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Emerging technologies and the teaching profession

Ethical and pedagogical considerations based on near-future scenarios

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Foreword

The digital transformation is affecting all spheres of work, the nature of jobs, tasks and skills as well as the way people learn and live. The teaching profession is no exception. Through eight near-future scenarios (3-5 years), the report adresses how digitalisation and automation can impact the teaching profession. The scenarios are not necessarily *desirable* developments but are there to provoke discussion.

The research for this report took place before Covid-19 emerged. Since spring 2020, the Covid-19 crisis forced an unprecedented and immediate shift to digital and online learning. Many of the issues stemming from the scenarios became even more relevant: the balance between human autonomy and machines, datafication of education, and pedagogical models that underlie educational technologies.

Therefore, this scenario exercise calls for the need to strategically reflect on the future of education and training based on issues that are emerging today and that require policy consideration. To ensure better pedagogical and social outcomes for a more inclusive education system tomorrow, and to create more accountability, transparency and trust, multi-stakeholder discussions are needed today on the ethical issues linked to emerging technologies in education and training.

This report on "Emerging technologies and the teaching profession" is the third and last JRC contribution to the forward-looking papers foreseen under the 2018 Digital Education Action Plan. The report is done on behalf of, and in collaboration with the Directorate-General for Education, Youth, Sport and Culture. The JRC published the second paper "Makerspaces for Education and Training: Exploring future implications for Europe" in 2019. It focussed on exploring the long-term potential that makerspaces and making activities can bring to education and training in Europe, trough background research, literature review, scenarios and policy insights. The first paper under this series was released in November 2018 and focussed on the impact of Artificial Intelligence on learning, teaching and education.

These reports are part of the JRC research on 'Learning and Skills for the Digital Era'. Since 2005, more than 25 major studies have been undertaken resulting in more than 120 publications.

More information on all our studies can be found on the JRC Science hub: https://ec.europa.eu/jrc/en/research-topic/learning-and-skills.

Abstract

Will today's emerging technologies impact the teaching profession in the future? Which parts of the teaching tasks or learning processes could be substituted, enhanced and transformed through automatisation, algorithms and machines?

To help educational stakeholders with strategic reflection and anticipatory thinking, eight future-oriented scenarios are outlined using foresight methods. The aim of the scenarios is to see the future as something to shape. These near-future scenarios aim to solve a number of problems that educators of today say prevent them from delivering quality education and training. They take place in classrooms, lecture halls, training centres and digital learning environments in which emerging technologies could be used to support educators in their profession.

Key challenges emerging from the scenarios relate to ethical considerations (e.g. balance between human autonomy and machines, datafication of education, pedagogical models) and the evolving competence requirements of teaching professionals. At the end of the report, a number of insights for policy reflection are raised. They aim to prompt the need today to discuss the future role of emerging technologies in education and training, and their impact on the teaching profession.

Contents

Annexes

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Executive Summary

In this report, eight near-future scenarios are presented (Table 1). They explore whether and how emerging technologies could be used to tackle challenges that educators throughout the EU have identified as preventing them from delivering quality education and training (OECD, 2019b). By emerging technologies we mean a wide range of applications and services that take advantage of Artificial Intelligence (AI), Virtual and Augmented and Mixed Reality, social robotics and wearable technology such as head mounted displays and sensors.

Lesson planning, teaching practices and clerical work
1. Grouping learners for more effective classwork
2. Automating clerical tasks and answering queries
Students' well-being, motivation and non-cognitive skills
3. Promoting empathy and conflict resolution skills
4. Supporting learners' social and emotional learning
Language acquisition by migrant learners
5. Edu-hacks for learning the language of schooling
6. Virtual Reality in Vocational Education and Training
Special education
7. The case of hearing loss in regular classroom
8. Robots and autistic children

TABLE 1: TITLES OF THE EIGHT SCENARIOS.

The report is aimed at people involved in education and training to support policy-making and to foster further discussions with the goal of helping better envision, debate and act upon the future of the teaching profession.

The three cross-cutting themes across the scenarios are:

- ethical considerations regarding the balance between human autonomy and machines in what comes to pedagogical judgement;
- datafication of education and pedagogical models that underlie educational applications and services;
- understanding the evolving competence requirements of those in the teaching profession.

Insights for Policy 1: All stakeholders in the field of education and training should consider the implications of yielding powers to emerging technologies to take pedagogical decisions, which otherwise would be taken by a teaching professional with adequate pedagogical and subject-specific content knowledge.

Insights for Policy 2: For educational applications and services that rely on autonomous decision-making (e.g. AI), three different approaches can be envisaged to deal with the distribution of responsibility between humans and an algorithm/machine.

Teacher-in-the-loop: Consider an application that autonomously evaluates high-stakes exams, or conducts a diagnosis of a learning disability. In such situations, an incorrect decision could cause severe harm to the end user (e.g. a loss of opportunity, unfair practices). Decisions or applications which could cause harm or have serious implications for the end user should first recommend a decision to an educator with enough transparent information available so that the educator can review it - and only then decide whether to execute the final decision or not (Figure 1, top-right).

Teacher-over-the-loop: Other types of decisions exist where it is enough that an educator maintains an overview of the decision taken by an application. This could be the case, for example, when an adaptive learning platform recommends a learning activity to a learner to achieve an intended learning outcome (Figure 1, bottom-right).

Teacher-out-of-the-loop: In a situation where there is a low probability and low severity of harm caused by, for example, an educational app that is used out of school, the educator's oversight is not required (Figure 1, bottom-left).

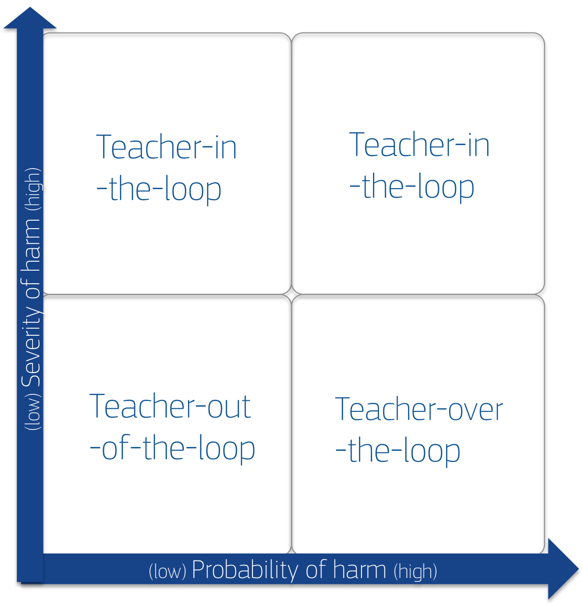

FIGURE 1: DIFFERENT DEGREES OF HUMAN OVERSIGHT WHEN DEALING WITH AUTONOMOUS DECISION-MAKING IN EDUCATION AND TRAINING.

Insights for Policy 3: Emerging technologies create new challenges for **datafication of education and training**. Safeguarding learners' privacy while using educational applications and services is important so that there is a balance between intruding into one's personal sphere and collecting digital learning data. Emerging technologies should contribute to creating conducive learning environments also for social and emotional learning.

Insights for Policy 4: Caution regarding the underlying **pedagogical models** of educational applications and services is needed. From the educational science point of view, it is essential to reflect on which theoretical constructs the pedagogical decisions are based and how traceable these decisions are (e.g. explicability). Turning digital data into deep insights about education and training is still a challenge.

Insights for Policy 5: **The intended learning outcomes and educational goals** of educational applications and services also require scrutiny. In the future, focus on the learner agency and helping learners to develop a variety of competences (e.g. in the cognitive, social and emotional domain) should remain in the focus of research and development in the field.

Insights for Policy 6: Emerging technologies in education and training can offer an opportunity to rethink and re-frame success in education and training, instead of automating and routinising teaching practices and learning processes. Emerging technologies should not be used to continue a practice which is ineffective or does not meet the needs of contemporary learning environments.

Insights for Policy 7: Supporting educators in applying emerging technologies in an effective manner in their profession (i.e. as tools to enable better teaching, learning and assessment processes) is a must. Empowering educators also as co-creators of new products and services offers new possibilities to help and support the profession. For this to take place, educators need to acquire basic knowledge of emerging technologies (e.g. underlying concepts, general principles and mechanisms), and of related ethical and legal issues.

Insights for Policy 8: To realise the potential of emerging technologies for education and training, policy-makers need to agree and be clear on educational objectives: what to achieve with emerging technologies in education and training systems, and what roles are they given? The discussion should strongly consider educational, social and ethical values, and not be confined to technical issues only.

1 INTRODUCTION

Automating parts of processes in education and training has a long history. One of the first "teaching machines[1]" dates back to the mid-1920s when it was used to mechanise drill and practice. Likewise, routinisation of tasks in the teaching profession, such as marking exams using multiple choice options, has long been a widely applied practice. Digitalisation, however, has escalated and accelerated these trends. In today's societies, certain occupations are at a higher risk of automation, especially those in which work organisation becomes highly routinised (David and Dorn, 2013).

Which parts of teaching tasks or learning processes should, or should not, be substituted, enhanced and transformed using task automatisation, algorithms and machines? What impact could it have on education and training over the upcoming 3 to 5 years, let alone in the longer term? How would that impact the teaching profession in the future and the role of the education institution with its socialising function?

As the developments of underlying technologies evolve rapidly, new technology-driven educational solutions emerge taking advantage of Artificial Intelligence (AI), Virtual and Augmented and Mixed Reality, wearable technology such as head mounted displays and sensors, social robotics and the Internet of Things enabled by the ultrafast 5G mobile standard. Together, they create new types of digital ecosystems which are *henceforth* called emerging technologies.

This report presents an anticipatory process to start a discussion about emerging technologies in education and training, and it focuses on their impact on the teaching profession. Using near-future scenarios (3-5 years), the aim is to tackle a number of challenges educators have identified as preventing them from delivering quality education and training throughout the EU. Key challenges to be addressed are: ethical considerations such as the balance between human autonomy and machines, datafication of education, and pedagogical models that underlie educational applications and services. In addition, the aim is to better understand the evolving competence requirements of those in the teaching profession.

The report is aimed at policymakers, and all educators and support staff working in the field of formal education and training. The aim of the scenarios is to help better envision and debate the added value and transformative power of emerging technologies in the field. The scenarios are a tool to expand our ideas on what is necessary and desirable for the future in Europe. They will help form a vision at the European level: how much of the human characteristics of teaching, which are embodied by educators and other educational staff, we are willing to substitute, transform or enhance using automatisation and machines?

By creating future visions and better understanding our values in education, it will be easier to identify where educational policies could, and should, intervene. Likewise, planning participatory work together with policymakers, educators, school principals, students and the EdTech industry will allow a joint vision and deliver a future where all learners can thrive.

This discussion should involve a large group of stakeholders whose future depends on well-educated citizens and a skilled labour force. Some examples of pertinent actions already exist. For example, to support Dutch schools and school boards to start discussing various aspects of ethical issues around digital education, the guide entitled *Weighing Values: An ethical perspective on digitalisation in education* (*Ethiekkompas*) was published in 2020. Annex 2 includes an example in English. Also recent work from UNESCO aims at expanding the discussion to engage policymakers at a more global

1 https://en.wikipedia.org/wiki/Teaching_machine.

level, e.g. the report of the International Conference on Artificial Intelligence and Education (UNESCO, 2019) and that by Pedro et al. (2019). The Joint Research Centre of the European Commission has also already started contributing to this discussion by releasing two Science for Policy reports, one called "The Impact of Artificial Intelligence on Learning, Teaching, and Education" by Tuomi (2019) and another one called "Makerspaces for Education and Training: Exploring future implications for Europe" by Vuorikari et al. (2019).

In the following chapter, the context for near-future scenarios is laid out by looking at the teaching profession today. In Chapter 3, the groundwork for scenarios is explained, Chapter 4 introduces eight near-future scenarios and Chapter 5 outlines observations for further policy reflection.

2

CHALLENGES FOR THE TEACHING PROFESSION TODAY

Looking at education and training today in Europe, it is important to understand the problems educators say prevent them from delivering quality teaching. Five challenges are highlighted from a recent survey that focused on secondary school teachers in 23 countries[2] (OECD, 2019b):

1. When teaching larger classes, educators tend to spend less time on teaching than on other tasks (Annex 4: Table 6). "Reducing class size by recruiting more staff" is an area which educators highlight as needed investment (Annex 4: Table 9).

2. 33% say that they have low efficacy in motivating student learning, for example, when students do not show interest in school work (see Annex 4: Table 7).

3. Around 20% of educators have more than 10% of students with migrant background and/or those whose first language is different from the language of schooling (e.g. over 40% in Austria and Sweden, Annex 4: Table 7).

4. 31% of educators teach in classes with more than 10% of special needs students (e.g. over 50% in Belgium, see Annex 4: Table 7). Yet at the same time, only 42% felt "well prepared" or "very well prepared" to teach in this setting.

5. Incidents associated with intimidation or bullying among students occur at least weekly in 14% of schools across countries (Annex 4: Table 8).

Furthermore, looking at the professional activities that educators carry out today, secondary school teachers were asked to report the average number of hours (i.e. 60 minutes) spent on eleven different activities during a complete calendar week (Figure 1, see Annex 4: Table 10). The hours spent on different tasks were added up to calculate a percentage of time that was spent on each task (EU average).

Figure 1 shows that teaching is at the core of the profession, however, over a complete calendar week, less than half of the working hours are spent on it (44%). Differences between countries are rather big: in Finland teachers spent on average 57% on teaching, but it was below 40% in Slovenia and Malta (Annex 4: Table 11). In terms of hours, the average time devoted to teaching translates close to 19 hours over a calendar week. This varies from 16.8 hours for Italian teachers to 21.2 hours by those in Hungary (OECD, 2019b).

In addition to teaching, to ensure that educators can maximise student learning, educators should have enough time to prepare lessons, to communicate with parents, to participate in professional development to keep their practices up-to-date, and to take part in professional collaboration among colleagues (OECD, 2019b, p. 28). In Figure 1, these activities are highlighted in yellow and red hues. In total, they account for less than three-quarters of all activities.

The activity of marking and correcting student work represents 11% percent of average time reported in Europe, which translates to 4.59 hours over a calendar week. This figure, however, varies greatly across education systems. On the one hand, Finnish educators reported spending an average of 2.95 hours on the task, and on the other, Portuguese teachers said to spend an average of 6.75 hours on it. Activity such as evaluating student work gives educators a unique opportunity to know more about their students' learning. Moreover, it can play a crucial role in planning learning activities (e.g. the case of formative assessment). However, finding a fine balance between overloading learners with homework, which

[2] All the data refer to TALIS (OECD, 2019b), if not otherwise reported. As the data collection took place before the withdrawal of the UK from the EU, thus data for England is included in the weighted EU averages as is reported by OECD (2019b).

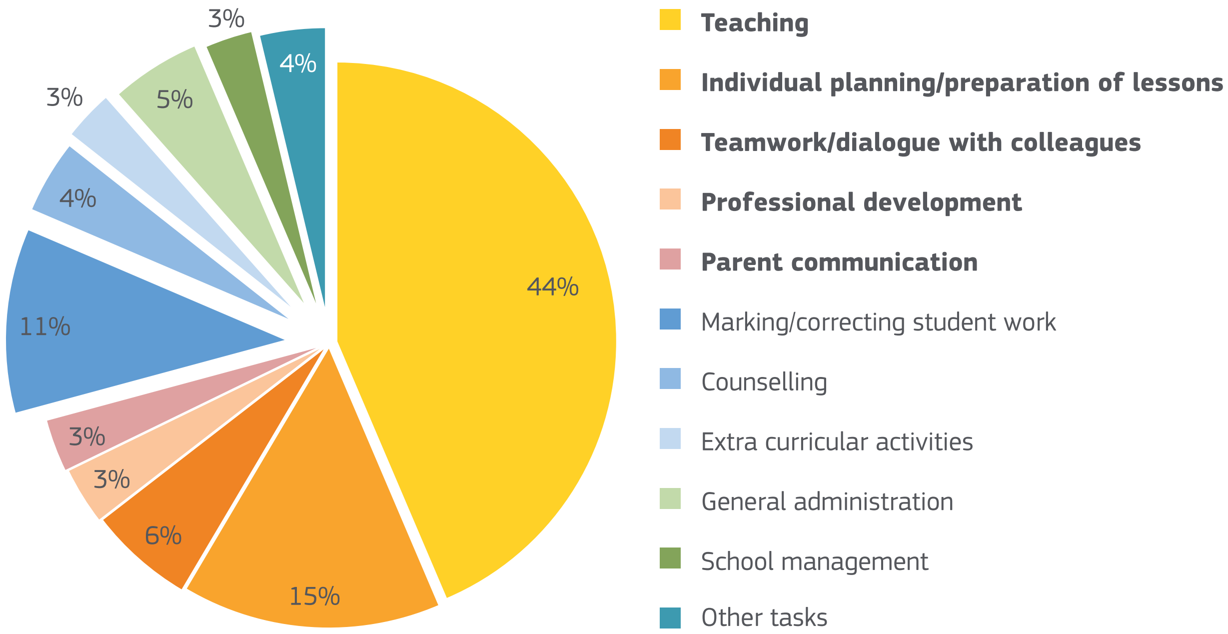

FIGURE 1: PERCENTAGE OF TOTAL TIME TEACHERS REPORT HAVING SPENT ON THE FOLLOWING ACTIVITIES DURING THE MOST RECENT COMPLETE CALENDAR WEEK. (Elaboration by JRC using data from Table I.2.27 by OECD, 2019b).

educators later spend hours marking and evaluating (e.g. Sherrington, 2018), and more effective ways of assessing and evaluating students' learning seems like a predicament that education systems in Europe face in very different ways. Regarding the benefits derived from homework, the OECD notes that a school system's overall performance relies more on other factors, e.g. instructional quality, how schools are organised (OECD, 2013).

By reviewing the activities that educators carry out as part of their profession, and by reviewing a number of current problems that they report having, a better understanding can be gained where and in which situations emerging technologies could support the teaching profession in the future.

2.1. | Three ways emerging technologies enter education and training

The term emerging technologies is used in this report to mean a wide range of applications and services that take advantage of Artificial Intelligence (AI), Virtual and Augmented and Mixed Reality, wearable technology such as head mounted displays and sensors, social robotics and the Internet of Things enabled by the ultrafast 5G mobile standard. These, and technologies yet to be invented, create new types of digital ecosystems based on the creation of data from various interactions that humans and their devices have across the internet (i.e. datafication).

Southgate et al. (2019) estimate that while Artificial Intelligence (AI) has been around for more than a half a century, it has only been during the last decade that interesting educational uses have started to emerge as AI is infused into various applications that are used for learning and teaching. On the other hand, while immersive technologies such as Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR) are quite different in their design, this era could be described as the one where these technologies are becoming intertwined. Three different ways in which they enter the field of education and training are considered below.

The **"purpose built"** EdTech products (1) are the most visible applications and deployments. They are develop both by the EdTech industry as well as academia and not-for-profit researcher communities (e.g. through national and EU-funded research). They can be classified in different categories, for example, Holmes et al. (2019) classified

AI-driven applications in education into *student-teaching technologies*, e.g. Intelligent Tutoring Systems[3]; *student-supporting technologies*, e.g. AI Learning companions; and *teacher-supporting technologies*, e.g. Virtual Teaching Assistants. Additionally, there are *institution-supporting technologies* such as AI-powered timetabling software or Learning Analytics that systematically collect data across applications and processes, for example, within a university.

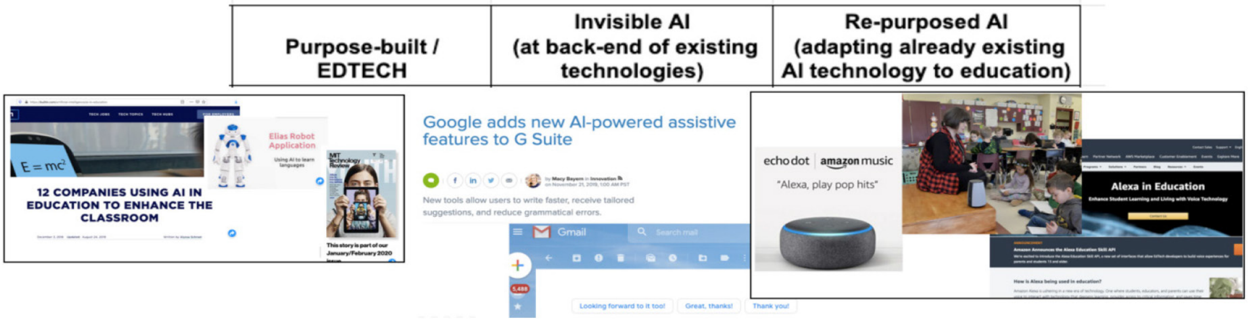

FIGURE 2: EXAMPLES OF EMERGING TECHNOLOGIES ARRIVING IN EDUCATION AND TRAINING.

Looking at the global market trends, EdTech investments are reported in different areas: Learning Analytics tools[4], adaptive educational technologies, and applications that recommend digital content and activities for learners (Global Market Insights, 2017). On the other hand, some applications based on Virtual Reality and Augmented Reality are being deployed more and more in the educational context thanks to affordable wearable technologies (see Buchem et al., 2019). Social robotics[5] that can interact and communicate are also being applied to educational means, although still on a rather experimental scale. Studies are, for example, emerging on the use of robotics as part of instructional practices to support robot-assisted learning (Ahtinen et al., 2020); teaching languages (Alemi et al., 2019; Hemminki et al., 2017) and to support learning by explaining one's reasoning to robots (Wijnen et al., 2019). More on the emerging tools for educational use can be read in a book provocatively entitled "Should Robots Replace Teachers" by Selwyn (2019) covering topics such as autonomous classroom robots, learning analytics and other automated decision-making apps. Southgate et al. (2019) extend their review to Virtual Reality as well as many AI-driven educational implementations.

The second way in which emerging technologies enter the field is (2) ***"invisibly infused into the computing applications we use in everyday life"*** (Southgate, 2019). Nowadays, internet search engines, smartphone assistants and integrated communication suites are all good examples of applications relying on Artificial Intelligence and machine learning. They increasingly rely on collecting certain data on users, their behaviour and interactions to drive algorithms that help and automate tasks. In an educational context, for example Google Docs and G Suite are increasingly used, however, users are often unaware that many of their assistive features are AI-powered (Bayern, 2019). Similarly, a number of Learning Analytics tools such as predictive and data-driven performance dashboards, or scheduling tools institutions use, rely on AI at back-end.

In other words, these technologies often enter through a 'back-door' along with existing technologies, platforms and other service solutions (e.g. content management systems and student information systems) **without the knowledge of end-users**. An analogy of this would be the development in smart phones: an embedded camera now contains many AI-related innovations from improving "selfies" to using facial recognition to automatically categorise photos. These advances happen without many consumers and users being aware of these technologies being driven by AI. Similar developments can already be seen in the area of education and training.

3 A software system running that mimics human tutoring, for example by providing immediate feedback or customised instructions to a student without the need for human intervention (see Glossary).
4 (see examples at Ferguson et al., 2016).
5 https://en.wikipedia.org/wiki/Social_robot.

Lastly, there are the **repurposed technologies** (3). These are existing technologies, which were first developed for another field and are then **adapted to educational contexts**. For example, automated translation from one language to another is a service which has greatly benefitted from AI evolution. Voice and face recognition technologies have also advanced thanks to AI and increasing computing power. There are currently educational initiatives that adapt these existing technologies for educational ends, e.g. the use of smart speakers in university dorms so that students can ask questions ranging from university's library hours to the location of the registrar's office (Miles, 2020); the use of voice recognition technologies to query student records (e.g. Alexa[6]); or the use of facial recognition technology to authenticate students (e.g. attendance).

2.2. | Educators preparedness to use digital technologies

Considering the three ways for emerging technologies to enter education and training, it is relevant to reflect on the skills and competences that those in the teaching profession would need. Does each of the different ways developed above require a slightly different awareness, understanding and skill set for educators to use emerging technologies efficiently in their teaching practices?

On the one hand, the **general pedagogical knowledge** is explained as *"specialised knowledge of teachers in creating and facilitating effective teaching and learning environment for all students, independent of subject matter"* (Cuerriero, 2017). In addition to general pedagogical knowledge, educators need **subject-specific knowledge** (e.g. about mathematics and how to teach them) as well as general **classroom management skills**. On the other hand, there is a need for the general **digital competence** to use and apply digital technologies for any given tasks in life (e.g. the DigComp Framework by EC, 2020a). Educators additionally need to make valuable educational use of them, this means that educators' general pedagogical knowledge and subject-specific knowledge should be extended to apply technologies for a given educational activity or a learning process[7].

The question of how different teaching approaches lead to students' learning outcomes (e.g. in cognitive, interpersonal and intrapersonal domain) is an area with a wide gap between theory and practice (e.g. OECD, 2019b). The consensus is, however, that there is not just one model that would work in all contexts. For this reason, educators' **professional judgement** is important: *"This is a complex skill that involves analysing and evaluating specific learning episodes or contextual and situational factors (e.g. students' prior knowledge, ability level, motivational factors, lesson objectives, curriculum goals), and connecting them to the knowledge of teaching and learning"* (Sonmark et al., 2017, p. 15).

At a national, European and international level, reference frameworks for educator competences dealing with digital education exist, e.g. DigCompEdu (EC, 2019d), ICT-CFT[8]. They emphasise that educators need to know how to integrate digital technologies into their teaching and learning, and be able to use them effectively. In about two thirds of European education systems, teacher-specific digital competence is among the essential competences educators are expected to have (EC/EACEA/Eurydice, 2019a).

Even if the recent professional development activities have covered the "use of ICT for teaching" for 57% of educators, the fast pace of technological development, and the need to update skills make many feel poorly prepared to face the challenges. On average, 16% still report a high level of need for professional development in ICT skills for teaching (see more country details in Annex 4: Table 12).

In the same way, there are variations in how educators feel prepared to deal with ICT for teaching purposes (see country details in Annex 4: Table 12). For example, 39% said to feel "well prepared" or "very well prepared" to use ICT for teaching. The differences across European countries are striking, as is shown in Figure 2: around two-thirds of

[6] Amazon contest to find new ideas to use Amazon Alexa in the education space (see Friedman, 2019): for ideas from teachers, see https://kaysemorris.com/30-ways-use-alexa-classroom/; https://blog.neolms.com/tapping-into-the-potential-of-ai-smart-speakers-to-boost-parental-engagement/.
[7] In this context, the framework of Technological pedagogical content knowledge is often mentioned: https://en.wikipedia.org/wiki/Technological_pedagogical_content_knowledge.
[8] Unesco: https://en.unesco.org/themes/ict-education/competency-framework-teachers.

teachers in Romania, Slovenia and Hungary feel prepared, but only 30% or less agree in countries such as Estonia, the Netherlands, France, Belgium, the Czech Republic, Finland and Austria.

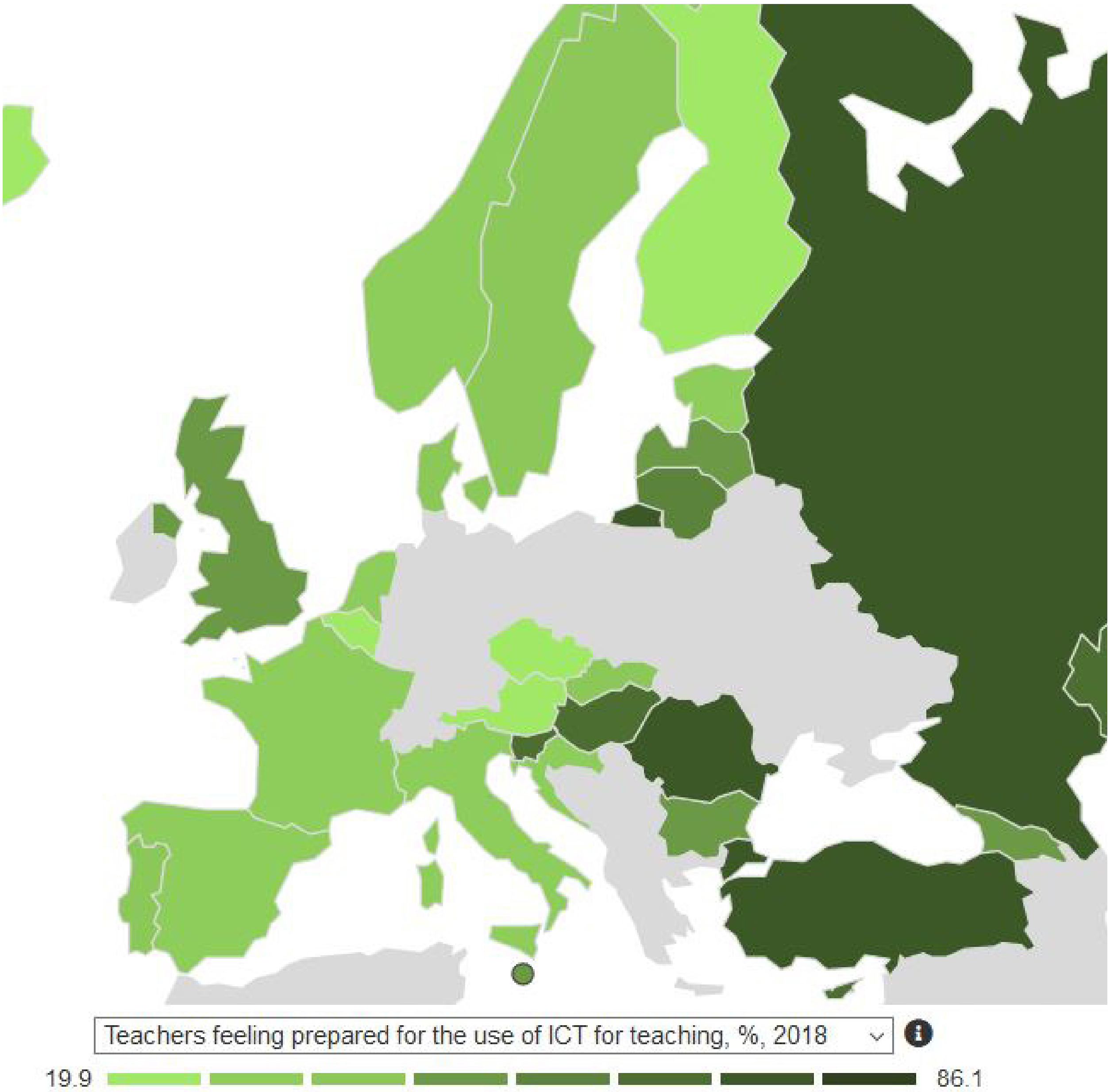

FIGURE 3: TEACHERS' PREPAREDNESS TO USE ICT FOR TEACHING. DIFFERENT SHADES OF GREEN ILLUSTRATE PERCENTAGE BETWEEN 19.9%-86.1%, SEE THE SCALE ABOVE (NO DATA AVAILABLE FOR GREY COUNTRIES). ILLUSTRATION BY OECD (2018).

With emerging technologies, and especially those that involve the use of computational methods for autonomous decision-making (e.g. AI), new concerns arise which are both related to technology and pedagogy. **Therefore, it is relevant to ask: to what extent should the user be aware of the underlying technology?** How much knowledge should educators have *about* AI to allow them to act in an **informed and effective way** as educators?

Furthermore, it will be interesting to understand the role of educators in creating new demand for educational technologies, for example, for new products and services that they think would actually help, support and enhance the teaching profession. This question is also related to skills, most likely new set of skills is needed to co-design and co-create applications and services that better meet educators' needs. The scenarios will also touch upon the question of skills and knowledge in order to start reflecting on future actions in the area of upskilling educators.

3 ETHICAL CONSIDERATIONS: PEDAGOGICAL JUDGEMENT, PEDAGOGICAL AIMS AND DATA

When deploying emerging technologies in education and training, one of the first and foremost **important ethical concerns deals with taking decisions**. Should machines or algorithms make decisions which teaching professionals with adequate pedagogical and subject-specific content knowledge would usually take? Under which conditions should a software application autonomously make a pedagogical judgement? Such pedagogical judgements could be about the type of educational interventions an application recommends for a learner, or they could be related to assessment and feedback loops. A pedagogical judgement could also be about the types of teaching approaches and practices that an educational application applies, or what kind of educational material is used for instruction.

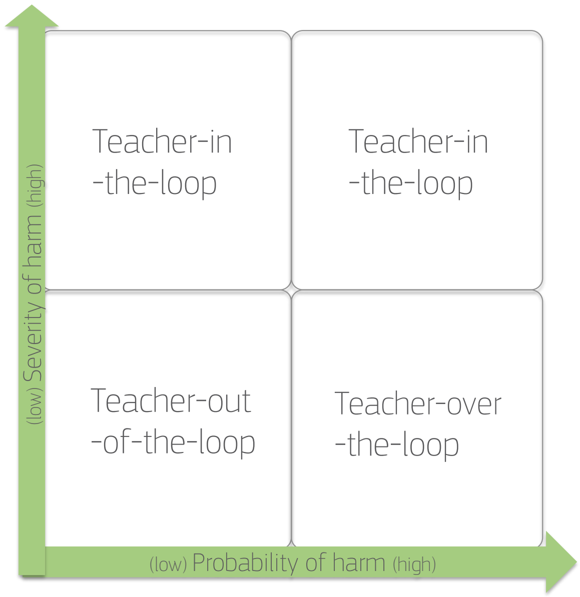

FIGURE 4: DIFFERENT APPROACHES OF DEALING WITH AUTONOMOUS DECISION-MAKING PROCESS.

Regarding autonomous decision-making empowered by algorithms and Artificial Intelligence, the following question is asked in order to assess possible risks: *How much harm would a wrong decision, based on computational methods used for autonomous decision-making, cause* (IMDA & PDPC, 2020)? In the case where the potential severity of harm would be high with a high probability of it causing harm to the user, a human should be consulted for the decision-making process. This approach is called "**human-in-the-loop**". In the following, three examples are given to illustrate various approaches for the context of education and training.

Consider an application that evaluates high-stakes exams, or conducts a diagnosis of a learning disability, and autonomously takes a decision. In such a situation, the potential severity of harm caused by an incorrect decision could lead to a loss of opportunity, discrimination or other unfair practices (i.e. harm made would be high with a high probability of it causing harm to the user). Therefore, to maximise benefits and minimise risk of harm, the most powerful human oversight in the decision-making process is needed. This is called "teacher-in-the-loop" (Figure 4, right upper corner)[9]. In these cases, the application should recommend a decision to an educator with enough transparent information available so that the educator can review it - and only then decide whether to execute the final decision or not.

On the other hand, there are situations in education and training where the severity of harm done by the decision is small. An example could be an adaptive learning software that recommends learning activities based on intended learning outcomes (below-right). In such

[9] Similarly, in a hypothetical situation where the potential severity of harm made would be high but a probability of it causing harm to the user is low, "teacher-in-the-loop" could also be considered (Figure 4, left upper corner). An example outside of education would be taking an airplane: harm caused by an accident would be high but a probability of it happening is very low, thus not really considered.

case, it is enough that a teacher can intervene with the system behaviour if it needs to be changed. This is called “teacher-over-the-loop”.

Third, in some low-stake decisions, an educator does not need to be consulted at all. This is called “teacher-out-of-the-loop” (Figure 4, bottom-left). This could be the out of school context, for example, where a learner uses prep software or an “edutainment” app.

The second main theme of the report is associated **the underlying pedagogical models** applied in educational applications and the data they rely on. From the educational science point of view, it is essential to ask: What data would the application use and for what purposes? How are the data models constructed, based on which theoretical constructs, and how traceable are the decisions made by the software (e.g. explicability)? Moreover, what values and assumptions are reflected in these data models, and who sets them? Last, data used for training algorithms are known to have biases (e.g. racial, social), how to evaluate that known biases in education systems are not propagated further through emerging technologies?

As an example, consider Intelligent Tutoring Systems. It is an educational software that uses computational methods for autonomous decision-making. It uses models on pedagogical knowledge, content knowledge and learners. Based on these models, an algorithm can then determine what kind of actions are taken next (Holmes et al., 2019). In these educational software applications, a **pedagogy model** entails the core pedagogical knowledge, usually linked to teaching a subject area. For example, mathematics software should be built upon a pedagogy model that contains pedagogical content knowledge on how to teach maths and some core general pedagogical approaches.

On the other hand, such educational software applications also contain a model on the **content** to be learned (e.g. area of maths and expected learning outcomes). Most importantly, there is the “**learner model**”[10], which contains data about the student, e.g. the level of maths and what maths exercises are already successfully completed. To bring all this together, an algorithm attempts to work in the same way as **educator’s professional judgement**. In other words, to analyse and evaluate specific factors (e.g. students’ prior knowledge, ability level, lesson objectives) in order to propose the next activities or interventions to the learner.

The model described above is a generic model used in educational software architecture that use computational methods for autonomous decision-making (e.g. AI). In the future, as well as **knowledge of such underlying models** and the **skills** to use the applications for pedagogical purposes, educators also should be in a position to **assess** the appropriateness, and ethical implications, of allowing the software to exercise **pedagogical judgement**. To introduce a wider European context to ethical considerations, the work of the European Commission focusing on ethical aspects of Artificial Intelligence is briefly introduced. The publication entitled “Ethics Guidelines for Trustworthy Artificial Intelligence by High-Level Expert Group on Artificial Intelligence” presents four ethical principles: *respect for human autonomy, prevention of harm, fairness and explicability* (AI HLEG, 2019).

In the future, there is a need for focused discussions around these ethical principles among a wide range of actors with regards to educational applications taking advantage of emerging technologies. To prompt such discussion, in Annex 1, some concrete questions are given that touch upon points elaborated above. The actors who should get involved in the future discussion range from those who design and develop educational applications (e.g. industry, developers, investors) and research the field (e.g. computer science researchers, education scientists); to those who use them (educators, learners); but also those who implement and govern their use (e.g. national and local education authorities, school boards) as well as regulators in the area of education and training.

[10] According to Global Market Insights (2919), the learner model holds the highest share in the AI in education market with a revenue of USD 262.6 million in 2017

3.1. | Datafication of education

The increasing rate of datafication of every aspect of life means more digital data to be generated. It is estimated that companies have assembled around 70,000 separate data points on any given child by the age of 18 (Kamenetz, 2019)[11]. More and more heterogeneous data are being collected in education and training, too, for monitoring, surveillance or evaluation purposes, also automatically from many digital platforms and devices (Jarke & Breiter, 2019).

Within the EU, the General Data Protection Regulation (GDPR) sets clear legal conditions for the use of personal data. Moreover, the users of the educational applications and services should be able to expect a level of safety and respect of their rights, as developers and deployers are subject to European legislation. This includes consumer protection, product safety and liability rules as well as fundamental rights (e.g. privacy, non-discrimination) (EC, 2020b). However, there are concerns associated with the data use, some of which are discussed below[12].

As data are generated from learners and their interactions with various digital tools in different contexts (e.g. in school, out of school, for education and training, for leisure use), a larger amount of collection of personal data, student learning records and other behavioural data takes place. The combination of such data could be turned into deep insights about education and training. However, a technology that records and analyses everything can easily be turned from a supporting tool into a mechanism to survey, control and direct individuals' actions (Selwyn, 2019). A balance between collecting digital data and intruding into one's personal sphere in education and training should be safeguarded (Pijpers et al., 2020). Below, a number of examples are reviewed for the purpose of background and groundwork for the scenarios.

A new area to understand student motivation in education and training is to look into communication tools between parents and school. These applications are increasingly used for giving feedback to learners, too. In Europe, 60% of students in all ISCED levels have teachers who use digital technologies to communicate with parents (EC, 2019a). A recent study looking at encouraging feedback to learners found that such feedback was unevenly distributed among learners (Oinas et al., 2017). Another study reported that parents felt they received less encouraging feedback about their children than educators believed they had given, on the other hand, educators said they experienced more ambiguity in digital communication than parents (Kuusimäki et al., 2019).

Classdojo is a prime example of a communication tool, but also a motivational tool, used from nursery throughout compulsory education. The tool is from a Californian-based company and it is already used in 180 countries (Saner, 2018). With Classdojo points, educators can reward pupils' desired behaviour in the classroom. Examples of positive behaviour include acts such as "helping others", "on task", "participating", "perseverance", "teamwork", "working hard". Educators can also focus on areas that need more attention, e.g. "learner off task", "talking out of turn", "unprepared". Through real-time reports, they have the possibility to share information with parents about their child's behaviour and school performance.

Collecting various types of digital data about students' motivations, behaviour in school and overall school performance can also have concerns. Emerging research on Classdojo raises concerns about data privacy and protection, especially in the European context (e.g. Williamson & Rutherford, 2017). Manolev et al. (2018) report Classdojo collecting millions of sensitive data profiles on students, educators and schools, creating long-lasting records. The use of such behavioural data profiles by for-profit EdTech companies can be unclear and not transparent. This raises further concerns about the misuse of sensitive data, especially when companies are operating outside the reach of the EU's GDPR legislation.

There are also worries that such tools could contribute to creating a culture of surveillance, or competition, in a classroom which might become another source of student stress and anxiety (see more in Williamson, 2018). Additionally, such permeability between the child's two worlds could be detrimental to privacy as the pressure in one place could be externalised and used by people in other contexts (e.g. home, sport clubs). Last, there is a possibility, however small, that

11 See more at "5 rights Foundation" https://5rightsfoundation.com/
12 As an example for more view points and discussion, see: http://instituteforethicalaiineducation.org/

even school systems themselves could misuse these data in an unintentional manner by creating behaviour profiles that might reinforce systematic disadvantages that further consolidate inequalities, e.g. grade tracking and prediction systems could become self-fulfilling prophecies, and young people's preferences early in life could become systemic disadvantage (Oates, 2018).

Another example to review for the purpose of scenario building is from late 2018. After a group of US high school students staged a walkout to protest that they were spending too much of their school days in front of a computer, the school said they would quit using "**Summit Learning**"[13], a personalised online learning platform with curriculum content for selected ages. Summit Learning is a philanthropy endeavour by Facebook's CEO and his wife who founded the Chan Zuckerberg Initiative in 2015[14]. A steady base of schools in the US are using the system, however, its critics point out many issues. One fear is the use, and possible misuse, of student performance data that a free of charge digital platform generates, this might include more personal learning data from minors. Buchanan & McPherson (2019) also voice worries about big data and how Silicon Valley could shape education in the future. In addition to concerns about personal data and "datafication" of education, some school districts and teacher unions have also become wary that this focus on automated personalised learning through a digital platform can undermine educators' authority and autonomy. This might obstruct local control over education (e.g. for further discussion see Barnum, 2019). Also, the scientific evidence on gains in learning outcomes achieved thanks to technology-enhanced, personalised learning approaches is still only emerging (Herold, 2019).

The third example focuses on the expected learning outcomes and educational goals put forward by EdTech applications. Today, both **Khan Academy and Squirrel AI**[15] have become well-known names for personalised learning. Similarly to known practices from the music, film and consumer product world, they recommend learners a new activity based on the behaviour of previous users or their own. To make recommending the next activity or resource simplified, such systems often rely on standardised questions which, in turn, encourage standardised answers by students. Such product design does not only limit learning opportunities but can also constrain the learner-agency, critical thinking and creativity – competences that are needed for the future.

Ethical issues related to learning goals set by educational applications are worth considering, too, especially when focusing on preparing students for a standardised or high-stakes test instead of focusing on gaining knowledge and competences that will be useful in all aspects of life. Whereas 'teaching to the test[16]' is not a new phenomenon, the new technology-intensive data approach brings it to a new level. For example in the US, a recent collaboration of Khan Academy with the SAT, a standardised test commonly used for college admissions, solely aims at improving a learner's score on the SAT test[17]. Similarly, many EdTech companies in China[18], including Squirrel AI, run technology-based after-school activities for students to gain better results in the competitive state-wide exam, Gaokao[19]. Mehrens et al. (1989) created a scale to evaluate how ethical several ways in which students are prepared to take a test are. The study proposed an ethical continuum: at one end, it identified instruction which followed general learning objectives and outcomes. At the other end, the least ethical practice was "instruction using the test to be used, either before or during test administration". In the future, similar ethical evaluations of emerging technologies could be considered. They could also be extended to include considerations to reduce existing inequalities in education and training. For example, when activities are only available to those whose parents can afford to pay for extra tuition, educational technologies can propagate inequalities on a larger and more amplified scale.

As a last example, the case of **Interactive Whiteboards** (IWB) is used to illustrate various motivations for EdTech implementations. Throughout the last decade, nationwide rollouts of IWB[20] took place in education and training (e.g.

[13] Summit Learning: https://www.summitlearning.org/
[14] https://en.wikipedia.org/wiki/Chan_Zuckerberg_Initiative
[15] See Hao (2019) for a description on Squirrel AI.
[16] https://en.wikipedia.org/wiki/Teaching_to_the_test
[17] Official SAT Practice: https://www.khanacademy.org/sat
[18] For examples of popular Chinese applications, see https://daxueconsulting.com/china-edtech-educational-technology-market/
[19] https://en.wikipedia.org/wiki/National_College_Entrance_Examination
[20] By 2012, it was estimated that one in eight classrooms across the world had an IWB (e.g. Futuresource Consulting, 2012).

Smith et al., 2005; Hennessy & London, 2013). However, the bigger driver of the IWB rollouts seemed to be the availability of the technology, and even the 'fascination for technology', rather than scientific evidence of their positive impact on learning outcomes as was generally expected (Hennessy & London, 2013). On a long term, they also rarely materialised in new pedagogical practices (e.g. Benoit, 2018).

3.2. | Three cross-cutting themes for the scenarios

The international examples presented above were put forward to prompt thinking about the vision for the future of education and training in Europe. The examples prompt questions about the type of education put forward through the underlying pedagogical models. Is it that of a standardised, controllable and predictable model of education, or rather a model that promotes competences such as learner-agency, critical thinking and creativity? They also focus on the role of the educator critically reflecting on the tasks and processes in the teaching profession that are at **a risk of automation or becoming highly routinised**.

The use of emerging technologies in education and training involves considerations that have **ethical consequences with children** (e.g. prevention or harm, fairness, privacy, not to increase injustices in education). This is a child rights policy issue that UNICEF (2019) is also looking at. Moreover, there are the reflections on ethical questions regarding **datafication** of education and its goals (e.g. to collect learners' performance data for better learning vs. for the interest of a private company). Lastly, there are reflections on the function that the **educational system** should play tomorrow: will emerging technologies be used to develop education systems and teaching approaches that diminish existing inequalities rather than propagate them on a larger and more amplified scale? Will they be used to transform teaching so that it develops more trust between learners and those who govern the system and its outcomes (e.g. educators, assessment boards)? What and whose goals are being promoted and achieved?

It is clear that the discussion about the future of emerging technologies in education and training should strongly consider social, educational and ethical values, and not only be technically oriented. A number of ethical considerations emerge which will create the three cross-cutting key themes for the scenarios. They are the following:

- How should the agency to make decisions be distributed between educators and technology?
- What kind of challenges are involved with data, underlying pedagogical models and datafication of education?
- What kind of competences do educators need, especially with regards to their digital competence?

The key themes are reflected in the scenario template. More information about the scenario template is available in Annex 3, which also includes a short methodological note.

4 NEAR-FUTURE SCENARIOS

In the following section, eight scenarios with a near-future outlook of 3 to 5 years are presented for issues that educators in Europe have identified as problematic in their profession (section 2). Scenarios were chosen as a method to create narratives around possible futures.

The scenarios are divided under four headings: Lesson planning, teaching practices and administrative work; Students well-being, motivation and non-cognitive skills; Language acquisition by migrant learners; and Special education (Table 1). The scenarios focus on educators' everyday tasks, e.g. teaching, supporting learners, evaluation, professional learning, classroom management and communication with parents, revolving around invented, yet realistic, settings.

For each of the four headings, a scene setter is first introduced which is followed by two scenarios. Each scenario is introduced with a short problem statement.

Lesson planning and teaching practices
1. Grouping learners for more effective classwork
2. Automating administrative tasks and answering common queries
Students well-being, motivation and non-cognitive skills
3. Promoting empathy and conflict resolution skills
4. Supporting learners' social and emotional learning
Language acquisition by migrant learners
5. Edu-hacks for learning the language of schooling
6. Virtual Reality in Vocational Education and Training
Special education
7. The case of hearing loss in regular classrooms
8. Social robots supporting special needs education

TABLE 1: NEAR-FUTURE SCENARIOS.

A template is used to present scenarios with additional information following the issues detailed in Section 3. Finally, a number of links illustrate how some of the future possibilities are already beginning to play out today.

4.1. | Lesson planning and teaching practices

The scene setter: Quality education requires enough time for planning and class preparation. This includes thinking about effective **teaching approaches**, e.g. broader strategies on lesson planning, selecting and applying teaching methods; ways of organising and managing the teaching and learning process; ways of assessment. On the other hand, the planning work results in concrete implementations in the classroom, i.e. **teaching practices** as well as the **tools and material used** (Guerriero, 2017, p. 264). In Europe, secondary school teachers report spending 15% of their average weekly hours over a calendar week on individually planning and preparing lessons. The task is important to design and carry out effective pedagogical practices, and to try out, revise and improve specific practices. This task is fairly equally spread over education systems in Europe, from the maximum with Maltese secondary school teachers (23%) to the minimum in the Netherlands (13%).

Especially when teaching larger classes educators complain about the big class size as they tend to spend less time on teaching than on other tasks (Annex 4, Table 6). This can mean that they have less time to implement effective teaching strategies, too. "Reducing class size by recruiting more staff" is number one priority for around 80% of educators in Austria, Malta, the Belgian Flemish Community, Cyprus, Spain and Portugal. The figure was less than half in the Slovak Republic and Denmark (Annex 4: Table 9). Two near-future scenarios are presented below that focus on envisaging the role of emerging technologies in supporting educators in effective teaching strategies and with other non-teaching tasks.

4.1.1. *Grouping learners for more effective classwork*

Problem statement: The OECD found that certain teaching strategies are positively associated with student performance and achievement. For example, by using cognitive-activation strategy, educators encourage students to find more creative and alternative ways to solve problems. Students might work in small groups to come up with a joint solution to a problem, and eventually the educator would ask students to communicate their thinking processes and results to their peers (OECD, 2019b, p. 4). Another recent study had similar findings outlining that "more collaborative discussion practices, student engagement in class, a positive classroom climate and student participation in discussions were positively related to higher student achievement." (Richman et al., 2019). However, educators in Europe said that they rarely use these practices in their teaching (Annex 4: Table 14), preferring other strategies.

Educators also face organisational and practical challenges, especially when planning more complex activities such as those called for by the cognitive-activation strategy. As an example, in an interview, educators saw teamwork with many practical challenges. E.g. organising the groups effectively from a pedagogical perspective is labour intensive, guiding teams can be hectic, teams may not work well together, there might be free-riders or friendship cliques making productive teamwork difficult (Toikkanen et al., 2015).

Scenario 1

Today, *the teacher* is planning a class-wide activity for students to collectively work on an exercise that involves fractions and the varying narratives behind why we use them as functions. The goal is to reinforce their ability to support one another in problem-solving situations.

Fifteen minutes before the students arrive, *a virtual teaching assistant* embedded into a learning platform begins prompting the teacher for the day's collaborative problem-solving activity. Then, *the virtual teaching assistant* asks *the teacher* how to arrange the students for the session: would she want grouping to be based on the same ability, mixed abilities, common interests, etc.? *The teacher* decides on "mixed-ability" groups, the reason being that through peer-learning and collaboration, some of the students will be able to catch up with their learning goals while others will be able to act as tutors. So today's organisation is not only about the subject knowledge, but also to help build socio-emotional capabilities (e.g. collaboration) through complementary knowledge and skills that students bring to groups.

Next, *the virtual teaching assistant* displays the student groupings on the nearest wall. *The teacher* thinks and pauses for a moment before dragging one name, then another, to swap two students' placements into different groups. The teacher also makes a voice command out loud so that *the virtual teaching assistant* can take in new input about the reasoning behind the change. This will enhance its capability to make groupings next time.

Soon the students are coming through the door. They will each see a specific colour glowing on their personal learning tablet — red, orange, blue or green — to indicate which table they are to sit at for the exercise.

(The scenario is modified from Luckin & Holmes (2017), a writing that describes an AI-driven Teaching Assistant in the Classroom).

Main function: To complement and augment educators' capabilities in grouping learners which can be time-consuming to organise. The application allows for a variety of scenarios depending on teacher's pedagogical goals and judgement. Like above, the mixed-ability grouping is based on both students' cognitive level (e.g. subject knowledge and skills) and socio-emotional capabilities (e.g. collaboration), for example, using the Zone of Proximal Development as a guiding principal. Other rules for grouping could be defined, too. Other tools might be needed to support educators in monitoring group work, supporting student learning and its assessment.

Approach: Purpose-built for educational use.

Ethical considerations for decision making:

"Teacher-in-the-loop" meaning that the teacher is supported by the technology and its recommendations. However, the final responsibility of the correct allocation of learners in groups still lies with the teacher who ultimately applies his/her professional judgement.

Prerequisites for data and modelling:

- Learner model: information about students' cognitive level, e.g. subject knowledge and skills, and socio-emotional capabilities, e.g. collaboration. The learner model could also include other variables, e.g. motivation, age group, gender.
- Pedagogical model: The model should be based on a separate method to group students based on educational theories and scientific evidence.

Teacher skills for the technology:

Teacher should have a basic awareness of what student data and interaction information is saved in the "learner model" by the system and how the algorithms might use this information to allocate students to different groups.

Main user/actor: Teacher

Type: Teacher-facing technology (a virtual teaching assistant)

Application: Integrated in learning platform & virtual facilitators

End-use: Compulsory education, secondary education, higher education, VET and/or work-based learning

Signals of change showing how some of the future possibilities are already beginning to play out today.

- A number of available educational apps (e.g. Google sheet, ClassDojo) already help educators with grouping a certain number of learners in a group, or randomly grouping them by names. However, the power of this scenario lies in the fact that the groups are intentionally formed based on desired learning outcomes linked to instructional strategies.
- TeamUP is a simple app that allows students to be grouped based on more criteria: http://teamup.aalto.fi/. It was originally created in an EU-funded project http://itec.eun.org. Toikkanen et al. (2015) discuss the participatory design model for TeamUP in more detail.

4.1.2. *Automating administrative tasks and answering common queries*

Problem statement: Educators frequently cite administrative overload as a source of frustration and a factor that reduces the attractiveness of their profession. Recent data show a worrying trend in their time allocation: within single lessons, since 2013, the average proportion of time spent on administrative tasks (including communication, paperwork and other administrative duties) has gone up in 11 EU countries (Annex 4: Table 13). Only in Sweden, Estonia and Romania did teachers spend slightly less time in 2018 on these tasks. If educators were given a choice, one of their top spending priorities in education would be to recruit more staff to reduce administration load (Annex 4: Table 9).

However, adding more staff does not always seem to solve the problem. A recent OECD report discusses cases of inadequate organisation and distribution of administrative work. For example, educators might accept a share of logistical and secretarial tasks due to insufficient administrative support, but eventually, such arrangements reflect inefficient use of resources as educators tend to be more highly remunerated than administrative staff. The report suggests based on international comparison that hiring additional support staff might neither be sufficient nor necessary to lessen educators' administrative burden, suggesting that a deeper look into dynamics and fine-grained analyses is needed (OECD, 2019c).

Recently, a number of reports have focused on educators' administrative overload and called for AI-driven deployments to help (e.g. Baker et al., 2019; Bryant et al., 2020). However, as few genuine root cause analyses exist for what has caused such administrative burden on educators, like with any technology, mechanising and automatising administrative practices might just make them increasingly difficult to change in the future (Tuomi, 2019). Therefore, firstly considering which practices are worth keeping will prevent the risk of consolidating old institutional structures and processes that serve the education of yesterday.

Scenario 2

Just before the first lecture starts on Monday morning, *the teacher* is checking the notes on a mobile phone while sitting at the back of the lecture hall. The students start pouring in and looking for seats. Once seated, an app on the students' mobile phones is activated and prompts them to say their names out loud so that a voice-activated *clerical assistant* can carry out the check-in and verify their identity through voice recognition.

One by one, students' images appear on the teachers' screen showing their location in the hall with their first name glowing brightly across the screen. This is particularly helpful at the beginning of the semester; this way *the teacher* can use first names, therefore adding more familiarity to interactions with students.

The lecture is the second part of a flipped learning activity. *The teacher* immediately sees from the *clerical assistant* that most of the students have watched the video lecture on the topic. Next, he is surprised to see that there were plenty of questions on the online forum that is used to support the class. "237 questions", he whispers out loud, to which the *clerical assistant* replies that it had already checked them and that *the teacher* must answer only a small fraction of questions during the class.

These questions are highlighted on the screen and *the teacher* projects them on a wall for a Q&A session. Soon, there is a lively discussion to clarify some key points explained in the video. This is a crucial pedagogical moment as the teacher wants to keep all learners engaged.

The *clerical assistant* already answered the remaining 227 questions in the forum. As these questions mostly concern routine issues about the content, in addition to some administrative aspects of the assignments, by the 4th year of the lecture[21], *the clerical assistant* has already learned how to answer them with 97% confidence.

Main function: To make obsolete the need for teacher's clerical work in taking students' attendance. To help answer mundane and routine questions that can be time-consuming to answer, however, important and time-sensitive for those who ask them.

Approach:

- Repurposed technologies: applying voice-activated and voice recognition technologies developed elsewhere to the context of education, e.g. Alexa Education Skills are now applied to educational applications (see Friedman, 2019).
- Purpose-built: the automated reply system.

Ethical considerations for decision making:

- For taking attendance, "teacher-over-the-loop": the system can operate alone, however, the educator can intervene with the system if its behaviour needs to be changed.
- Students who ask questions in the forum should be aware of whether their questions are answered by a machine or human. Additionally, with voice-based chatbots, students should be aware of whether their questions are logged and saved for further use (e.g. training the system, make FAQs) and if their identity is protected.
- When commercial technologies (e.g. Alexa skills for voice recognition, see Friedman, 2019) are applied to the context of education, users should be aware that the commercial entity itself might use the behavioural and personal data collected for secondary purposes or sell it to third parties. Without their knowledge, student data could be used for building behavioural models for further commercial exploits.

21 "One of the secrets of online classes is that the number of questions increases if you have more students, but the number of different questions doesn't really go up." Professor Ashok Goel, Georgia Tech University, implemented AI assistant in his class of some 300 students. See the Georgia Tech News article listed below for more details.

Prerequisites for data and modelling:

- Learner model: names of all students enrolled in the class and their behaviour (e.g. attendance in class, interaction with the course content and forum).
- Domain model: to answer the questions that students ask in the forum, the system needs to build a model of the knowledge of the domain that is taught. This model also includes organisational aspects of the course (e.g. homework assignments and due dates, reading lists).

Teacher skills for the technology:

A teacher should have a basic awareness of how the "domain model" is conceived and reinforced so that there is an awareness of how it might answer the routine questions that students ask (e.g. the limits of its confidence to answer a specific question or not).

The teacher should have skills and basic knowledge to intervene or override the systems' behaviour if needed (e.g. change students' attendance if needed, replace the answer by AI).

Main user/actor: administrators in education; teacher
Type: education system-facing AI: a clerical assistant
Application: student information systems, student records and data management systems
End-use: compulsory education, secondary education, higher education, VET and/or work-based learning

Signals of change show how some of the future possibilities explored in the scenario are already beginning to play out today:

- The scenario is inspired by an article that describes a real-world case in Georgia Tech, US, where a "Teaching Assistant" was implemented, in part, using technologies from IBM's Watson platform: https://www.news.gatech.edu/2016/05/09/artificial-intelligence-course-creates-ai-teaching-assistant. Eicher et al. (2018) discuss it in more detail.
- Examples of use in European universities to answer questions about timetabling, library, student services:
  — ADA is used by Bolton College: https://www.jisc.ac.uk/news/personalised-ai-assistants-and-automated-marking-bolton-college-04-dec
  — Beacon: https://www.staffs.ac.uk/news/2019/01/introducing-beacon-a-digital-friend-to-staffordshire-university-students
- Example of software that tracks students' attendance automatically by identifying users faces and linking this information to School Management System, e.g. https://www.smileme.in/

4.2. | Students well-being, motivation and non-cognitive skills

The scene setter: In any learning process, learner's motivation drives the behaviour. Engaged learners tend to take more responsibility for their learning processes and outcomes. Some instructional approaches design their methods and learning processes to take advantage of such competences, e.g. active learning (Deslauriers et al., 2019) or game-based learning (Holmes, 2018).

Motivation is one of the core psychological processes. The ability to keep oneself motivated can be regarded as part of non-cognitive skills like feelings, patterns of thought and behaviours. They are socially determined and can be developed throughout the lifetime (UNESCO, 2016). The competence of "Personal, social and learning to learn" is one of the European Key Competences for Lifelong Learning (EU, 2018). It is described as one's ability to reflect upon oneself; effectively manage time and information; work with others in a constructive way; remain resilient; and manage one's own learning and career (Caena, 2019; Sala et al., 2020).

Young people's physical, psychological and social well-being is crucial to their ability to learn and develop as citizens of a society. Their well-being is also linked to academic performance; teenagers, who feel part of a school community and have a good relationship with their parents and educators, are more likely to perform better academically and be happier with their lives, although academic excellence does not always result in a better quality of life for students (OECD, 2017). Creating safe learning environments can play a crucial role. Yet, regular incidents associated with intimidation or bullying among students occur at least weekly in 14% of schools across the EU countries (Annex 4: Table 8). A recent UNESCO study shows that in Europe, 25% of students are bullied, with little difference between the sexes in bullying victimisation (UNESCO 2019a).

New research and apps are emerging in this area. The School Day Wellbeing Model focuses on students' overall well-being at school and supports the role that the school leadership can play in it (Kylväjä, 2019). The app helps school staff to make pedagogical decisions based on insights into students' well-being in categories such as learning environment, social and emotional skills. Kuopio, a municipality in Finland, is piloting the app with 2400 students and 150 teachers in 2020 (Sormunen, 2020).

Better understanding of the importance of motivation and other non-cognitive competences (e.g. conflict resolution) to cope in an educational environment is essential. Two near-future scenarios are presented below that focus on envisaging how emerging technologies could support educators and learners in creating more conducive learning environments in terms of students' well-being, motivation and non-cognitive skills.

4.2.1 *Promoting empathy and conflict resolution skills*

Problem statement:

Cyberbullying can intensify the phenomena of bullying; it makes it harder for the victims to distance themselves from it and it makes the scale more amplified. Data in 2018 showed that the majority (57%) of cyberbullying in Europe is from a classmate of the child being bullied (Statista, 2020). Educators, school principals and educational staff often feel powerless and are unable to distinguish the complexity of argumentations and counter argumentations of students and parents.

Scenario 3

Luisa claims that she has been facing hurtful comments from her classmates. Luisa's teacher was aware of the situation and concerned about her loss of self-esteem. However, before the arrival of the new Empathy programme, he felt unable to recognise the complexity of the situation.

Luisa's school now pioneers *Empathy*, an emotional intelligence programme that aims to prevent any type of violence. The curriculum involves "social and emotional literacy" where empathy is modelled and proactively practiced by all students. This helps young people, but also teachers, to identify incidences of conflicts or bullying in real life and online. Secondly, they have recently started using AI-based *peace* technologies (Honkela, 2017).

Chatbot software is embedded into mobile phones' interfaces with a robot-like appearance. All users are aware that it is there to detect violent words and tones in discussions and message communications, e.g. anger, disgust, fear, sadness, aggressiveness and racist slurs both in groups and among individuals. Machines can be more efficient and faster in identifying any incident by predicting it based on previous data - even before it occurs.

If an incident occurs, in a game-style, the tool prompts guided chat between those involved in bullying as perpetrators and victims, as well as several classmates, challenging them to support the victim with the aim of ending the bullying. Teachers, principals or educational guidance counsellors are involved in mediation, too, which in many cases also involves parents. Luisa's teacher thinks the tool greatly complements all other attempts to encourage non-cognitive skills among the students. Through positive encouragement, it also produces better behaviour in a socially responsible manner.

The neutrality of the application has generated trust within the school. Parents, who had given their informed consent before using the system, have been giving positive feedback to the school about their children's anxiety. Luisa, who was feeling psychologically self-constrained to talk about the issue, was eventually able to interact with the chatbot, and then later with the teacher, too. She has found new compassionate friends and is coping better.

Main function: To assist educators in cultivating "social and emotional literacy" among students. The application helps to create an environment that prevents bullying, and supports educators and staff dealing with it when it happens. To create awareness among students and parents, and to engage them in a new way.

Approach:

- Repurposed: e.g. WatsomApp or the peace-machine demo could be extended to educational context
- Purpose-built for education: chatbot and support functions

Ethical consideration for decision making:

- An incident requires "teacher-in-the-loop", meaning that the educator/educational staff are supported by the technology and its recommendations. However, the staff should evaluate, activate and follow through the final responsibility for monitoring and taking action through interventions.
- The chatbot needs "teacher-over-the-loop" meaning that the system can operate alone. However, educators can intervene with the system if its behaviour needs to be changed (e.g. if students are misusing it).

Prerequisites for data and modelling:

- Different scenarios for the ground rules around the system and what it does with the data could be designed depending on the level of data privacy desired. They could range from "listening in" to all conversations when the device is turned on and parsing the communications for certain words without recording it, to recording and keeping all communications for machine learning. However, the latter in particular has high privacy concerns for individuals and the organisations.

Teacher skills for the technology:

Teacher should have a basic knowledge of how a tool with many components like this one functions (e.g. chatbot for monitoring, application for intervention and follow-through) so that they can intervene or override the systems' behaviour.

Teachers need up-to-date psychosocial knowledge and increased competence while new forms of bullying are emerging with the use of social media.

Main user/actor: Teacher; other educational staff; school councillor, school medical staff, learner; parents

Type: A hybrid between an education system-facing technology and teacher-facing technology: socio-emotional teaching/learning

Application: Embed into interfaces of existing systems, e.g. chat interfaces, learning management system

End-use: Compulsory education, secondary education, higher education, VET and/or work-based learning

Signals of change show how some of the future possibilities explored in the scenario are already beginning to play out today:

- The scenario is inspired by work that applies AI-driven technologies to predict and help resolve conflicts:

— Conflict prediction using AI to intervene before disasters arise: https://www.bbc.com/future/article/20190219-how-artificial-intelligence-could-unlock-world-peace

— The Peace Machine is a vision to use AI technologies to release human potential and support emotional, ethical and cultural development to reduce violence, oppression and destructive conflict: https://peacemachine.net/

- Existing applications and research on similar issues:

  — AI assisted legal service for the victims of social media harassment and cyberbullying: https://ec.europa.eu/eipp/desktop/en/projects/project-11762.html

  — A research project to create a virtual companion to guide teens in using social media: https://www.upf.edu/web/e-noticies/home/-/asset_publisher/wEpPxsVRD6Vt/content/id/225844405/maximized#.XnkBNHt7nIU

  — Enhancing Security And Privacy In The Social Web: https://encase.socialcomputing.eu/

- Existing non-technology related work:

  — KivaSchool is an antibullying program for schools to participate: http://www.kivaprogram.net/

  — In Danish schools, empathy is part of a compulsory subject of study: https://www.morningfuture.com/en/article/2019/04/26/empathy-happiness-school-denmark/601/

4.2.2. *Supporting learners' social and emotional learning*

Looking at students' well-being holistically, as an interplay of different situations in their lives both in school and out of school, can help in understanding their more fundamental psychological needs and motives. This can lead to better well-being, study motivation and even better learning outcomes.

Scenario 4

Since there had been a change in the national funding formula for Higher Education for performance-based funding, the university where Peter had enrolled for undergraduate studies immediately offered career guidance to all new students. During the first session, the lecturer was going through the course syllabus, which includes details about specific interest groups on different job profiles and possible career pathways after the Bachelor's degree. The students were told that a number of local businesses would come and introduce their paid internship programmes.

Students were also told that they could take a motivation test to profile themselves and use it to discuss drivers that motivate them in life with a career counsellor. This could help them to look for interesting career pathways and how to prepare for them after graduation.

Peter was also told that if he wished, he could allow the university to use his motivation profile to suggest additional support services and activities. Personalised time management support while studying was a new big hit; automated nudges would be sent as reminders about upcoming tests and assignments with hints on study strategies.

Peter's Bachelor's programme promises to support resilient, collaborative and autonomous learners. Based on his motivation profile, the university could help support Peter to develop more reflective practices and revise his meta-learning model. Maybe his assumptions about how he learns effectively are not accurate? Did you get good results using your last strategy to prepare, for example? Apart from the support system to prompt him to reflect on his own, he could also join groups of other learners.

This prompted Peter to ask about ways the university would safeguard his privacy. Also, to what extent, with his consent or without, would they link it to his personal data and other student information, for example, his grades and time to diploma?

To his amazement, the lecturer reassured him that the university was collaborating with a number of online job-vacancy platforms. They could get him personalised job ads and put him in a preferential position for those companies who used such databases to call candidates in for job-interviews. Commercial platforms would also have access to his profile, if he wished, so that he could get special discount offers sent to him.

Main function: The software would focus on issues around motivation and study strategies, two issues that many educators struggle to deal with. By enhancing student mental well-being and providing real-time nudges and insights into study strategies, the software would allow educators to better support learners both in their growth as future citizens but also as future professionals.
Approach: Purpose-built for education

Ethical consideration:

- When data associated with motivation and personality traits are collected, there are many ethical considerations for its use. This is principally when it's about training algorithms, making recommendations and planning profiled educational interventions (e.g. for an example, see the Facebook–Cambridge Analytica data scandal[22]). However, data can also be used to create tools for empowering individuals so that they can learn to know themselves better. The aim of this scenario is therefore to prompt discussion at a general level rather than go into the details of one specific application and its functions.

Main user/actor: Learner
Type: A hybrid between an education system-facing technology and learner-facing technology: socio-emotional teaching/learning
End-use: Compulsory education, secondary education, higher education; VET and/or work-based learning

Signals of change show how some of the future possibilities explored in the scenario are already beginning to play out today:

- Existing applications and research on social and emotional learning:
  - "Schoolday" provides educators and school leaders with real-time insights into their students' well-being daily: https://schoolday.fi/en/solutions
  - "Panorama Student Success" helps educators monitor students across academics, attendance and social-emotional learning: https://www.panoramaed.com/social-emotional-learning-sel
  - A method to capture, track and develop socio-emotional skills through observation and feedback: https://pentabilities.com/
- A digital assistant designed to help students navigate and organise their tertiary experience at Deakin University: https://www.deakin.edu.au/about-deakin/media-releases/articles/deakin-genie-digital-student-assistant-wins-major-global-business-award and https://www.youtube.com/watch?v=mI0gdSCjGQ8
- Existing non-technology related work:
  - Schools for Health in Europe (SHE) is a non-profit making foundation overseeing the progress and functioning of SHE: https://www.schoolsforhealth.org/
  - How universities can enhance student mental wellbeing: the student perspective (Baik et al., 2019)

4.3. | Language acquisition by migrant learners

The scene setter: When moving to a new country and a new language context, people face the challenge of learning the target language of the new place. With increased mobility between EU countries, and the rising number of third country migrants and refugees coming to the EU, European classrooms, lecture halls, training centres

[22] https://en.wikipedia.org/wiki/Facebook%E2%80%93Cambridge_Analytica_data_scandal.

and digital learning environments have become more linguistically diverse (EU, 2019). Education and training have the potential to be one of the most important levers for the successful integration of migrants into society. However, multilingualism can impose a complex linguistic landscape for instruction.

Some contemporary language models[23] promote communicative language teaching through interactions embedded into meaningful contexts and authentic opportunities. Mobile apps exist to support non-native speakers in communicating using multimodal methods[24] (e.g. pictures, pictograms and other visuals combined with voiceovers). Others take advantage of context-aware smartphone technology[25] to provide support doing certain common tasks (e.g. shopping, medical checks).

Formal instruction can play a crucial role in supporting the target language acquisition. Education systems in Europe differ in their practices, but many offer separate lessons on the language of schooling as a support measure. At the same time, newly arrived migrants might be enrolled in mainstream classes, or they might begin by attending lessons where the knowledge of the language of schooling is not considered essential, e.g. arts, technology, crafts, music, gymnastics and foreign languages, and sometimes maths and chemistry (EC/EAC/Eurydice, 2018, p. 84).

Two near-future scenarios are presented below that focus on envisaging the role of emerging technologies in supporting educators in effective teaching strategies and other non-teaching tasks.

4.3.1. *Edu-hacks for learning the language of schooling*

Problem statement: On average, 19% of secondary school teachers in EU teach in classes with more than 10% of students whose first language is different from the language of schooling[26] (OECD, 2019b). The cross-country differences within the EU are large. While over 40% of teachers in Austria and Sweden are faced with this situation, in countries like Lithuania, Czech Republic and Hungary this is around 6% and below (Annex 4: Table 7). Working as a teacher in a multicultural or multilingual setting can be challenging: only 24% of EU teachers said to be "well prepared" or "very well prepared" to do so (Annex 4: Table 7).

Scenario 5

Milica looks down at the language translation app on her phone. It does a terrible job translating from Serbian to German, but still helps her get through the day in her new school in Vienna, Austria. Since arriving from Serbia[27], she can follow German classes to learn the language of schooling. However, she finds the progress slow and frustrating.

At school, Milica likes attending the mainstream classes with other students best. Even with her limited language skills, but with the help of some low-tech applications, she is able to keep up. In History class, for example, the teacher activated the use of "Immersive Reader[28]" programme to show breaks between syllables. This is great, as the long German compound nouns can be overwhelming to her. At the touch of a button, she can also hear the whole page read aloud and see the text highlighted at the same time - she finds that this helps her learn the right pronunciation faster. From time to time, she uses Alexa for doing her written homework, too: "Alexa, how do you spell....[29]?".

[23] E.g. see Communicative Competence: https://www.learnalberta.ca/content/eslapb/about_communicative_competence.html
[24] Kuvakom: https://play.google.com/store/apps/details?id=fi.kvl.kuvakom&hl=en
[25] EU-project MASELTOV: http://www.maseltov.eu/
[26] OECD term is "language of instruction", the preferred term by the European Commission "language of schooling" as used by EU, 2019.
[27] Migrant background defined as newly arrived/first generation, second generation or returning migrant children and young people (Eurydice, 2019).
[28] Available in 22 EU languages: https://support.office.com/en-us/article/languages-and-products-supported-by-immersive-reader-47f298d6-d92c-4c35-8586-5eb81e32a76e?ui=en-US&rs=en-US&ad=US
[29] As of summer 2019, Amazon's Alexa supports English, French, German, Italian, Spanish and Portuguese (Brazilian).

Her mum sometimes says that she cheats by using the technology, but her teachers don't see it like this at all. On the contrary, using free translation apps is as normal today as using a calculator to do your maths exercises. "It's a tool for language learning", her Serbian home language[30] teacher says. They sometimes use it in class to learn where the machine translation makes mistakes between the two languages[31]. This is a modern approach to learning languages, but it also builds and supports Milica's language awareness[32] and competences to interact with automatisation in new spheres of life.

The teachers in Milica's school periodically meet up to discuss ways in which they can support language learning among the newly arrived migrant population. They often redesign teaching practices using new language tools in order to better integrate them in different aspects of school life.

Main function:

- To complement educators in supporting second language learning by students with migrant background. To augment and make language learning more relevant and contextualised for them.

Approach:

- Re-purposed technologies, i.e. applying technologies that were not developed to support migrant students in education to do so.

Ethical considerations:

- In general, the risk of harm by the technology in language learning is rather low, so "Teacher-out-of-the-loop" approach can be appropriate. For example, when it comes to reading aloud or spelling. "Teacher-over-the-loop" approach can be more suitable for machine translation where sentence structure and word choice are particularly problematic (Groves & Mundt, 2015), so a teacher can intervene with the system if its behaviour needs to be changed.
- When commercial technologies (e.g. free translation tools) are applied to the context of education, users should be aware that the commercial entity itself might use the behavioural and personal data collected for secondary purposes or sell it to third parties. Without their knowledge, student data could be used for building behavioural models for commercial purposes.

Prerequisites for data and modelling:

- Domain model: for various tools, different models exist, but in general, the language translation tools are equipped with the latest domain models.

Educator skills for the technology:

- Educators should have a basic knowledge of the tools to be used in supporting language learning.
- The "teacher-over-the-loop" approach means that the teacher should have skills and basic knowledge to intervene or override the systems' behaviour (e.g. replace words suggested by automated translation).

Main user/actor: Learner, teacher

Type: Learner-facing technology: language learning

Application: Stand-alone tools, but could be integrated as part of learning platforms and smart content

End-use: Compulsory education, secondary education, higher education, VET and/or work-based learning

[30] In Austria, Sweden and Finland the top-level education authorities have designed a curriculum specifically for the teaching of home languages (EC/EACEA/Eurydice, 2019).

[31] "I use Google translate as a tool for teaching grammar and translation": http://teaching-the-teacher.weebly.com/blog/making-use-of-google-translate

[32] In three education systems (Germany – Brandenburg, Austria and Finland), raising language awareness is a transversal learning objective of the curriculum (EC/EACEA/Eurydice, 2019).

Signals of change show how some of the future possibilities explored in the scenario are already beginning to play out today:

- Educators already use online translation services for educational purposes:
  - — Teaching tips to share: http://teaching-the-teacher.weebly.com/blog/making-use-of-google-translate
  - — Bahri, H., & Mahadi, T. S. T. (2016). Google Translate as a Supplementary Tool for Learning Malay: A Case Study at Universiti Sains Malaysia. Advances in Language and Literary Studies, 7(3), 161-167.
  - — Groves, M., & Mundt, K. (2015). Friend or foe? Google Translate in language for academic purposes. English for Specific Purposes, 37, 112-121.
- Example of software developed for children to transform speech to writing: KidSense. Children's speech is usually harder to translate, the AI in this tool uses certain algorithms to translate accurately and privately: https://kidsense.ai/

4.3.2. *Virtual Reality in Vocational Education and Training*

In Vocational Education and Training (VET), the lack of language skills can be a considerable obstacle for students with migrant background (Flisi et al., 2016). Especially when migrant learners with insufficient skills in the instruction language attend VET, trainers need support in their capacity to integrate language acquisition into the instruction of trade-specific theory and practice. Another challenge is the practice period at the work-place and supporting VET trainees in their attempt to converse in the language of the workplace and apply the specific vocabulary suitable for the job.

Scenario 6

When simulation-based pedagogies were first developed in late 2015, Henk, a trainer for 25 years, was still sceptical whether they could really deliver what Augmented, Virtual and Mixed Reality (AR, VR and MR) enthusiasts said they would; allowing learners to go through complex learning scenarios again and again, honing their skills and practices, without any additional expenses or inconvenience.

Henk has now changed his view completely. He believes that, thanks to AR, VR, MR and wearable technologies, the proper balance between gaining knowledge and building experience is better delivered in vocational education and training. Besides, this way of training has made some of the assessment tasks obsolete. For practical skills' assessment, for example how to use particular bits of equipment, students can now record their best performance in the VR environment, and the software automatically compares it to a modelled performance.

Henk thinks, however, that the best part of simulation-based pedagogies is their ability to accommodate languages. Henk has witnessed many trainees with a migrant background quickly learning the trade-specific practices and handling of machinery. But he often struggled to teach them the theoretical concepts and the new specific vocabulary associated with it. Mixed Reality experiences provide learners with access to various kinds of additional information, either on their displays or through voice-overs, which is a huge advantage.

On the one hand, correctly pronounced terms and concepts can be practiced in their real context throughout the simulation experience. By focusing on an object and blinking, the written term appears. By blinking twice, a voice over says it out loud and allows the trainee to practice the right pronunciation. More interactive capacities are available through voice commands, too, which work in many languages.

On the other hand, the theoretical material is available in many languages so that when Henk is teaching it, the trainees can follow it in the language of schooling but also in their mother tongue. Adding new translations to the system can be done almost on the fly. Many trainees with migrant background provide translations in their own languages or validate the machine translated ones. They enjoy contributing back to the system and making it better for other learners.

The system already has a virtual chatbot, a voice-activated software agent, that helps trainees during the work placements. It can extract virtual manuals and workflows for plenty of machinery that it identifies through image recognition. Simultaneous translations support has recently been tested, too, so that the trainees with migrant background can be supported in real-time. It is still experiencing some errors functioning, especially when it comes to understanding slang terms and dialects!

Main function:

- To enhance lab practice sessions in vocational training by bringing the physical practice closer to theoretical knowledge. Also, virtual lab practice can reduce the need for machinery in the lab, as well as making it easier to have models for old and new models.

Approach: Re-purposing VR and wearable technologies for education and training.

Ethical considerations for decision making:

- For simulation-based lab practices such as this one, "teacher-over-the-loop" approach could be considered. The educator will set the goal for simulation allowing the learner to practice it on their own. "Teacher-out-of-the-loop" approach is suitable for the virtual chatbot, as it only links to the reference material.
- In the field of language learning, there are different views on seeing technology as a substitute for not having to improve one's language competence vs. it being an aid and support.

Prerequisites for data and modelling:

- Content model: The simulation-based lab practices need to model the ideal practices for a given equipment.
- Learner model: For each learner, their movements are compared to the ideal model. This can even be done anonymously, but when the student records their best practice example for assessment, they need authentication.
- Pedagogical model: Depending on the sophistication level of the model, the system can give various types of feedback to the user. The simpler one could just show the difference between the two.

Teacher skills for the technology:

- Teacher should have a basic knowledge of the wearable technology for VR to manipulate the equipment and lab practices.

Main user/actor: Learner and the educator

Type: Learner-facing technology (individual's learning and development) and teacher-facing technology (assessment, evaluation and diagnosis)

Application: Augmented and Virtual Reality

End-use: Compulsory education, secondary education, higher education, VET and/or work-based learning

Signals of change showing how some of the future possibilities are already beginning to play out today:

- The scenario is inspired by the work that uses robots for language learning among adult migrants:
  - — Robots used to help adults with migrant background to gain vocabulary at work: https://yle.fi/uutiset/3-10669121 (in Finnish only) See Google translation: https://translate.google.com/translate?sl=auto&tl=en&u=https%3A%2F%2Fyle.fi%2Fuutiset%2F3-10669121
  - — A pilot to learn second language among adult migrant population (Hemminki et al. (2017): https://www.pedocs.de/volltexte/2019/18142/pdf/cepsj_2019_3_Tuna_Tuna_The_use_of_humanoid_robots.pdf
- Existing applications and research:
  - — Research on virtual internships in VET: https://www.ntnu.edu/imtel/virtual-internship

- Example of a commercial provider for VR-based vocational courses: https://www.classvr.com/virtual-reality-in-education/virtual-augmented-reality-for-vocational-courses/
- VR in training healthcare professionals: http://oxfordmedicalsimulation.com/
- EU project on industrial training enabled by smart Wearable Technology: http://wekit.eu/
- Introduction to Wearable-Enhanced Learning Trends, Opportunities, and Challenges by Buchanan et al. (2019): https://link.springer.com/chapter/10.1007/978-3-319-64301-4_1

4.4. | Special education

The scene setter: Children and young people with special needs can have a wide range of learning disabilities (e.g. speech-language pathologies, dyslexia, dyscalculia), problems regulating their emotions (e.g. hyperactivity), attention disorders (e.g. the variant of ADHD without hyperactivity), developmental disorders affecting communication and behaviour (e.g. Autism Spectrum Disorder, from Asperger to more severe variants on the autistic spectrum), or physical disabilities.

Current research, along with some industry applications, look into adapting emerging technologies in special education. For example, **social robots** that interact and communicate, and **humanoid robots**[33] (which resemble humans) could offer new insights. With autistic children, robots' predictability and consistency can potentially play a positive role, especially in learning social and emotional skills, and social interaction in general. In autism-robotics literature, this is called "*repeatability*: a robot can repeat usually-variable social behaviour (e.g. a facial expression) over and over, helping autistic children to begin identifying patterns and associating meanings with the behaviour" (Alcorn et al., 2019, p. 5; Dautenhahn et al., 2009).

In a recent publication, 31 autism education staff were interviewed on their views on the general concept of humanoid robots as an educational tool (Alcorn et al., 2019). Their views highlighted that educational activities with social and/or humanoid robots should always be carefully planned with educational goals, and preferably with some evaluation of their success. Moreover, there was an emphasis on adults mediating these educational interventions, pointing to the concepts of "teacher-over-the-loop" and "teacher-in-the-loop" (e.g. teacher should be able to make child-level personalisation to the robot depending on the needs of the intervention).

Two near-future scenarios are presented below that focus on envisaging the role of emerging technologies in supporting educators working in special needs.

4.4.1. *The case of hearing loss in regular classrooms*

Problem statement: In the EU, students with diverse needs often attend regular school systems but education systems differ in their practices. Many hearing impaired individuals need special education but with the help of technologies, their integration in mainstream education could be facilitated. Current research is looking into adapting technologies to hearing loss students (e.g. Baglama et al., 2018).

On average 31% of secondary school teachers in the EU teach in classes with more than 10% of special needs students. In France, 40% do so, but only 25% felt well prepared for teaching in a mixed-ability setting[34]. Additionally, in France, on average 70% of principals report a shortage of educators with the competence to teach students with special needs (Annex 4: Table 7).

[33] https://en.wikipedia.org/wiki/Humanoid_robot
[34] Term used by the OECD.

Scenario 7

Patricia is a primary school teacher in Orleans, France. In her 27-student classroom, 3 students have some degree of special needs. These children are assigned to her class as part of a nationwide school policy[35]. Patricia's goal is to create a fair, inclusive atmosphere where learning can thrive, even if one of the children is diagnosed with hearing loss. As Patricia does not have a degree in special needs education, she was thankful for the opportunity to participate in a mentoring programme to teach hearing impaired children.

The school uses innovative technologies adapted for hearing loss and impaired students. Wirelessly powered intelligent hearing aids, which are connected to smartphones, can learn sounds from the environment and classify them as "background noise" or "important noise". This allows the hearing impaired to focus on the sounds that they want to hear. The app enables the user to set preferences for these sounds. For hearing impaired students, this means that they will be able to fully participate in classroom activities with other students and therefore have better social interactions.

Also, classroom acoustics are adapted so that distractions caused by lights and air vents are lessened. The seating is arranged so that the teacher's face is clearly visible. Patricia is also using interactive whiteboards (IWBs) and soundfield amplification systems that are directly connected to the intelligent hearing aids. Assistive learning technologies are often used too. For example, digital captions used with multimedia content such as videos can be helpful not only for children with hearing impairments, but also for the rest.

Main function:

- Various off-the-shelf technologies are put together around the classroom to assist educators who lack background in special needs education in teaching in a heterogeneous classroom without affecting the classroom climate.

Approach: Re-purposed technologies for education and training.

Ethical considerations for decision making:

- In most of the off-the-shelf technologies, which directly assist the learner with their disability, "teacher-out-of-the-loop" is the most privacy-enhancing approach. However, in cases where these technologies connect with other devices in the classroom (e.g. IWB) and especially if they send some learner performance-related data, "teacher-over-the-loop" approach could be considered.

Teacher skills for the technology:

- In the case of a learner's personal devices interacting with other classroom devices, some basic knowledge of the underlying concepts and mechanisms could be required.

Main user/actor: Learner, educator
Type: Learner-facing technology
Application: Stand-alone applications which have the capacity to connect with nearby devices such as a mobile phone, IWB, through IoT
End-use: Compulsory education, secondary education, higher education, VET and/or work-based learning

Signals of change show how some of the future possibilities explored in the scenario are already beginning to play out today:

- The scenario is inspired by the previous work in the field:

[35] Eurydice, 2018b.

- Widex's Evoke is an example of a machine learning based hearing aid performing these tasks (http://www.widex.es/evoke).
- "AI Has Already Started Reshaping Special Education": https://www.forbes.com/sites/ilkerkoksal/2018/04/17/ai-has-already-started-reshaping-the-special-education/#33a1fea29d54

- An article about AI providing alternatives for Special Education by Jun (2019).
- EU project EweDraw: multisensory games for teaching and learning arithmetical and geometrical concepts with primary school children, suitable for visually impaired children and those with dyslexia: https://www.wedraw.eu/

4.4.2. *Social robots supporting special needs education*

Problem statement: Supporting autistic children in learning and applying skills in one setting (e.g. in speech therapy) and transferring them successfully to another relevant setting or situation (e.g. home) is a challenge special education teachers, support staff and carers deal with daily. For example, when practising turn-taking, an autistic child may have no issues with sharing toys with a therapist, but the child may be unable to apply the "share" rule to classmates (Rudy, 2020).

Social robots[46] could offer new insights. Research has looked into better understanding whether the social skills learned with a robot in a laboratory experiment would generalise to another situation or setting in real life, especially over the long-term. Some positive results are already reported; for example, the robot improved the autistic child's empathy towards other peers (Hao, 2020). This condition is essential for robotics in education, also for its ethical aspects.

Scenario 8

Throughout the last 10 years of her teaching career in Flanders[37], Liesbeth has regularly had students with autism spectrum disorder (ASD) who follow mainstream education. However, before getting a humanoid autism-robotics assistant in the class, providing the social and emotional stability for those with diverse needs was challenging.

The new robot assistant is trained to work in situations that may arise with ASD children who follow mainstream education. The robot helps to increase the attention and engagement of the ASD child. At the same time, it reduces anxiety and disruptive behaviours. It can also help situations in the classroom by mediating between the child and others, if needed. Liesbeth thinks that all students in class benefit socially by learning how to be more at ease with different people – and robots.

The robot is part of an educational robotics research project. The end-goal is to create a robot that serves the teachers' needs in a setting like that of Liesbeth's. The idea is that she could, almost on the fly, easily use the robot for her educational needs by having full control over pedagogical interventions. The robot could, for example, be programmed to work on different goals depending on needs and take different roles (e.g. provoker, reinforcer, trainer, mediator, prompter, and diagnostic information provider[38]). Alas, this currently remains a dream, as the robot occasionally stalls at an important moment or reboots itself when another type of behaviour would have been more relevant.

Thanks to the research project, Liesbeth has learned a great deal about how to better plan tailored interventions for each individual ASD child. They all have a wide spectrum of different needs. She has learned a great deal about machine learning, too, and how collecting data about a child's interaction with the robot (e.g. eye gaze, verbal response) can help her refine pedagogical interventions.

She looks forward to the second part of the research project: it will extend the use of the autism-robotics assistant to in-home experiences, therefore possibly also helping parents who might struggle to help their ASD child with homework. It was her idea and she is exited that the research team selected her idea for further development.

36 Some current examples of robots include Flobi, KASPAR, Milo, NAO, PARLO, Pepper, QTrobot.
37 Kooistra, 2017 and Eurydice, 2019a.
38 See Huijnen et al. (2019).

Main function: The robot can assist and support the ASD child with social and emotional skills, and in some cases (keeping the learner focused on the task at hand) with social interaction to a certain extent. However, more pedagogically-oriented interventions are still at an early development stage.
Approach: Purpose-built for educational use

Ethical considerations for decision making:

- In child-robot interaction, especially when dealing with autistic children, there is a fear that in the long term, the robot would replace human relationships rather than help to improve them.
- Researchers are still studying the phenomena of transferring (social and emotional) skills learned with a robot to another relevant setting with humans. If this transfer does not eventually happen, teaching these skills with a robot becomes an ethically questionable practice.
- Some humans have a tendency to unconsciously assume that behaviour by a robot or machine is analogous to human behaviours (i.e. anthropomorphisation, see Eliza effect[39]).
- For human oversight of decisions, teacher-in-the-loop and teacher-over-the-loop could be preferable. However, many robotics toys today, for example, consider human-out-of-the-loop all together, which might not only have ethical problems but safety and security concerns too (Chaudron et al, 2017).

Teacher skills for the technology:

- For the moment, early research reports that manipulating both the robot and the software to make it function is a major issue. On the one hand, it is associated with the lack of skills. On the other, it is associated with the time it takes away from other practices during the class/ instruction.

Main user/actor: Teacher
Type: Learner-facing technology, teacher-assisting
Application: Social/ humanoid robots
End-use: Compulsory education, secondary education, higher education, VET and/or work-based learning

Signals of change showing how some of the future possibilities are already beginning to play out today:

- The scenario is inspired by the previous work in the field to collect educators' views on using humanoid robots with autistic learners by Alcorn et .al (2019): https://www.frontiersin.org/articles/10.3389/frobt.2019.00107/full
- Existing applications and research:
  - Roles, Strengths and Challenges of Using Robots with Autism Spectrum Disorder BY Huijnen et al. (2019): https://link.springer.com/article/10.1007%2Fs10803-018-3683-x
  - In-home use of socially assistive robots for children on the autism spectrum: https://www.youtube.com/watch?v=NbTDF3_djI8

[39] https://en.wikipedia.org/wiki/ELIZA_effect

5 INSIGHTS FOR POLICY REFLECTIONS

This report started by introducing three cross-cutting key themes for the near-future scenarios. For each of the key themes, this section first provides a transversal analysis of the scenarios. Then, policy reflections are provided to facilitate strategic reflection and start identifying where educational policies could - and should – intervene. Lastly, existing practices are highlighted to help policymakers and all other stakeholders come together to better shape the future.

5.1. | Decision-making agency between humans and technology

Summary of the scenarios

All near-future scenarios take the position that educators' professional competence remains at the core of the profession and that educators' general pedagogical knowledge is an integral part of it. This is specialised knowledge for creating and facilitating effective teaching and learning environments for all students, fostering individuals' cognitive as well as motivational learning processes (Guerriero, 2017). It is formed on the foundations of pedagogical knowledge, in combination with new knowledge and experience that emerges from practice and research. When educators make pedagogical decisions, they exert professional judgement, for example, to choose suitable teaching practices according to intended learning outcomes.

The scenarios prompt ethical reflections regarding the balance between human and technology, and the roles to be taken. Such ethical decisions are context-dependent, as the eight scenarios illustrate. Especially the scenarios that involve the use of computational methods for autonomous decision making (e.g. AI) prompt readers to explore how the four Ethical Pillars for Artificial Intelligence (human autonomy, prevention of harm, fairness and explicability) could play out in the field of education and training.

Examples include reflections such as: Would it be right to yield the ultimate pedagogical decision to a machine and who will bear the responsibility (e.g. the developer of the system, the educator, the school principal, the learner)? How to ensure that the pedagogical judgement is fair and unbiased; and how to address issues around accountability, e.g. what protocols are in place to prevent and respond to harm?

In the future, explicit decisions need to be taken on the distribution of responsibility between a human and a machine/algorithm (e.g. teacher-in-the-loop, teacher-over-the-loop or teacher-out-of-the loop).

The main message for education and training

When designing and enabling emerging technologies for educational use, creating trust in the system is important. This means that **various degrees of human oversight should be considered in the decision-making process** (IMDA&PDPC, 2020, p. 30). Three examples are given for the context of education and training.

"Teacher-in-the-loop" (1): Consider an autonomous decision-making application that evaluates high-stakes exams, or conducts a diagnosis of a learning disability. In such a situation, an incorrect decision could cause severe harm to the end user (e.g. a loss of opportunity, unfair practices). Therefore, the most powerful human oversight in the decision-making process is needed. The application should recommend a decision to an educator with enough transparent information available so that the educator can review it - and only then decide whether to execute the final decision or not.

"Teacher-over-the-loop" (2): There are other types of decisions where it is enough that an educator maintains an overview of the decision taken by an application. This could be the case, for example, when an adaptive learning platform recommends the next learning activity to a learner to achieve an intended learning outcome. In such case, the possible severity of harm done due to a decision taken by the algorithm alone is relatively low. However, with the over-the-loop oversight, the educator could still decide to change the recommendations made, or even modify the criteria on which the algorithm works.

"Teacher-out-of-the-loop" model (3): There are also circumstances with a low probability and low severity of harm. In such a situation, educators can be out of the loop. For example, when a student uses an educational app out of school, the educator's oversight is not required.

All stakeholders in the field of education and training should discuss the implications of yielding emerging technologies the power to take decisions which otherwise would be taken by a teaching professional with adequate pedagogical and subject-specific content knowledge. The 'teacher-in-the-loop'-approach can essentially send the message that educators should always be in the loop, at some level.

Examples of existing practices

To ensure better pedagogical and social outcomes for a more inclusive education system tomorrow, and to create more accountability, transparency and trust, multi-stakeholder discussions are needed today on the ethical issues linked to emerging technologies in education and training.

- To initiate discussions in the areas of design, implementation and governance of emerging technologies in education and training, Annex 1 elaborates on a number of issues using the four EU ethical pillars (*respect for human autonomy, prevention of harm, fairness, and explicability*). Engagement by all stakeholders can ensure better accountability throughout the education and training community, and at an education system level, too.

- Practical actions to create more transparency and trust in the field are needed to follow-up the discussions. An example of such a practice is the Nesta EdTech Innovation Testbed[40], which focuses on how to be more accurate about what the EdTech products promise and to better understand what 'good' EdTech actually looks like. In collaboration with the UK's Department for Education and Durham University, EdTech innovations are being introduced in 200 schools to evaluate whether the tool does what it says it does (rather than any other more generalised outcome).

5.2. | Challenges with data, underlying pedagogical models and datafication of education

Summary of the scenarios

The scenarios are driven by the needs of European educators that arise from the OECD survey data. The scenarios connect emerging technologies with the challenges that educators, support staff and administrators face. The focus is to support everyday teaching, classroom management and assessment work, instead of proposing to substitute educators' core knowledge, processes and pedagogical judgements that are central to their professional competence.

The scenarios also intentionally challenge the reader to think beyond the teacher-replacing paradigm of

40 https://www.nesta.org.uk/project/edtech-innovation-testbed/

emerging technologies. Instead, they propose a set of different uses focusing on augmenting the capacities of educators and assisting them. In other scenarios, emerging technologies transform educational settings to promote empathy, motivation and psychological well-being, thus creating a more conducive environment where learning can thrive.

Last, the scenarios aim to focus the reader on the pedagogical models that emerging technologies rely on. For example, the scenarios move away from pedagogical models that follow controllable and predictable education based on the automated distribution of content and learning activities. Instead, the reader is invited to ponder the type of value propositions in education and training: the vision that supports learners of tomorrow to be ready for a rapidly changing world by taking agency, being creative, critical and resilient.

Instead of automating and routinising teaching practices, emerging technologies in education and training should be better connected to solve the problems that educators say they frequently face in their profession.

The main message for education and training

The increasing rate of datafication of every aspect of life will allow more digital data to be generated. Datafication also takes place in education and training. This means the collection of behavioural and personal data from learners and their interactions with various digital technologies in different contexts (e.g. in school, out of school, for education and training, but also for leisure) in addition to education systems collecting student learning records, demographic and other personal data.

The first message is that there is a general expectation that the combination of such data could be turned into deep insights about education or training. However, even today, the field of learning sciences is still struggling to better understand what kind of data are meaningful for learning and how to turn data into educational interventions that support student learning. For example, during an online course, is a high number of hours spent on revising material a sign of a student struggling or a sign of strong engagement (Nguyen et al., 2019)? Other studies show that measuring online engagement in mechanistic ways does not correspond to what learners feel being valuable to their learning (Dyment et al., 2020).

The second message is safeguarding learners' privacy so that there is a balance between collecting student learning data and intruding into one's personal sphere. There is a fear that the "always-on" collection of learner data could turn into constant monitoring of learning. This could generate increased anxiety and create learning environments that are not conducive for social and emotional learning. Education is more than just learning and performance, the education institution is also a community with a socialising function promoting inclusivity (Pijpers et al., 2020).

The third message revolves around pedagogical models and instructional practices that underlie educational applications and services based on emerging technologies. Today, some pedagogical models typically allow predictable and controllable learning pathways to be created, following the model of music and consumer product recommendations. They often rely on standardised questions which, in turn, encourage standardised answers so that recommending the next activity or resource is simplified. In such a case, there is a risk that the pedagogical model does not encourage learner-agency, critical thinking and creativity – competences that are needed for the future.

Therefore, the message arising from the scenarios is that more attention should be paid to pedagogical models in the future. They should inspire people to develop more holistically in their cognitive domain (e.g. cognitive processes and strategies such as creative thinking, reasoning; knowledge; creativity). More emphasis could be placed in developing pedagogical models that engage learners in social and emotional learning to practice and reinforce this important set of non-cognitive competences that include taking agency and initiative, perseverance, self-regulation, negotiation and conflict resolution skills, and intellectual openness. These near-future scenarios give examples of applications that could help cultivate such areas.

The final message to be highlighted is around the organisation of work and its management, including accountability in education and training. Recently, a number of reports have focused on the issue of the administrative burden on educators. As a response, AI-driven deployments are called to help. However, if there are no real root cause analyses for what has caused educators to assume a share of logistical, administrative and secretarial tasks, there is a fear that through automation of these tasks, one would further solidify outdated practices instead of making systems more efficient. Therefore, to prevent the risk of consolidating old institutional structures and processes that serve yesterday's education, an opportunity presents itself to critically consider the underlying organisational assumptions about accountability, success, and the type of evidence collected to support them.

The pedagogical models should focus on the learner agency and helping learners to develop a variety of competences (e.g. in the cognitive domain, social and emotional learning) instead of making these core competences redundant. Emerging technologies and the datafication of education offer an opportunity to rethink and re-frame success in education and training; they should not be used to support old practices that are no longer effective for future needs.

Examples of existing practices

To envision and create new pedagogical paradigms for emerging technologies in education and training at national and European level, concrete efforts are needed. This includes a discussion around the datafication of education. A large group of stakeholders should be included. Some actions are highlighted below:

- In the Netherlands, ethics is one of the five themes covered in the 'Digitalisation agenda for primary education and secondary education[41]'. The basic principle is the following: "technology offers many possibilities, but there are limits to what we actually want to use it for in education". The programme plan of the Dutch 'Strategic agenda for digitalisation in vocational education' explicitly focuses on the ethical dimension as part of 'data-driven education'.

- The Dutch guide called "Weighing values: an ethical perspective on digitalisation in education"[42] promotes ideas such as "Ethics by design" to influence the development of new technology, and encourages schools and school boards to enter into conversations with providers and designers of digital resources based on values that are important in education and training (see Annex 2).

- The Dutch school boards can now join forces in a cooperation called SIVON[43] to increase the influence of the education sector when it comes to digital market and EdTech developments that disrupt educational values. It works on the issues of security, infrastructure and procurement. Another example is the Edu-K[44] platform and its privacy agreement that follows the Dutch tradition of public-private dialogues. Providers of digital products and services in Dutch education, who sign the agreement, commit themselves to a set of rules relating to privacy and information security. In spring 2020, 220 providers had already signed it[45].

- The French Ministry of Education put forward a tendering process for EdTech Industry[46] to develop new pedagogical tools based on Artificial Intelligence. The ethical issues related to the use and collection of educational and personal data are reinforced at each step of the iterative process. The first research and development phase, which started in 2019, includes 6 tools, after which there is a second phase for a bigger deployment and roll-out.

41 See bibliography for The Netherlands Ministry of Education, Culture and Science, 2019.
42 https://wijzer.kennisnet.nl/ethiekkompas and http://kn.nu/weighingvalues
43 https://www.sivon.nl/
44 https://www.edu-k.nl/
45 https://www.privacyconvenant.nl/
46 https://eduscol.education.fr/cid118880/partenariat-d-innovation-et-intelligence-artificielle-p2ia.html

5.3. | Needs for future competences for educators

Summary of the scenarios

The near-future scenarios demonstrate that educators' competences to use and apply technologies in everyday life are not sufficient, but they also need knowledge, skills and the right attitude to apply them in their teaching profession. The latter requires good professional judgement: how to best apply a given technology to a given pedagogical task, and when it is better not to apply it at all. This has implications both for initial teacher training and for professional development.

Emerging technologies impose a burden of continuously updating one's knowledge and skills. In many of the scenarios, educators carry on a dialogue with their colleagues or engage in continuous professional learning activities to further share and learn. This concept puts forward the idea of educators as learning professionals.

Moreover, in some of the scenarios, educators actively feed into the development cycle of new EdTech products and services. They put forward new ideas and new use cases that solve problems that educators themselves face in their profession. In other words, educators become co-creators of new applications and they 'create demand' for future EdTech solutions, instead of just being users of such technologies. Essentially, the future EdTech solutions should be co-designed and co-created using processes that involve educators, learners and other stakeholders in the development process. To achieve this, a broad range of digital competence, general pedagogical knowledge and subject-specific pedagogical knowledge is needed.

Educators should be supported in applying emerging technologies in an effective manner in their profession. The support and upskilling need to be continuous, embedded in their practices, supported by peers and experts, and incentivised by education authorities. To empower educators as co-creators of new products and services, opportunities with EdTech are needed.

The main message for education and training

Today, without educators being aware, many of the ICT solutions used in classrooms, lecture halls, training centres and digital learning environments are already powered by Artificial Intelligence (AI), as it has become "invisibly infused" into these technologies.. Popular word processing applications rely on them for spell-checking tools. Without hesitation, students use an online translation service which relies on AI techniques. Similarly, purpose-built educational applications thrive on student data used for autonomous decision-making techniques (e.g. AI).

This has ramifications for what kind of data are collected about users in educational contexts and who has access to it, especially when it is about personal learning data for minors. The users of educational applications and services should be able to expect a level of safety and respect of their rights thanks to European legislation such as consumer protection, product safety and liability rules, as well as fundamental rights, e.g. data protection, privacy, non-discrimination (COM, 2020). More awareness needs to be raised in the future as this is a new and rather uncharted territory in education and training.

To prepare educators, educational institutions, learners and future citizens for the increasing fast pace of technological development, European reference frameworks for individuals' digital competence (the DigComp Framework, EC, 2020a), educators' digital competence (the DigCompEdu Framework, EC, 2019d) and educational organisations (DigCompOrg, EC, 2019e) already exist.

These frameworks and their accompanying self-reflection tools may need to better address the concepts of datafication of education and technologies that use computational methods for autonomous decision making (e.g. AI). In addition to these existing frameworks covering knowledge, skills and attitudes *about* datafication of education and AI, they could also guide ethical reflections. Last, it could also be relevant to reflect on how such reference frameworks could empower both citizens and educators as creators of new products and services that would actually help, support and enhance their work.

The digital competence framework for educators (DigCompEdu) could also include ethical reflection regarding teaching *using* AI (e.g. ethical issues related to data and personalised learning, algorithms and pedagogical models). DigCompOrg and the SELFIE tool for schools' digital capacity[47] could also be reviewed from this point of view. Moreover, to better connect with changing values and attitudes, human development and the competence of "learning to learn" should also be more central (LifeComp).

Educators need a basic knowledge of emerging technologies (e.g. underlying concepts, general principles and mechanisms), and of their ethical and legal issues. Secondly, they need competences to apply them as tools to enable better teaching, learning and assessment processes.

Examples of existing practices

There is a clear need for policies and practices that will ensure that the implementation of emerging technologies in education and training will be purposeful, robust and safe thanks to the sufficient level of both digital and pedagogical competences that all parties involved should possess.

Three types of initiatives and actions already exist: ones targeted at all citizens, including educators, to upskill *about* AI and emerging technologies. Secondly, there are the ones focusing on the educational use of emerging technologies. Thirdly, there is the idea of co-creating educational applications and services driven by emerging technologies.

In the future, education policymakers could also pay attention to the educators' role in creating applications and services that actually help, support and enhance them in their tasks. Today, educators and learners already work together with EdTech developers and the industry as part of the testing cycle (e.g. example of Testbed in 5.1.3). The idea could be extended so that educators and learners become co-creators too. This puts forward a vision that the current supply of technologies would not only be 'pushed-in' by EdTech industry, but co-created by and with the stakeholders.

Sharing knowledge and practices within and across education institutions as well as across Member States can be an enabler. Some examples from national and regional initiatives are given below.

- "**The Elements of AI**" is a free online course to demystify what can and cannot be done with AI, what it actually is and how to start creating AI methods. The course is open to anyone, with the aim of upskilling citizens on their knowledge and skills of AI. The current aim is that 1% of European citizens would have studied the course online by 2021. The course is already available in English, Finnish, Swedish, Estonian and German and new languages will be added from spring 2020 onwards[48]. The course is co-created by Reaktor and the University of Helsinki.

- **Artificial Intelligence in the classroom** is a continuous development course from the Spanish Ministry of Education for teachers, organised by INTEF[49]. Participants learn about AI in terms of machine learning and they even create their own "virtual assistant". The face-to-face course also includes coding of apps and robotics (Micro:bit, Arduino). Other counties are creating online courses specifically targeting teachers, too, e.g. France, Portugal.

- **Educational hackathons**[50] are a good example of user-driven innovation. The main idea is to better incorporate user needs in new EdTech products and services by giving users an active role in the innovation process. In hackathons, educators and learners are part of the co-creation and co-construction processes. Such activities are enabled by having educators with a solid basic understanding of emerging technologies

47 https://ec.europa.eu/education/schools-go-digital_en
48 https://www.elementsofai.com/eu2019fi
49 Online CPD course: http://code.intef.es/inteligencia-artificial-en-el-aula-con-scratch-3-0/; face-to-face: https://intef.es/Noticias/curso-de-verano-pensamiento-computacional-e-inteligencia-artificial-de-cero-a-cien-en-un-verano/
50 https://ec.europa.eu/education/news/digital-education-hackathon-winners-2019_en; http://educationhack.nl/

and AI so that new ideas and solutions can be co-created.

- The Smart Learning Environments for the Future project[51] works based on **challenges**[52] that are formulated by school boards, regional education providers and educators. On the other hand, the **EdTech companies** discover and start to co-develop new products and services with educators and learners in a facilitated manner. New products and services are already being tested in educational institutions in 7 Finnish cities.
- To redress **the lack of research evidence in the EdTech sector**, EDUCATE[53] aims to co-create a research proposal to inform the ongoing development of EdTech products. During the first three years, the programme, which was partly funded by the European Regional Development Fund, supported 260 EdTech companies.

5.4. | Closing remarks

There is great potential in emerging technologies for the benefits of education and training. First and foremost, however, the objectives need to be clear: what to achieve with these in education and training systems, and what roles are they given? It is clear that the discussion should strongly consider educational, social and ethical values, and not only be technically oriented.

In order to create new realities for the future, analysis of the objectives to be achieved, together with the ways in which they could be achieved, is essential. This includes outlining common strategic objectives together with a wide range of stakeholders at a regional, national and European level. Educational authorities could show leadership and begin to take more ownership of the vision.

51 https://www.oppimisenuusiaika.fi/the-new-era-of-learning/

52 Example of challenges in Helsinki: “lean-teaching”, “I’m diamond: bring up best sides of my learning”, “babel fish” https://forumvirium.fi/lisaa-ai-kaa-oppimiselle-helsingin-uudet-haasteet-julkaistu/

53 https://www.ucl.ac.uk/ioe/departments-and-centres/centres/ucl-knowledge-lab/educate

Summary table	Decision-making between human and machines	Challenges regarding data and pedagogical models	Competence building
What do the scenarios tell?	The scenarios are driven by the needs of educators and present new ways to address existing problems with the help of emerging technologies. Ethical questions regarding the balance between a human and technology are prompted in order to explore ethical issues around human autonomy, prevention of harm, fairness and explicability.	The scenarios move away from "closed content models" based on predefined learning outcomes in well- structured domains (math, languages). Such models typically allow predictable and controllable learning pathways to be created, following the model of music and consumer product recommendations (also known as "personalised learning" by EdTech). Emerging technologies have potential for much more noble learning goals.	3 ways for emerging technologies to enter the field: purpose-built EdTech, invisibly at the back-end, re-purposed for educational use. Educators need more knowledge about technologies that use computational methods for autonomous decision-making (learn *about* AI). To further enhance the teaching profession, the focus is on their use for educational goals (e.g. learn *with* AI).
What is the main message for education and training?	How the decision-making agency is distributed between humans and a machine (e.g. algorithm driven by AI) needs careful reflection. The degree of oversight ranges from teacher-in-the-loop, to teacher-over-the-loop, to teacher-out-of-the-loop. End users of the systems, but also those who research, design, implement and govern them, should take part in such reflection (see Annexes 1 and 2).	To prepare learners for a rapidly changing world, new paradigms and models are needed for emerging technologies in education and training. They should help people to develop a wide range of competences and cognitive processes, take agency for their own learning while, at the same time, fostering critical thinking, creativity and social and emotional learning.	To prepare educators, learners and future citizens for the increasing presence of AI, existing frameworks for digital competence (DigComp) and that of educators' digital competence (DigCompEdu) need recalibrating. In addition to covering knowledge, skills and attitudes, they should also guide ethical reflections *about* AI and *with* AI (e.g. ethics of pedagogical practices, data, algorithms and pedagogical models).
What can education authorities (e.g. MoE) do?	Set up multi-stakeholder discussions on ethical issues around emerging technologies in education and training. The 4 EU ethical pillars (elaborated in Annex 1 and Annex 2) and scenarios can be used to guide and prompt the creation of a common vision on better pedagogical and social outcomes for more inclusive education.	Dutch example about discussing the ethical issues related to student data, which is part of national digital education plan, is a pertinent action for the time. Moreover, procurement work by French MoE involves iterative R&D and evaluations in read settings.	Educators need upskilling; good examples include teacher training on AI by INTEF in Spain, online courses on AI by French and Portuguese MoEs. "Elements of AI" shows a good example for the general public. Basic understanding of issues allows better co-creation and co-construction processes.

TABLE 2: SUMMARY OF INSIGHTS FOR FURTHER POLICY REFLECTION.

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Glossary

The original glossary is produced by Southgate et al. (2019). The report itself is licensed under Creative Commons Attribution 4.0, https://creativecommons.org/licenses/by/4.0/.

Adaptive learning	An approach to delivering learning activities and resources paced or suited to the abilities or requirements of individual learners.
Agent	A physical or virtual entity that makes seemingly autonomous decisions. These decisions are based on data perceived from the environment (through sensors or provided by other systems). Multi-agent systems have more than one agent, and these agents can communicate with others.
Algorithm	A process or set of instructions for completing a task. In computing, these instructions tell the computer or machine how to accomplish a task or operation.
Artificial intelligence	Artificial intelligence refers to a machine or computer program that uses human like thinking to complete a task.
Augmented reality	Augmented reality (AR) overlays information and virtual objects on the real world environment.
Big data	Big data is the ability to search, aggregate, and compare large data sets which may comprise non-numeric information (e.g. text, images).
Cognitive Computing	Software and algorithm development approaches that use programming designed to mimic human cognition.
Domain knowledge/ model	Domain knowledge refers to the knowledge that human experts hold in a specific area that an AI system is being created to operate in. This knowledge can be in the form of norms, rules, and conventions. For example, an AI system designed to recognise speech patterns would need to include the expert knowledge from the domain area of linguistics
Emerging technologies	A wide range of applications and services that take advantage of Artificial Intelligence (AI), Virtual and Augmented and Mixed Reality, wearable technology such as head mounted displays and sensors, social robotics and the Internet of Things enabled by the ultrafast 5G mobile standard.
head mounted display	A head mounted display (HMD) is a device (goggles or a headset) worn over the eyes that displays virtual objects and environments (e.g. Google Cardboard, VR Gear, Oculus Rift). Virtual reality HMDs completely block out the real world replacing it with a virtual world. Mixed reality HMDs allow the user to see the real world and augment or anchor virtual objects in it so that the user can interact with these objects (e.g. Microsoft HoloLens or Magic Leap).
Intelligent tutoring system	A software system running on a computer that mimics human tutoring, for example by providing immediate feedback or customised instructions to a student without the need for human intervention.
Internet of Things	The network of devices connected to the internet that communicate with each other. The devices that comprise the Internet of Things (IoT) are everyday machines, equipment, and appliances that have embedded computer chips to collect and communicate data.
Immersion	Where the properties of a technology (visual and auditory stimuli) are designed to allow the user to feel a sense of presence ('being there') in a virtual environment.
Learning analytics	The application of analysis techniques to data gathered from learning and educational systems.
Machine learning	A subfield of artificial intelligence, machine learning is the science of get machines to learn like humans in an autonomous way. See also Adaptive Learning, Artificial Neural Network, Evolutionary Computation, Data Mining, Deep Learning.
Mixed reality	Mixed reality (MR) overlays and anchors virtual objects on to the real world and often allows users to interact with these objects. Sometimes the term is used to refer to the inclusion of physical objects that can be interacted with as part of a virtual environment. The term 'mixed reality' is relatively new and still being defined

TABLE 3: GLOSSARY.

- ANNEX 1: ETHICAL PILLARS FOR ARTIFICIAL INTELLIGENCE IN EDUCATION AND TRAINING
- ANNEX 2: EXAMPLE OF THE DUTCH ETHICS COMPASS TO GUIDE DISCUSSION
- ANNEX 3: METHODOLOGICAL NOTE
- ANNEX 4: DATA TABLES

ANNEXES

Annex 1 | Ethical Pillars for Artificial Intelligence in Education and Training

	Design	Implementation	Governance
EU Ethical principle 1: Respect for human autonomy			
	How the human oversight is implemented over processes in AI systems (e.g. Implementation of Teacher-in-the-loop; Teacher-over-the-loop; and Teacher-out-of-the-loop)? Does the allocation of functions between humans and AI systems follow human-centric design principles? Regarding teaching and learning processes, and the learner agency: which parts should or should not be substituted, enhanced and transformed by automatisation, algorithms and AI systems?	How will the education institution (e.g. school, university, VET) address the danger that AI-driven application might undermine teachers' professional judgement and expertise?[54] Is there an institution wide policy addressing learner agency when interacting with AI driven educational applications?	AI systems may fundamentally change the work sphere. What procedures and policies are in place to support humans in the working environment, and aim for the creation of meaningful work? E.g. such technologies may support standardised and controllable versions of education,
EU Ethical principle 2: Prevention of harm			
	Does the design of the AI systems entail the protection of human dignity as well as mental and physical integrity? Does it augment, complement and empower human cognitive, social and cultural skills? Is it designed not to cause nor exacerbate harm or otherwise adversely affect human beings?	Is the context of use (e.g. student information system; learning platform) in which the AI system is implemented safe and secure, as well as technically robust and not open to malicious use? Are the educators able to view algorithms and manipulate or tweak them where necessary?	What procedures and policies are in place to ensure that the AI systems cannot cause or exacerbate adverse impacts due to asymmetries of power or information, such as between employers and employees, businesses and consumers or governments and citizens?

TABLE 4: QUESTIONS COMBINED FROM SOUTHGATE ET AL. (2019) AND FROM AI HLEG (2019).

TABLE CONTINUES ON NEXT PAGE →

[54] Selwyn, 2019, p. 122.

	Design	Implementation	Governance
Accountability (Southgate et al. 2019, p.48-49)		Is there a school and system wide procedure for reporting and responding to AI harm? Do all stakeholders in the school community know about and how to access this procedure?	What protocols are in place to respond to prevent and respond to harm? What early warning systems are there that harm may be occurring that can trigger action?
EU Ethical principle 3: Fairness			
Fairness (Southgate et al. 2019, p.48-49)	Has the issue of potential bias in the design of the system been proactively addressed and documented?	How will school address potential inequalities in an AI world? Does the system use autonomous experimentation and could this create an unfair burden on students and teachers? Does the AI system introduce unjust and punitive types and levels of surveillance on students and teachers?	What procedures and policies are there to ensure that AI systems positively address rather than exacerbate inequity, discrimination and prejudice in education? What evidence is there that an AI system can be used to address equity concerns in schools?
Accountability (Southgate et al. 2019, p.48-49)	Have the designer and vendor of an AI system clearly articulated their responsibilities to ethical use of AI? What systems do they have to ensure ethical accountability?	Who is accountable for the procurement of ethical AI?	
EU Ethical principle 4: Explicability			
Transparency (Southgate et al. 2019, p.48-49)	Is the system designed and implemented for traceability, verifiability, non-deception and honesty and intelligibility?	Can students, teacher, parents and community inspect and have opportunities to respond to AI systems training and decision making in ways that are intelligible or authentically empowering to them?	How will those in governance or procurement positions ensure genuine traceability, verifiability, non-deception and honesty, and intelligibility of AI systems prior to purchase and during implementation? How will transparency be operationalised if harm occurs?
Explainability (Southgate et al. 2019, p.48-49)	Is the system designed to explain to students, parents and teachers its purpose, process, decisions and outcomes in an accessible way?	What opportunities, approaches and public forums are available for students and parents to explore, explain and share information & experiences of AI in schooling?	Do policy-makers, procurement officers, and school leaders have access to appropriate independent technical expertise to explain and advise on AI systems?
Awareness (Southgate et al. 2019, p.48-49)	How have the manufacturers of system engaged with the education stakeholders to raise awareness of AI, its limitations, potential and risks?	Have students and parents/ caregivers been made aware of the type of data harvesting and sharing arrangements required by the system?	Is there a rigorous process for seeking parental consent and student assent before systems are deployed?

TABLE 4: QUESTIONS COMBINED FROM SOUTHGATE ET AL. (2019) AND FROM AI HLEG (2019).

Annex 2 | Example of the Dutch Ethics Compass to guide discussion on questions surrounding education and digitalisation

The following step-by-step plan is a concrete delineation of moral deliberation for questions surrounding education and digitalisation.

The Ethics Compass: delving into an ethical question together

This step-by-step plan (based on Bolt, 2003) is intended for everyone in education dealing with ethical questions surrounding digitalisation. What you view as good conduct is determined by the values you care about. Therefore, the 'Ethics Compass' starts with values.

Step 1

Determine the most important values

Determine the most important values for your school, board or group.

Values are general, abstract ideas or ideals toward which we strive and which shape our actions. Values can be categorised on different levels, from universal to personal. In education, these are often a mix of public, personal, ideological and pedagogical values. Examples include: equality, privacy, autonomy, safety.

Step 2

Formulate the ethical question

Formulate the ethical question as follows: would it be right to...?

Step 3

Collect the initial reactions

What are the initial reactions? Does the question prompt a certain emotion or intuition?

Make notes describing your initial thoughts about the issue. These notes do not have to be a final draft.

Step 4

Formulate pros and cons

Which pros and cons can you think of? When coming up with arguments, consider:

- What values are promoted or threatened and for whom?
- What is the rationale behind that? What facts or assumptions are you basing this on?
- Use the principle of omni-partiality: think separately from your own personal interests and reason from the perspectives of the various parties involved.
- Are the perspectives and prompt questions from the main ethical schools of thought (see Appendix 2) relevant to this consideration? For example, the prompt question: would you trade places with the people who will be affected by this? Why or why not?

If needed, look over your notes from the previous step about your initial reactions, intuitive judgements or emotions. Those are often based on certain values. Those can help you with your argumentation.

Step 5

Weigh the pros and cons

If needed, add arguments and adjust or remove less strong arguments. In doing so, follow these steps:

- When supporting your arguments, examine the following: what do we already know, what don't we know yet, and what has yet to be researched further? Make notes if you need to.
- Do all of the arguments hold up? Do they contain fallacies used (*see Appendix 3*)?
- Does it sufficiently cover the perspectives of different parties?
- Are values mentioned that you identified as an important value for your education in Step 1?

Which arguments do you find to be the most important? Highlight these to indicate their importance.

Step 6

Formulate the answer

Discuss what the answer to the ethical question should be. Use the pros and cons from Step 5. You may not be able to find an answer yet. If so, use this step to provide commentary.

a. Yes, because...
b. Yes, provided...
c. No, unless...
d. No, because...
e. An answer cannot (yet) be formulated, because...

Step 7

Evaluate

Evaluate the process with the group. Ask the following questions:

- Does everyone believe the ethical question was properly answered?
- Do the process or parts of the process need to be repeated?

TABLE 5: THE ENTIRE PUBLICATION INCLUDING THE ETHICS COMPASS IS AVAILABLE AT: http://kn.nu/weighingvalues.

Annex 3 | Methodological note

Foresight methods involve a process to create collective intelligence on the medium to long-term future. Foresight methods can be used to make informed present-day decisions by helping to understand the possible future consequences of current trends, to detect new signals of change and to determine their potential developments and implications. Various methods of foresight exist ranging from alternative scenarios to vision building and serious games as a way to make foresight more applicable and more concrete. In policymaking, the aim is to see the future as something to shape when taking action. Thanks to breaking away from conventional and short-term thinking, foresight can be a tool to equip decision-makers to better navigate the future and to shape it, too (Sucha et al., 2020).

The following implementation steps were taken: (1) Definition of the scope: the objectives and the scope of the foresight exercise were defined through desk research and literature review which included academic literature but also other types of reports (e.g. EU-projects), practitioner guidelines and books/online writings on the topic of emerging technologies and artificial intelligence in education and training. (2) Detection of trends and identification of signals of change. A small expert workshop was organised in May 2019 by the European Commission JRC, and it was hosted by Aalto University in Helsinki, Finland. This helped define the scope and clarify the boundaries of the issue to be addressed. The outcome of these processes was the template used for scenarios (Box 1).

Box 1.
Data model for scenarios

By Model
- Learner Model
- Pedagogical Model
- Domain Model

By technology-approach
- Purpose-built for educational use
- Re-purposed technologies
- Invisible at the back-end

By Type

Teacher-facing technology (to complement/augment/substitute)
- Lesson planning, teaching methods, instructional strategies
- Teaching and lesson delivery
- Classroom management
- Assessment, evaluation and diagnosis (includes marking/correcting students' work)
- Support professional learning and CPD (dialogue and teamwork)
- Communication (parents, student counselling)

Learner-facing technology (to complement/augment)
- Individual's learning and development (both cognitive and social-emotional)
- Affective-motivational disposition (e.g. strategies to motivate learners)

Education institution/System-facing technology (to complement/substitute/make obsolete)
- Admin and clerical work
- School management

By application
- Learning platform & virtual facilitators
- Intelligent Tutoring System (ITS)
- Smart content
- Fraud & risk management

By End-Use
- Higher Education
- Compulsory education; Secondary education;
- VET and/or work-based learning

By Deployment
- On-premises
- Cloud

By Technology
- Machine Learning
- Deep Learning
- Natural Language Processing

(3) The generation of scenarios and insights for policy reflection. Scenarios were created by JRC, DG EAC and DG EMPL in consultation with DG CNECT. Additionally, a small number of European experts were interviewed for the purpose (see Acknowledgement section). The topics were also briefly presented to policymakers of the ET2020 working group (DELTA) in Zagreb on 2-3 February 2020, coordinated by the European Commission (DG Education, Youth, Sport and Culture).

Background for the scenario template: In order to describe the examples of the report in a comprehensive way, a more precise vocabulary was needed than that first suggested by Holmes et al. (2019) and then by NESTA (e.g. "learner-facing" and "teacher-facing"). To include more nuanced aspects to the vocabulary (see "Type" in Box 1), we included information from teachers' general pedagogical knowledge which consists of three main overlapping components (Cuerriero, 2017):

- **Instructional processes**: Teaching methods and lesson planning; and Classroom management).
- **Student learning processes**: Motivational-affective dispositions (e.g. cognitive, motivational, emotional dispositions of individual students); and Learning and Development (e.g. learning processes and development, student heterogeneity and adaptive teaching strategies).
- **Assessment**: Evaluation and diagnostic procedures; and Data use and research literature.

Annex 4 | Data tables

All the data tables refer to TALIS Vol I (OECD, 2019b), if not otherwise reported. As the data collection took place before the withdrawal of the UK from the EU, thus data for England is included in the weighted EU averages as is reported by OECD (2019b).

Relationship between class time spent on actual teaching and teacher and class characteristics (Table I.2.16)	Class time spent on actual teaching and learning
Results of linear regression based on responses of lower secondary teachers (Statistically significant values are indicated in bold)	Dependent on :Class size
Austria	-0.080
Belgium	-0.011
– Flemish Comm. (Belgium)	**0.224**
Croatia	-0.002
Cyprus	-0.098
Czech Republic	-0.055
Denmark	**-0.161**
England (UK)	**-0.308**
Estonia	**-0.103**
Finland	**-0.176**
France	-0.087
Hungary	-0.103
Italy	-0.335
Latvia	-0.011
Lithuania	-0.175
Malta	-0.059
Netherlands	-0.011
Portugal	-0.314
Romania	-0.025
Slovak Republic	-0.031
Slovenia	-0.330
Spain	-0.099
Sweden	-0.068
OECD average-31	-0.123
EU total-23	-0.162
TALIS average-48	-0.102

TABLE 6: RELATIONSHIP BETWEEN CLASS CHARACTERISTICS (E.G. SIZE) AND CLASS TIME SPENT ON ACTUAL TEACHING.

	Teachers' self-efficacy to motivate students w/ low interest in school work (Table I.2.20)	More than 10% of students are immigrants or with migrant background[55] (Table I.3.28)	More than 10% of students are non-native speakers[56] (Table I.3.28)	Teachers prepared for teaching in a multicultural or multilingual setting (Table I.4.20)	More than 10% of students have special needs (Table I.3.28)	Teachers prepared for teaching in a mixed-ability setting (Table I.4.20)	Shortage of teachers teaching special needs students (Table I.3.63)
Austria	62	42	42	15	23	27	14
Belgium	62	35	35	16	52	37	56
– Flemish Comm.	76	33	39	17	53	41	39
Bulgaria	71	2	40	26	8	37	18
Croatia	49	1	8	20	10	28	25
Cyprus	84	26	37	49	10	64	19
Czech Republic	40	2	3	10	24	18	30
Denmark	81	22	21	26	33	45	33
England (UK)	73	21	27	43	41	69	23
Estonia	79	2	13	16	14	24	47
Finland	61	16	15	14	26	35	15
France	47	33	16	8	40	25	70
Hungary	82	1	2	28	21	76	35
Italy	90	20	17	19	37	37	48
Latvia	68	1	23	32	9	42	26
Lithuania	65	1	6	35	11	52	20
Malta	74	19	29	23	23	36	29
Netherlands	74	15	15	17	46	27	21
Portugal	97	10	8	19	19	39	48
Romania	72	2	8	43	12	77	45
Slovak Republic	68	1	11	21	22	36	30
Slovenia	63	6	16	27	31	57	28
Spain	55	27	22	26	19	28	25
Sweden	63	43	41	32	40	61	30
EU total-23	**67**	**21**	**19**	**24**	**31**	**42**	**38**

TABLE 7: ISSUES AND CLASSROOM SETTINGS REPORTED BY TEACHERS.

[55] "students who are immigrants or with a migrant background".
[56] "students whose first language is different from the language(s) of instruction or from a dialect of this/these languages".

Percentage of principals reporting that the following incidents occurred at least weekly in their school			
Table I.3.42	Intimidation or bullying among students	A student or parent/guardian reports postings of hurtful information on the Internet about students	A student or parent/guardian reports unwanted electronic contact among students
Austria	15.0	3.2	3.6
Belgium	35.6	9.2	12.1
– Flemish Comm. (Belgium)	40.3	9.2	15.6
Bulgaria	25.6	0.2	1.7
Croatia	3.8	0.8	0.5
Cyprus	16.2	1.0	1.0
Czech Republic	2.9	0.2	0.2
Denmark	4.6	0.0	0.0
England (UK)	20.7	13.9	27.1
Estonia	12.0	1.6	1.1
Finland	29.4	0.0	0.5
France	26.8	4.2	4.5
Hungary	10.2	1.9	1.2
Italy	3.2	0.8	2.6
Latvia	9.0	0.3	0.0
Lithuania	18.2	0.0	0.0
Malta	30.0	6.2	6.2
Netherlands	12.9	5.2	12.9
Portugal	7.3	0.0	0.4
Romania	13.5	1.5	1.3
Slovak Republic	9.0	0.0	0.0
Slovenia	13.7	0.7	1.4
Spain	5.0	1.2	2.4
Sweden	26.0	4.6	3.4
OECD average-30	14.3	2.5	3.4
EU total-23	**13.8**	**2.9**	**4.5**

TABLE 8: INTIMIDATION OR BULLYING REPORTED BY PRINCIPALS.

Percentage of teachers who reported the following spending priorities to be of “high importance”		
Table I.3.66	Reducing class sizes by recruiting more staff	Reducing teachers’ administration load by recruiting more support staff
Austria	80	61
Belgium	77	54
– Flemish Comm. (Belgium)	81	67
Bulgaria	W	w
Croatia	57	54
Cyprus	84	61
Czech Republic	56	57
Denmark	45	19
England (UK)	73	66
Estonia	55	58
Finland	67	32
France	M	m
Hungary	67	75
Italy	68	46
Latvia	50	53
Lithuania	67	46
Malta	80	71
Portugal	92	74
Romania	56	56
Slovak Republic	40	51
Slovenia	50	52
Spain	85	62
Sweden	57	64
EU total-23	**66.0**	**56.1**

TABLE 9: TEACHERS’ WISH LIST (E.G. HYPOTHETICAL SPENDING PRIORITIES).

% of time spent on various tasks (Table I.2.27)	EU total-23
teaching	44%
individual planning/preparation of lessons	15%
marking/correcting student work	11%
teamwork	6%
general administration	5%
counselling	4%
other tasks	4%
CPD	3%
parent communication	3%
extra curricula activities	3%
school management	3%

TABLE 10: PERCENTAGE OF TIME TEACHERS REPORT HAVING SPENT ON VARIOUS ACTIVITIES DURING THE MOST RECENT COMPETE CALENDAR WEEK. TEACHERS REPORTED AVERAGE NUMBER OF HOURS (I.E. 60 MIN), OUT OF WHICH THE TOTAL PERCENTAGE IS COUNTED BY THE JRC.

Percentage of time spent on teaching out of the total of all 11 activities (Table I.2.27)	% of teaching
Finland	57%
Estonia	49%
Belgium	48%
Denmark	47%
Latvia	47%
Hungary	46%
Austria	46%
France	46%
Slovak Republic	45%
Spain	45%
Italy	44%
Croatia	44%
Czech Republic	43%
Sweden	43%
Bulgaria	42%
Romania	42%
Netherlands	42%
Portugal	42%
Lithuania	42%
Slovenia	39%
Malta	38%
Cyprus	37%

TABLE 11: PERCENTAGE OF TIME TEACHERS REPORT HAVING SPENT ON TEACHING DURING THE MOST RECENT COMPETE CALENDAR WEEK (TEACHING IS ONE OF 11 ACTIVITIES).

	Sense of preparedness for teaching: Use of ICT for teaching (Table I.4.20)	Professional development includes: ICT skills for teaching (Table I.5.18)	Teachers' needs for professional development: ICT skills for teaching (Table I.5.21)
Austria	20	46	15
Belgium	28	40	18
– Flemish Comm. (Belgium)	34	45	9
Bulgaria	50	63	23
Croatia	36	73	26
Cyprus	62	55	11
Czech Republic	28	41	13
Denmark	40	47	11
England (UK)	51	40	5
Estonia	30	74	19
Finland	21	74	19
France	29	50	23
Hungary	66	69	20
Italy	36	68	17
Latvia	48	77	23
Lithuania	57	69	24
Malta	49	48	14
Netherlands	29	61	16
Portugal	40	47	12
Romania	70	52	21
Slovak Republic	45	60	17
Slovenia	67	59	8
Spain	36	68	15
Sweden	37	67	22
EU total-23	**39**	**57**	**16**

TABLE 12: TEACHERS PREPARED FOR THE USE OF ICT FOR TEACHING; PROFESSIONAL DEVELOPMENT AVAILABLE; NEED FOR DEVELOPMENT.

Change between 2013 and 2018 (TALIS 2018 - TALIS 2013)	Average proportion of time teachers report spending on **actual teaching** and learning in an average lesson	Average proportion of time teachers report spending **on administrative tasks** in an average lesson
Austria	n/a	n/a
Bulgaria	-2.8	1.2
Croatia	-0.9	0.4
Cyprus	-2.6	1.9
Czech Republic	-0.4	0.4
Denmark	-2.0	1.5
England (UK)	-1.5	0.3
Estonia	1.1	-0.2
Finland	-0.7	0.2
Flemish Comm. (Belgium)	-2.5	0.7
France	-1.2	0.1
Hungary	n/a	n/a
Italy	-0.5	1.0
Latvia	-0.2	0.0
Lithuania	n/a	n/a
Malta	n/a	n/a
Netherlands	-1.5	0.4
Portugal	-2.3	0.0
Romania	-1.0	-0.1
Slovak Republic	-0.1	0.0
Slovenia	n/a	n/a
Spain	-2.0	0.5
Sweden	1.0	-0.6

TABLE 13: CHANGE BETWEEN 2013 AND 2018 OF TIME SPENT ON ACTUAL TEACHING AND ON ADMINISTRATIVE TASKS.

Percentage of teachers who reported that they “frequently” or “always” use the following practices in their class Table I.2.1	Give tasks that require students to think critically	Have students work in small groups to come up with a joint solution to a problem or task	Ask students to decide on their own procedures for solving complex tasks	Present tasks for which there is no obvious solution
Austria	47	42	35	12
Belgium	44	34	25	31
– Flemish Comm. (Belgium)	40	42	27	25
Bulgaria	61	49	52	20
Croatia	60	31	22	34
Cyprus	75	52	46	32
Czech Republic	40	27	33	11
Denmark	61	80	52	51
Estonia	46	40	29	16
Finland	37	42	26	34
France	50	49	26	26
Hungary	56	35	36	28
Italy	68	46	43	44
Latvia	73	47	45	57
Lithuania	77	52	69	13
Malta	60	43	41	31
Netherlands	54	48	40	39
Portugal	68	50	45	67
Romania	68	53	44	22
Slovak Republic	59	40	49	30
Slovenia	58	28	28	29
Spain	65	46	41	44
Sweden	49	51	45	25

TABLE 14: COGNITIVE ACTIVATION PRACTICES.

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