Online-Journals.org

iJET International Journal of Emerging Technologies in Learning

iJET | eISSN: 1863-0383 | Vol. 18 No. 16 (2023) | OPEN ACCESS

https://doi.org/10.3991/ijet.v18i16.36169

PAPER

# The Teacher of the Future

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**ABSTRACT**

Schools are cultural curators, along with libraries and museums. The development and use of technologies are a fact and an important tool in the evolution of the educational process, shaping new attitudes in the functioning of the educational community among parents, students, and teachers. At the same time, cultivating and improving the emotional intelligence of all those who make up the school environment will lead to well-being without stress, which is benefitial for the whole world. The teacher of the future is called and must give a resounding presence as he is the connecting link between the school, students, and parents. This article is a bibliographic review of the research results and articles to date about the school and especially the teacher of the future and deals with the existential technological identity of the educational future, its role in shaping the existential identity of the student in educational and social becoming, and the additional important skills a teacher should have for creative, happy, and well-balanced students.

**KEYWORDS**

technologies, emotional intelligence, metacognition, skills, educator/teacher of the future

## 1 INTRODUCTION

Technology is pushing education through some very interesting changes and offering it some previously unimaginable opportunities by breaking down the traditional idea that human education begins with the fundamental skills of "reading, writing, and arithmetic," or, in their modern incarnation, "holistic language, problem solving, and conflict resolution."

While there appears to be a rise in the use of technology by the educational community and it is anticipated that the field of education will grow and adapt depending on the four basic variables that control society, education today largely follows the same educational policy and path for years: 1) Enhancing and increasing online accessibility, 2) The creation of novel technologies, 3) Equal distribution of living and educational conditions, and 4) Problem-solving and gamification are given particular importance and consideration [1].

Public education has been common since the 19th century, and only 12% [2] of people could read and write. In 2016, only 14% of the world's population was illiterate,

Drigas, A., Chaidi, I., Papoutsi, C. (2023). The Teacher of the Future. *International Journal of Emerging Technologies in Learning (iJET)*, 18(16), pp. 87–114. https://doi.org/10.3991/ijet.v18i16.36169

Article submitted 2022-10-17. Resubmitted 2023-02-28. Final acceptance 2023-06-09. Final version published as submitted by the authors.

and over the 50-year period, there has been a gradual decline in illiteracy to less than 10%. [3] has reported that there is still a gap between the developing and developed countries in terms of educational outcomes, with the rate of secondary school graduates being 76.86% for males and 84.82% for females. Between 2020 and 2050, the percentage of the world's population that is illiterate is projected to fall from 10% to 5%, while the percentages in the lower-educated sectors will continue to vary at the same levels. Although learning has improved or increased, new pedagogy and philosophy of education have been modified in response to global socio-economic and political developments, and there is technological development, classroom teaching continues to use the "traditional" model of education, with students being divided into age groups, an "omniscient" instructor, and learning based on stereotyped standards through a set curriculum for each subject. Regardless of the subject (math, science, art, etc.), the grade is the same (quiz, test, final exam), and there are no noticeable modifications.

The UN International Telecommunication Union (ITU-2018) estimates that, due to technical progress, 90% of the world's population will have access to the Internet in the next few years [4]. The "Internet of Things" (IoT) is expected to emerge as a result of the expansion of the Internet into homes and cities, with technologically enhanced gadgets [5]. Machine learning (ML) and artificial intelligence (AI) will be integrated into numerous applications due to the vast amount of data that will be produced. Additionally, advancements in biotechnology and AI will lead to the development of sophisticated neurological implants, smart glasses, and smart contact lenses. Furthermore, the COVID-19 pandemic has highlighted the importance of e-learning and virtual classrooms as the most cost-effective forms of teaching in underdeveloped countries, as evidenced by the increase in school closures. Despite concerns about quality and social equity, e-learning is considered a strategy for improving people's access to education, especially in poor nations [6].

The development of tools and applications that support digital learning, such as Massive Open Online Courses (MOOCs) and other applications, that will offer developing countries access and flexibility in how education is approached, will undoubtedly result from the explosion of technological development and easy access to the Internet. Emerging and new technologies related to Internet connectivity include augmented reality (AR), virtual reality (VR), haptics, cloud computing, and ML [7–9]. Robotics is also becoming increasingly relevant, providing students, parents, and teachers with access to a wealth of data supported by ML algorithms and AI, enabling them to track student tasks, learning progress, retention, and assessments, allowing personalized learning experiences tailored to individual needs and interests, including those with special educational needs [10].

Education is essential for the socioeconomic growth of a country. Teaching is one of the noblest professions in the world. For a significant duration, educators have focused on studying the diverse objectives of education in a complex society. About all of the aforementioned, it is recognized that educational concepts and programs reflect compliance with societal demands to assess the quality of education, technology, and teaching methods, as well as the implementation of social and professional mobility of qualified teachers who can advance their knowledge [11].

The classroom of tomorrow's school will no longer be enclosed by the familiar four walls but will be "transported" to where the student can learn. Each student will be connected via the Internet to a vast web of learning, where they can seek knowledge, examples, answers, and solutions to the topics assigned to them, find students who have the same topic, and join working groups and groups with common educational interests.

Additionally, the work of teachers and students will change as a result of robots, new technologies, and the constant change of work in the future: a sizable portion

of their lessons will be devoted to learning to code and build robots; they will assemble adaptable machines and tools; they will improve their Science, Technology, Engineering, and Mathematics (STEM) skills; and they will learn about: In addition to providing useful information for students with health issues, 3D printing, space travel, renewable energy, building virtual environments, blockchain, smart digital applications, and wearable devices that measure heart rate and blood pressure will also be tools for approaching knowledge because of their accessibility.

As a result of the technological explosion and the use of emerging technologies, there will be an adaptation to the new demands of school programs, and education will become "gamified," like the philosophy in the private school Ad Astra of Elon Musk and Joshua Dahn, which gave their place to Astra Nova. Also, Ad Astra and Astra Nova encourage students, by playing with the currency unit "Astra," to educate themselves in money management and the philosophy of entrepreneurship.

Synthesis School, an open-access educational platform with games and activities Ad Astra and Astra Nova, another offshoot of Ad Astra, combine cutting-edge technology and philosophy without gym classes, schools, textbooks, etc., with the aim of connecting children and youth from all over the world to form teams and play games to develop their understandings and turn them into skills.

Schools that place a high priority on organized learning and learning how to handle issues provide students with a kind of "preview" by asking, "What does training look like along the way?" Sal Khan, the creator of the Khan Academy's reversible classes and founder of Ad Astra, muses: "Just what does training entail? Computer programs and data in the brain. However, conventional training is awful since it is tedious and uninteresting, so the best way to learn is through gaming. Children should play video games to learn."

The Montessori educational approach, which encourages self-directed learning via educational activities in a well-organized educational environment, is another philosophy of knowledge that is supported by various school systems.

The job of the teacher of the future is altering as a result of the aforementioned. The teacher, from the role of knowledge transmitter, will move to the role of student self-teaching catalyst using technology to identify the needs and particularities of each student and find the appropriate paths to search for knowledge. The teacher will return to the original—and forgotten—the role of the Socratic teacher, involving students in the learning process and turning them from passive recipients of his teaching into active fellow travelers in the discovery of knowledge, giving them time to judge, absorb, contemplate, apply, compose, and envision. Socrates, two and a half thousand years later, seems to have been right: the teacher, supporter, guide, supporter, helper, and adviser lead to the autonomy of the student, learning how to learn. Maybe we can finally achieve it with the help of technology too [1].

And while technology gives impetus to the approach to knowledge respecting the needs, peculiarities, and interests of the student with the help of the teacher, the teacher of the future will be charged with the responsibility of developing and improving the emotional intelligence of students so that it becomes the use of technology to their advantage but also for technology to be a tool for developing EQ in the areas of empathy, metacognition, giftedness, etc., based on the emotional pyramid's pillars.

## 2 METHODOLOGY

In this paper, "The Teacher of the Future," an attempt is made to investigate the characteristics, abilities, and digital skills with which the teacher of the future should be "equipped" in a digital school as an important pillar of the educational community.

The main objective of this paper is to present scientific results about the characteristics and skills of the future teacher to function effectively in the future classroom and in the school in general, with the necessary skills to improve the learning process that will develop to meet the challenges of the digital future to teach, develop, and improve students' skills according to new globalization data with the help of new dynamic technologies, so that they develop the necessary skills for learning [12]. In addition, the effective operationalization of a new concept—the emotional mentor—is therefore required in the postmodern educational reality and is required both at home and in the classroom [13]. Curriculum that promotes affective and metacognitive literacy is needed. We need teachers whose training also includes emotional competence in human resources and education.

The present study is a semi-systematic review, as it is a method that allows the investigation of a scientific field that is not widely known. Thinking that many related issues may arise through the research, we chose to be open to different research methodologies and studies.

In our review, we focused on the presentation of scientific articles on the Google Scholar, Med, Researchgate, and Google platforms, with the following inclusion criteria: Articles: Teacher of the Future, Emerging Technologies and the Teacher of the Future, and Digital Skills of the Teacher in the School of the Future.

The survey was conducted in English. The keywords used included "teacher of the future," "emerging technologies and learning," "Metacognition, Skills, and emerging technologies," and "emotional intelligence and emerging technologies."

This paper is divided into sections according to the themes that emerged from the research. The results are presented in a narrative manner in small sections, each of which presents a topic related to the teacher of the future, while conclusions are drawn at the end.

## 2.1 The teacher of the future

Today's world is defined by global changes and a borderless society, and we are facing new challenges on many levels. New innovative practices are being adopted in business, culture, and even education. A new era is beginning, although many believe that technological learning cannot replace traditional teaching methods. The truth lies in how well a learner engages with relevant, real-world content, and pedagogy is the cornerstone of the teaching-learning process.

Today's children are tech savvy from a very young age, and the educational system should try to follow and transform itself according to the trends of new technologies, as a result of which teachers will "love," turn to their help, and participate in the educational transformation that takes place.

Already, the use of technology has invaded teaching with gamification, AI, remote classrooms, etc., and teachers use tools such as presentations, visits, exhibitions, plays, recitations, etc. But the next step is to have a variety of curricular and non-curricular subjects integrated with the opportunity to "infuse" students with skills through special curricula on subjects—what is learning and what are the methods and tools of learning—for complete learning through exploration, experimentation, work, and research. The teachers are guides and companions of the students in the discovery of knowledge and approach, as well as in the development of each child based only on their choice, ability, and attitude.

The school teachers of 2050 will no longer write on blackboards or use white paper for notes but will engage in meaningful discussion, and teaching is a profession of choice among quality candidates. Collaboration, engagement, conflict,

creativity, planning, and decision-making are at the top of the charts for both teacher and learner/student. And as it is known, every era has a booming trend with the latest rise of technologies. It is anticipated that the new generation will become more interested in nanotechnologies and cutting-edge AI technologies in the future.

The role of the teacher is important, as acknowledged by the popular saying, "When the student is ready, the teacher will appear." But the teacher should be ready and be the facilitator to help the student overcome the teacher.

With the constructivist approach, teachers are trained to ask questions, learn by doing, and do projects that will provide experiential learning. Education through workshops, seminars, games, activities, collective projects, etc., is not limited to the physical classroom itself. Robots and AI will become the norm in our lives. The curriculum and teaching, however, should focus on programs to understand the psychological, emotional, intellectual, and social needs of a child, and perhaps if there is not the competent guidance of a teacher, the nurturing of souls is lost [14].

Teaching and learning with the help of technology are becoming more universal and global, and thus the teacher of the future in the classroom must consider three decisive factors for the successful approach to knowledge by his students:

1. Recognize the pupil: In the "big picture" of each student's potential, interests, background, family, hopes, dreams, setbacks, victories, etc., the teacher will always be the most knowledgeable.
2. Being familiar with the material: The instructor is always the finest source for information on how the material may and ought to be "applied" locally. The instructor should have a good understanding of the "subject" and be able to identify all the priorities, traps, strategies, and shortcuts that apply to each student at that time.
3. Recognize the area: Until perhaps an AI-based robot can do it better than a person, every "content" is applied to a "location," and nobody can know this better than humans.

The functions of a teacher are summarized above [15]: a) Group Dynamics Expert, b) Learning Travel Planner, c) Mentlancer, d)Social-Emotional Leader, e) Experience Manager, f) Activity Learning Manager, g) Project-Based Learning Specialist, h) Data Analyst, i) Business Analyst, j) Curriculum Developer, k) Curriculum Animator, l) Learning Object Curator, and m) Digital Subject Specialist.

## 2.2 Skills of the teacher

The success of younger generations in the knowledge society is a global challenge, and importance of developing effective teaching, with well-prepared teachers is emphasized. In its statement [16], the UN adopted the objective of ensuring inclusive and equitable quality education and promoting opportunities for lifelong learning for all. Goals were set for both the availability of competent instructors and the standard of education. It is crucial to offer all children and youth with a high-quality education and to hire skilled teachers to advance sustainable development globally in the years to come [17].

Three categories of skills are identified by [3]

1. Cognitive and metacognitive abilities, which include critical thinking, creative thinking, learning to learn, and self-regulation
2. Interpersonal skills
3. Technical skills

Practical and physical skills include using new information and communication technology gadgets. Social and emotional skills include empathy, self-efficacy, responsibility, and collaboration.

To adapt to a changing environment and an unpredictable future, it is vital to reevaluate the role of the future school and the profile of teachers in the twenty-first century. Functional abilities that will be critical now and 2025 include critical and creative thinking, complex problem solving, active learning and learning methodologies, and creativity [18].

The essential competencies of the twenty-first century include critical thinking, problem-solving, collaboration, adaptation and flexibility, creativity and invention, communication, construction, information media and technology skills, social awareness, career orientation, self-management, and leadership abilities [19]. These are the skills that the teacher of the future must have in order to pass them on to their future students.

In the 21st-century, emotional intelligence stands out among these abilities and has a positive impact on many facets of everyday life. To achieve emotional self-realization, a person must gradually and hierarchically learn and acquire a set of skills called emotional intelligence. This involves responding to emotional cues, recognizing and expressing emotions, being fully aware of and managing one's own emotions as well as those of others, developing social skills for better intrapersonal, interpersonal and professional relationships, demonstrating empathy and compassion, and accurately discriminating emotions with the ultimate goal of emotional development of one's potential, self-actualization, transcendence, and finally the unity of emotions because humanity is a social animal [20].

During their teacher training, future teachers should pay special attention not only to the development of their emotional intelligence but also to the development of their emotional and psychological stability [21] [22]. Educational institutions should also show maximum interest in emotional education.

Educators' emotional intelligence is foundational to both their personal and professional well-being, as well as the well-being and development of children in a stable, healthy, and quality school environment [23]. The role of the teacher is twofold:

1. They contribute decisively to the transmission and acquisition of knowledge and skills.
2. In the context of a modern school, they contribute to the all-round development of the students' personality, emphasizing the coverage of their social and emotional needs.

The pyramid model of emotional intelligence [24], which has nine levels includes all the skills a prospective teacher must have to build and increase both their emotional intelligence and, in turn, that of their students. These nine levels include:

1. Emotional stimuli
2. Emotion recognition
3. Self-awareness
4. Self-management
5. Social awareness—empathy—the discrimination of emotions
6. Social skills—expertise
7. Self-actualization—universality of emotions
8. Transcendence
9. Emotional unity

To achieve this, the prospective teacher should use the right meta-cognitive and meta-emotional strategies and training [25].

Continuous lifelong learning and in-depth understanding, including learning-strategy categories such as organizing, processing, and metacognitive monitoring, are important concepts for future teachers to understand and apply [26]. Emphasizing the importance of transition to meta-learning, future teachers should act as metacognitive role models [27] by developing a dominant 21st century skill, which is metacognition—thinking and awareness of learning processes [28]. This ability requires the metacognitive skills such as planning, self-monitoring, self-observation, self-regulation, and self-evaluation [29] [30]. Also, [31] outlining how metacognitive pedagogical knowledge depends on metacognitive self-awareness. It is argued that educators need to possess a pedagogical understanding of metacognition, model thought processes, and ensure that problem solving is transparent and clear. By enhancing their metacognitive abilities, future teachers will increase their levels of emotional, intellectual, spiritual and physical intelligence.

The eight pillars of metacognition are listed below:

1. Mnemosyne
2. Discrimination
3. Recognition
4. Adaptation
5. Self-regulation
6. Self-observation
7. Applying theory
8. Learning theory [32] [33]

These pillars can serve as an excellent guide for the cultivating metacognitive skills in future teachers as they promote the establishment of awareness and self-awareness, the development of intelligence in all areas (physical, intellectual, emotional, and spiritual), and the proper functioning of cognitive and psychophysiological systems. The pillars of metacognition are a valuable tool for self-learning, self-development, self-healing, and self-awareness. Each pillar includes a variety of methods that help develop specific metacognitive skills and characteristics, gradually progressing to higher degrees of self-organization, intelligence, and consciousness. Teachers can more effectively impart these skills to their students after they have learned how to use self-regulation strategies and adapt their learning [34]. This becomes possible when e teacher themselves have developed metacognitive skills through anti-aging strategies and mindfulness training, stress reduction, neuroplasticity, brain rewiring, and hormonal balance [35].

The development of metacognition is crucial to the knowledge acquisition process, both for one's academic achievement and for the overall functioning of the cognitive machinery. The eight layers of the pyramid of knowledge: 1. Stimuli, 2. Data, 3. Information, 4. Knowledge, 5. Expertize and discrimination 6. Universal knowledge, 7. Self-actualization, and 8. Transcendence, represent the eight levels that a person must go through to achieve transcendence [36]. The higher the level of the pyramid, the more self-organization, awareness, and consciousness there is, and the less entropy there is. To successfully finish the process of "building" the knowledge pyramid and pass the information to their students, teachers must strengthen their skills of observing, controlling, and modifying their cognitive processes. Since consciousness is a personal, ongoing, and constantly changing activity rather than a static state, it serves as the axis for the pyramid of knowledge.

The cognitive, metacognitive, emotional, and other skills that the future teacher should possess will lead to their giftedness. The pyramid model of giftedness: 1. Natural abilities, 2. Higher cognitive skills, 3. Critical/creative thinking, intrapersonal skills, 4. Self-regulation, 5. Gift/talent/excellence in a field/Sternberg's Facets of Creativity 6. Universal knowledge creation, 7. Self-transcendence, and 8. Unity consciousness provides a collection of competencies classified in a hierarchy according to the difficulty of their acquisition and their significance in multi-level cognitive experiences [37]. The future charismatic teacher goes beyond intellectual excellence and interweaves the manipulation of physical abilities with the regulation of the totality of one's personal virtues, knowledge, and emotions.

According to the technical or learning function, the teacher is responsible for organizing the didactic learning processes. To effectively fulfill their role, the teacher must have the corresponding teaching training, i.e., knowledge and experiences related to general teaching and special teaching. In this way,the teacher equips the student with the necessary and appropriate cognitive and professional qualifications that correspond to their personal and social life.

To succeed in their careers, prospective teachers must possess the following qualities: a love for their students and an interest in working with them; a passion for pedagogy; mental and pedagogical alertness; observance; pedagogical tactics and imagination; organizational skills; the ability to conduct justice, kindness, assertiveness, and perseverance in harmony; the ability to choose the right path in pursuit of a goal; composure, kindness, and self-control. Future educators must learn the techniques for instilling in children a sense of accountability [38].

Realizing the unique function that education plays in society and nurturing the future generation is an important part of psychological preparation for school. The ability to engage in pedagogical activity, interest in teaching, flexibility, depth, and strength of the nervous system, the optimal state of cognitive processes (perception, attention, mental imagery, perceptual speed, memory, language, problem-solving, pattern recognition, and association), understanding the need for the pedagogical profession, respect for universal and national values and effective communication with students are among the knowledge of requirements for a modern teacher [39].

For a complete and correct education, the teacher must delve into the psychopedagogical field, be able to correctly assess the special situation and personality idiosyncrasies of each child, such as their mental health and talents, their age-related maturity, their spiritual needs, and their living conditions [38], and deal with them with mental empathy and scientific stability, aiming at the full development of their students.

A future teacher can be seen as a facilitator of skill development—such as reading and numeracy, higher-order cognitive skills, or social and emotional skills—rather than simply a classroom provider through group work so that they can co-create, organize classes, and watch each other's work. Universities and institutions should structure the development of these talents in the teaching workforce to support the development of the skills needed to become global citizens through group work and group discussions on topics such as empathy, cultural respect, ethnic and gender identities, human values, and a general awareness of contemporary global issues, seeing the teacher as a member of humanity and not just a particular region or nation, helping their students develop the same perspective.

Education is evolving [40]. Future educators will need to be "equipped" with fresh abilities that will enable them to react to information in their fields of study. In brief:

1. e-Teacher: Technology will play a role in education in the future. Technology will take over the classroom; therefore, the teacher needs to evolve into an e-Teacher—

a creative clown who loves technology and is willing to use Facebook, Instagram, and Snapchat—of course for instructional purposes. Be as social media-aware as you can since kids are always on the cutting edge of technology and social media.

2. Paperless: Administrative records are "retired." The conventional notebook has been replaced by technology, and the paperless classroom has become the new traditional classroom. All will be kept on learning management systems and offer electronic grade books, discussion forums, and digital agendas: iPad, Chromebook, Showbie, etc.
3. Edtech chameleon: You may become paperless with the aid of applications and solutions for educational technology. Numerous educational software programs, like BookWidgets, may make a class engaging and interactive and help students meet their learning objectives. The teacher of the future will need to be flexible, seek out the best technological advances, and adapt not just to the new technology but also to his or her own teaching and educational goals.
4. Formative: The future teacher will be free from the grading system; they will not value the student's benchmarks and grades but their progress, improvement, and development, i.e., they will focus more on the formative assessment of the student and their feedback as the student' development is the real achievement.
5. Students: Due to the rapid advancement of technology, teachers of the future will need to be more student-like. They will need to become informed and adept at using technology, besides knowing and comprehending cutting-edge tools, applications, and functionalities.
6. Suspicious: An e-Teacher does not necessarily accept every edtech tool or application. They are also suspicious, as applications, social media, and the Internet have both pros and cons. The teacher of the future must know how to handle common threats such as cyberbullying or fake news, checking the source and the comments regarding the lesson being taught.
7. Collaborative: Using learning management systems and other tech tools that involve collaboration and knowing how other colleagues teach, what materials they use, and how they interact with their students as they share their ideas facilitates collaboration with colleagues and reduces workload through collaboration.
8. Interactive: The teacher of the future must, through technology, make learning more fun and exciting with live edtech tools where interactive lessons help improve your students attention a little more.

A broad range of talents are required for the teaching profession. To deal with the incredible age of science and technology, teachers must have a broad perspective. The holistic model below demonstrates our approach to the traits of instructors in the twenty-first century. The skills of the future teacher include critical thinking, collaboration, communication, creativity, emotional intelligence, metacognition, digital skills, lifelong learning, leader (councilor – supporter), innovator (motivator – visionary), and flexible and adaptable.

## 2.3 Technologies – digital skills

**AI – machine learning.** In a laboratory at Dartmouth College, an Ivy League university in the United States, the phrase "artificial intelligence" was first used in 1956 to refer to "the science and engineering of constructing intelligent machines, especially clever computer programs" [41]. AI is evolving quickly and is used in several industries [42]. Every artificial intelligence program depends on a variety of

intricate locations to investigate and encode the chain of If...THEN, logical rules, and actions that the computer does. AI "special systems" based applications are used in a variety of disciplines, such as medical diagnostics, credit ratings, etc., and are enhanced and expanded as a result of the interactions of the rules [43].

As a subfield of computational learning theory research in AI, ML investigates the study and development of algorithms to identify patterns in data to generate predictions and judgments. Enhanced supervision, unsupervised learning, and supervised learning are the three primary ML techniques. Artificial neural networks (ANN), an AI technique based on the structure of biological neural networks, are the foundation of ML. ANN is used in deep learning, which has numerous intermediate layers. Numerous applications of AI have been created as a result of the aforementioned. Figure 1 summarizes the AI technologies.

| TECHNOLOGY | DETAILS | MAIN AI TECHNIQUES | DEVELOPMENT |
|---|---|---|---|
| **Natural language processing (NLP)** | AI to automatically generate texts (as in auto-journalism), and interpret texts, including semantic analysis (as used in legal services and translation). | Machine learning (especially deep learning), regression, and K-means. | NLP, speech recognition, and image recognition have all achieved accuracy in excess of 90%. However, some researchers argue that, even with more data and faster processors, this will not be much improved until a new AI paradigm is developed. |
| **Speech recognition** | NLP applied to spoken words, including smartphones, personal assistants, and conversational bots in banking services. | Machine learning, especially a deep learning recurrent neural network approach called long short-term memory (LSTM). | |
| **Image recognition and processing** | Includes facial recognition (e.g. for e-passports); handwriting recognition (e.g. for automated postal sorting); image manipulation (e.g. for deep-fakes); and autonomous vehicles. | Machine learning, especially deep learning convolutional neural networks. | |
| **Autonomous agents** | Includes computer game avatars, malicious software bots, virtual companions, smart robots, and autonomous warfare. | GOFAI and machine learning (for example, deep learning self-organizing neural networks, evolutionary learning and reinforcement learning). | Research efforts are focusing on emergent intelligence, coordinated activity, situatedness, and physical embodiment, inspired by simpler forms of biological life. |
| **Affect detection** | Includes text, behaviour and facial sentiment analyses. | Bayesian networks and machine learning, especially deep learning. | Multiple products are being developed globally; however, their use is often controversial. |
| **Data mining for prediction** | Includes financial predictions, fraud detection, medical diagnoses, weather forecasting, business processes and smart cities. | Machine learning (especially supervised and deep learning), Bayes networks and support vector machines. | Data mining applications are growing exponentially, from predicting shopping purchases to interpreting noisy electroencephalography (EEG) signals. |
| **Artificial creativity** | Includes systems that can create new photographs, music, artwork, or stories. | Generative adversarial networks (GANs), a type of deep learning involving two neural networks pitted against each other.<br><br>Autoregressive language models that use deep learning to produce human-like text. | GANs are at the cutting edge of AI, such that future applications are only slowly becoming evident.<br><br>An autoregressive language model known as GPT-3 can produce impressive human-like text. However, despite appearances, the system does not understand the text that it outputs.[18] |

**Fig. 1.** The artificial intelligence technologies [9]

Artificial intelligence and ML are two quickly evolving technologies that will be crucial to the sociopolitical growth of global health and well-being and, subsequently, to individual education. The Net opinion services—all over where, with the help of chatbots, they will be the motto of the upcoming technological evolution. Tools based on AI and ML will be useful intervention tools in the educational process. They will offer the opportunity for adaptation depending on their impact on the teacher, the student, and other relevant factors. These tools enables faster and safer diagnosis of various deficits in students, leading to more effective interventions. Teachers will have access to a wide selection of suitable intervention programs that cater to each student's interests, capabilities, particularities, individual aspirations, deficits, and goals This personalized approach to education will enhance the educational process more efficient and effective. The development of emotional AI involves emotional/cognitive computers "catch," analyze, and respond to human emotions using AI. This technology aims to enable the development and improvement of people's socio-emotional intelligence, contributing to their overall well-being and better living in society as a whole.

According to UNESCO, AI in education and learning changes the role of the teacher [9], empowers him, and improves teaching through three pillars: a) AI-driven discussion forum monitoring, b) AI-human "dual teacher" model, and c) The publications on Effective and Ethical Use of AI in Learning and Teaching: Key Messages [43] explain that the use of AI-powered teaching aides falls within this category (Figure 2).

- AI will change the teacher's role: it will take over most knowledge-based teaching and assessment so that teachers can focus on the social aspects of education.
- AI might support teaching in a range of ways: OER content recommendation, detecting student emotions, so-called intelligent tutoring systems, AI-powered teaching assistants, automatic test scoring, and automatic forum monitoring.
- AI is becoming a catalyst for reforming education itself: it will enable a greater emphasis on project based learning, flexible learning, collaborative learning, and self-regulated learning, thus improving educational quality overall.
- AI is already being used to support remote learning in different modes with classes being delivered remotely, classes being guided remotely, and classes being shared remotely, each of which brings benefits and challenges.
- Students will need to develop a new range of digital competencies around issues such as information processing, computational thinking and digital learning.
- Teachers' professional development needs to be improved, as does governance, accessibility and the trustworthiness of AI.
- AI and education researchers should develop AI systems that assist teachers and improve teaching, accelerate the development of responsible AI, develop stronger policies for ethics and equity, and involve educational policy makers and practitioners.
- The main obstacle to the wide adoption of AI technologies is the lack of robust evidence for its efficacy and its impact on student academic achievements.

**Fig. 2.** AI in education [44]

**Cloud computing.** The future of education, and therefore learning, depends largely on access from anywhere to learning and collaboration, both locally and globally, as a social good. Cloud computing is a "technology" for future education [44]. Cloud computing operating offers services without commitment, with only the required guarantee of the necessary existence of infrastructure and a fast, strong, reliable Internet connection. This enables students and teachers to access the cloud through technology, using either mobile phones or iPads or their own device (BYOD), providing them with direct access to the cloud.

Students will have direct access to their grades, comments, and assignments via PC, smartphone, or tablet. Likewise, teachers will be able to assign, collect, and grade online work, as well as share assignments and recommend resources and materials from global libraries. They can recommend interactive simulations, apps, videos, documents, podcasts, audio, or interactive images, among other things. The integration of cloud technology and mobile devices will allow for seamless integration across the entire school. This will connect teachers, students, and everyone involved in the learning process, supporting teaching whether it is conducted off-site or on-site, resulting in a paperless classroom. In this scenario, teachers will be able to teach from anywhere and students will have the flexibility to learn from anywhere.

Through the cloud, teachers will encourage personalized and independent learning by respecting the individualities of their students. Each student will have the opportunity to learn according to their interests in their own way. This approach adopts a kind of flipped classroom, which allows students to develop collaborative skills using e.g., Google Apps.

**Fiber networks – Gigabit.** All fiber optic networks are designed to connect homes and businesses with lightning-fast Internet connections. The fiber optic cables that form these networks offer several advantages, that includes the fastest and most reliable broadband technology that provides much higher bandwidth than traditional copper cables or the wireless ones, high-capacity, transmit rapidly flashing pulses of light, and carry multiple data streams simultaneously in various light wavelengths or colors, enabling the transmission of multi-gigabit Internet speeds and more powerful video, Internet services, and speech [45].

Educational institutions are leading the way in digital transformation, and online learning allows them to benefit from more secure digital storage and the implementation of concepts such as AR and VR. Fiber optic technology enables teachers to upload content, educational films, and videos, and have virtual communication with their students. Utilizing a fiber optic internet connection improves the quality of their lessons, making the teaching and learning approach more immersive and enriched. One significant advantage of optical fibers is their immunity to external electrical interference. This attribute ensures that students and teachers enjoy a safe, secure, and reliable Internet connection, free from disruptions.

**5 G/6 G – wireless technologies.** Wireless technology: Wireless technology is the use of magnetic fields or radio waves to transmit electricity wirelessly without wires, offering new powerful telecommunications and new services [46]. The "5G" cellular technology revolution refers to the next significant stage of mobile standards following 4G/IMT-advanced standards. All characteristics of prior technologies are included in 5G technologies, making them more potent and soon to be in high demand. The electronics of the future will include a significant number of autonomous cars, AR/VR devices, infrastructure sensors for smart transportation and public safety applications, airborne drones, and smart homes. Our connected future will be very different from the past.

The applications of the 5G network contribute not only to health, the automotive industry, and energy but also to education at all levels. Specifically, through the 5G network, the usage of AR and VR services will transform schooling. This transformation will help students of all levels to better understand unknown aspects of the macrocosm and the microcosm and to develop the concept of a "smart classroom" and more broadly, a "smart school" at both the student and administrative levels on a daily basis. Teachers will be able to employ "distance learning" and "teleworking," which will allow everyone, especially students with learning difficulties, to approach knowledge more effectively.

The next generation of telecommunications networks, or 6G, is expected to be even faster than 5G and will be developed to universally fulfill customer demands for high network capacity, efficiency, and low latency. The key characteristics of the technical applications that 6G technology is anticipated to support completely include 3D Projection, eHealth, Pervasive Connectivity, Industry 4.0 and Robotics, and Unmanned Mobility.

Metaverse – It is a universe of interoperable digital worlds that may potentially replace the Internet and the physical world. In the 2030s, humans are projected to spend more time in the digital world than in the real world [47]. The term "metaverse" describes a digital landscape that allows participants to create virtual environments where users can connect in novel ways not possible through other means. The Metaverse offers opportunities for enhanced human interaction, incorporating the best elements of gaming, the digital workplace, and even education.

The Metaverse recreates the existing world virtually and allows customization by creators, developers, or users based on their preferences. In traditional education, students attend physical educational structures and participate in sessions, classes, and workshops to learn and access knowledge. However, Metaverse-based education goes beyond traditional online courses, offering a more communicative interaction between teachers and students. In this setting, avatars of both teachers and students can interact with each other. Education through the Metaverse will eliminate limitations on the number of people who can learn from their favorite teacher. Thousands of pupils and students can benefit from the training simply by sitting down, wearing the necessary equipment, and having an Internet connection to enter the Metaverse.

**The Internet of Things.** [48] defines IoT as a network of physical objects, or "things," that are equipped with sensors, software, and other technologies to communicate and exchange data with other hardware and software over the Internet. This network allows us to have specific control over all traditional electrical items, from low-tech household appliances to high-tech industrial tools, through smart recommendations. IoT has become a significant 21st-century technologies, enabling the connection of common items such as baby monitors to the Internet via embedded devices. This connectivity enable seamless communication among people, processes, and things. Low-cost and low-power sensor technologies, connectivity, cloud computing platforms, ML and analysis, and conversational AI are the factors that make IoT successful.

Digitization and the integration of IoT in education can address the challenges that schools are facing today. By leveraging mobile technology and IoT, schools can increase the security, monitor essential resources, and improve information access in the learning environment. The advancement of IoT technologies also allows for the conversion of paper notes into digital files, the implementation of wearable technology to track student participation, and the simplified monitoring of student attendance. Smart pens, tablets, and smart boards are examples of linked technologies that can improve how instructors and students share educational resources. IoT, therefore, has the potential to improve educational standards while simultaneously saving time and physical resources, as well as human resources.

This technology can also empower teachers to develop "smart lesson plans" by:

**a)** Making better-informed instructional decisions using student performance data to continuously assess the effectiveness of their teaching.
**b)** Teachers can utilize data from IoT sensors to construct pertinent courses that are tailored to the requirements of each student.
**c)** Implementing intelligent teaching robots that adapt the pace and content of the curriculum based on how accurately students respond to questions, providing personalized learning experiences.

In technology-based education, teachers have two main responsibilities:

1. Creating and presenting electronic content to learners, and
2. Fostering positive interactions between educators and students. IoT in education facilitates the development of smart classrooms and assists teachers in tailoring their instruction to accommodate varying levels of student understanding. IoT offers the potential to create smart schools with smart school characteristics centered on school management, teachers, and students (Figure 3). [49]

| IoT for School Management | IoT for Teachers | IoT for Learners |
|---|---|---|
| Energy Management | Autonomous attendance system | Distance learning |
| School Premises security | New Pedagogies | Virtual classrooms, distance learning |
| Special need management | Feedback system | Enhanced productivity |
| Smart school transport | Assessment and evaluation system | Enhanced interaction, learning efficiency |
| Health management system | STEM education | Personalized learning environments |

**Fig. 3.** IoT enabled smart school features [49]

**Body antennas – wearables.** Body-centric communications have several uses including the military, smart homes, smart healthcare, personal entertainment, identification systems, and space travel. Wearable antennas can be used by people of all ages, athletes, and patients to continuously monitor their vital signs, collecting human-centric data such as heart rate, brain frequency, health issues, oxygen level (Oximetry), and stress level. Smart watches with built-in Bluetooth antennas, smart glasses with built-in Wi-Fi, GPS, and IR antennas, body-worn action cams with Bluetooth and Wi-Fi connectivity, and tiny sensor devices in sneakers with Bluetooth and Wi-Fi connectivity are some examples of wearable smart gadgets [50]. In the realm of education, specially designed body antennas—wearables are particularly helpful in special education, where many students have health issues—can assist students' with unique characteristics and communication challenges by promptly notifying teachers about any concerns, enabling timely intervention and support.

**Robotics.** Robots can help teachers as supportive and motivating learning assistants, in guiding written assignments, answering questions, doing routine tasks, delivering or teaching an educational concept, etc., and improving student learning in classrooms, making their work easier and teaching and learning more efficient and successful.

AI-powered robots have access to a database of information, enabling them to find the necessary information within seconds. They quickly and reliably provide the teachers with more time to focus on students who require individualized teaching programs, offering guidance and support. Robots enhance the learning experience by making it enjoyable, friendly, and seamless. They do not judge students for their mistakes and also they do not get tired of repeating the same thing without making students feel embarrassed for not understanding something.

However, it is crucial for the instructor to be mindful of how student interact with the robot and emphasize that robots are employed to be helpers, not replacement for teachers or human friend [51]. Educational Robotics allows students to learn STEM subjects through a variety of methods.

Educational robotics has the potential to enhance and support students' cognitive, social, and emotional skills. It offers a valuable solution for students who cannot attend school due to specific physical conditions, severe allergies, chronic or convalescing conditions. Robotics in the classroom enables students with special needs to create their own tailored learning plans and gain information by their preferred learning styles [52]. Also, the robots leverage gamification and push children

with cerebral palsy and autism to do physical exercises to improve their motor skills and through sensors and cameras assess the development individually, providing continuous constructive feedback and encouragement. Social robots, which interact with humans, help teach social-emotional and educational skills to students with special needs, such as with attention deficit hyperactivity disorder, hearing impairment, Down syndrome, and autism [53].

**Avatars and digital assistance/counselors.** An AI avatar is a digital character, representing an electronic human form equipped with advanced AI that lives in a virtual environment such as a game, social network, dating app, or online world and can be used in many tasks, it can literally "think" alone, provides reliable feedback, does not tire, and can guide learning by pointing out where reinforcement is needed.

An application software known as a virtual assistant, AI assistant, or digital assistant comprehends natural language voice instructions and performs tasks on behalf of the user. As a new form of technology to aid in teaching and learning, avatars are gaining appeal. Avatars can be employed in immersive learning settings or as agents for e-learning systems. According to research, utilizing avatars may have a variety of advantages, such as improved student engagement and chances for meaningful online connections. When considering whether to use avatars in the design and development of courses, educators should take effective design concepts and criteria into account [54].

A pupil adopts a new persona and starts to think and behave in that manner. To submit their ideas for instructional scenarios, students are required to put themselves in the shoes of their avatars. These systems with adaptive learning provide educational intervention, creating structure, reliability, and progress. However, it is difficult to choose educational strategies and methods suitable for each person, and there are doubts about how everyone will interact in such communication.

The world becomes the class, and the class becomes the world. That doesn't mean the real world is going away. On the contrary, blending the two creates a digital and analog learning space where many good coaches (once called teachers) focus on the creative, motivational, and communicative aspects of the digital realm [55]. Emerging technologies will bring new possibilities for those who can exploit their potential [56], such as the use of avatars with advanced artificial intelligence.

**Virtual reality.** Virtual reality headsets or multi-view environments are often used in VR technology, where, through a gaming controller or other haptic device, graphics, sounds, and other sensations mimic a user's actual presence in a virtual or imagined world or convey vibrations and other sensations to the user. This tactic in formation can be used as force feedback in medical, video game, and military applications [57].

Virtual reality is the process of employing technology to create a simulation of a real-world experience that a person may access at any time. The VR headset, a head-mounted display (HMD) that blocks out the outside world and shows a 3D world or stitched images to create a simulation for the user with the VR headset blocking out the user from the outside world and presenting it with a new point of view, is the foundation of a really good VR experience.

Virtual reality systems' primary characteristics are as follows:

1. Involvement: Any VR system's objective is to completely submerge the user in a brand-new simulation world and produce an engaging experience with three degrees of control:
   - **a)** Enlarge their field of view with the visor,
   - **b)** They can wear sound-canceling surround sound headphones on stage, and
   - **c)** They can give their minds control of the stage by moving their heads.

2. Interaction: App developers strive to build more immersive experiences in various films and video games. The value of VR simulations may be increased by allowing users to interact with characters or acquire items from the environment. Finally becoming a reality, virtual reality has both advantages and disadvantages. The following are some of the primary benefits and drawbacks (Figure 4):

| Pros and Cons of VR | |
|---|---|
| **Pros** | **Cons** |
| Better than reality | High cost |
| Used in various fields | Communication should not be replaced for group of people |
| User have awesome experiences | Feeling of worthlessness |
| Gives detail views | Users addict to the virtual world |
| Connects with people | Technology is still experimental |
| Effective communication | Training in VR environment is not real |

**Fig. 4.** Pros and cons of virtual reality [58]

Virtual reality education allows students to communicate with each other using avatars and facial expressions to discuss and interact through advanced types of "simulations", and with a VR headset, an entire science lab can be simulated for biology or chemistry experiments. Students with learning and behavioral difficulties and deficits using the virtual environment are given the opportunity and more time to study a subject, while the teacher takes advantage of this by providing help and feedback to more students, which positively affects their learning, providing a safe, secure environment for students to try and practice different situations [59].

**Virtual labs and virtual experiments.** Virtual labs are learning and teaching simulation environments designed to improve students' lab proficiency. They are among the most crucial e-Learning resources because they let students do a variety of experiments without being constrained by space or time, examine ideas and theories without having to go into a scientific lab, and study at their own speed. Using simulations and virtual microscopes, the teacher uses virtual laboratories to provide pupils with access to cutting-edge equipment for experimentation. The instructor uses virtual laboratories to practically apply various course curriculum topics as a visual aid for teaching complex concepts. The teacher allows the students to experiment without the risk of injury or damage to the equipment, to compare and draw conclusions, to "keep" the interest and attention of the students, and to involve them in the whole process of research, discovery, and learning, allowing them to learn through their non-punitive mistakes and providing the flexibility to learn at their own pace [60].

**Virtual classes and virtual presence.** With the use of video conferencing, teachers and students may engage with one another and the course content in a virtual classroom while the virtual presence of the instructor feels like they are actually in a virtual location, allowing the trainees or students to feel personally connected to other students and the teacher in an online learning community.

The role of the teacher in a virtual classroom is their positive presence in the virtual space, which is emphasized through the following: a) keeping students

connected and engaged; b) providing clear communication instructions; c) providing support and guidance when needed; d) offering academic feedback; e) providing facilitation and modeling of learning; and f) providing a personalized personal connection with the student. The positive presence necessary for effective teaching and learning also comes with the application of the following learning strategies:

1. The live, modern teaching sessions with the face and voice of the teacher,
2. In virtual Classrooms: teaching a lesson by sharing information, facilitating discussions, demonstrating skills, and more
3. The teacher's presence in the students' meeting rooms
4. Full assistance during office hours for students to make individual appointments, ask questions, or get help
5. Help in homework sessions for students who may need it. Children can learn at their own pace with pre-recorded virtual lessons, which is the best option for children who have physical disabilities [61].

**Future devices and new technology.** Smartphones simplify and increase accessibility for students by allowing them to have books and other educational resources at their fingertips, contributing to education by:

a) Homework tracking tools: Teachers can check student assignments, due dates, assignment submissions, grades, and more.
b) Mass notification: Teachers will be able to use the management functions of the smartphone education app to set to-do list reminders for all students.
c) Instant class recording: Teachers might quickly capture pictures, record lectures, etc. utilizing a virtual classroom program.
d) Instant note-taking, commenting, and feedback
e) Explore a range of learning apps [62]

Another technological achievement useful in education is holograms, which can make learning and teaching much easier without the need for physical presence. They help achieve greater conceptual clarity, allow the visualization of abstract concepts, and ensure effective communication between students and teachers.

**Human-machine interfaces/new era.** A user interface or dashboard that links a person to a machine, system, or device is known as a human-machine interface (HMI). HMIs exist in a variety of shapes and sizes, including embedded displays in machines, computer monitors, and tablets, but their main function is to display data on machine performance and development. The process of combining human and machine intelligence to develop efficient machine learning algorithms, known as "human-in-the-loop" ML, combines active learning and supervised machine learning [63].

Brain-computer interfaces (BCIs) are devices that link the human brain to computers to improve cognitive ability and reasoning. Using BCIs, brain impulses are collected, analyzed, and converted into commands that are sent to output devices to carry out the intended activities. BCIs do not use the typical neuromuscular output routes [64]. According to researchers, BCI studies show promising results in both cognitive assessment and training contexts in various populations (ADHD, ASD, dyslexia), as well as with the specific cognitive skills that interventions are intended to improve attention, memory, language, and visuospatial skills [65].

**New skill industry revolution 5.0 And beyond/components.** As we rely more on Industry 4.0 technologies such as AI, big data (BD), the IoT, digital platforms, augmented and VR, and 3D printing, the fifth industrial revolution is emerging in unexpected ways [66].

**Augmented reality.** Augmented reality in education can change the way teachers teach using technology by making lessons more interactive to benefit students by bridging IoT and virtual reality.

Augmented reality in the classroom:

1. Make classes more interactive: AR technology helps teachers make learning more interactive and engaging, keeping students engaged, bringing abstract topics to life, helping them learn with 3D models, using 3D simulations, etc.
2. Act as a guide: Unlike other technologies, AR enables instructors and trainers to take on the role of guides in the classroom.
3. Teaming up with students: AR teachers improve teacher-student collaboration in classrooms by using game-based digital elements that make learning interesting and interactive.
4. Making the most of technology: Teachers are learning how to handle and use gizmos and gadgets to become as self-sufficient as today's students in making the most of technology.
5. Using technology for evaluation: AR in education makes assessment more "fun" and not a burden through LMS and applications that have the possibility of fun quizzes and puzzles, etc. [67].

## 3 DISCUSSION – CONCLUSION

The teacher who possesses pedagogical and digital skills holds the role of mediator, puts the student at the center, and utilizes new technologies pedagogically [68], thus directing students on a path of self-learning and motivating them in continuous interaction. Also, being part of a digital learning community can contribute to highlighting the teacher's collaboration and communication skills with their peers and to the enrichment of their digital skills. Pedagogical, scientific, and digital skills can help a teacher master the role of curriculum transformer as well. The needs of the 21st century require upgrading the education of students and finding new ways of preparing them for their inclusion in society as active and critically thinking citizens. The main goal is their active involvement and autonomy in learning through a heuristic course of self-learning, meaningful collaboration, and communication. At the same time, they must be able to solve problems critically, learn how to learn, and be emotionally intelligent. Educators can make a catalytic contribution to the cultivation of students' skills by utilizing and strengthening the organizational, social, emotional, pedagogical, and digital skills that they possess by ensuring access to digital resources and systems and designing appropriate materials.

The most important challenge facing today's education is the lack of connection between the education offered and real life and, by extension, the labor market. However, the benefits of emotional and metacognition education are beneficial for improving communication skills and achieving happiness in students' lives and later as adults. That kind of education provides resources that help to activate creativity, solve problems, improve analytical critical thinking, create the conditions for active learning with a growth mindset, upgrade personal judgment and decision-making ability, develop self-awareness, improve interpersonal communication skills, but also leadership, help to accept diversity and upgrade cultural intelligence, and enhance the pursuit and acceptance of change. Such powerful skills call for qualified teachers who possess these skills to integrate them into the learning process, meeting the needs of students in the twenty-first century and "seeing the sun" in each child. Cooperative

learning and classroom discussions replace concept teaching, with students receiving specialized training to get them ready for social life, while teachers take into account the wide range of human capacities, such as the multiple intelligences of Gardner [12].

Perhaps in the coming years, the majority of students around the world will not need to attend school "physically" but will be able to connect from their homes, or from anywhere else through technology applications to a virtual school where the teacher will teach using technology. Students, accompanied by the teacher and with the help of emerging technologies, will interact with their classmates, take part in virtual tours, and perform assignments.

The teacher is a companion, adviser to the students, assistant in the discovery of knowledge, and partner, always giving the present with his human presence next to the students and their parents. All individuals associated with the instructor will have the chance to "play" a significant role in the best method of information transfer, the development of intellectual prowess, and overall well-being using technology as an ally in the anticipated future transformation of education. Education is "the kindling of a flame, not the filling of a jar," as Socrates once remarked. By using technology, educators will create a personalized education with the equal participation of all students and the appropriate technological achievements to ensure that each student will find his own way to approach knowledge.

Finally, we must emphasize the important and effective role that digital technologies play in the field of education. These technologies, which include mobile devices [69–74], a variety of ICT applications [75–103], AI and STEM [104–107], and games [108–111], facilitate and enhance educational procedures such as assessment, intervention, and instruction. Through IoT, many tactics and methods may be implemented into instructional systems. In addition, the use of ICTs in conjunction with theories and models of metacognition, mindfulness, meditation, and emotional intelligence cultivation [112–135], as well as environmental factors and nutrition [136–139], accelerates and enhances educational practices and outcomes, particularly for gifted students with attention-deficit/hyperactivity disorder.

To sum up, emerging technologies are the result of the above. Although they are the future of the school and will affect the stakeholders; teachers, students, and parents, in the educational process, however, the following are suggested:

1. Building adaptive platforms [140] as they use learning styles to provide a more effective learning experience as more modern adaptation techniques are integrated into e-learning systems and techniques compatible with educational theories
2. Programs for continuing professional development and acquiring a culture of life-long learning.
3. Emotional and metacognition training for self-development to maintain their well-being and be effective in their lives and careers
4. Programs and training for enhancing digital skills and contemporary technology
5. Innovative courses can be created in institutions and universities for teacher preparation to give future educators the cognitive, metacognitive, emotional, and digital tools they need to deal with the issues of a student body that is becoming more and more varied.
6. The teacher of the future must follow technological imperatives in order to bridge the technological gap between oneself and students.
7. The use of technology by the teacher should focus on each student and their particularities.
8. The teacher will use technology for the benefit of the student in order to approach knowledge.

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