. This represents a recursive risk for future GPT models trained on text from the internet that the GPT models themselves have generated and that also contains their biases and errors. The outcomes, as a consequence, are unfair (Steimers and Schneider 2022, 10). The bias problem requires continuous human oversight. (Kasneci et al. 2023, 3; Küchemann et al. 2023, 2; UNESCO 2023 Guidance for GenAI, 15f.)
- The misuse of AI systems: GenAI can produce offensive and unethical materials (UNESCO 2023 Guidance for GenAI, 16; HAI Report 2023). Furthermore '[o]ne of the primary and most readily apparent risks of AI is its potential to manipulate human users' (Giannini 2023, 5).[50]
- The problem of AI hallucination:[51] GenAI is based neither on observations of the real world nor on other key aspects of a scientific approach, nor is it aligned with human or social values: 'For these reasons, it cannot generate genuinely novel content about the real world, objects and their relations, people and social relations, human-object relations, or human-tech relations. Whether the apparently novel content generated by GenAI models can be recognised as scientific knowledge is contested.' In this regard, GenAI poses a serious risk to education in the future (UNESCO 2023 Guidance for GenAI, 16).
- The reduction in plurality: With GenAI comes the risk of 'constraining and undermining the development of plural opinions and plural expressions of ideas' (UNESCO 2023 Guidance for GenAI, 17).
- The increasing of existing inequalities 'caused by the widening divide in training and controlling GenAI models: current ChatGPT models are trained on data from online users which reflect the values and norms of the Global North' (UNESCO 2023 Guidance for GenAI, 14). And it is yet to be determined whether 'its deployment, according to a specific plan and timeline, [will] likely widen or narrow existing educational divides' (Giannini 2023, 7; UNESCO 2023 Guidance for GenAI, 14; Selwyn 2022, 162).

5.2.5 Regulatory framework

Thesis

AI applications in the education sector are high risk; counter-thesis: within the scope permitted by data protection law, ChatGPT can certainly be used in teaching (see Albrecht 2023, 71, 74).

On 21 April 2021, the Proposal for a Regulation on a European approach for Artificial Intelligence (Artificial Intelligence Act – AI Act) was submitted by the European Commission. The final draft, which all EU Member States have approved, has been available since 21 January 2024.[52] Following a final round of voting between representatives of the European Parliament, the European Council and the

[50] Such misuse, however, does not apply exclusively to AI (Kasneci 2023, 1).
[51] The concept of hallucination is problematic as it contributes to the anthropomorphisation of AI. An alternative would be the concept of 'inventing stories' (Albrecht 2023, 41).
[52] EU AI Act Final draft 2024: https://artificialintelligenceact.eu/the-act/. For the background to the AI Act since 2018, see EU-OSHA 2022 AIWM Regulations.

European Commission (trilogue), the AI Act was eventually adopted in June 2024.[53] This makes Europe the first continent to have common legislation on AI. While the European Commission was originally pursuing a soft law approach with its 2019 guidelines for trustworthy AI, a legislative approach for the development, placement on the market and use of AI is now coming into law. The AI Act has been created as a horizontal EU legal instrument, that is, it applies to all AI systems. The AI Act is valid for both AI system providers and users. The AI Act also applies to AI systems developed in third countries.

The AI Act follows a risk-based approach. This means that the greater the potential risks from the use of AI, the more stringent the requirements placed on providers should be. The AI Act makes a distinction between: (i) unacceptable risk, (ii) high risk, (iii) limited risk, and (iv) low or minimal risk. AI systems used in the areas of education and vocational training are classified as 'high risk'.

An 'unacceptable risk' refers to banned AI practices that represent a clear threat to people's safety, livelihoods and rights. AI systems that have negative impacts on the safety of people or on their basic rights are 'high risk'. The AI Act draws a distinction in this case between AI systems used as safety components of a product or which fall under EU health and safety regulations (e.g. toys or cars) and AI systems used in eight specific areas. One of these areas is education and vocational training. AI systems with 'limited risk' include systems that interact with humans (e.g. chatbots), emotion recognition systems, biometric categorisation systems, and AI systems that generate or manipulate image, audio or video content (i.e. deepfakes). These systems are subject to a limited number of transparency obligations. All other AI systems representing only a 'low or minimal risk' can be developed and used in the EU without having to meet additional legal requirements. The AI Act, however, provides for the creation of codes of conduct to encourage providers of AI systems that are not high risk to voluntarily apply the mandatory requirements for high-risk AI systems (EU 2023 AI Act Briefing).

Figure 5: AI Act Risk pyramid

Source: Zaber 2024; European Commission: https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai

Based on the impact-oriented approach of the ethical guidelines for trustworthy AI (EC 2019), what should actually be critical is not the AI system but the impacts of its use on people and society (see in this regard EU 2023 AI Act Briefing, 7). The use of AI may have serious consequences for the health and safety of students and teachers, and in some circumstances, even long-term consequences.

In terms of risk, it is important that AI systems are technically robust: 'Technical robustness requires that AI systems be developed with a preventative approach to risks and in a manner such that they reliably behave as intended while minimising unintentional and unexpected harm, and preventing unacceptable harm.' (EC 2019 Ethics guidelines, 16). This includes protection against security vulnerabilities allowing

[53] EU AI Act - Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024: https://eur-lex.europa.eu/eli/reg/2024/1689/oj

misuse by attackers (e.g. hacking), and an emergency plan, but also a high degree of precision, reliability and reproducibility. Steimers and Schneider however point out that robustness in the context of AI systems represents a new challenge 'as these systems are used for very complex tasks in complex usage environments, which involve a certain degree of uncertainty' (Steimers and Schneider 2021, 9).

Data protection also has a potential influence on the health and safety of teachers and learners. The key legal regulations in this regard in the EU can be found in the GDPR and the updated version of the Data Protection Convention.

Data protection is primarily about protecting privacy, 'a fundamental right particularly affected by AI' (EC 2019 Ethics guidelines AI, 17). The GDPR, adopted in 2016 and in force since 2018, addresses personal data protection and automated decision-making. The invasion of privacy (by accessing personal data) and misuse of personal data can have severe consequences on mental health. Article 22 of the GDPR guarantees, for example, 'the right to not be subject to decisions based "solely" on the automated processing of personal data'.[54] In contrast, the Data Protection Convention requires that personal data that are automatically processed 'must be accurate, obtained and processed fairly and lawfully, collected only in relevant and adequate amounts and used only for specified and legitimate purposes'[55] (EU-OSHA 2022 AIWM, 4).

Opportunities of AI from the perspective of its legal regulation

- The EU AI Act explicitly considers the area of general and vocational education. In doing so, the AI Act takes into account the social significance of such a sensitive area as general education.
- The AI Act classifies the use of AI systems in education as 'high-risk'. This means, on the one hand, that in principle use of AI in the education sector is not prohibited. On the other hand, the AI Act is confirming that AI systems have a high-risk potential as regards the safety and health of learners, teachers and educational facilities.
- A clear legal basis therefore exists for the use of GenAI in the classroom. As a consequence, the integration, for example, of ChatGPT in a learning platform should require a risk analysis.
- Following adoption of the AI Act, a phase of 24 months will begin before the AI Act comes into law in the education sector. The 'regulatory sandbox approach' could be used over this transition phase in the education sector.[56] One example of this is the testing of the 'privacy by design' concept for the educational credential in the United Kingdom (UK). By participating in the regulatory sandbox, the UK Department for Education wants to ensure that the privacy of users of the educational credential is protected at all times.

Risks and challenges

- Legislation is lagging behind developments: 'Publicly available generative AI (GenAI) tools are rapidly emerging, and the release of iterative versions is outpacing the adaptation of national regulatory frameworks. The absence of national regulations on GenAI in most countries leaves the data privacy of users unprotected and educational institutions largely unprepared to validate the tools' (UNESCO 2023 Guidance for GenAI, Summary).
- Ethical and legal issues may call into question the legitimacy of using GenAI in the classroom (SWK 2024, 4).
- For many AI systems, the data protection aspect does not currently play a role in the use of AI in the classroom: e.g. feeding pupils' data into AI data collection; lack of transparency about where these data are stored by commercial providers; cost-effective access to products by

[54] GDPR: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02016R0679-20160504&qid=1532348683434
[55] Data Protection Convention: https://www.coe.int/en/web/data-protection/convention108/modernised
[56] Spain created in 2022 an AI regulatory sandbox as the first pilot programme to test the proposed EU AI Act: https://digital-strategy.ec.europa.eu/en/news/first-regulatory-sandbox-artificial-intelligence-presented. The United Kingdom https://ico.org.uk/for-organisations/advice-and-services/regulatory-sandbox/ and Norway https://www.datatilsynet.no/en/regulations-and-tools/sandbox-for-artificial-intelligence/ also launched regulatory sandbox initiatives that include AI (Russo 2023). The Regulatory sandbox is a free service developed by the Information Commissioner's Office (ICO).

means of ‘payment with data’ (Fütterer et al. 2023; see SWK 2024, 16; see also Kasneci et al. 2023, 8).

- Issues of copyright are as yet unresolved due to the lack of ‘traceability’, i.e. the difficulty in fully recording the origin of data, processes and artifacts involved in creating an AI model (UNESCO 2023 Guidance for GenAI, 36; see also SWK 2024 15; Mora-Cantallops 2021, 1).
- The lack of technical reliability and accuracy of GenAI systems (Küchemann et al. 2023, 2, 8; Christodoulou 2020, 3) and the infringement of personal rights can impact adversely on the psychological health of teachers and learners (e.g. increase in digital stress – depression, anxiety, social isolation) (UNESCO 2021 Recommendations Ethics AI, 37; EU-OSHA 2024, 11).
- There are no criteria for testing the safety of AI models and applications that claim to have an educational benefit: ‘It is rather remarkable that they have largely bypassed scrutiny of this sort to date’ (Gannini 2023, 5f.).
- GenAI providers are not allowing their systems to be the subject of rigorous independent review (UNESCO 2023 Guidance for GenAI, 14).
- There is a limited democratic control of the companies promoting GenAI: access to and use of domestic data (public good) (UNESCO 2023 Guidance for GenAI, 14f.).
- Although the longer-term impacts of GenAI are not yet known, most countries are in the early stages of implementing GenAI in the education sector (UNESCO 2023 Guidance for GenAI, 20).

5.2.6 Costs

Thesis

AI results in significant savings in the education sector; counter-thesis: instead of investing in expensive advanced technology, it is better to invest the money in improving the learning and working conditions for pupils and teachers.

The last 10 years have seen a significant increase in AI investment. In 2022, private investment in AI was 18 times higher compared to 2013 (HAI 2023, Top 7).

In 2022, the global market for AI in education had an estimated value of USD 2,126 million and is likely to increase between 2022 and 2030 at an average annual growth rate of 36.6%. The proportion of AI solutions in the education sector aiming to help educators automate administrative tasks and improve the effectiveness of teaching was estimated at 77.4% for 2022. In this regard, a key trend identified is the preference for ‘smart content’: learning platforms offering interactive learning material by integrating gamification techniques to create a realistic and entertaining teaching environment (Prescient & Strategic Intelligence 2024).

While previous assessments suggested that technology has the potential to automate half of the time workers spend on their jobs, today it is assumed that current GenAI and other technologies have the potential to automate work activities that currently take up 60 to 70% of workers’ time: ‘The acceleration in the potential for technical automation is largely due to generative AI’s increased ability to understand natural language, which is required for work activities that account for 25 percent of total work time. Thus, generative AI has more impact on knowledge work associated with occupations that have higher wages and educational requirements than on other types of work’ (McKinsey & Company 2023, 3).

Many of the work activities involving communication, monitoring, documentation and interaction with people in general therefore have the potential to be automated by GenAI, ‘accelerating the transformation of work in occupations such as education and technology, for which automation potential was previously expected to emerge later’ (McKinsey & Company 2023, 41).

According to McKinsey, advances in the possibilities offered by technology could have the greatest impact on those activities performed by educators, specialists and creative professionals. McKinsey states that, without GenAI, the overall potential for technical automation for the ‘Educator and workforce training’ occupational group for 2023 is 15% and with GenAI 54% (McKinsey & Company 2023, 41).

Opportunities

- Reduction in costs:
    - Organisations that have introduced AI report significant reductions in cost and (in the case of private education providers) increases in revenue (see HAI 2023, Top 8).
    - AI-supported teaching solutions used in a cloud network provide several benefits. These include developing responses to reduce risk, automatic software updates, round-the-clock support availability, reduction in IT operating costs and elimination of the need to update internal systems (Prescient & Strategic Intelligence 2024, 3).
    - Reducing a school's operating costs by making greater use of AI-controlled teaching assistants (Prescient & Strategic Intelligence 2024, 10).
    - Open-source LLMs can be run on an in-house infrastructure and can therefore be more cost-effective (Honroth 2024; Küchemann et al. 2023, 10).
- Increase in the effectiveness of education:
    - Increasing investment in AI in the education sector is supporting the introduction of personalised learning systems, which in turn help to reduce the workload on teachers, to improve the learning process and to give pupils real-time feedback on areas needing improvement (Prescient & Strategic Intelligence 2024, 6).
    - Multidisciplinary cooperation between Google and third parties, e.g. in the education sector 'to help create well-rounded AI training programs tailored to diverse cohorts' (Fisher 2024).
- AI for all – inclusive AI:
    - More integrative tech innovations: AI helps to bridge the digital and economic divide (Fisher 2024).
    - GPT-3 is free: OpenAI has caused a worldwide sensation and fuelled discussions (SWK 2024, 7).
    - Free to all, accessible AI courses: Google is promising EUR 25 million to expand AI education and competency for individuals and organisations throughout Europe: Google has also translated its catalogue of free introductory AI courses into 18 languages (Fisher 2024).
    - Google's AI Opportunity Initiative, which was launched in February 2024, aims to appeal to groups facing obstacles when accessing technical education, including women, minorities, rural communities, migrants, low-income households and people with disabilities.

Risks and challenges

- 'Industry has taken over' (HAI 2023, Top 1):
    - Multinational technology corporations have a major influence on education: 'Huge amounts of data and massive computing power … are mostly available only to the largest technology companies and a few economies (US, China, to a lesser extent Europe)' (UNESCO 2023 Guidance for GenAI, 14).
    - The AI world raises a dilemma in relation to investment decisions: 'Billions of dollars are now being invested in generative AI companies, when they could be directed towards teacher development and making needed improvements to schools and other physical and social infrastructure that benefit children' (Giannini 2023, 7).
    - The inspection and validation of new and sophisticated AI applications for use in schools cannot be left to industry: 'Such industry self-regulation would introduce an unacceptable conflict of interest' (Giannini 2023, 6).
    - Companies do not appear to be aware of the risks to the health and safety of teachers and learners associated with the use of digital technologies in general, and AI-based technologies in particular (see EU-OSHA 2024, 12).

- Increasing the digital and economic divide:
    - There is a risk that, without active intervention, AI will reinforce existing inequalities between genders, ethnic groups, income groups and other social aspects: 'AI could exacerbate existing inequalities' (Adrian Brown, Centre for Public Impact, UK).
    - The introduction of LLMs in education may widen the digital divide: 'Not all educational institutions possess the financial and intellectual resources necessary to adopt and integrate such technologies. This could result in disparities in educational quality and opportunities, perpetuating existing inequalities among learners' (Küchemann et al. 2023, 8; Kasneci 2023, 8).
    - Cost of training and maintenance and cost to verify information and maintain integrity (Kasneci et al. 2023, 8).
    - Financial barriers created by private providers for learners from lower socio-economic groups: Inequalities in the use of fee-based learning programmes may increase (SWK 2024; 17, 20).
    - 'Frontier technology is not the solution in these challenging contexts, even if it might be a piece of it. Well-run schools, enough teachers, and teachers with the requisite conditions, training and salaries that allow them to be successful remain the main ingredients of a sustainable remedy' (Giannini 2023, 7).

6 Reflections on a teacher-centred approach to the integration of AI-based technologies in schools

In hardly any other policy area is the use of digital technologies, and in particular AI-based technologies, as hotly debated as in the education sector. Learners are usually the focus in this regard. Teachers are viewed almost exclusively in their role as mediators of technology, and less often as those affected by and shapers of technological developments.

Furthermore, teachers are responsible for the safety, health and wellbeing of their students; however, how teachers themselves can be supported in times of disruptive change and how they look after themselves is rarely discussed.

Discussions about the use of digital technologies in education continue to be dominated by a technology-centred approach. The teacher-centred perspective urgently needs to be added to this discussion.

6.1 New risks and potential for teachers

AI systems are complex systems that are also used in complex environments, in this case the education sector. This complexity results in specific uncertainties that must be taken into account in the risk assessment. We still have a lack of knowledge regarding the realistic possibilities of these technologies. In the face of deep learning and large multimodal language models based on large amounts of data and not on human decisions, we are reaching the limits of interpretability and explainability; there is also a lack of rules, regulations and standards (see Steimers and Schneider 2022; Giannini 2023).

Table 3 summarises the possible risks and opportunities for teachers stemming from the introduction of AI-based technologies in schools.

Table 3: Risks and potential from the use of AI-based technologies for teachers

Factor	Risks	Potential
WORKLOAD	▪ An increase in 'hidden work' increases the blurring of the boundaries between work and private life for teachers. ▪ Pace at which teachers work continues to accelerate. ▪ Lack of transparency (and explainability) of AI systems increases the cognitive load. ▪ Digital control and surveillance using real-time data can affect mental health. ▪ Use of AI-based technology can contribute to a reduction in peer learning and peer support for teachers. ▪ Human–robot collaboration may result in interaction being removed from the work of teachers.	▪ Reduction on workload for routine tasks, such as marking. ▪ Support with lesson planning, e.g. course development. ▪ Less work and greater precision when grading. ▪ Easy development of customised applications for the classroom. ▪ Simplification of resource planning (task and time schedule) and optimisation of work organisation in the school.
AUTONOMY	▪ Reduction in the room for manoeuvre. ▪ Undermining of status and authority. ▪ Tendency towards acting in machine-readable form ('prompt engineering'). ▪ Excessive trust in AI technology. ▪ Reduction in mindfulness. ▪ Loss of specific skills.	▪ Maximised when teachers maintain control in a transparent manner over their entire work process ('human-in-command' approach). ▪ Greater freedom due to reduced workload for routine tasks. ▪ More time for pedagogical tasks, own professional development as well as being creative or developing creativity.
PROFESSIONAL DEVELOPMENT	▪ A lack of AI literacy. ▪ Lack of intrinsic motivation for the use of AI-based technology. ▪ Integration of AI non-existent in the initial teacher training. ▪ Lack of AI-specific professional development courses for teachers. ▪ Risk of deprofessionalisation.	▪ Easier access to professional development for teachers. ▪ Greater flexibility in the use of further training and consultation services. ▪ Support with the development and implementation of alternative integrated learning scenarios, e.g. transdisciplinary approaches, vertical teaching, mixed classes. ▪ Enabling new forms of exchange between colleagues, e.g. via platforms and eCommunities. ▪ Support with professional development by identifying new trends and predicting future skills requirements.

ETHICS	▪ Bias problem inherent in AI. ▪ Problem of 'hallucination'. ▪ Risk of restricting and undermining plurality. ▪ Increasing of inequality. ▪ Risk of misuse of AI.	▪ AI improves access to education for all. ▪ AI contributes to the development of inclusive learning environments. ▪ AI provides the opportunity to reduce the digital divide between schools, e.g. by means of a fair allocation of teachers according to the needs of schools and equalisation of socio-economic inequalities between pupils by means of free access to AI applications. ▪ Sensitively integrating the biases and risks of AI into learning and educational scenarios makes students familiar with the issues from the outset. ▪ Practical application of the guiding questions from the 'Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for Educators' in school practice. ▪ Enhancing of the teaching profession as a result of AI expertise. ▪ Teacher is at the centre of the AI school strategy, which follows the European guidelines for trustworthy AI ('for, with and about AI').
REGULATION	▪ Legislation cannot keep pace with technological development. ▪ Lack of technical reliability and accuracy of AI systems creates a safety problem. ▪ Lack of validation of AI-based systems for use in the education sector. ▪ Non-compliance with data protection when using AI-based technologies in the education sector. ▪ Unresolved copyright issues.	▪ The EU AI Act provides an EU-wide legal basis for the use of AI systems in the education sector. ▪ Based on the EU AI Act, a proactive prevention strategy is being developed to avoid the high risks that the use of AI systems can have for students, teachers and other staff in educational institutions. ▪ Use of AI-based systems should be included in the school's risk analysis. ▪ The transition phase until the EU AI Act comes into law in the education sector can be used for testing purposes ('regulatory sandbox approach').
COSTS	▪ Influence of multinational corporations on education. ▪ Economisation of the education sector (EdTech). ▪ A dilemma regarding investment decisions: Investing in advanced technology or the refurbishment of schools? ▪ Widening of the digital and economic divide.	▪ Reducing costs in educational facilities through the use of AI. ▪ Greater technical efficiency, e.g. due to cloud networks and open source solutions. ▪ Reducing a school's personnel costs, e.g. through the use of AI-controlled teaching assistants. ▪ Investment in the AI education of individuals and organisations by high-tech companies, e.g. Google.

Source: author's elaboration

6.2 Strategies and measures for minimising the risks and exploiting the potential for teachers

According to the AI Report of the European Digital Education Hub's Squad on Artificial Intelligence in Education (EDEH), almost all European countries, 23 out of 27 Member States, have an AI strategy (EC 2023 AI Report, 70).[57]

All Member States with a national AI strategy dedicate at least one distinct section to AI competencies. While all countries provide measures for higher education institutions, most (but not all) also address the primary and secondary levels. A few countries also include the preschool level (Jorge et al. 2022, 52; see also the detailed table from page 55). Squad comes to the following conclusion: 'Countries are working on several models for reskilling and upskilling and the introduction of AI skills in formal and informal education, but specific measures targeting assessment of AI use in education are not present' (EC 2023 AI Report, 70).

According to AI-Watch, at least 12 countries have also developed an AI policy for teacher training, although this relates to more of a broad range of digital capabilities: national teacher training initiatives are often not targeted (Jorge et al. 2022, 52, 53).

Overall, Squad diagnoses a 'lack of strategies to specify measures that are conducive to effective use of AI for educational purposes' and identifies a 'need for establishing an integrated education governance package for AI that encompasses educational reform, ensuring inclusive, equitable and ethical use of AI' (EC 2023 AI Report, 63).

In the following sections, the teacher is assumed to be the key element for such a strategy and a distinction is made between strategies and measures at the following levels: European level, national level, institutional level and teacher level (see EC 2023 AI Report, 26f.). Finally, a policy pointer is provided for each level.

6.2.1 European level

Since 2024, even though the EU AI Act has not yet been transposed into the national law of all the Member States of the European Union, the AI Act has, for the first time, provided a Europe-wide legal basis for the use of AI systems. This makes the EU a world leader in this respect.

It remains to be seen what impact the AI Act will have on the education sector. On the one hand, it emphasises the role of AI 'to help modernise entire education systems, to increase educational quality, both offline and online and to accelerate digital education, thus also making it available to a broader audience'; on the other hand, the AI Act classifies AI systems that influence access to education and training as high-risk systems, 'since they may determine the educational and professional course of a person's life and therefore affect their ability to secure their livelihood'. On the one hand, the importance of AI literacy is emphasised; on the other, only providers and deployers of AI systems are addressed with this requirement (EC 2024 AI Act; cf. Maynard 2023).[58]

It is unclear whether the AI Act will help teachers and school leaders to better assess the potential and risks of AI systems and to use them responsibly in teaching and for school administration, or whether the AI Act will lead to new bureaucratic hurdles and thus increase the workload of teachers and restrict their freedom to act.

To promote the digital literacy of teachers and school leaders, the DigComp and DigCompEdu competence frameworks and, above all, the specific AI competences supplementing DigCompEdu from 2024 are available at European level. The DigCompEdu supplement lacks a direct reference of AI competences to teachers' health, safety and wellbeing.

As far as the ethical component is concerned, the European 'Ethical guidelines on the use of artificial intelligence (AI) and data in teaching and learning for educators' provide teachers and school leaders

[57] Squad on AI in education = an online working group of the European Digital Education Hub (EDEH), an initiative of the European Commission, funded by the Erasmus+ programme 2021-2027. In the Squad, members collaborate online and produce a concrete output that is shared across the EDEH community. Squad members usually dedicate about one hour per week of their time, two bi-weekly calls and squad activities.

[58] Final draft (2024) of the EU AI Act: https://artificialintelligenceact.eu/the-act/. Amendment 65 and 214, 14 June 2023.

with a good basis for examining the potential and risks of AI and for dialogue with pupils, parents, colleagues, representatives of ministries, and the providers and distributors of AI.[59]

Policy Pointer

Guidance should be developed to support teachers and school leaders in distinguishing between AI systems that help to improve their own working conditions and therefore the quality of education, and AI systems that present legal and ethical problems in the context of education. The concept of AI literacy must be expanded to include the aspects of health, safety and wellbeing of teachers and learners.

6.2.2 National level

The European Commission's working group on AI in education recommends pursuing a gradual approach at national level 'to gradually introduce AI tools into school contexts and to constantly monitor the societal effects that can emerge, leaving open the possibility to step back when unintended consequences occur'. Such a strategy can include the following steps: (1) reviewing current AI systems and data use; (2) initiating policies and procedures; (3) carrying out a pilot of the AI system; (4) collaborating with the AI system providers; (5) monitoring the operation of the AI system and evaluating the risks; (6) raising awareness and community engagement (discussing and collaborating with colleagues and other schools, communicating with parents, learners and the school community and keeping them up to date) (Jorge et al. 2022, 72).

Current and good examples of governance packages following such an approach can currently be found in Austria and Germany.

- **Austria: AI – an opportunity for Austria's schools**

On 14 November 2023, the package of measures 'Artificial Intelligence - Opportunities for Austrian Schools' was presented to the public. This comprehensive approach integrates AI into everyday school life: from AI pilot schools using individualised learning pathways and GenAI such as chatbots as a learning aid to customised teaching materials and the further education and training of teachers in AI. This is about much more than just technology: the focus is on ethical aspects, data protection and the responsible use of AI.

The package of measures for Austrian schools supports teachers, school leaders, pupils and parents in recognising risks and challenges and in uncovering potential and opportunities.[60]

- **Germany: LLMs and their potential in the German education system**

On 17 January 2024, the Standing Scientific Commission of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (SWK) presented an impulse paper on 'Large Language Models and their potential in the education system'. In it, the commission provides suggestions for use in teaching, for research and development tasks, and for educational policy discussions. Germany is initially prescribing a transition phase for the introduction of technologies based on GenAI in schools. During this phase, learning scenarios will be trialled and teachers will be given the necessary training in this area. To this end, the aim is to achieve cooperation between different disciplines (e.g. computer science, linguistics, philosophy, education, psychology, neurosciences) and a close collaboration with education media, specialised didactics and the institutes for teacher training. The use of LLMs in particular is only planned in Germany from year 8 onwards, which in principle does not rule out the use of AI-based tools at primary level. When using GenAI in schools, a sense of proportion is required from those responsible. The responsibility for the deployment is seen as lying with the teachers. For Germany, valid data on the extent to which teachers are already using AI tools are not yet available (SWK 2024).

[59] Ethical guidelines on the use of AI and data in teaching and learning for educators: https://op.europa.eu/en/publication-detail/-/publication/d81a0d54-5348-11ed-92ed-01aa75ed71a1

[60] Federal Ministry of Education, Science and Research (BMBWF) of Austria: Teachers in the selection and use of AI systems https://www.bmbwf.gv.at/Themen/schule/fpp/infomail/2023_12/ki.html; A creative and critical-reflective approach to AI in schools https://www.bmbwf.gv.at/Themen/schule/zrp/ki.html

The impulse paper addresses the demands on teachers' competencies for critical reflection, use of LLMs to promote learning, media didactic competence enhanced with AI that requires the ability to trial AI tools themselves and new skills for examiners. In addition, the paper also addresses the risk of loss of competencies as well as legal and ethical challenges.

It will be necessary to observe how AI is introduced in a country like Germany with a low level of digital maturity in the school system in contrast to Austria, for example, where the level of digital maturity in the school system is high.

Policy Pointer

National policies and measures must ensure that AI is used not only to empower teachers, but also to promote their health, safety and wellbeing. To this end, national AI readiness must be taken into account and 'breaks' must be made possible. During the breaks, AI can be used to enter into an exchange of experiences between colleagues from different Member States.

6.2.3 Institutional level

AI should be used at school level for the purpose of:

- reducing the workload of teachers and school leaders,
- promoting cooperation between colleagues, and
- improving relationships with pupils and parents.

The prerequisites for this are, for example: the offer of free use of AI applications; the implementation of AI at organisational level; strict compliance with data protection regulations; more time for the professional development of teachers; the involvement of teachers in the selection and use of AI systems; and a creative and critical-reflective approach to AI in schools.

What is needed is a salutogenic AI school strategy that prioritises the health, safety and wellbeing of teachers and learners. Such a school strategy should consider that teachers are not a homogeneous group. A salutogenic AI school strategy should take into account the needs of different groups of teachers, for example, teachers with and without previous experience of using AI systems, teachers with both a lot and very little teaching experience, and teachers with pre-existing physical and mental health conditions.

Policy Pointer

The development of an AI school strategy is a necessary prerequisite for the safe and healthy integration of AI-based technologies into teaching and school administration. In addition, schools should provide scope for experimentation to find out how AI can best be integrated into their school. In this way, the individual and organisational learning process can be optimised without displacing people from the centre of the action (according to Florian Nuxoll 2023).

6.2.4 Teacher level

School teachers are faced with the paradox of being in a privileged position as regards being active in prevention measures relating to their pupils' physical and mental health but in a weak position if they themselves do not receive adequate training and personal support.

According to an international study by Costardi et al., there is not 'any specific digital intervention for teachers to deal with their own mental health, which represents a gap when compared to interventions related to their students' (Costardi et al. 2023, 756). AI applications offer the opportunity to remedy this in the future and at the same time help with overcoming the stigma of mental illness.

Teachers have so far only been seen as mediators in the context of AI: teaching for, with and about AI. The support programmes for teachers therefore focus on further training in digital literacy, or now, AI literacy, and on didactic-methodological further training for the integration of AI-based tools in the classroom. However, it is necessary to equip teachers with the resources to help them look after their own and their institution's health, safety and wellbeing.

Studies on how teachers dealt with the coronavirus crisis have shown that the resources of work autonomy, social support and functional coping strategies serve as a buffer for the load and stresses experienced by teachers and can therefore contribute to their physical and psychological health. This requires proactive strategies that include the ability to recognise and use resources for dealing with stress factors and the ability to seek out and receive social support from colleagues (Deroncele-Acosta et al. 2024).

It is important for a proactive strategy that digitalisation, in this case AI, is not perceived by teachers as an 'actor' who does, teaches and learns things at school, and where teachers and students are participants who lack the knowledge, opportunities to act and scope to be actors themselves (Magnusson 2022).

A proactive strategy in the education sector, which is defined as a high-risk area for dealing with AI, includes: (1) appraisal of uncertainty; (2) mindfulness as individual and collective awareness and alertness to the impact of the use of AI systems in schools; and (3) perceived social support.

Policy Pointer

The crisis experience from the COVID-19 pandemic has taught us a way out of the structural and personal dilemma of placing excessive demands on teachers: most teachers remain resilient once the necessary support from colleagues is available and recognised.

However, with the renewed disruption in the education sector, due to GenAI, now is the time for teachers to 'reinvent' their role by seeing themselves as actors and co-creators of digital educational practice. To this end, measures that have so far been lacking must be offered or teachers must be provided with appropriate resources, e.g. for the self-management of wellbeing, with socio-emotional support programmes, but also with measures for role reward and to increase the attractiveness of the teaching profession.

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