Artificial Intelligence in Teaching and Learning

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Abstract

First, we analyze the implications of the Artificial Intelligence Act (AI Act) for education. The education domain has been listed in the AI Act as one the fields within which Artificial Intelligence (AI) is classified as high-risk. That is because AI-systems in education affect the professional path of natural persons. Thus, AI–systems used in education (e.g. plagiarism checkers, automatic graders) will require a certification issued by a third party. We exemplify incidents of AI-related tools in the education domain. Second, we discuss the ongoing educational policies and university policies for the Skills Economy (SE).We address the role of technologies for Education 4.0, a taxonomy introduced by the World Economic Forum (WEF). Third, we examine some of the benefits, current limitations and risks of using Large Language Models (LLMs) in education. We discuss the transformative effects of LLMs in both teachingand learning.

Keywords: AI in Education, AI Act, AI policy, Large Language Models, Skills economy

1. Our Motivation

There's little consensus among educators how to address the use of AI tools in schools. As teachers, we are currently trying to find a balanced way to use AI in class, by navigating among: (i) the risks of overused or misused AI (e.g. devaluing student skills, removing student responsibility, reducing control, academic misconduct); (ii) the opportunities of using AI (e.g. improve learning, improve productivity), orthe opportunity costs of underused AI in education.

Baker et al. (2018) have used the term "Educ-AI-tion" to explore the future of AI in education, while DaleAllen considers that "AI in education can only grow at the speed of trust" (Cardona, 2023, p. 10). ArtificialIntelligence in Education (AIED) is approached by the European Union in terms of human rights, aimingto protect the rights both for teachers and learners. Personalized learning remains the mainstream education narrative. In this line AIED has been argued to be part of the solution since AIED provides thecapabilities to create a more adaptive and effective learning environment.

Digital learning and transformation of education cannot ignore or exclude AI. Teaching innovations and new learning practices are already starting to be in place. There is however a trick as rapid technologicaldevelopments also bring risks and challenges that have overcome policy debates and regulatory frameworks including the recently adopted Artificial Intelligence Act (AI Act).

2. The Role Of The Artificial Intelligence Act In Education

The AI Act was agreed on 9 December 2023 by the European Parliament and Council presidency after almost three years from its first proposal by the European Commission in April 2021. The AI systems are categorized into unacceptable risk, high risk and limited risk. High risk AI systems refers to systems that may negatively affect safety (e.g. toys, cars, aviation, medical devices, lifts) or fundamental rights, in 8 areas: biometric identification, critical infrastructure, employment, public services, law enforcement,migration, but also education. On the one hand, the AI Act recognises the role of AI to provide competitive advantages by personalizing digital tools in education. It also recognises the role of using AI to modernize education by increasing education quality, accelerating digital education or making education available to more learners. On the other hand, The AI Act raises concerns about using AI systems to detect emotion in education institutions. Moreover, AI systems detecting the emotional stateof persons in the context of education is prohibited. AI systems used (i) to support decisions on admissions, (ii) to assess or monitor the level of education of an individual, (iii) to detect prohibited behavior of learners during tests are considered high risk.

Artificial Intelligence in Education (AIED) systems are not limited to students, but also to teachers or institutions. In this line, Wayne and Tuomi (2022) have used three-class taxonomy: (1) student-focused,
(2) teacher-focused, and (3) institution-focused AIED to discuss and exemplify various AI tools used in education.

First, student focused AI systems include: (i) *intelligent tutoring systems*, in which AI generates a personalized pathway (e.g. Spark, Gooru Navigator that maps topics covered by open educational resources with learn profiles or competencies needed); (ii) *AI assisted apps*, for learning various disciplines like languages or math (e.g. Photomath)[1]; (iii) *AI assisted simulations*, including game based learning, VR, AR (e.g. training in medicine, visualize molecules in chemistry); (iv) *AI to support or diagnose learners with disabilities* (e.g. autism, text2speech, StorySign by Huawei); (v) *automatic essay writing* (AEW) triggering the current arm race between AEW and AEW detectors that will impact the assessment; (vi) *chatbots* providing guidance in academic services, accommodation, facilities, (e.g.

[1] Note that the Chinese Ministry of Education banned AI-assisted homework apps such as applications for photographing homework and solving them.

Ada, teaching assistant Georgia Tech that hides that is an AI); (vi) *automatic formative assessment,* providing feedback on writing (e.g. OpenEssayst, Grammarly) based on surface features or various autograder (e.g. Stanford autograder); (vii) *learning network orchestrators* aiming to enable connectionbetween a learner and a human educator (e.g. OpenTutor); (viii) *dialogue-based tutoring systems* basedon the Socratic method (e.g. AutoTutor); (ix) *exploratory learning environments,* in which the learners explore a learning environment (e.g. FractionLab); (x) *AI assisted lifelong learning assistant,* in line withmetaverse apps or digital twins.

Second, teacher-focused AIED include: (i) *plagiarism detection* (e.g. Turnitin, Plagiarism Checker X, Grammarly); (ii) *smart curation of learning materials* scraping the web for learning resources (X5GOn, TeacherAdvisor, CleverOWL); (iii) *classroom monitoring,* including monitoring attention (based on headsets for instance, e.g., BrainCo[2]), campus movement, downloads from the online learning management systems, items bought from the cafeterias; (iv) *automatic summative assessment, or* autograders, for written tasks (e.g. US SATS), e-Rater scoring engine; (v) *AI teaching assistant,* including assessment assistant to provide feedback (e.g. Graide); (vi) *classroom orchestration.*

Third, institution-focused AIED refers to: (i) *admissions* (grade system recommends admission based on test scores, academic background and recommendation letters), Salesforce (e.g., student selection); (ii) *course-planning;* (iii) *scheduling and timetabling*; (iv) *school security; (v) identifying dropouts and students at risk;* (vi) *e-Proctoring* with AI assisted camera or microphones, tracking keystrokes or mouse movements, considered by Wayne and Tuomi (2022) "one of the clearest examples of using AI to automate poor pedagogical practices, rather than using it to develop innovative approaches".

AI in education has targeted various application domains: (i) to reduce administrative work of educators,
(ii) to reduce drop-out rates, (iii) to increase learner motivation, (iv) to assess individual progress, (v) to identify learning difficulties. The regulation mentions that AI should be "ethical by design" to guarantee fundamental rights. AI technologies cannot be used to the detriment of in-person education, as teachersmust not be replaced by any AI. Instead, the aim is to develop tools that support the teachers. One remark is that until now, most of the AIED tools have been developed by computer scientists with few interaction from educators. To support large scale adaptation, AI programmers need to involve and collaboratively with teaching communities in the development, deployment and use of AI technologies. Teachers should always be able to control and correct the system's decisions. Note that AI systems must not take any final decision that could affect educational opportunities, such as students' final evaluation, without full human supervision. Also, educators must control any use of AI technologies in schools, while automated biometric identification (e.g. facial recognition) for educational and cultural purposes should be banned.

2. 1 Towards AI standardization in support of the AI Act

Applying the AI Act assumes the existence of standards. Hence, EC has issued a draft standardization request to CEN and CENELEC, regarding ten items: (i) risk management system,(ii) governance and quality of datasets, (iii) record keeping, (iv) transparency, (v) human oversight, (vi) accuracy (vii) robustness, (viii) cybersecurity, (ix) quality management system, (x) conformity assessment. As CEN and CENELECare working to fulfill the request, relevant standards for AI do exist. Soler Garrido et al. (2023) have analyzed the standardization landscape in support of the AI Act. For instance, data quality is covered by ISO/IEC 5259, risk management by CEN-CENELEC Risk, ISO/IEC 23894, while the requirements for certification bodies appear in ISO/IEC 42006. For education, regarding metrics and thresholds, the standards will specify how to select and justify metrics, and what threshold is

[2] In China, teachers say that headsets influence pupils to become more disciplined, while they pay more attention.

adequate.The emerging standards will specify the conformity assessment procedures at the technical level. Tartaro (2023) has signaled the need to specify when the conformance assessment body would ask thedeveloper more tests, or the body itself engages in testing the system..

One of the current practices to approach risk management in AI is to verify the compliance of the systemagainst a checklist. One example is the Checklist for Artificial Intelligence in Medical Imaging (CLAIM) (Mongan et al., 2020), recently updated by Tejani et al. (2023). The checklist does not support technicalauditors, but it guides the reviewers and editors to assess the articles on AI in medical imaging. One criteria refers to data, for which the requirements include the need to specify eligibility criteria, preprocessing steps, selection of subsets, definition of each element, de-identification methods, handling missing values. Another important criteria refers to the ground truth, whose definition should point to a reference standard, qualification and preparation of the annotators, annotation tools, inter- and intrarater variability and measures to mitigate discrepancies. For evaluating the model, the performance metrics should be complemented with explainability methods and testing on external data.One advantage of such checklists is that they provide a practical road map for developers or users ofAI systems.

Checklists for using AI in education are now starting to appear. One option would be: (i) add an AI policy for the class; (ii) explain students why it is important to use their own minds when doing the assignments;
(iii) highlight examples of successful students that used AI in a proper way (according to your policy);
(iv) check if the digital tools used in the classroom do not take personal information or intellectual property from the students; (v) check the accessibility of digital tools. For instance, Turnitin provides a checklist to guide students using AI to avoid academic misconduct. The checklist is split into two parts: points to consider before or during the assignment, and points to consider after the submission to respond to questions on the ethical use of AI in the assignment.

Recall that one of the primary objectives of the AI Act is to protect fundamental rights, in our case of theteacher and learners. One topic is that many AI tools used in education are paid. Take for instance, ChatGPT4. A student using GPT4 might have better results than one student using the free version of the ChatGPT3.5. Also, students paying for better cloud services would be able to provide better projectsthan the students working on the infrastructure at the universities. The risk is that these AI tools will increase the discrepancies between students with different material possibilities (Groza and Marginean,2023).

Enacting the AI Act requires developing standards for various subdomains of AI. It also requires the existence of bodies with enough technical expertise to assess conformance of an AI system against the running standards. Therefore, (R1) the need for a technical committee at ASRO (Romanian Association for Standardisation) for working on standards for artificial intelligence in education.

2. 2 AI incidents in education

We present here six incidents of AI-related tools in education. The first two incidents were reported in the AI Incidents Database (AIID), while the next four incidents appear in the AI, Algorithmic, and Automation Incidents and Controversies (AIAAIC[3]3) repository.

A first incident reports an AI system used to rate the effectiveness of school teachers in New York has resulted in thousands of disputes. The system classifies teachers as *effective, highly effective, or ineffective.* The assessment can be used to give raises to teachers, but also to fire those receiving two

[3] AIID available at https://incidentdatabase.ai, while AIAAIC at https://www.aiaaic.org/aiaaic-repository

ineffective ratings. The concerns were related to the lack of accuracy or relevant input features, or eventhe use of the tool in different domains for which it was designed (Math and English only). The AI Act would consider such a system as a high-risk one, since AI affects the professional path of a natural person. The timeline of the incident shows that the first complaint occurred in 2004, whereas some databecame available in 2012. With AI Act, the EC aims to reduce the risk of launching such systems on themarket, and also to minimize the time to remove them from the market

A second incident reports a statistical-based system that used data from past admissions decisions to select university applicants for admissions interviews (Kleinberg et al., 2018b). The system had a 90-95match with the admission panel's selection. Each year, 60 among 2.000 applicants may have been refused the interview based on their gender or race (Lowry & Macpherson, 1988). After 4 years of usingthe system applicant screening, it was recognised that the system was biased against women and ethnicminorities. Since such systems are used to support decisions on admissions, AI Act will classify them as high risk. Therefore, a certification will be required before deploying in a real environment. This thirdparty assessment would be relevant in such AI systems that have been designed - like the exemplified system above - by a single person from the St George hospital. Note that the system did not introduce new bias, but it just reflected the bias already in the system. Assuming that one develops similar systemstoday, the company will benefit from a third party expertise to signal possible flaws before entering the market.

Third, offering different prices for the same product has become a common practice online. By analyzinghow prices depend on the zip code, Vafa et al. (2015) have found that Asians were twice as likely to get a higher price for Princeton Review's SAT prep resources. Obviously, the system discriminates betweenchances of education If the system uses a rule-based reasoning mechanism to decide on prices, it maybe classified as an AI system, according to the definition of AI in the AI act. Note that the AI Act lists in the Annex technologies that are considered AI.

Fourth, the ML system that predicted the likelihood of students passing a course was found to be biasedagainst Guamanian students. That was because the system was trained with an unbalanced dataset containing few Guamanian students. Resampling the data and retraining the system fixed the issue. Byfollowing the good practice in ML or auditing the system will be quick to signal the issue.

Fifth, Anushka and Bromwich have signaled that the ExamSoft, a facial recognition-powered exam proctoring software used for the New York State bar exam, doesn't work well for non-white students (Patil and Bromwich, 2020). AI-based proctoring systems have been recently reviewed by Nigam et al. (2021), concluding that it is difficult to assess whether the benefits of online proctoring systems outweightheir risks. Since AI-based proctoring systems affect the chances of learners to education, the AI Act would classify them as high-risk. However, certifying such systems have the role to increase the trust and also to signal the cases in which they are reliable or not.

Sixth, the GRADE admission algorithm developed and used by the University of Texas at Austin was dropped over bias concerns in 2020, after 7 years of usage (2013-2019). The system was used as a support tool for admission at the computer science department. Note that in computer science, historicaldata indicate that ~80% are male candidates. This signals a red flag on the high risk of a biased system..The system relies on few " highly predictive features" (high GPA, background from reputable institutions, recommendation letters). First, GPA scores are highly dependent on race. Second, analyzing recommendation letters with natural language processing have shown that a small set of keywords (e.g.best, reward, research was a good prediction for admission.

The above examples of AI incidents in education are not new: the first one is from the 2000's, while thesecond in the 90's. They occurred in an era in which AI was in its teenage years. As AI is moving towardsadulthood and it becomes widespread, it is the time to regulate it. In our view, the approval of the AI Act,affecting also the AI tools used in education, is an important step in the right direction. Note

that The AIID was used by Feffer et al. (2023) as an educational tool to raise awareness of AI risks.

The European strategy for AI clearly states that AI is a tool designed to support humans, and not to replace them. To operationalise this principle let the following 2 examples. First, consider the situation of lack of teachers for specific topics (e.g. math). One question might be: "Using AI to teach those topics? or "Using AI to train more math teachers?". Answering "Yes" to the first question means "replacing humans with AI''. Answering "Yes" to the second question, means "supporting humans with AI". The

second example assumes the lack of teachers in rural areas. As a solution, one can use AI-teachers for personalized learning in rural areas, i.e. replacing humans. Or, one can use AI to support teachers from rural areas to teach large classes, i. e. augmenting teacher capabilities.

One consequence of augmenting teachers with AI-based capabilities might be the uniformisation of teaching performance. AI augmentation will make high-skilled teachers relatively more substitutable bylowering the skill and pedagogical barriers to achieve the same performance. The same observation applies to learners too: AI will enable low-skilled students to perform at par with high-skilled students. AI augmentation will support low-skilled learners to achieve similar performances to the high skilled students. Using AI in learning will support low-skilled students to increase their grade. The range of improvement is a function of LLMs capabilities. However, since LLMs are trained with average data, their performance will also be average. One can say that LLMs work on the principle: "average-in, average- out". That is, AI will augment the low-skilled students towards the average student. Thus, underthe assumption of using AI in class, the grades would be shifted towards the range 7-10 (above averageand maxim). However, high-skilled students may still figure out entirely new ways to use AI and move into entirely new skills when augmented by AI.

As a more technical observation, deploying only Machine learning in AIED tools might not be enough. Current tasks on which ML excels (e.g. identifying cats in pictures) cannot contribute to education. Instead, (R2) symbolic reasoning and domain knowledge have better chances to support the augmentation of human cognition and learning.

3. Educational Policies For Skills Economy

3. 1 Skills economy: context, challenges and opportunities

The Skills Economy (SE) is seen by the World Economic Forum[4] as a transition in how businesses and individuals think about professional value and success, placing individual skills — the skills we have andneed, and our ability to acquire new ones — at the forefront of decision-making, while challenging the significance of traditional credentials and job titles. SE recognizes being highly skilled as a proxy for success and acknowledges the potential of technical skills for economic growth. In this economy, knowledge and skills are the key drivers of productivity, innovation, and competitiveness. Successful and competitive global economies need the knowledge economy and the SE to become equally balanced[5].

According to the World Economic Forum, the term "skills economy" was first coined in a 1997 report bythe Organization for Economic Co-operation and Development (OECD). The report argued that the ability to acquire and apply skills would be increasingly important for workers in the 21st century. The Skills-center vision of the economy has built on key eagles such as transformative leadership, agile governance and collaborative actions. Policy levers for SE interleave skills policy (e.g. nudges, welfare reform, labor law) with industrial policy (e.g. standardized credits, placed-based policy, information

[4] https://www.weforum.org/agenda/2023/10/skills-economy-what-is-it/
[5] https://www.worldskillsuk.org/wp-content/uploads/2022/09/WorldSkillsUK_SkillsEconomyReport_v5-1.pdf

andevidence, missions). Laurent Probst, PwC pointed out that SE extends beyond the education domain and it is becoming a national strategic issue: "A paradigm shift is putting skills development strategies at the center of wider developmental objectives."

Having a skills-centric vision for the economy means: (a) treating *people as the key asset* of the economy, (b) taking a *people-centered approach* to policy making, c) treating *lifelong learning as a right*[6].Key Characteristics of the SE are:

1. Rapid Technological Advancement: Technological advancements are transforming the workplace, creating new industries and jobs while also making others obsolete. This constant change demandsa workforce that is adaptable and able to learn new skills quickly.
2. Global Competition: Businesses are operating in a globalized economy, competing with companies from all over the world. To thrive in this competitive environment, individuals need to possess the skills that are in demand globally.
3. Shift to Knowledge-Based Work: The traditional manufacturing-based economy is giving way to a knowledge-based economy, in which the creation and application of knowledge are the primary drivers of economic growth. This shift emphasizes the importance of skills that are related to knowledge acquisition, analysis, and innovation.
4. Rise of the Gig Economy and Flexible Work Arrangements: The gig economy, characterized by short-term, project-based work, is growing rapidly. This shift has led to an increased demand for skills that are transferable across different industries and roles.
5. Changing Labor Market and Demand for High-Level Skills: The traditional manufacturing-based economy is giving way to a knowledge-based economy. This is leading to an increased demand forskills such as critical thinking, problem-solving, and creativity.
6. Continuous Learning and Adaptability: Individuals must engage in continuous learning to stay relevant in their careers as technology and market demands evolve.
7. Entrepreneurship and Innovation: Entrepreneurial skills and an innovative mindset are crucial in the Skills Economy, fostering the creation of new products, services, and business models.
8. Emphasis on Soft Skills: In addition to technical skills, there is a growing recognition of the soft skills such as communication, collaboration, adaptability, and critical thinking.
9. Diversity and Inclusion: A diverse and inclusive workforce is considered essential for creativity and problem-solving in the Skills Economy.
10. Policy and Educational Adaptations: Governments and educational institutions are adapting policies and programs to equip individuals with the skills needed for the modern workforce, emphasizing STEM (science, technology, engineering, and mathematics) education, digital literacy, and lifelong learning.

SE presents both challenges and opportunities, reflecting the dynamic nature of the modern workforce and the evolving demands of the global economy. At least the following ten challenges exist: (1) Rapid Technological Change: can render certain skills obsolete, requiring individuals to constantly update theirskills; (2) Digital Divide: disparities in access to technology and digital skills can lead to a digital divide, limiting opportunities in underserved communities; (3) Skill Shortages and Mismatches: of certain high-demand skills, while other individuals may possess skills that are not aligned with current market needs;
(4) Inequality and Inclusivity: segments of the population may face barriers to accessing quality education and training, contributing to skill and income inequalities; (5) Lack of Recognition for Informal Learning: skills acquired through informal channels (e.g. self-directed learning, work experience), may not be formally recognized, limiting individuals' opportunities; (6) Global Competition: individuals and businesses face intense competition from a global talent pool, requiring a higher level of competitiveness; (7) Adaptation of Educational Systems: traditional educational systems may struggle to adapt quickly enough to the changing demands of the SE, leading to a gap between education and industry needs; (8) Overemphasis on Technical Skills: while technical skills are

[6] https://www.worldgovernmentsummit.org/docs/default-source/publication/2022/unleashing-the-skills---en.pdf

crucial, an overemphasis on them may neglect the importance of soft skills such as communication, critical thinking, and creativity;
(9) Job Insecurity: rapid technological changes and automation can lead to job displacement and create uncertainties about the future of work for some occupations; (1) Resistance to Change: humans and organizations may resist embracing new technologies or adapting to new ways of working, hindering progress in the SE.

Similarly, the list of ten opportunities includes: (1) Lifelong Learning: The SE emphasizes the importance of continuous learning, providing individuals with opportunities to upskill and reskill throughout their careers (2) Entrepreneurship and Innovation: The SE encourages entrepreneurial mindsets, creating opportunities for individuals to innovate, start businesses, and contribute to economic growth (3) RemoteWork and Flexibility: advancements in technology allow for remote work and flexible work arrangements,providing individuals with greater flexibility and access to global job opportunities; (4) Global Collaboration: the interconnected nature of the SE enables global collaboration, allowing individuals andbusinesses to tap into diverse perspectives and resources; (5) Diverse Career Pathways: the SE supports diverse career pathways, recognizing the value of skills acquired through formal education, apprenticeships, on-the-job training, and other non-traditional routes; (6) Inclusive Education: SEencourages inclusive education policies and practices, aiming to reduce disparities and ensure that diverse populations have access to quality education and training; (7) Technology-Enabled Learning: technology facilitates innovative and accessible learning methods, such as online courses, virtual reality, and interactive simulations, making education more personalized and efficient; (8) Collaboration Between Education and Industry: closer collaboration between educational institutions and industries helps align curriculum with industry needs, ensuring graduates are better prepared for the workforce;
(9) Recognition of Soft Skills: employers increasingly recognize the importance of soft skills, providing individuals with opportunities to develop and showcase attributes such as communication, teamwork, and adaptability; (10) Policy Support and Investments: governments and organizations can leverage policies and investments to support skills development, creating an environment conducive to continuous learning and workforce adaptation.

There is evidence of a systematic approach to addressing the challenges and opportunities presented by the SE. Various countries, organizations, and educational institutions have recognized the need for a strategic and coordinated approach to ensure that individuals are equipped with the skills required forsuccess in a rapidly changing economic landscape: (1) *National Skills Strategies* have been already developed in several countries, outlining the government's vision for developing a skilled workforce aligned with the economy, built on the collaboration with industry stakeholders, educational institutions,and training providers; (2) *Industry Collaboration and Sectoral Skill Councils* aiming at identifying the specific skills needed in various sectors and work towards developing training programs and curricula to address those needs; (3) *Educational Reforms* to adapt curriculum to the requirements of SE by integrating technology into teaching methods, emphasizing practical skills, or promoting interdisciplinaryapproaches to learning; (4) *Lifelong Learning Initiatives* by funding for adult education programs, recognition of prior learning, and the development of flexible learning pathways; (5) *Public-Private Partnerships* can lead to the development of training programs, apprenticeships, and internships that align with industry needs, resulting in a more responsive and dynamic approach to skills development;
(6) *Digital Skills Initiatives such as* coding programs, digital literacy courses, and the integration of technology into educational curricula; (7) *Entrepreneurship and Innovation Programs* that support the development of entrepreneurial skills, creativity, and the ability to adapt to a rapidly changing business environment; (8) *Global Skills Partnerships* to address specific skill shortages by collaboration with othernations, sharing best practices, and sometimes facilitating the movement of skilled workers across borders; (9) *Data-Driven Approaches* used by policymakers to identify emerging skill needs, track labormarket trends, and assess the effectiveness of skills development initiatives, aiming at more informed decision-making and targeted interventions; (10) *Recognition of Non-Formal Learning* such as online courses, workshops, and on-the-job training, is gaining importance and systems are

being developedto validate these skills and therefore to provide individuals with diverse learning pathways.

3. 2 Leading organizations approaches; frameworks, standards, regulation

Several organizations, both international and national, support the SE approach by developing initiatives, programs, and policies aimed at enhancing the skills and employability of individuals. Table 1 lists some prominent organizations actively involved in supporting the Skills Economy.

Table 1. Organizations promoting the Skills Economy

Organization	Role
World Economic Forum (WEF)	Future of Jobs and Future of Work reports, changing nature of work and top 10 skills required in the future; facilitates public-private collaboration through various initiatives toaddress global workforce challenges.
Organizationfor Economic Co-operation and Development	OECD Offers policy recommendations to help member countries adapt their educationand training systems to needs of the SE. OECD skills strategy has three vectors: (i) developing relevant skills during the life course, (ii) using skills effectively in work and society, (iii) strengthening the governance of skills systems (OECD Skills for a Competitive Future report (2019): Skills to shape a better future)
International Labour Organization (ILO)	Promotes social justice and decent work; Engages in skills development, lifelong learning, and the changing world of work; Design policies that support a skilled andadaptable workforce; UNESCO-ILO: Recommendation on Vocational Training(Revised), guides the development and delivery of vocational training programs.
UNESCO	Promotes education for sustainable development. Engages in education quality, accessibility, and relevance, aligning with the principles of the SE, in line with the UNESCO Education for Sustainable Development Goals framework
European Commision	In October 2022, EC issued Ethical guidelines on the use of AI and data in teaching andlearning to provide guidance to educators, policymakers, and developers on how to use

	AI and data responsibly in education.
EU Centre for the Development of Vocational Training	Cedefo, an EU agency focused on vocational education and training (VET), supports thedevelopment of VET systems that meet the needs of the Skills Economy in Europe.
Asian DevelopmentBank (ADB)	ADB supports skills development initiatives in the Asia-Pacific region; provides fundingfor projects that aim to improve education and training systems, with a focus on enhancing the employability of individuals.
World Bank	WB works on projects related to education, skills development, and labor market reforms;provides financial and technical assistance to countries to strengthen their education in line with the demands of the SE.
National Skills Development Corporation	NSDC, a public-private partnership in India, promotes skill development initiatives bycollaborating with industries and training providers to enhance the skills of the Indianworkforce.
SkillsFuture	SF, a national movement in Singapore, encourages individuals to develop their skills throughout their lives. It includes initiatives such as SkillsFuture Credit, which providesfinancial support for individuals to pursue skills-related courses.

Many countries have national agencies or departments dedicated to skills development and education.For example, in the UK, the Department for Education and Skills plays a key role in shaping policies related to education, training, and skills. There are various frameworks, standards, and regulations, which exist at both international and national levels to address the changing landscape of the SE.. These frameworks aim to guide the development of policies, curricula, and practices to ensure that individualsare equipped with the necessary skills for the modern workforce.

International frameworks are exemplified here with three enterprises. First, the *Global Initiative on Decent Jobs for Youth* (ILO), an initiative by the International Labour Organization focuses on promoting youth employment and addressing the skills gap. It provides a framework for collaboration between governments, employers, and workers to enhance youth employability. Second, the *European Qualifications Framework* (EQF) is a common European reference framework that facilitates the comparison of qualifications across different European countries. It helps ensure that qualifications arerecognized and transferable, supporting mobility within the European Union. Third, the UNESCO *Global Action Programme* (GAP) on Education for Sustainable Development emphasizes the importance of education in fostering sustainable development. It encourages the integration of key competencies, including skills related to sustainability and global citizenship, into educational curricula.

National Standards and Frameworks include the following four initiatives: First, *National Qualifications Frameworks* (NQFs) have been established in many countries to provide a comprehensive and transparent framework for organizing and recognizing qualifications. NQFs help ensure that skills acquired through formal and informal learning are recognized and contribute to lifelong learning. Second, *National Occupational Standards* (NOS) define the skills, knowledge, and understanding required for a particular occupation. They serve as a reference point for the development of training programs, qualifications, and assessments, aligning skills with industry needs. Third, *National Skills Development Policies* outline countries' strategies for skills development, by covering areas such as education, vocational training, workforce development, and lifelong learning. Fourth, *Sector Skill Councils* (SSCs) address the skills needs of particular sectors by working with

employers to identify skills requirements, develop occupational standards, and design training programs.

Four types of regulatory frameworks may contribute to SE: (i) regulation on quality assurance in education, implemented by governments to ensure that educational institutions maintain high standards,including accreditation processes and regular evaluations; (ii) data protection and privacy regulations inskills training to protect the privacy and data security of individuals participating in online courses or using digital learning platforms; (iii) workforce development legislation often addressing issues such asapprenticeships, on-the-job training, and partnerships between educational institutions and industries;
(iv) Legislation Supporting Lifelong Learning: encouraging lifelong learning, recognizing the importanceof continuous skill development throughout one's career. These regulations provide a structured approach to addressing the challenges and opportunities presented by the Skills Economy. They help ensure that educational and training systems are responsive to the needs of the labor market and that individuals can acquire and demonstrate relevant skills for success in the workforce.

3. Impact of Skills Economy on education

Important findings appear in the UNESCO report on "The futures we build: abilities and competencies for the future of education and work". First, among the most-mentioned skills for the future are *socio-emotional (40%)*. *Cognitive and hybrid skills* follow with 25% each. A second remark is that there is no common language to refer to these abilities and skills, which complicates communication between teachers, learners, employers and employment advocates. Third, skills for life and for the future of workare not very different, as they are all connected to the ability of human beings to live together harmoniously. Fourth, education is no longer constrained to the four walls of a classroom. Fifth, emotional intelligence is important to emotional education for helping people discover, know and regulate their emotions and allow them to incorporate them as competencies.

A hypothesis about the future in 10 years-time might be "55-60% of the culture, people and infrastructurethat will exist in 10 years time already exists today", "the other 20-25% does not exist yet but can be predicted because we are already building it. [...] This predictable portion also includes trends that are maintained year after year, infrastructure development, and the birth of new generations. Finally, only 20% of what will happen is highly unpredictable, especially due to the speed of technological developments and political instability" (UNESCO, 2023).

WEF developed in 2020 the Education 4.0 framework for the teaching and learning of skills needed in the 21st century (World Economic Forum, 2023). The concept is built by interleaving 4 types of skills (global citizenship, creative, technology, interpersonal), with 4 types of learning (personalized and self-paced, accessible and inclusive, problem-based and collaborative, life-long and student driven). WEF identified that education providers (i.e. suppliers) and the business community (i.e. demanders) do not have a common language regarding skills. Common ontology is essential to drive the skills agenda forward.

Now, this newly developed skills taxonomy builds on that framework, clearly spelling out Education 4.0abilities, skills, attitudes and their associated definitions to create a bridge between businesses and education providers.The taxonomy is built on three aptitudes: (1) abilities and skills, (2) attitudes and values, and (3) knowledge and information. The taxonomy of abilities and skills are broken down into cognitive, interpersonal and physical skills. Cognitive skills include definitions for creativity, critical thinking and digital skills or programming. The rationale behind this structure is to provide confidence for business and education communities that they are talking about the same skills and concepts when pursuing partnerships and projects. In short, for supply and demand to match. For instance, WEF, with

support from the LEGO foundation, has introduced a taxonomy for the future of learning, i.e. Education
4.0 (World Economic Forum, 2023), aiming to connect the skills acquired by children with the skills defined for adults in the Global Skills Taxonomy.

Following the above lines, a set of recommendations might be: (R4) Invest in lifelong learning (making learning opportunities more accessible and affordable, programs should instill in students a mindset of lifelong learning; (R5) Focus on soft skills (e.g. communication, teamwork, problem-solving); (R6) Promote apprenticeships and vocational training (as they provide workers with the skills they need in the SE); (R7) Support innovation in education (by using new technologies for personalisation and efficiency), by investing in research and development to create new and innovative learning tools; (R8)Invest in teacher training: to equip educators with the skills and knowledge to teach in a changing world;(R9) Enhance collaboration between education and business, for workers to have the skills that businesses need; (R10) Address equity and inclusion, as SE can exacerbate existing inequalities. Governments and businesses ensure that everyone has the opportunity to develop the needed skills.

4. Using Large Language Models In Education

AI aims to mimic human intelligence. Machine Learning (ML), one subset of AI, plays its part around notonly enabling machines to learn from data, but also to improve their performance and make decisions (with or without explicit programming). In the early 21st century, evolving from ML, a class of new algorithms arose under the name of Generative AI (GAI). They are capable of generating new data mirroring the input. The targeted fields regard content creation and data augmentation. This is where and when Large Language Models (LLM) arrived into place by their capabilities related to human-like text generation. The likelihood of a word is predicted being given the previous words used in the text. The first and, maybe, the most well-known example of its kind is OpenAI's Generative Pretrained Transformer (*GPT-4*. n.d.) introduced in 2018 through GPT-1 and evolving into GPT-2 in 2019, and GPT-3 in 2020. This core technology behind LLMs evolved and it included the following: When talking about LLMs in education, there are two perspectives: teachers and learners, serving the latter to a dualpurpose: helping in learning with and about AI. Mollick and Mollick (2022) summarize ways in which AI can be used to generate assignments and ways in which AI can be used to help instructors teach (Mollick and Mollick, 2023). Seven supportive roles for LLMs are listed: AI-tutor for increasing knowledge, AI- coach for increasing metacognition, AI-mentor for balanced and ongoing feedback, AI-teammate to increase collaborative intelligence, AI-tool for augmenting student performance, AI-simulator for a boostto practice, and AI-student to check the understanding (Mollick & Mollick, 2023b).

Jan 2021-Oct 2022	Nov-Dec 2022	Jan-Feb 2023	Mar 2023	Apr 2023	May 2023
LaMDAxlarge Chinchilla CodeGen InCodermGPT, PaLM, OPTI-IML Minerva	ChatGPT , GPT 3.5	WebGPT, Bard LLaMa	GPT-4	BloombergGPT, StableLM,Dolly 2.0,Titan , BingChat	PaLM2

4. 1 LLMs impact in education

LLMs have already proved a strong impact on education in different dimensions. The ethical concerns must be taken into account. Also, important human intervention in teaching and learning must exist

as these models complement, rather than replace. Some important aspects previewed from the teachers and learners perspective are presented below along with aspects impacting both of them.

Teacher's perspective.

Content Creation and Curriculum Development. LLMs can assist educators in developing and generating educational materials, plans or content, gathering relevant resources and updating curriculum materials and bibliography.

Benefits of content creation and curriculum development imply: (1) *Effort and time* reducing in the creation of educational content and curricula development; (2) Rapid updates and revisions of educational materials can be better mapped on current and relevant content; (3) Automated content creation can be adapted/maped/translated to cover diverse audiences in cases of cultural and languagedifferences to better suit individual needs; (4) Scalability of content creation and curriculum development can cover larger student cultures/populations in terms of different learning environments.(5) Analysis on learning data may help the process of decision making regarding adjustments or improvements in the curriculum development.

Risks and challenges refer to: (1) Difficulty in Handling Complex Topics regarding the generation of complex or abstract topics and content when refined expertise and nuanced understanding are implied;
(2) There are risks on standardized content by potentially limiting opportunities for exploration, creativity,and adaptability in teaching; (3) Biassed training data used for automated content creation may resultin the generation of content that reflects or perpetuates existing biases which in its turn may affect the diversity and inclusivity in educational materials; (4) The overall quality, refinement of the materials maydiffer when compared with the professional created content by human educators.

Teacher Professional Development may incorporate LLMs as supportive tools Those tools/models can provide resources, ideas, and guidance on the newest and (historical if needed) pedagogical approaches, as well as assistance in staying updated on the latest research and trends.

Among the *benefits* of professional development that values human expertise, collaboration, and a deepunderstanding of the unique challenges and contexts faced by educators it is worth mentioning: (1) LLMs can point teachers to educational resources, research articles, teaching strategies, best practices, facilitating important factors of continuous learning; (2) Individual teacher profile of needs andpreferences can direct to specific areas of interest and growth; (3) LLMs can help educators in gatheringinformation related to the latest trends, research, and innovations in education; (4) in the same trend idea, the pedagogical guidance may be guarded by suggesting effective teaching methods, management strategies of individuals and approaches to address diverse learning needs.

Risks and challenges mirroring this topic touch: (1) The lack of difficulty of truly individualization of the professional development experiences that account for the unique needs and contexts of each teacher;
(2) If the training data for LLMs contains biases, recommendations for professional development may be skewed; (3) Careful planning and coordination is required when successfully integrating LLMs into existing professional development practices to ensure that the technology aligns with educators' needsand/or preferences due to rapid changes in the educational landscape.

Learner's perspective

Personalized Learning. With the aid of LLMs, personalized learning experiences can be created by tailoring content under the form of exercises, tests and different other material to individual student needs. To some extent, adaptive learning platforms based on LLMs can analyze towards understanding

of students strengths and weaknesses proposing different levels of difficulty tasks involved into the learning processes.

Benefits of LLMs in Personalized Learning include: (1) Adaptive content delivery providing a personalized learning experience through analyses of individual student progress; (2) The generation and/or recommendation of instructional/educational materials that align with individual learning style, mapped on one student or even individual classroom proficiency level, may output a more engaging and, eventually, a more effective learning; (3) Based on one student strengths and weaknesses, properexercises, assignments or tests can be developed and thus strengthening areas that require additionalattention; (4) Customized guidance through a curriculum content that suit individual needs and challenges can also be provided by LLMs; (5) LLMs based systems also may provide options of incorporating visual, auditory, and kinesthetic elements to suitable to proper levels and styles of individual students/classrooms improving accessibility and inclusivity; (6) Multilingual support on language-specific resources, pronunciation feedback, can be provided, improving student support and early interventions for at-risk students.

Risks and Challenges regarding personalized learning include: (1) Algorithmic bias induced by biases in training data, leading to unequal learning perspectives; (2) Human connection may be diminished, potentially affecting the development of interpersonal and social skills; (3) Privacy concerns may rise from the fact that personalized learning platforms collect extensive data on students.

Language Learning can be impacted by LLMs providing real-time translation, pronunciation assistance, contextual language usage examples, enhancements of vocabulary acquisition and grammar understanding. It is important to supplement technology-based learning with human guidance and cultural immersion for real-life language practice.

Among the *benefits* related to the topic are underlined the following: (1) Assistance of real-time translation of text or spoken language facilitate comprehension and communication through different languages; (2) Vocabulary and grammar enhancement and assistance introduced by LLMs models can increase the vocabulary array by including contextually relevant examples improving language proficiency. Instant feedback on grammar, syntax, and sentence structure help in the development andusage of accurate language.Following this line it is also impacted the pronunciation by bringing enhancements into the users knowledge; (3) Adaptive learning materials based on individual progress tailor the language learning experience characteristic to each learner profiled proficiency level; (4) LLMscan simulate interactive language practice scenarios (like dialogues, conversations) allowing learners to apply language skills in practical scenarios.

Risks and challenges touched by the topic include: (1) The lack authenticity and nuances of real communication may hinder the development of interpersonal and conversational skills. The automatic language usage may neglect slang or informal language used by real life scenarios and even skip the depth and richness of cultural understanding; (2) LLMs may create dependency on technology leading to disruptions on true language learning and interpretation of emotions.

Automated Q&A and Tutoring integrated into virtual tutoring systems, answering queries on various topics can be based on the LLMs serving, this way, as virtual teaching assistants. Important combination of LLMs efficiency and scalability with human tutoring enhancing personalized, and contextually rich support can lead to a more comprehensive and effective learning experience.

Among the related *benefits* one can enumerate: (1) The non-stop access to information and assistance of all learners allows for flexibility in learning schedules. Also, in terms of time consuming, clarification and reduced waiting time for assistance can be provided by the LLMs that can instantly answers to

queries; (2) The fact that the encompassing systems can handle a large number of queries simultaneously drive to a broad audience efficiently and at scale; (3) Consistency into the LLMs responses to similar queries imply reduced variability into both the quality and accuracy of the providedinformation; (4) By analyzing the learner performance in terms of individual strengths and weaknesses, LLMs offer personalized guidance and support; (5) LLMs can complement real educators/instructors/teachers by providing additional support and resources.

The gathered *risks and challenges* underlined within this paper are represented here by: (1) The real personalized assistance may be missing as the LLMs may not fully understand the unique learning preferences, manners of each different learner. In the same idea, it worth mentioning that LLMs may face challenges in handling highly complex or nuanced queries that require deep expertise or contextualunderstanding beyond their training data; (2) LLMs may lack human specific abilities in understand and,accordingly, in expressing and parsing emotional or motivational aspects of learning, which are essential for expressing efficiency in tutoring and support; (3) When inaccuracies, inconsistencies or biases are present into the training data, there is a risk of retrieving into the outputs of misinformation or biased responses to learner queries or the already well-known hallucinations; (4) The interactive and dynamic nature required by tutoring activities that involve discussions, collaborative problem-solving, or hands- on tasks is missing.

Accessibility and Inclusion can be easily covered by the LLMs that can be employed in creating accessible content for diverse learning needs and assisting students with disabilities by offering naturallanguage interfaces for communication and learning.

Benefits of this matter are a strong point to nowadays sensitive learners: (1) LLMs can enhance accessibility by providing text-to-speech features, screen readers, and other accessible and assistance based technologies for *learners with visual or reading impairments*; (2) The importance of language translation has no doubts promoting *inclusivity in diverse linguistic communities* and making educationalmaterials accessible to those speakers coming from different regions of the globe; (3) The property of adaptation of some content in order to meet diverse learning needs, targets personalized learning experiences for *students with different learning abilities and preferences*; (4) The ability of generation ofalternative formats for educational content for *students with different abilities* relay on LLMs. Proper examples can be found in audio descriptions for images or converting text into braille;
(5) By providing content in multiple modalities, clear instructions, cutting distractions out into fostering amore inclusive learning environment, the LLMs can be configured to support *neurodiverse learners*.

Risks and challenges related to the topic include: (1) Biases included into the training data for LLMs, impacting the inclusivity of educational materials, may imply some stereotyped content generation or recommendations. It may be possible the perpetuation of already existing or exclusion of certain groups;
(2) In content that requires a deep understanding of cultural or societal factors, inaccuracies or misunderstandings may occur from the incapacity of fully understanding the context or nuances of certain topics. Also applicable to underrepresentation or misrepresentation of certain groups, cultures, or perspectives; (3) In some scenarios related to the full absence of real human interaction may impactthe development of social and emotional skills. These are crucial for holistic learning and inclusivity, aswell as for learners with disabilities.

Teacher and learner perspective

Automated Grading and Feedback. Using LLMs for these tasks imply the automated evaluation and suitable grading of assignments, assessments and tests, and then providing quick and consistent feedback to students. Some usage involves the written responses analysis, errors identification or even suggesting improvement.

Benefits of automated grading and feedback when LLMs are involved, for specific related tasks imply: (1) *Efficiency* defined in terms of time and effort consumption for teachers. The references here involvea reduction in time and effort for assignments and tests/exams preparing and evaluation, preserving teachers a plus on other aspects of their roles; (2) Automated systems provide *consistent* evaluation. Using them can minimize possible grading bias or variability that might occur among different human graders when fatigue or stress or the quantity related to limited time of work may be involved; (3) Deriving from the previous idea, the feasibility in assessing a larger number of assignments or exams preservingan efficient manner of evaluation when a high enrollment is involved transform the *scalability* of the automated grading into a benefit; (4) *Objective evaluation* process based on predefined grading criteriacan be applied uniformly; (5) Automated LLMs based feedback can be used in providing *personalized comments* mapped on each student, underlying specificity.

Risks and challenges of automated grading and feedback when LLMs are involved imply: (1) When it comes to understanding the context, or creativity in student responses, it might become possible the misinterpretation of validation criteria or overlooking of valid points of grading systems. The same idea can be captured by the possibility of losing the full range of correct answers; (2) True insights into humans like critical thinking or deeper understanding in providing feedback to students may lack from the LLMs interpretation. Also the fully provided feedback without any human interaction might lead to student disengagement; (3) In the cases of biased training data used in the development of the LLMs based grading models, it is well known that it may perpetuate and reinforce the existing biases.

Research and Information Retrieval can equally be addressed for both perspectives, teacher and learner, as LLMs can assist in conducting research of information by summarization, information synthesis and literature reviews, relevant questions and answers generation, having all in common the navigation through enormous amounts of data.

Benefits of research and information retrieval include: (1) LLMs enable students, educators, and researchers to access a vast amount of educational information quickly, facilitating comprehensive literature reviews and research, summarizing and organizing research papers, articles, and educational materials; (2) Regarding the learning online resources, LLMs can recommend educational resources (including textbooks, articles, and multimedia content). The scope is to support not only the curriculum development, but also the individual learning needs; (3) LLMs can focus on educational content centered to specific needs and adaptive learning experience; (4) In language translation, LLMs can pass over the language barriers, enabling the access to educational content in different languages, and to communication in international forums or communities; (5) A very strong point to this matter relay on thecapabilities offered by the LLMs in exploring cross-disciplinary connections from diverse fields and facilitating a comprehensive understanding of educational topics.

Risks and Challenges of research and information retrieval include: (1) Producing accurate and nuanced summaries of educational content not resulting in oversimplification or misrepresentation of nuanced orcomplex topics, may not be struggling for the models; (2) Following the previous idea, LLMs may have limitations in fully understanding the cultural nuances, or historical background associated with certain educational topics, impacting the accuracy of their insights; (3) Popular or trending

educational topics may influence the LLMs conducting to possible neglecting of valuable educational content; (4) The verification and credibility of information not realized by the LLMs may represent risks providing responses that can be outdated, inaccurate, or from questionable sources.

The application of LLMs in education gives rise to ethical considerations, encompassing concerns about bias in training data, privacy, and the imperative for transparency in automated decision-making processes. Ethical considerations also arise concerning the responsible deployment of automation in education. These encompass aspects of transparency, accountability, and the imperative to ensure that automated systems align with ethical principles and values. Ethical considerations arise concerning the privacy and security of data, as well as the responsible utilization of LLMs in professional development. Ensuring the ethical use of automated Q&A and tutoring systems necessitates thorough consideration of ethical issues, encompassing privacy, data security, and transparency in decision-making processes.

4. 2 Prompt engineering for education

At a first glance, generative AI, including LLMs, looks simple: it is just typing in a question or any other prompt. But, when receiving an undesired output, things become not that straightforward. The reality implies that writing effective prompts is not that obvious. Standing as a proof, using LLMs based systems led to an increase in the newly prompt-engineering jobs on recruitment websites (Popli, 2023). As defined in the UNESCO book, the term "prompt-engineering" refers to the processes and techniques forcomposing input to produce generative AI specific output, that more closely resembles the user's desired intent (Fengchun and Holmes, 2023).

Effective prompt engineering occurs when the prompt formulates a cohesive chain of reasoning focusedon a specific problem or a sequence of thoughts presented in a logical order. Fengchun and Holmes (2023), made recommendations in order to achieve effectiveness in obtaining the desired output: (i) theuse of simple, clear and straightforward language in order to be easily understood, avoiding complex and/or ambiguous wording; (2) incorporation of examples to demonstrate the preferred response or theintended format of the generated completions; (3) Incorporate context, as it is essential for producing completions that are pertinent and meaningful; (4) Refine and iterate as necessary, experimenting withdifferent variation; (5) maintain ethical standards by refraining from using prompts that could generate inappropriate, biased, or harmful content.

Although LLMs can assist educators and researchers in generating helpful text and other outputs to enhance their work, the process is not always straightforward. It often requires multiple iterations of a prompt before achieving the desired output. A concern arises regarding young learners who, being less experienced than teachers, might unintentionally accept such an output without critical engagement. This output may be superficial, inaccurate, or even harmful. In summary, a LLMs based system may beuser-friendly at a surface level. However, for more advanced outputs, it requires expert human input andmust undergo critical evaluation before utilization.

4. 3 Controversies around LLMs in education

Researchers, teachers, and learners are encouraged to adopt a critical perspective on the value orientations, cultural standards, and social customs embedded in LLMs. Policymakers should be cognizant of and actively address the exacerbation of inequities resulting from the growing disparity in training and controlling Generative AI models(Fengchun and Holmes, 2023). There is a need to recognize the absence of adequate regulations safeguarding the ownership of domestic institutions andindividuals, as well as the rights of domestic users of LLMs. Teachers, and learners should be aware

whether the LLMs based systems and tools they are utilizing comply with existing regulations or infringeon someone else's intellectual property rights. They should also be aware that all generated content andshared on the internet might be subject to exploitation by other users as well.

Teachers, and learners need to recognize that generative AI systems function as opaque entities, with no possibilities to understand the rationale behind the creation of specific content. The lack of explanations regarding how the outputs are generated can confine users within the logic established byparameters within generative AI systems. These parameters might embody particular cultural or commercial values and norms, thereby introducing implicit biases into the generated content. LLMs based systems have the capability to generate offensive and unethical content. Additionally, students should be aware about the potential long-term issues concerning the reliability of knowledge, especiallywhen future LLMs are built on text generated by previous LLMs.

Nevertheless, the LLMs lack understanding; instead, these tools string words together in ways commonly found on the internet. The generated text may also contain inaccuracies. Of great importance is the lack of comprehension of the text a LLM produces. It often does generate statements that are incorrect. Therefore, it is crucial for them to approach everything generated with a critical mindset. Whilethe primary responsibility for continuously addressing biases in LLMs datasets and outputs lies on the developers/providers side, it is crucial for the user-side to understand that the text output represents only the most prevalent or dominant view of the world at the time of its training data. Learners and teachers should never just accept the information provided by LLMs. Critical assessments must consistently apply. Additionally, users must be mindful of how minority voices may be overlooked since they are inherently less common in the training data.

5. Recommendation

We focused on the role of the new technologies in teaching and learning. First, we discussed how the tools used in education will be affected by the AI Act. Second, we analyzed the education policies for the Skills Economy and its impact on education. Third, we analyzed the usage of Large Language Models both from the teacher perspective and learner's perspective.

In line with the AI Act, we recommended (R1) the creation of a working group as part of the technical committee at Romanian Association for Standardisation for standards for artificial intelligence in education. We also recommend (R2) the support for interleaving symbolic reasoning with machine learning, aiming to develop more transparent and explainable AI systems in education. The key recommendation (R3) for AI tools in education remains "Educator in the Loop".

Regarding Skills Economy we recommended: (R4) Invest in lifelong learning; (R5) Focus on soft skills (R6) Promote apprenticeships and vocational training; (R7) Support innovation in education; (R8) Investin teacher training; (R9) Enhance collaboration between education and business; (R10) Address equityand inclusion.

Regarding LLMs, they are undergoing rapid evolution, anticipating to significantly influence education, yet their complete comprehension remains a work in progress. Consequently, the long-term implicationsof LLMs used for education and research demand immediate and fine tuned attention and a more comprehensive review. The recommendation would be that (R11) any transformation brought about byLLMs in education should undergo a thorough review and be guided by a human-centric approach.

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