

Editorial

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The Role of Educational Leaders in the Age of Artificial Intelligence (AI)

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Abstract

Background/purpose. In the first quarter of the twenty-first century, unprecedented developments in technology began to revolutionize ‘modern’ society and started the era of Industry 4.0, which is characterized by the rapid integration of the newest technologies such as the Internet of Things (IoT), smart technologies, and artificial intelligence (AI) into every aspect of life. Educational institutions, as open social systems, have strongly felt the pressure of changing their pedagogies and practices in response to the demands of Industry 4.0. This has given impetus to the emergence of Education 4.0, which has required redesigning the teaching-learning processes to meet the paramount and multifaceted demands of the digital era while achieving a balance between external demands and the science of pedagogy. Realizing this mission has not only become a crucial task for educational leaders but also emerged as a critical measure of effective leadership in the new era.

Materials/methods. This paper builds its argument over the existing literature on the interplay of technology and education and offers some perspectives on the changing roles of leaders, particularly in higher education context, facing the rapid technological revolutions surrounding the current universities.

Results. In the age of AI, it is crucial that educational leaders must have flexibility, agility, and productivity as well as develop their communication, collaboration, critical thinking, creativity, problem-solving, and entrepreneurship competencies. They should also act as digital leaders to enable a digitally-enhanced learning community in the university through establishing a culture of innovation built over the values of openness, transparency, customer centricity, freedom to experiment, diversity, inclusion, trust, and sustainability.

Conclusion. In the new era, educational leaders must be aware of their key role in discovering the benefits of novel technologies on one side while devising measures and strategies to tackle their risks on the other.

1. Introduction

Throughout history, humanity witnessed moments that were deeply transformative, shaking the foundations of their culture, lifestyles, politics, and economics (Henriksen et al., 2021). Starting from the late twentieth century, we have been witnessing such immersive moments of technological breakthroughs. In the first quarter of the twenty-first century, unprecedented developments in technology began to revolutionize the ‘modern’ society and started the digital era (Hodson, 2018; Hoehe & Thibaut, 2020). Some of the mind-blowing scenes that were once presented in sci-fi films have already become the reality of our lives, while some are just around the corner.

The invention of computer and internet technologies during the twentieth century has brought about the phase of ‘Industry 4.0’, which is characterized by the rapid integration of the newest technologies such as the Internet of Things (IoT), connected objects, smart technologies, machine learning, and artificial intelligence (AI) into every aspect of life (Joseph & Hamilton-Ekeke, 2016). This new era of technological innovations has transformed operations in many fields, and education is no exception.

Educational institutions, as open social systems, have strongly felt the pressure of changing their pedagogies and practices in response to the demands of Industry 4.0 (Anggraeni, 2018; Adiguzel et al., 2023; Al-Dosari et al., 2025; Kin & Kareem, 2019), which has given impetus to the emergence of Education 4.0. This rising paradigm in the field of education has been built upon two fundamental premises: if schools were to realize their mission of providing an education that aligns with the needs of future generations, (1) tools like IoT, virtual reality (VR), augmented reality (AR), and AI must be integral part of education, and (2) new pedagogies must be developed to equip students with the skill set they will need during or beyond Industry 4.0 era (Çetin & Karsantik, 2022; González-Pérez & Ramírez-Montoya, 2022).

Considering that ‘almost 65% of children entering primary schools today will ultimately work in new job types and functions that currently don’t yet exist’ (World Economic Forum, 2016), it becomes crucial to redesign current education systems so that they can offer the personalized, inclusive, and lifelong learning experience that is essential to develop today’s students as the citizens of a future society; one that is likely to witness even greater and faster changes than we currently assume (Advani, 2023). Despite the current ‘coexistence of the digital world with the analogue world’ (Huk, 2021), the new developments in machine learning and AI technologies, particularly the recent birth of AI-based generative chatbots (e. g. ChatGPT) or robotic systems carry significant implications for Education 4.0 with their strong potential to facilitate personalized and adaptive learning via their capabilities of predictive modelling and learning analytics (İpek et al., 2023; Malynovska, & Smyrnova, 2023). AI can also support the transformation of the content, curriculum, and management of education (Kin & Kareem, 2019).

Under these circumstances, Education 4.0 necessitates a paradigm shift that is attained by the collaborative efforts of various agents in the field of education and calls for the integration of digital technologies into organizational processes, pedagogies, instructional practices, professional development activities, and teaching/learning infrastructure (González-Pérez & Ramírez-Montoya, 2022). However, it should also be noted that these technologies provide extraordinary facilities to support education on the one hand while raising unforeseen challenges that cannot be ignored on the other (Hodson, 2018). The technological breakthroughs we are witnessing today are like a double-edged sword with inconceivable promises and threats not only at present but also in the foreseeable future (Henriksen et al., 2023).

This changing context of educational institutions once again underlines the significance of leadership in creating an environment that facilitates Education 4.0 (Advani, 2023), an idea that first

flourished in organizational literature as Leadership 4.0. Equipping students with the competencies essential for a quality life and enabling the growth of society by this means is one of the fundamental duties of schools (Pata et al., 2022). The evidence from an abundance of research on educational leadership points out that leadership is a significant component of turnaround schools (Hitt & Meyers, 2018), and the educational leader is the 'key figure in the individual school's development, either blocking or promoting changes, acting as the internal change agent, overseeing the processes of growth and renewal' (Huber & West, 2002, p. 1072). The evidence also supports Evers and Lakomsky's (1996, p. 72) earlier notification that schools are 'made up of intricate nets of complex interrelationships that crisscross formal positions of authority and power, carry knowledge and expertise in all directions, not just downwards'. As such, empowering all school staff to become transformative agents strengthens the school's capacity for change (Daniëls et al., 2019). In sum, educational leaders matter as the leader of leaders in the institution, but the real transformation comes with the collective leadership capacity and the collaborative efforts of everyone engaged in a shared vision and commitment to change (Hallinger, 2003; Ozdogru et al., 2025). From this perspective, educational leaders influence and mobilize others in pursuit of this goal (Hitt & Tucker, 2016) while leadership is enacted 'through relationships between and among individuals' to promote the identification of all school community with this vision and goals towards meaningful change' (Leithwood, 2012, p. 3). In brief, 'education leadership is enacted by many different kinds of individuals; it comprises many functions and actions that operate contingently in a wide variety of contexts' (Riehl, 2015, p. xx).

Unlike management, the need for leadership usually emanates from a strong and urgent need for transformative change. Leading the change process through making strategic decisions, defining change-oriented strategies, and creating a culture of collaboration and innovation is what makes the difference (Oliveria & Saraiva, 2023). In the new context of education, achieving a balance between the external demands and the science of pedagogy while redesigning the teaching-learning processes to meet the paramount and multifaceted demands of the digital era has not only become a crucial task for educational leaders but also emerged as a critical measure of effective leadership (Kin et al., 2020; Omar & Tai, 2019).

2. The Changing Context of Education

Education has been taking place in an environment entwined with technology for quite a long period. The potential benefits of technology-enhanced instruction in technology-integrated classrooms have been advocated since the invention of computers and the internet (Yang & Wu, 2012). Research has supported this idea by revealing that recent technologies facilitate the quality of instruction and student learning by several means (Busalim et al., 2019; Ipek et al., 2023; Liu et al., 2017; Morgado et al., 2025). Considering the convenience and diverse functions of digital technologies to promote knowledge sharing, information processing, collaboration, and communication, they have also become essential means of equipping students with twenty-first-century skills (Senthil, 2018).

Two historic moments experienced recently, however, have increased awareness of the inevitable interference of advanced technologies in education, with all its pros and cons. One of these moments was the COVID-19 outbreak that immensely affected societies all over the world (Karakose et al., 2023). Nationwide lockdowns imposed to prevent the spread of the disease entailed emergency remote teaching, which promoted the use of several internet-based technologies instantaneously and accelerated the digitalization of teaching and learning environments (Fullan et al., 2023; Garcia et al., 2023). The COVID-19 circumstances also instigated the use of digital technologies such as mobile phones, laptops, or social networking sites more extensively in daily life and changed the way people interact with them (Li et al., 2021; Meng et al., 2022). This new situation

prompted the idea that it might be high time to transform traditional approaches to student learning, assessment, and growth (Elbanna & Armstrong, 2023; Wong & Ng, 2022) if schools are to realize their mission of preparing younger generations for the future.

The second groundbreaking moment, initiated by the developments in machine learning and artificial intelligence, was the release of AI-based chatbots, particularly OpenAI's ChatGPT. Quickly after its release, it attracted the attention of millions with its great performance in various tasks such as nationwide exams, code-generation, and augmentation, writing texts, or generating answers to analytical questions on several subjects (Frieder et al., 2023; Noever & McKee, 2023; Ouyang et al., 2022). With its capability to perform tasks that normally require human intelligence, to engage in personalized conversations through remembering the content of previous discourses, and taking the context, tone, needs, or preferences of the user into consideration (Farrokhnia et al., 2022; Michail et al., 2023), ChatGPT has started much debate in all fields, including education. While being cautious about its potential risks in the face of enduring traditional methods of teaching and evaluation (e. g. academic dishonesty, cheating, misguidance, or misinformation), educational scholars have underlined several benefits of AI-based chatbots to facilitate learning in the current and forthcoming society (Adiguzel et al., 2023; Luo et al., 2023; Murad et al., 2023), as well as bringing 'novel opportunities for educational transformation' (Zhai, 2023, p. 1).

With the advent of AI-based technologies, changing the landscape of education has become a hot topic among scholars and practitioners, which focuses on a broad and systemic transformation in educational objectives/purpose, teaching/learning processes, materials and methods, assessment, and evaluation (Zhai, 2023). Despite this awareness, though, schools have not yet embraced current technologies as much as students, parents, teachers, and other stakeholders have incorporated them into their daily lives (Riveros, 2015). Although the current student population is called 'digital natives' who were born into 'a media-rich, networked world of infinite possibilities' (Suleimanova et al., 2020) and they are 'no longer the people our educational system was designed to teach (Prensky, 2001, p. 1), many teaching methods and patterns of communication used in 'modern' schools are still rooted in the paradigms of the industrial revolution (Industry 1.0) (Sheninger, 2014). We can even witness once again a huge gap between the science of pedagogy and the actual teaching in schools, 'pretending that a 2000-year-old method of teaching is [still] the best way to teach' (Henriksen et al., 2023).

Indeed, we cannot meet the demands of the future with the solutions of the past. Traditionally, the main goal of education was knowledge transfer and socializing students to fit into society. However, today's digital technologies provide easy and broader access to knowledge (e., chatbots, search engines), which fundamentally strikes the first goal. In addition, these technologies have brought about diverse means of communication and connections (e.g., social network sites and blogs), which strike the second goal of changing the way students socialize. With the advent of AI technology, the basic goals of traditional education, such as knowledge transfer or the development of basic skills (e., reading and writing), can already be achieved by these intelligent machines (Zhai, 2023). As a result, we have to acquiesce that today's students 'learn in different ways and have different experiences with technology compared to many of their teachers and most of their administrators' (Levin & Schrum, 2014, p. 640), and they will lead their lives in an era that will likely be different from the one they are educated in.

Educational systems are currently making inroads into what Ilomäki and Lakkala (2018) called a 'slow revolution'. During this stage, schools are using these technologies to support existing teaching methods, such as developing materials, visualizing content, or sharing information. The observed changes are quite small, such as replacing some routines or making minor changes in some practices, but the goals and content of teaching remain the same. However, schools, as the triggers of social growth, need to go beyond this slow adaptation process and put effort into a more 'active

transformation', which requires the collective efforts of educational leaders, teachers, and principals to plan and change the curriculum and instruction as well as use digital technologies in ways that facilitate their efforts (Ilomäki & Lakkala, 2018).

Another significant point is that the intelligence of machines is 'artificial' and cannot go beyond the capabilities of human beings. They can access and process huge amounts of data in a matter of seconds, but they do not have soft skills such as creativity and critical thinking (González-Pérez & Ramírez-Montoya, 2022), nor can they simply automate human social intelligence and emotional connections such as empathy or flexibility (Fullan et al., 2023). As Fullan (2021, p. 24) articulated,

machines and their AI. We have already seen that machines are not as great as some people think they are, but they can be intimidating as we face their colossal computational power. We have overestimated machines and underdeveloped social intelligence.

This has significant implications for designing Education 4.0. In the current circumstances, AI technologies have already proven their computational power to replace people in various tasks, such as data collection and mining, calculation, processing large documents, writing codes, poems, stories, drawing, painting, and fine-tuning pictures (Taecharungroj, 2023). Therefore, in the new age, schools need to give up focusing on developing skills that can already be done by machines and focus on facilitating genuine and unique human skills (Branson & Marra, 2020). Considering that AI cannot 'replace complex human decision-making, especially in situations that require the integration of emotions, experience, and scientific knowledge, [e]ducation should prioritize the cultivation of students' creativity and critical thinking skills so that they can adeptly tackle and solve diverse problems in the environment, resources, economy, politics, and other areas of future life' (Zhai, 2023, p. 2).

This brings us to the twenty-first-century skills defined as essential skills for the success of the future workforce in the wake of the century (Figure 1). The Partnership 21, a nonprofit organization founded by the collaborative efforts of governments and businesses, developed a framework to define the twenty-first-century skills which include three basic competencies:

- I. Life skills flexibility and adaptability; initiative and self-direction; social and intercultural skills; productivity and accountability; leadership and responsibility),
- II. Learning skills, creativity and innovation, critical thinking, and problem-solving; communication and collaboration (4Cs)
- III. Literacy skills: information literacy, media literacy, ICT literacy

The newest developments in digital technologies and AI have underlined the significance of these skills once again, not only as the backbone of the Industry 4.0 workforce but as a sine qua non of a fulfilling life in the foreseen digital society (Branson & Marra, 2020; Kaufman, 2013; Silva, 2009). Education 4.0 requires that these skills essentially become an integral part of the national curricula and be targeted by all the agents in schools (Larson & Miller, 2011).

It has now become an obligation rather than a preference to transform the current technology-referenced learning environment to a technology-enhanced learning community where digital tools increase the possibilities to assist students in achieving their full potential (Zhong, 2017), and foster the development of core, contextual and digital competencies as a whole (van Laar et al., 2017). As Noh and Karim (2021) stated, this could only be achieved with a design-thinking mindset that incorporates collaboration, experimentation, prototyping, empathy, optimism, and, most importantly, the mindfulness of these processes into every aspect of education.



Figure 1. The P21 Framework for twenty-first-century skills.

Source: <https://www.battelleforkids.org/networks/p21>

While the implementation of AI has a strong potential to revolutionize education, producing positive educational outcomes necessitates more than merely employing advanced AI technologies (Castaneda & Selwyn, 2018). The incorporation of technology should be closely aligned with theories of learning, guiding both instructional design and technological progress (Bower, 2019). According to Zheng et al. (2021), AI-enhanced learning can be realized via the interconnected use of AI technologies, educational content, and pedagogical methods. In addition, while developing AI-enhanced learning activities, educators and professionals should consider six essential components to attain the desired learning goals: students, context, tasks, pedagogical strategies, methods of interaction, and the application of AI technologies (Adiguzel et al., 2023; Al-Azzam & Al-Oudat, 2025; Alkandari, 2025; Zheng et al., 2021). The true and versatile use of digital technologies in Education 4.0 also requires the development of four elements in the school community: learning environment/student learning, teachers' professionalism, partnerships/networking, and leadership (Ilomäki & Lakkala, 2018; Karakose et al., 2025a; Korhonen et al., 2014).

A common concern after the release of advanced technologies such as AI has been whether people will lose their jobs or these technologies will replace them with their outstanding performance. The same argument is occasionally made in the context of education, and people wonder whether robots with AI could replace teachers or educational administrators. However, as Mondal et al. (2023) once iterated, they could be only 'complementary to human teachers rather than a substitute' (p.203), and they do not make teachers redundant but charge them with new roles and responsibilities. In the new context, teachers have 'become facilitators of learning, rather than repositories of cultural wisdom' or knowledge (Kin et al., 2020, p. 4), inasmuch as designing personalized instruction that caters to the unique and changing needs of their students (Brown-Martin, 2018). To this end, students should no longer be viewed as the recipients of information but should be guided to seek and use knowledge in support of their own learning goals. Teachers could achieve this by making use of technological tools to make data-informed decisions about their students' progress, to provide students with a personalized experience of learning where students actively take part in designing the content and pace of their learning, to offer differentiated instruction that caters for the diverse needs of students, to provide customized and instant feedback to students both in and out of class, and to encourage peer collaboration and students' ownership of their learning. In brief, teachers should have the skills and knowledge of new technologies which can facilitate the aptitude, effort and learning environment of students as the three pillars of successful

learning (Robinson et al., 2013), and support each student's learning by providing personal counselling and assistance in their becoming autonomous learners (Paz-Albo, 2017).

It is a widely accepted notion that 'an educational innovation succeeds or fails with the teachers who shape it' (Lieberman & Pointer Mace, 2008), which also holds true for the case of the digital revolution of the educational landscape. This requires teachers to act both individually and collectively as change agents, initiators of innovation, and pursuers of professional development so that they can offer technologically mediated solutions to the complex needs of students.

3. Educational Leadership 4.0

Assuming that we all agree that Education 4.0 should target strengthening students' capabilities to act proactively and discerningly within the world of AI, the position and roles of educational leaders in this new educational landscape deserve closer attention (Fullan et al., 2023). Research in the educational leadership field has so far evidenced the significant role of educational leadership in student achievement, mostly indirectly through its impact on teacher and school-level variables (Sun & Leithwood, 2012; Özdemir et al., 2022). Studies show that educational leaders improve the effectiveness and performance of schools by increasing the commitment and satisfaction of teachers, enhancing their professional development, and creating a culture of trust and collaboration at school (Leithwood et al., 2020; Robinson et al., 2008). Educational leaders also have a critical role in promoting a culture of change and innovation by employing a smooth process of change that incorporates the efforts of all agents.

Education 4.0 requires an instant paradigm shift that would challenge the purpose, content, methods, and procedures of education accepted and practiced in schools for quite a long time. In such a context, the role of strong leadership attuned to the expectations of Education 4.0 becomes even more significant (Guzmán & Lewis, 2020), given that the concept of leadership is already associated with change, unlike management, which is more transactional in nature. In the leadership literature, scholars have reached a consensus that there is no one perfect leadership style, but the type of leadership required is determined by the interplay among the characteristics of the context, the followers, and the leader. Therefore, determining the leadership competencies necessary for the successful adaptation of schools to Education 4.0 can be a good starting point (Çetin & Karsintik, 2022; Karakose et al., 2025b; Kin & Kareem, 2019).

As Eberl and Drews (2021) underline, 'the challenge to digital transformation is not the availability of technology, but developing new leadership competencies' (p. 225). In the face of abrupt and drastic changes, flexibility, productivity, and agility are considered fundamental qualities for educational leaders to be able to act effectively in response to these changes (Oliveria & Saraiva, 2023). As suggested by Ghamrawi et al. (2024), such agile leadership, which incorporates elements of crisis management, constant professional development, and improved collective capacity of the school community, has become crucial in leading Education 4.0. successfully.

In addition to these basic qualities, educational leaders are expected to have certain competencies, most of which align with twenty-first-century skills. Kin and Kareem (2019) list eight essential competencies: communication, collaboration, critical thinking, creativity, innovation, decision-making, problem-solving, entrepreneurship, and technology. Similarly, Raksanakorn et al. (2022) summarize these competencies under four categories: problem-solving and decision-making skills, creative thinking skills, emotional intelligence, and interpersonal skills.

In another framework, Kin et al. (2020) identified eight core competencies for sustainable leadership in the Education 4.0 era (Figure 2). Leadership for learning is positioned at the center of this framework, which is surrounded by six core competencies; critical thinking, communication and ethics, collaboration, decision-making and problem-solving, entrepreneurial, and digital dexterity.

Emotional intelligence surrounds the whole framework as an essential component of all the other competencies. In leadership for learning, the two core tasks of schools – teaching and learning – are placed ‘at the center of technology integration efforts to maximize the possibilities of digital learning spaces’ (Richardson & Sterrett, 2018, p. 611).

Two prominent leadership scholars, Harris and Jones (2023), state that ‘leadership is fundamentally about making deep human connections and having compassion for others’. Indeed, schools are placed within the juxtaposition of cultural, social, economic, and political relationships in the wider society, and thus, emotions are often at play. In the face of the pressures of the constantly changing environment, stress and strong emotional reactions are often observed. As such, the emotional intelligence and communication skills of educational leaders become significant for promoting emotional equilibrium and wellbeing in the school community (Gómez-Leal et al., 2022; Kin et al., 2020; Moore, 2009).



Figure 2. Educational leadership competencies in the era of Education 4.0 (Kin et al., 2020)

As Education 4.0 urges schools to transform into a system based on collaborative and active problem-solving rather than fixed procedures, keeping the channels of communication open, engaging in transparent communication with the school community, and facilitating schoolwide collaboration in decision-making and problem-solving become the key responsibility for the educational leaders (Kin & Kareem, 2019; Tai et al., 2018). In the same vein, educational leaders’ emotional intelligence plays a vital role in supporting their reasoning and cognitive activities by enabling them to manage and understand their own emotions as well as others’ (Doe et al., 2015; Omer & Tai, 2018).

Since all transformation efforts in education aim to facilitate student learning and equip them with the skills they will need in their lives, leadership for learning maintains its significance during the new era. Based on the accumulated empirical results of the most effective leadership models on student outcomes, the models of instructional, transformational, and distributed/shared leadership were merged under the concept of ‘leadership for learning’ (Hallinger, 2011; Harris & Jones, 2019; Wu & Shen, 2022). Educational leaders practice instructional leadership through supervising and supporting instruction, collaborating with teachers, and promoting their professional development, enhancing students’ learning experience (Gurr et al., 2007; Zhan et al., 2023). Transformational leadership, on the other hand, aims at transforming schools into systems where the whole school community collaborates to realize constant improvement and change (Leithwood & Jantzi, 2007).

Transformational educational leaders promote change through four mechanisms: creating an idealized influence toward a shared vision, providing teachers with individual support, inspirational motivation, and intellectual stimulation to realize that vision (Anderson, 2017). As a result, transformational leaders create a culture of change and innovation, eventually facilitating student growth (Leithwood & Jantzi, 2005; Li & Karanxha, 2022).

As for the shared or distributed forms of leadership, the central role of the principal as an educational leader is minimized. In contrast, the leadership roles and responsibilities are shared by the school community. Considering the new context of schools that demands intensive work on restructuring the traditional educational landscape, assuming all the responsibility on the shoulders of the principal is neither rational nor sensible (Karakose et al., 2022). Therefore, building a schoolwide, collective leadership capacity and supporting the leadership of teachers becomes the central goal of leadership (Printy & Liu, 2021). In the new era, school improvement and effectiveness necessitate more of a collective initiative than an individual one (Brown et al., 2020; Camburn et al., 2003; Kin & Kareem, 2019).

Educational leaders' being entrepreneurial is crucial since it gives them the sensitivity to observe contextual problems before they get stagnant (Brauckmann-Sajkiewicz & Pashardis, 2022; Osiyevskyy et al., 2023). Critical thinking, on the other hand, helps educational leaders to view events from different perspectives and search for the best solution (Meemar, 2018). When these qualities are combined with creativity and innovativeness, it becomes easier for the school principal to redesign existing methods, materials, and practices and to enable sustained innovation.

Considering that effective integration of novel technologies into all facets of education is at the center of Education 4.0, educational leaders are expected to have the knowledge of these technologies, and be a role model in applying them. In addition, the capabilities of educational leaders to exploit existing or forthcoming technologies, e., digital dexterity, and embracing these technologies as a means of facilitating teaching and learning become crucial for effective leadership (Kin et al., 2020).

Oberer and Erkollar (2018) state, 'a significant challenge for Industry 4.0 is not only to find or implement the right technology, it is also a lack of digital culture and skills in the organization' (p. 5). They also offer a leadership 4.0 model for a successful transformation. Accordingly, these leaders, also called 'digital leaders', recognize the importance of people, technologies, and innovations, and understand the mutual influence of human-machine interaction. With their developed personal skills, open-mindedness, and knowledge of new technologies, digital leaders will likely achieve strategic success in sustained digital transformation (Guzmán et al., 2020; Oberer & Erkollar, 2018). Digital transformation is, by all means, not confined to applying newer technologies but includes the alignment of these technologies with the structure, culture, people, and tasks (Shin et al., 2023). Therefore, the basic competencies elaborated earlier maintain their significance for effective digital leadership. When applied effectively, digital leadership can make a difference in the era of Education 4.0 since it is agile, cross-hierarchical, team-based, and cooperation-oriented with a strong focus on innovation (Guzmán et al., 2020).

In the educational leadership field, digital leadership is defined as the leadership to bring about change using digital devices (Hamzah et al., 2021), and digital leaders are expected 'to mobilize, implement, and absorb the use of digital devices as a medium of teaching and learning through strategic planning aligned with the vision of the school' (International Society for Technology in Education (ISTE), 2023). Accordingly, the ISTE Standard defines five dimensions of digital leadership as visionary leadership, digital era learning culture, excellence in professional practice, systemic improvement, and digital citizenship.

As one of the prominent scholars who conducted some intensive work on digital leadership, Sheninger (2014) identified five pillars of digital leadership: communication, professional development and growth, rethinking classroom spaces and learning environments, facilitating student engagement and learning, and discovering opportunities. By means of these, digital leaders can leverage the use of technology in support of student learning (Lander, 2020). In a similar vein, Karakose et al. (2021) found that digital educational leaders have five basic qualities: pertinent use of digital technologies, support for digital transformation, support for technology-based professional development, creating a digital learning culture, and having good managerial, interpersonal, and digital skills. These results also stress that digital leadership is beyond having access to newer technologies but necessitates building a vision and strategy of technology integration and conveying this to the whole school community through establishing a new digital culture (AlAjmi, 2022; Shin et al., 2023).

Considered as a whole, the scope of digital leadership extends from being visionary to creating a digital learning culture, from emphasizing certain values to enabling continuous professional development, from realizing systemic improvement and partnerships to enabling digital citizenship (Table 1).

As summarized in Table 1, digital leaders first establish a vision for technology integration and draw a clear plan to realize this vision with the participation of all educational agents, which is crucial for building a shared vision. Concordantly, these leaders ensure the accessibility of new technologies and act as a role model in utilizing these technologies in support of teaching and learning. At this stage, it is also essential to promote professional development of not only teachers but also of themselves to build a digital learning community. In the digital era, building strategic partnerships and developing networks also emerge as significant means of supporting the school community in their efforts to follow and integrate the latest technologies. Successful digital transformation could better be supported by making these values an integral part of the new culture: diversity and inclusion, sustainability, trust, freedom to experiment, openness, transparency, student centrality, and a focus on teachers (Karakose et al., 2022; Zhong, 2017).

Table 1. Components of Digital Leadership*

<i>Visionary Leadership</i>	Creating a clear vision of technology Building strategies to support all agents
<i>Digital Learning Environment</i>	Enabling access to digital devices Modeling technology use Guiding effective technology utilization
<i>Professional Development</i>	Providing opportunities Creating a learning community
<i>Developing a Digital Learning Environment</i>	Maximizing learning Employing competent staff Building strategic partnerships/networking
<i>Values</i>	Openness / open communication channels Transparency and customer-centricity Freedom to experiment Diversity and inclusion Teacher focus/trust Sustainability
<i>Digital Citizenship</i>	Digital filtering / responsible use of technology

* Adapted from: Eberl & Drews, 2021; Zhong, 2017.

The efforts to align the educational landscape with the demands of Industry 4.0 can also be interpreted as a new scale of school improvement. Studies on school improvement often point out leadership as a major factor in enabling improvement (Liljenberg & Wrethander, 2023). Tam et al. (2018) explain that school improvement requires effective management of change and can be achieved by changing schools' organizational, social, and intellectual capital. At the organizational level, the knowledge, skills, and practices of change management should support and guide the social and intellectual capital of the school. The intellectual capital comprises the knowledge, skills, values, and dispositions towards technology integration. In contrast, social capital refers to the mutual respect and trust among all teachers, students, and parents supported by open communication channels and networks. Among these capitals, social capital is considered the most influential in the success of change. According to this framework, digital educational leaders should engage in developing the intellectual capital of the school by providing professional development opportunities and building a strong social capital.

Research shows that most of the change initiatives in organizations end up with failure because employers reject enacting the change (Rehman et al., 2021). This resistance often comes from the fear of the unknown. This fear emanates from their assumption that the expected change will attack their immediate world, which they have worked hard to build and feel comfortable with its established routines. It also results from being overwhelmed or unable to adapt, significantly reducing self-confidence and efficacy beliefs. Therefore, the success of a change initiative depends on leaders' effective management of individual and collective perceptions about it and requires taking strong measures to ensure security and necessary training (Elbanna & Armstrong, 2023).

Another leadership model developed recently from the investigations into how insects like ants or bees survive changing circumstances through collective behavior and intelligence. Swarm leadership, as it is called, is considered to be a viable means of encouraging the flexibility, robustness, decentralized decision-making, and self-organization demanded by Industry 4.0 (Guzmán et al., 2020). This leadership is enacted through the collaborative and adaptive work of individuals within a group. It aims to leverage the collective intelligence – so-called swarm intelligence – of that group to respond quickly to the changing circumstances. The use of swarm intelligence often produces more complex and intelligent outcomes than an individual agent could achieve alone. Consequently, swarm leadership increases the collective capacity and agility of the group to solve problems and make decisions efficiently in dynamic and uncertain environments. With all these benefits, swarm leadership seems to be an appropriate model to turn schools into digitally enhanced learning environments and to achieve the Education 4.0 ideal.

4. The Challenge Awaiting Educational Leaders

The breakthroughs in AI and AI-based technologies have accelerated debates over what threats could accompany their benefits and what the world would look like in the near future if these AI tools occupied all facets of human life. Like in other areas, these technologies come with their risks and challenges for education while supporting learning and teaching at school (Fullan et al., 2023).

One of the inherent challenges for educational leaders could be managing what outcomes these rapidly transforming technologies produce for better or worse, since these changes occur even before people engage in and understand their earlier versions. Consider ChatGPT, for instance. While people were exploring the astonishing features of its previous versions, OpenAI released its latest version, ChatGPT 4.0, with all the alluring and mind-blowing capabilities. Although people who faced such a technology for the first time in their lives were fascinated by its extraordinary capabilities, many from diverse backgrounds soon engaged in hot discussions about their potential threat to the existing systems in society. From the perspective of education, for example, its strong potential to instigate and ease academic dishonesty (cheating) was among these hot topics. As the current

student population was exposed to traditional teaching and evaluation methods, the instant emergence of such a technology in the arena made educational agents raise eyebrows. In this context, many educational leaders' first reaction was to ban its use, considering it a threat to education. However, it is significant to acknowledge that these technologies have entered the educational landscape since the day they appeared on the stage and have the potential to bring both beneficial and hazardous outcomes (Heath et al., 2022; Limna et al., 2022).

Another significant challenge of these technologies is the digital divide they create in society, which is very likely to deepen the already-existing injustices in education (Lythreath et al., 2022; Rhoades & Brundrett, 2009). However, enabling the beneficial and equitable use of these technologies by all students is one of the key liabilities of educational leaders (Montenegro-Rueda et al., 2023). Although public schools are already incumbent on providing all students with the opportunities to develop the skills they need to fully participate in "Society 4.0" characterized by high tech job market and global networking, the widening digital divide between students from diverse backgrounds, socioeconomic status, and ethnicity stands as a significant challenge to realizing this goal (Flanagan & Jacobsen, 2003).

A new phenomenon that appeared in Society 4.0 is 'digital addiction', which basically comprises addiction to any online or offline digital tools such as smartphones, social media, and video games (Allcott et al., 2022; Basel et al., 2020). Usually starting with an extreme and impulsive use of these technologies, digital addiction was evidenced to give harm to young people's brain functions, decrease their academic achievement, interfere with their daily responsibilities, and have adverse effects on their healthy routines and interaction patterns (Karakose & Polat, 2025; Meng et al., 2022).

Adolescents, most of whom are students, make up the most vulnerable group to digital addiction and its adverse effects (Al-Khani et al., 2021; Kuss & Lopez-Fernandez, 2016). This presents another novel case to be dealt with by educational agents, particularly educational leaders, so that they can transform these technologies into a power to leverage their digital knowledge and competencies rather than becoming slaves to them.

This AI age, then, brings additional responsibilities to educational leaders. Fundamentally, educational leaders have to engage in the challenging process of updating their knowledge of these AI-based, digital technologies even before they become integral to students' lives. Providing direction and guidance to lead healthy technology integration school-wide, educational leaders have to 'fill any gaps in their technological knowledge and skills... spread this practice to the school learning environment' (Hamzah et al., 2021, p. 217). In addition, they have to be aware of their key role in discovering the benefits of these technologies on one side, while devising measures to tackle their risks on the other. In the current circumstances, educational leaders turning their backs on these technologies or completely banning them would be as absurd as an ostrich burying its head in the sand.

Research on the influence of these technologies has recently provided several benefits such as assisting teachers and students during the course of their studies, offering diverse means and materials that could cater for students' personal learning needs, producing more intelligent and interesting content, and enhancing school effectiveness/efficiency through optimizing the management of schools (Limna et al., 2022; Montenegro-Rueda et al., 2023). However, much of this research also underlines that the optimum use of these technologies necessitates effective means of human-machine collaboration (Sallam et al., 2023) so that they could empower teachers and make the teaching process more engaging, hence achieving better learning outcomes (Tlili et al., 2023). To enable this, educational leaders need to tackle such issues as the 'new ethical and societal risks, including perpetuating systemic bias and discrimination, compromising students' privacy, increasing student monitoring and surveillance, jeopardizing student autonomy, disadvantaging traditionally

marginalized students, and amplifying racism, sexism, xenophobia, and other forms of inequity (Trust et al., 2023).

5. Conclusion and Final Thoughts

The value of this paper lies in its capacity to point toward the possible implications of the new context of education in the twenty-first century, which is characterized by instant and unprecedented technological breakthroughs. The paper has particularly focused on the implications of these dramatic changes in the realm of technology to the role of the educational leader and attempted to offer broader perspectives, building upon the requirements of Industry 4.0, Society 4.0, and Education 4.0.

In the face of the very complex, hard-to-control, rapidly changing, and often unpredictable technological trends, educational leadership has become even more of a challenge than in the past. In brief, in the new education landscape, ‘on the one hand, there seems more to control but, on the other hand, control seems harder to come by’ (Shepherd, 2004, p. 2). Under these circumstances, putting all the responsibility and burden of adapting education to its changing environment on a single, hero-leader – i.e., the principal – seems unlikely to produce the desired outcomes of Education 4.0. In this context, the shared/distributed forms of leadership built upon a shared vision of technology integration, a climate of cooperation and trust, and a strong desire to pursue continuous professional development are warranted (Luksha & Kinsner, 2020).

Early studies revealed that technology-savvy educational leaders/communities act as the building blocks of a school’s progress in technology integration (Anderson & Dexter, 2005; Sterret & Richardson, 2020). To achieve this, educational leaders need to determine a clearer direction on optimally combining technological resources and educational theories to improve students’ learning experience and to equip them with the competencies of this age (Dexter, 2011).

In the new era of Education 4.0., educational leaders are still charged with developing a vision, generating and ensuring the implementation of school improvement plans, developing and sustaining a climate of trust, promoting collaboration/cooperation, keeping the communication channels open, and effectively managing the process of change (Çetin & Karsantik, 2022), but this time with more creative, diverse, and innovative ways of thinking (Fullan et al., 2023). Only then can they enable technology to facilitate education rather than dominate it, and serve the goals of Education 4.0 to cultivate students’ potential as citizens of the future society (Avidov-Ungar et al., 2022; Zhai & Pellegrino, 2023).

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References

- Adiguzel, T., Kaya, M. H., & Cansu, F. K. (2023). Revolutionizing education with AI: Exploring the transformative potential of ChatGPT. *Contemporary Educational Technology*, 15(3), ep429. <https://doi.org/10.30935/cedtech/13152>
- Advani, A. (2023). Education 4.0: Here are three skills that students will need for the jobs of the future. <https://www.weforum.org/agenda/2023/01/skillsetscultivatedbyeducation40davos23/>
- AlAjmi, M. K. (2022). The impact of digital leadership on teachers' technology integration during the COVID-19 pandemic in Kuwait. *International Journal of Educational Research*, 112, 101928. <https://doi.org/10.1016/j.ijer.2022.101928>
- Al-Azzam, S. H., & Al-Oudat, M. (2025). Artificial Intelligence-Based Classification and Prediction of Academic and Psychological Challenges in Higher Education. *Educational Process: International Journal*, 15, e2025150. <https://doi.org/10.22521/edupij.2025.15.150>
- Al-Dosari, I., Albahiri, M. & Alhaj, A. (2025). Enhancing AI Utilization Skills in Education: Challenges and Proposals for Elementary School Teachers in Bisha. *Educational Process: International Journal*, 16, e2025242. <https://doi.org/10.22521/edupij.2025.16.242>
- Al-Khani, A. M., Saquib, J., Rajab, A. M., Khalifa, M. A., Almazrou, A., & Saquib, N. (2021). Internet addiction in Gulf countries: A systematic review and meta-analysis. *Journal of Behavioral Addictions*, 10(3), 601610. <https://doi.org/10.1556/2006.2021.00057>
- Alkandari, H. (2025). Students' learning in the time of Artificial Intelligence (AI): Students' perceptions of using AI tools to improve their language learning in Kuwait. *Educational Process: International Journal*, 15, e2025154. <https://doi.org/10.22521/edupij.2025.15.154>
- Allcott, H., Gentzkow, M., & Song, L. (2022). Digital addiction. *American Economic Review*, 112(7), 24242463. <https://doi.org/10.1257/aer.20210867>
- Anderson, M. (2017). Transformational leadership in education: A review of existing literature. *International Social Science Review*, 93(1), 113. <https://www.jstor.org/stable/90012919>
- Anderson, R. E., & Dexter, S. (2005). School technology leadership: An empirical investigation of prevalence and effect. *Educational Administration Quarterly*, 41(1), 49–82. <https://doi.org/10.1177/0013161X04269517>
- Anggraeni, C. W. (2018). Promoting Education 4.0 in English for survival class: What are the challenges? *Metathesis Journal of English Language, Literature, and Teaching*, 2, 12–24. <https://doi.org/10.31002/metathesis.v1i2.676>
- Avidov-Ungar, O., ShamirInbal, T., & Blau, I. (2022). Typology of digital leadership roles tasked with integrating new technologies into teaching: Insights from metaphor analysis, *Journal of Research on Technology in Education*, 54(1), 92107. <https://doi.org/10.1080/15391523.2020.1809035>
- Basel, A. M., McAlaney, J., Skinner, T., Pleva, M., & Ali, R. (2020). Defining digital addiction: Key features from the literature. *Psihologija*, 53(3), 237253. <https://www.ceeol.com/search/articledetail?id=878143>
- Bower, M. (2019). Technology-mediated learning theory. *British Journal of Educational Technology*, 50(3), 10351048. <https://doi.org/10.1111/bjet.12771>
- Brauckmann-Sajkiewicz, S., & Pashirdis, P. (2022). Entrepreneurial leadership in schools: Linking creativity with accountability. *International Journal of Leadership in Education*, 25(5), 787801. <https://doi.org/10.1080/13603124.2020.1804624>
- Branson, C., & Marra, M. (2020). Industry 4.0, democracy and education: What these mean for school culture and leadership right now?. *Leadership in Education*, 18, 1731.
- Brown, C., MacGregor, S., & Flood, J. (2020). Can models of distributed leadership be used to mobilise networked generated innovation in schools? A case study from England. *Teaching and Teacher Education*, 94, 103101. <https://doi.org/10.1016/j.tate.2020.103101>

- Brown-Martin, G. (2018). *Education and the fourth industrial revolution*. <https://medium.com/learningreimagined/educationandthefourthindustrialrevolutioncd6bcd7256a3>
- Busalim, A. H., Masrom, M., & Zakaria, W. N. B. W. (2019). The impact of Facebook addiction and self-esteem on students' academic performance: A multigroup analysis. *Computers & Education*, 142. <https://doi.org/10.1016/j.compedu.2019.103651>.
- Camburn E. M., Rowan B., Taylor J. E. (2003). Distributed leadership in schools: The case of elementary schools adopting comprehensive school reform models. *Educational Evaluation and Policy Analysis*, 25(4), 347–373. <https://doi.org/10.3102/01623737025004347>
- Castañeda, L., & Selwyn, N. (2018). More than tools? Making sense of the ongoing digitizations of higher education. *International Journal of Educational Technology in Higher Education*, 15(1), 110. <https://doi.org/10.1186/s412390180109y>
- Çetin, M., & Karsantik, I. (2022). Current trends in school management: Educational leadership in Education 4.0. In Y. Alpaydin & C. Demirli (Eds.) *Educational Theory in the 21st Century: Science, Technology, Society and Education* (pp. 197216). Singapore: Springer Nature.
- Daniëls, E., Hondeghem, A., & Dochy, F. (2019). A review on leadership and leadership development in educational settings. *Educational Research Review*, 27, 110125. <https://doi.org/10.1016/j.edurev.2019.02.003>
- Dexter, S. (2011). School technology leadership: Artifacts in systems of practice. *Journal of Educational leadership*, 21(2), 166189. <https://doi.org/10.1177/105268461102100202>
- Doe, R., Ndinguri, E., & Phipps, S. T. (2015). Emotional intelligence: The link to success and failure of leadership. *Academy of Educational Leadership Journal*, 19(3), 105.
- Eberl, J.K., Drews, P. (2021). Digital leadership – mountain or molehill? A literature review. In: Ahlemann, F., Schütte, R., Stieglitz, S. (eds) *Innovation Through Information Systems. WI 2021. Lecture Notes in Information Systems and Organisation* (vol. 48, pp. 223237). Springer, Cham. https://doi.org/10.1007/9783030868000_17
- Elbanna, S., & Armstrong, L. (2023). Exploring the integration of ChatGPT in education: Adapting for the future. *Management & Sustainability: An Arab Review*. <https://doi.org/10.1108/MSAR0320230016>
- Evers, C. W., & Lakomski, G. (1996). Science in educational administration: A postpositivist conception. *Educational Administration Quarterly*, 32(3), 379402. <https://doi.org/10.1177/0013161X96032003005>
- Farrokhnia, M., Banihashem, S. K., Noroozi, O., & Wals, A. (2023). A SWOT analysis of ChatGPT: Implications for educational practice and research. *Innovations in Education and Teaching International*, 115. <https://doi.org/10.1080/14703297.2023.2195846>
- Flanagan, L., & Jacobsen, M. (2003). Technology leadership for the twenty-first century principal. *Journal of Educational Administration*, 41(2), 124142. <https://doi.org/10.1108/09578230310464648>
- Frieder, S., Pinchetti, L., Griffiths, R. R., Salvatori, T., Lukasiewicz, T., Petersen, P. C., ... & Berner, J. (2023). Mathematical capabilities of ChatGPT. *arXiv preprint arXiv:2301.13867*. <https://doi.org/10.48550/arXiv.2301.13867>
- Fullan, M. (2021). *The right drivers for whole system success*. Melbourne, Australia: Centre for Strategic Education
- Fullan, M., Azorín, C., Harris, A., & Jones, M. (2023). Artificial intelligence and educational leadership: Challenges, opportunities and implications. *Educational leadership & Management*, 18. <https://doi.org/10.1080/13632434.2023.2246856>
- García, B., AlarioHoyos, C., PérezSanagustín, M., Morales, M., & Jerez, O. (2022). The effects of the COVID19 pandemic on the digital competence of educators. *Electronics*, 12(1), 8285. <https://doi.org/10.3390/electronics12010082>

- Ghamrawi, N., Shal, T., & Ghamrawi, N. A. (2024). Educational leadership 4.0: Are We Ready?. In *IoT, AI, and ICT for educational applications: Technologies to enable education for all* (pp. 173190). Cham: Springer Nature Switzerland.
- Gómez-Leal, R., Holzer, A. A., Bradley, C., Fernández-Berrocal, P., & Patti, J. (2022). The relationship between emotional intelligence and leadership in educational leaders: A systematic review. *Cambridge Journal of Education*, 52(1), 121. <https://doi.org/10.1080/0305764X.2021.1927987>
- González-Pérez, L. I., & Ramírez-Montoya, M. S. (2022). Components of Education 4.0 in 21st century skills frameworks: Systematic review. *Sustainability*, 14(3), 14931524. <https://doi.org/10.3390/su14031493>
- Gurr, D., Drysdale, L., & Mulford, B. (2007). Instructional leadership in three Australian schools. *International Studies in Educational Administration* (Commonwealth Council for Educational Administration & Management (CCEAM), 35(3), 2029.
- Guzmán, V. E., Muschard, B., Gerolamo, M., Kohl, H., & Rozenfeld, H. (2020). Characteristics and skills of leadership in the context of Industry 4.0. *Procedia Manufacturing*, 43, 543550. <https://doi.org/10.1016/j.promfg.2020.02.167>
- Hallinger, P. (2003). Leading educational change: Reflections on the practice of instructional and transformational leadership. *Cambridge Journal of Education*, 33(3), 329352. <https://doi.org/10.1080/0305764032000122005>
- Hallinger, P. (2011). Leadership for learning: Lessons from 40 years of empirical research. *Journal of Educational Administration*, 49(2), 125142. <https://doi.org/10.1108/09578231111116699>
- Hamzah, N. H., Nasir, M. K. M., & Wahab, J. A. (2021). The effects of principals' digital leadership on teachers' digital teaching during the COVID19 pandemic in Malaysia. *Journal of Education and E-Learning Research*, 8(2), 216221. <https://doi.org/10.20448/journal.509.2021.82.216.221>
- Harris, A., & Jones, M. (2023). Compassionate leadership. *Educational leadership & Management* 43(3), 185–188. <https://doi.org/10.1080/13632434.2023.2235540>.
- Heath, M., Asim, S., Milman, N., & Henderson, J. (2022). Confronting tools of the oppressor: Framing just technology integration in educational technology and teacher education. *Contemporary Issues in Technology and Teacher Education*, 22(4), 754777.
- Henriksen, D., Woo, L. J., & Mishra, P. (2023). Creative uses of ChatGPT for education: A conversation with Ethan Mollick. *TechTrends*, 67, 595–600. <https://doi.org/10.1007/s1152802300862w>
- Hitt, D. H., & Meyers, C. V. (2018). Beyond turnaround: A synthesis of relevant frameworks for leaders of sustained improvement in previously low-performing schools. *Educational leadership & Management*, 38(1), 431. <https://doi.org/10.1080/13632434.2017.1374943>
- Hitt, D. H., & Tucker, P. D. (2016). Systematic review of key leader practices found to influence student achievement: A unified framework. *Review of Educational Research*, 86(2), 531569. <https://doi.org/10.3102/0034654315614911>
- Hoehe, M. R. & Thibaut, F. (2020). Going digital: How technology use may influence human brains and behavior. *Dialogues in Clinical Neuroscience*, 22(2), 9397. <https://doi.org/10.31887/DCNS.2020.22.2/mhoehe>
- Hodson, R. (2018). Digital revolution. *Nature*, 563(7733), 131. <https://doi.org/10.1038/d4158601807500z>
- Huber, S. & West, M. (2002). Developing educational leaders: A critical review of current practices, approaches and issues and some directions for the future. In K. Leithwood, P. Hallinger (Eds.), *Second international handbook of educational leadership and administration*, Part 2, (pp.10711099). Kluwer Press.
- Huk, T. (2021). From education 1.0 to education 4.0: challenges for the contemporary school. *The New Educational Review*, 66, 3646. <https://doi.org/10.15804/tner.2021.66.4.03>

- Ilomäki, L., & Lakkala, M. (2018). Digital technology and practices for school improvement: innovative digital school model. *Research and Practice in Technology Enhanced Learning*, 13(25), 132. <https://doi.org/10.1186/s4103901800948>
- İpek, Z. H., Gözümlü, A. İ. C., Papadakis, S., & Kallogiannakis, M. (2023). Educational applications of the ChatGPT AI system: A systematic review research. *Educational Process International Journal*, 12(3), 2655. <https://dx.doi.org/10.22521/edupij.2023.123.2>
- International Society for Technology in Education (ISTE). (2023). *International technology standards for education leaders*. <https://iste.org/standards/educationleaders>
- Joseph, R., & HamiltonEkeke, J. T. (2016). A review of digital addiction: A call for safety education. *Journal of Education and eLearning Research*, 3(1), 1722. <https://eric.ed.gov/?id=EJ1148542>
- Karakose, T., & Polat, H. (2025). Science Mapping of the Knowledge Base on the Effects of Artificial Intelligence (AI)Based Chatbots on Student Learning Outcomes: A Bibliometric Study. In: Lampropoulos, G., Papadakis, S. (eds) *Social Robots in Education. Studies in Computational Intelligence*, vol 1194. Springer, Cham. https://doi.org/10.1007/9783031829154_18
- Karakose, T., Demirkol, M., Yirci, R., Polat, H., Ozdemir, T. Y., & Tülübaş, T. (2023). A conversation with ChatGPT about digital leadership and technology integration: Comparative analysis based on human–AI collaboration. *Administrative Sciences*, 13(7), 157. <https://doi.org/10.3390/admsci13070157>
- Karakose, T., Gurr, D., Tülübaş, T., & Kanadlı, S. (2025a). What factors mediate the relationship between leadership for learning and teacher professional development? Evidence from meta-analytic structural equation modelling. *Educational Management Administration & Leadership*, 0(0). <https://doi.org/10.1177/17411432241308461>
- Karakose, T., Kocabas, I., Yirci, R., Papadakis, S., Ozdemir, T. Y., & Demirkol, M. (2022). The development and evolution of digital leadership: A bibliometric mapping approach-based study. *Sustainability*, 14(23), 16171. <https://doi.org/10.3390/su142316171>
- Karakose, T., Polat, H., & Papadakis, S. (2021). Examining teachers' perspectives on school principals' digital leadership roles and technology capabilities during the COVID19 pandemic. *Sustainability*, 13(23), 13448. <https://doi.org/10.3390/su132313448>
- Karakose, T., Tülübaş, T., Kanadlı, S., & Gurr, D. (2025b). What factors mediate the relationship between principal leadership and teacher professional learning? Evidence from meta-analytic structural equation modelling (MASEM). *Journal of Educational Administration*, 63(1), 6376. <https://doi.org/10.1108/JEA0520240160>
- Kaufman, K. J. (2013). 21 ways to 21st century skills: Why students need them and ideas for practical implementation, *Kappa Delta Pi Record*, 49(2), 7883. <http://doi.org/10.1080/00228958.2013.786594>
- Kin, T. M., & Kareem, O. A. (2019). Educational leaders' competencies that make a difference in the era of education 4.0: A conceptual framework. *International Journal of Academic Research in Business and Social Sciences*, 9(5), 214–225. <https://doi.org/10.6007/IJARBS/v9i4/5836>
- Kin, T. M., Kareem, O. A., Musa, K., Ghouri, A. M., & Khan, N. R. (2020). Leading sustainable schools in the era of Education 4.0: Identifying educational leadership competencies in Malaysian secondary schools. *International Journal of Management in Education*, 14(6), 580610. <https://doi.org/10.1504/IJMIE.2020.110690>
- Korhonen, T., Lavonen, J., Kukkonen, M., Sormunen, K., & Juuti, K. (2014). The innovative school as an environment for the design of educational innovations. In H. Niemi, J. Multisilta, L. Lipponen, & M. Vivitsou (Eds.), *Finnish innovations and technologies in schools* (pp. 99–113). Rotterdam: Sense Publishers.
- Kuss, D. J. , & LopezFernandez, O. (2016). Internet addiction and problematic internet use: A systematic review of clinical research. *World Journal of Psychiatry*, 6(1), 143–176. <https://doi.org/10.5498/wjp.v6.i1.143>

- Lander, J. (2020). The relationship between principals' pillars of digital leadership, aligned values and actions, and teacher technology use. Unpublished Dissertation, St. John's University, New York.
- Larson, L. C., & Miller, T. N. (2011). 21st century skills: Prepare students for the future. *Kappa Delta Pi Record*, 47(3), 121–123. <https://doi.org/10.1080/00228958.2011.10516575>
- Leithwood, K., Harris, A., & Hopkins, D. (2020). Seven strong claims about successful educational leadership revisited. *Educational Leadership & Management*, 40(1), 522. <https://doi.org/10.1080/13632434.2019.1596077>
- Leithwood, K., & Jantzi, D. (2005). A review of transformational educational leadership research 1996–2005. *Leadership and Policy in Schools*, 4(3), 177–199. <https://doi.org/10.1080/15700760500244769>
- Leithwood, K., & Jantzi, D. (2007). Transformational educational leadership for large-scale reform: Effects on students, teachers, and their classroom practices. *School Effectiveness and School Improvement*, 17(2), 201–227. <https://doi.org/10.1080/09243450600565829>
- Levin, B. B., & Schrum, L. (2014). Lessons learned from secondary schools using technology for school improvement: It's just not that simple!. *Journal of Educational Leadership*, 24(4), 640–665.
- Li, Y., & Karanxha, Z. (2022). Literature review of transformational educational leadership: Models and effects on student achievement (2006–2019). *Educational Management Administration & Leadership*. <https://doi.org/10.1177/17411432221077157>
- Li, Y. Y., Sun, Y., Meng, S. Q., Bao, Y. P., Cheng, J. L., Chang, X. W., ... & Shi, J. (2021). Internet addiction increases in the general population during COVID-19: Evidence from China. *The American Journal on Addictions*, 30(4), 389–397. <https://doi.org/10.1111/ajad.13156>
- Lieberman, A., & Pointer Mace, D. H. (2008). Teacher learning: The key to educational reform. *Journal of Teacher Education*, 59(3), 226–234. <https://doi.org/10.1177/0022487108317020>
- Liljenberg, M., & Wrethander, M. (2023). Leadership for school improvement—linking learning to leading over time. *Professional Development in Education*, 49(1), 30–44. <https://doi.org/10.1080/19415257.2020.1752288>
- Limna, P., Jakwatanatham, S., Siripipattanakul, S., Kaewpuang, P., & Sriboonruang, P. (2022). A review of artificial intelligence (AI) in education during the digital era. *Advance Knowledge for Executives*, 1(1), 19. <https://ssrn.com/abstract=4160798>
- Luksha, P., & Kinsner, W. (2020). Transformation into a new education paradigm and the role of ecosystemic leadership. *Cadmus*, 4(2), 182–198. <https://www.cadmusjournal.org/files/pdfreprints/vol4issue2/TransformationintoaNewEducationParadigmPLukshaWKinsnerCadmusV4I2P2Reprint.pdf>
- Luo, W., He, H., Liu, J., Berson, I. R., Berson, M. J., Zhou, Y., & Li, H. (2023). Aladdin's genie or Pandora's box for early childhood education? Experts chat on the roles, challenges, and developments of ChatGPT. *Early Education and Development*. <https://doi.org/10.1080/10409289.2023.2214181>
- Lythreathis, S., Singh, S. K., & ElKassar, A. N. (2022). The digital divide: A review and future research agenda. *Technological Forecasting and Social Change*, 175, 121–139. <https://doi.org/10.1016/j.techfore.2021.121359>
- Meemar, S. S. (2018). Exploring the relationship between thinking skills and educational leaders' performance. *International Journal for Research in Education*, 42(2), 266–288. <https://scholarworks.uaeu.ac.ae/ijre/vol42/iss2/8>
- Meng, S. Q., Cheng, J. L., Li, Y. Y., Yang, X. Q., Zheng, J. W., Chang, X. W., ... & Shi, J. (2022). Global prevalence of digital addiction in general population: A systematic review and meta-analysis. *Clinical Psychology Review*, 92, 102–128. <https://doi.org/10.1016/j.cpr.2022.102128>
- De Kare-Silver, M. (2011). E-shock 2020: how the digital technology revolution is changing business and all our lives. Springer.

- Mondal, H., Marndi, G., Behera, J. K., & Mondal, S. (2023). ChatGPT for teachers: Practical examples for utilizing artificial intelligence for educational purposes. *Indian Journal of Vascular and Endovascular Surgery*, 10(3), 200205 https://doi.org/10.4103/ijves.ijves_37_23
- Montenegro-Rueda, M., Fernández-Cerero, J., Fernández-Batanero, J. M., & López-Meneses, E. (2023). Impact of the implementation of ChatGPT in education: A systematic review. *Computers*, 12(8), 153. <https://doi.org/10.3390/computers12080153>
- Morgado, E., Leonido, L., Pereira, A., & Gouveia, L. B. (2025). Technology-Mediated Education: Impact of AI on the main distance learning modalities. *Educational Process: International Journal*, 16, e2025211 <https://doi.org/10.22521/edupij.2025.16.211>
- Moore, B. (2009). Emotional intelligence for school administrators: A priority for school reform?. *American Secondary Education*, 2028. <https://www.jstor.org/stable/41406313>
- Murad, I. A., Surameery, N. M. S., & Shakor, M. Y. (2023). Adopting ChatGPT to Enhance Educational Experiences. *International Journal of Information Technology & Computer Engineering*, 3(1), 2025. <https://doi.org/10.55529/ijitc.35.20.25>
- Noever, D., & McKee, F. (2023). Chatbots as problem solvers: Playing twenty questions with role reversals. *arXiv preprint*, arXiv:2301.01743. <https://doi.org/10.48550/arXiv.2301.01743>
- Noh, S.C.; Karim, A.M.A. (2021). Design thinking mindset to enhance education 4.0 competitiveness in Malaysia. *IJERE*, 10(2), 494502. <https://eric.ed.gov/?id=EJ1299320>
- Oberer, B., & Erkollar, A. (2018). Leadership 4.0: Digital leaders in the age of industry 4.0. *International Journal of Organizational Leadership*. <https://ssrn.com/abstract=3337644>
- Oliveira, S. R. M., & Saraiva, M. A. (2023). Leader skills interpreted in the lens of education 4.0. *Procedia Computer Science*, 217, 12961304. <https://doi.org/10.1016/j.procs.2022.12.327>
- Omar, A. K., & Tai, M. K. (2018). The development of principal change leadership emotional intelligence model. *International Journal of Management in Education*, 12(3), 276313. <https://doi.org/10.1504/IJME.2018.092871>
- Omar, A. K., & Tai, M. K. (2019). Emotional intelligence of school principals in managing change: Malaysian perspective. *International Journal of Management in Education*, 13(3), 281306. <https://doi.org/10.1504/IJME.2019.100414>
- Osiyevskyy, O., Sinha, K. K., Sarkar, S., & Dewald, J. (2023). Thriving on adversity: Entrepreneurial thinking in times of crisis. *Journal of Business Strategy*, 44(1), 2129. <https://doi.org/10.1108/JBS0620210110>
- Ouyang, S., Zhang, J. M., Harman, M., & Wang, M. (2023). LLM is like a box of chocolates: The nondeterminism of ChatGPT in code generation. *arXiv preprint*, arXiv:2308.02828. <https://doi.org/10.48550/arXiv.2308.02828>
- Özdemir, N., Gümüş, S., Kılınc, A. Ç., & Bellibaş, M. Ş. (2022). A systematic review of research on the relationship between educational leadership and student achievement: An updated framework and future direction. *Educational Management Administration & Leadership*. <https://doi.org/10.1177/17411432221118662>
- Ozdogru, M., Tulubas, T., Karakose, T., Kanadlı, S., Kardas, A., & Papadakis, S. (2025). How does teacher self-efficacy mediate the relationship between student outcomes and principal leadership for learning? Results from meta-analytic structural equation modelling (MASEM). *Acta Psychologica*, 258, 105144. <https://doi.org/10.1016/j.actpsy.2025.105144>
- Pata, K., Tammets, K., Väljataga, T., Kori, K., Laanpere, M., & Rõbtsenkov, R. (2022). The patterns of school improvement in digitally innovative schools. *Technology, Knowledge and Learning*, 27(3), 823841. <https://doi.org/10.1007/s10758021095145>
- PazAlbo, J. (2017). Is Personalized Learning the Future of School?, *Childhood Education*, 93(4), 295299. <https://doi.org/10.1080/00094056.2017.1343581>
- Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon*, 9(5), 16. <https://doi.org/10.1108/10748120110424843>

- Printy, S., & Liu, Y. (2021). Distributed leadership globally: The interactive nature of principal and teacher leadership in 32 countries. *Educational Administration Quarterly*, 57(2), 290325. <https://doi.org/10.1177/0013161X20926548>
- Raksanakorn, K., Khumsamart, S., & Ratthanarin, T. (2022). The leadership enhancement in Education 4.0 school administrators. *International Education Studies*, 15(3), 7784. <https://doi.org/10.5539/ies.v15n3p77>
- Rehman, N., Mahmood, A., Ibtasam, M., Murtaza, S. A., Iqbal, N., & Molnár, E. (2021). The psychology of resistance to change: The antidotal effect of organizational justice, support, and leader-member exchange. *Frontiers in Psychology*, 12, 678952. <https://doi.org/10.3389/fpsyg.2021.678952>
- Richardson, J. W., & Sterrett, W. L. (2018). District technology leadership then and now: A comparative study of district technology leadership from 2001 to 2014. *Educational Administration Quarterly*, 54(4), 589616. <https://doi.org/10.1177/0013161X18769046>
- Riehl, C. J. (2015). Mostly unpunctuated disequilibrium: A commentary on new directions in research and practice in education leadership. In A. J. Bowers, A. R. Shoho, & B. G. Barnett (Eds.), *Challenges and opportunities of educational leadership research and practice: The state of the field and its multiple futures* (Vol. 6, pp. 225248). Charlotte, NC: Information Age.
- Rhodes, C., & Brundrett, M. (2009). Leadership development and school improvement. *Educational Review*, 61(4), 361374. <https://doi.org/10.1080/00131910903403949>
- Riveros, A. (2015). A review of digital leadership: Changing paradigms for changing times, by E. Sheninger. *Leadership and Policy in Schools*, 14(4), 490494. <https://doi.org/10.1080/15700763.2015.1026451>
- Robinson, V. M., Lloyd, C. A., & Rowe, K. J. (2008). The impact of leadership on student outcomes: An analysis of the differential effects of leadership types. *Educational Administration Quarterly*, 44(5), 635674. <https://doi.org/10.1177/0013161X08321509>
- Robinson, R., Molenda, M., & Rezabek, L. (2013). Facilitating learning. In *Educational technology* (pp. 1548). Routledge.
- Sallam, M. (2023, March). ChatGPT utility in healthcare education, research, and practice: Systematic review on the promising perspectives and valid concerns. *Healthcare*, 11(6), 887–907. <https://doi.org/10.3390/healthcare11060887>
- Senthil, V. (2018). Does the more internet usage provide good academic grades?. *Education and Information Technologies*, 23(6), 2901–2910. <https://doi.org/10.1007/s1063901897498>.
- Sheninger, E. (2014). *Digital Leadership: Changing paradigms for changing times*. Thousand Oaks, CA: Corwin/OPC.
- Shepherd, J. (2004). What is the digital era?. In *Social and economic transformation in the digital era* (pp. 118). Hershey, PA, USA: IGI Global.
- Shin, J., Mollah, M. A., & Choi, J. (2023). Sustainability and organizational performance in South Korea: The effect of digital leadership on digital culture and employees' digital capabilities. *Sustainability*, 15(3), 20272049. <https://doi.org/10.3390/su15032027>
- Silva, E. (2009). Measuring skills for 21st-century learning. *Phi Delta Kappan*, 90(9), 630–634. <https://doi.org/10.1177/003172170909000905>
- Sterrett, W., & Richardson, J. W. (2020). Supporting professional development through digital principal leadership. *Journal of Organizational & Educational Leadership*, 5(2), <https://digitalcommons.gardnerwebb.edu/joel/vol5/iss2/4>
- Suleimanova, O., Vodyanitskaya, A., Yaremenko, V., & Fomina, M. (2020). Digital Engines at work: promoting research skills in students. *Proceedings of the International Conference on Education and New Developments*. Zagreb, 349352. <https://doi.org/10.36315/2020end074>

- Sun, J., & Leithwood, K. (2012). Transformational educational leadership effects on student achievement. *Leadership and Policy in Schools*, 11(4), 418-451. <https://doi.org/10.1080/15700763.2012.681001>
- Taecharungroj, V. (2023). "What can ChatGPT do?" Analyzing early reactions to the innovative AI Chatbot on Twitter. *Big Data and Cognitive Computing*, 7(1), 35. <https://doi.org/10.3390/bdcc7010035>
- Tai, M. K., & Kareem, O. A. (2018). The relationship between emotional intelligence of school principals in managing change and teacher attitudes towards change. *International Journal of Leadership in Education*, 22(4), 469-485. <https://doi.org/10.1080/13603124.2018.1481535>
- Tam, V. C., Chan, J. W., Li, S. C., & Pow, J. (2018). Developing and managing school human capital for information and communication technology integration: A case study of a school-based e-learning project in Hong Kong. *International Journal of Leadership in Education*, 21(4), 447-461. <https://doi.org/10.1080/13603124.2017.1318958>
- Tlili, A., Shehata, B., Adarkwah, M. A., Bozkurt, A., Hickey, D. T., Huang, R., & Agyemang, B. (2023). What if the devil is my guardian angel: ChatGPT as a case study of using chatbots in education. *Smart Learning Environments*, 10(1), 15. <https://doi.org/10.1186/s4056102300237x>
- Trust, T., Whalen, J., & Mouza, C. (2023). ChatGPT: Challenges, opportunities, and implications for teacher education. *Contemporary Issues in Technology and Teacher Education*, 23(1), 123. <https://www.learntechlib.org/primary/p/222408/>
- Van Laar, E., Van Deursen, A. J., Van Dijk, J. A., & De Haan, J. (2017). The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in Human Behavior*, 72, 577-588. <https://doi.org/10.1016/j.chb.2017.03.010>
- Van Quaquebeke, N., & Gerpott, F. H. (2023). The now, new, and next of digital leadership: how artificial intelligence (AI) will take over and change leadership as we know it. *Journal of Leadership & Organizational Studies*, 30 (3), 265-275. <https://doi.org/10.1177/15480518231181731>
- Wong, C. P., & Ng, D. (2020). The roles of educational leaders in developing future-ready learners: The case of Singapore. *International Journal of Educational Management*, 35(1), 249-269. <https://doi.org/10.1108/IJEM0620200283>
- World Economic Forum. (2016). Global challenge insight report: the future of jobs employment, skills and workforce strategy for the fourth industrial revolution. https://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf
- Wu, H., & Shen, J. (2022). The association between principal leadership and student achievement: A multivariate meta-metaanalysis. *Educational Research Review*, 35, 100423. <https://doi.org/10.1016/j.edurev.2021.100423>
- Yang, Y. T. C., & Wu, W. C. I. (2012). Digital storytelling for enhancing student academic achievement, critical thinking, and learning motivation: A yearlong experimental study. *Computers & Education*, 59(2), 339-352. <https://doi.org/10.1016/j.compedu.2011.12.012>
- Zhai, X. (2023). ChatGPT and AI: The game changer for education. <https://ssrn.com/abstract=4389098>
- Zhai, X., & Pellegrino, J. W. (2023). Large-scale assessment in science education. In N.G. Lederman, D. L. Zeidler, J. S. Lederman (Eds.) *Handbook of research in science education* (Volume III, pp. 1045-1098). Routledge.
- Zhan, X., Anthony, A. B., Goddard, R., & Beard, K. S. (2023). Development, factor structure, and reliability of the Shared Instructional Leadership Scale in public secondary schools. *Educational Management Administration & Leadership*, 51(1), 75-94. <https://doi.org/10.1177/1741143220963103>

- Zheng, L., Niu, J., Zhong, L., & Gyasi, J. F. (2021). The effectiveness of artificial intelligence on learning achievement and learning perception: A meta-analysis. *Interactive Learning Environments*. <https://doi.org/10.1080/10494820.2021.2015693>
- Zhong, L. (2017). Indicators of digital leadership in the context of K12 education. *Journal of Educational Technology Development and Exchange (JETDE)*, 10(1), 2740. <https://doi.org/10.18785/jetde.1001.03>

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