Review

Transformational leadership's role in shaping Education 4.0 within higher education

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Abstract: Integrating Education 4.0 in higher education necessitates a transformational leadership approach that champions innovation and technology adoption. This paper reviews the impact of transformational leadership in fostering a conducive environment for Education 4.0, emphasising personalised and technology-enhanced learning experiences. With their vision and motivational prowess, transformational leaders are crucial in steering educational institutions through digital transformation, encouraging the adoption of advanced technologies like artificial intelligence, virtual reality, and data analytics. These leaders are pivotal in nurturing a culture of continuous improvement and empowerment, actively involving team members in pursuing collective achievements and personal growth. The study highlights the importance of transformational leadership in addressing the dynamic challenges and opportunities presented by Education 4.0. By inspiring educators and students to embrace change, transformational leaders facilitate the integration of innovative teaching methods and technologies, enhancing learning outcomes and preparing students for the demands of the digital age. The findings suggest that transformational leadership is instrumental in creating a flexible, relevant, and forward-thinking educational environment that aligns with the objectives of Education 4.0. This paper advocates strategically emphasising the development of transformational leaders within academic institutions. Such leadership is essential for navigating the complexities of digital-area education, ensuring institutions remain adaptive and responsive to technological advancements, and equipping students with the necessary skills to thrive in a rapidly evolving landscape.

Keywords: transformational leadership; Education 4.0; education policy; higher education; opinion paper

1. Introduction

The transformational leadership approach is widely recognised for its visionary and charismatic leaders who inspire individuals to unleash their full potential (Kotamena et al., 2020; Nuel et al., 2021). These leaders adeptly communicate compelling future visions, fostering creativity, innovation, and personal growth within teams (Lim et al., 2021; Men et al., 2021). This approach cultivates a culture of continuous improvement and empowerment, motivating team members to actively participate and make meaningful contributions to collective accomplishments.

Transformational leaders are critically important in guiding educational institutions while incorporating advanced technology in Education 4.0 (Abu-Rumman, 2021; Al-Husseini et al., 2021). Education 4.0 integrates cutting-edge technologies, including artificial intelligence, virtual reality, and data analytics (Dhivya et al., 2023; Zhang et al., 2024). Its primary objective is to provide personalised and adaptable learning experiences that equip students with the necessary skills to thrive in the ever-changing digital landscape (Caratozzolo et al., 2021; Haleem et al., 2022).

In Education 4.0, technology is crucial in enabling remote education, personalised learning paths, and data-driven analysis of student performance (Goh and Abdul-Wahab, 2020; Williams et al., 2020). Transformational leaders are essential in driving change in a dynamic environment, motivating educators, employees, and students to embrace and adapt enthusiastically to new concepts and advancements (Maisyura et al., 2022). They foster a culture of lifelong learning and establish fruitful collaborations with industry and technology experts, ensuring that higher education remains flexible, relevant, and capable of equipping students for the demands of the contemporary labour market.

Transformational leadership is essential in ushering in Education 4.0 within higher education, transcending mere technological adoption to fundamentally restructure educational strategies, pedagogies, and outcomes for the 21st-century workforce. Education 4.0, as outlined by the World Economic Forum (2023), signifies a comprehensive transformation towards critical thinking, creativity, collaboration, and digital literacy. This shift demands leadership that integrates technology and reshapes the educational landscape to be more adaptive, innovative, and student-centred, ensuring practices are both technologically advanced and pedagogically robust (Hamzah et al., 2024).

This paper explores the critical interaction between transformational leadership and Education 4.0, demonstrating how visionary leadership is instrumental in sculpting the future of education. Examining theoretical foundations and applying empirical insights highlights such leadership's transformative impact on educational innovation and quality (Kılınç et al., 2024; Vermeulen et al., 2022). Addressing the complexities and opportunities of Education 4.0, the analysis provides actionable recommendations for leaders and policymakers to foster an educational environment that meets the evolving demands of our digital era (Knight et al., 2023; McCarthy et al., 2023).

In adopting a conceptual review methodology, this study meticulously compiles, analyses, and interprets existing literature on transformational leadership and Education 4.0 within higher education frameworks. We systematically examine peer-reviewed articles, seminal texts, and case studies to unravel the dynamics between leadership and educational innovation. This process enables a deeper understanding of current discourse and identifies gaps and opportunities for future research. The selection criteria for sources included relevance to the themes of transformational leadership and Education 4.0, contributions to theoretical or practical knowledge, and insights into the implementation challenges and successes within diverse educational settings.

2. Transformational leadership

Transformational leadership is a leadership paradigm that prioritises the dedication and capability of individuals within an organisation (Asbari, 2020; Burn, 1978; Hai et al., 2021). The transformational leadership paradigm fosters commitment among education workers to enhance educational institutions collaboratively (Prestiadi, 2020; Saad Alessa, 2021). More remarkable dedication will help institutions attain their educational objectives. Transformational leadership is characterised by a leader's ability to inspire and motivate followers to achieve exceptional outcomes beyond their expected accomplishments (Teoh et al., 2022; Fauzi et al., 2024). This process includes formulating a forward-looking perspective, questioning the existing state of affairs, and enabling individuals to achieve their utmost capabilities.

This leadership strategy extends well beyond fundamental transactional interactions, emphasising the transformative impact it can have on individuals and organisations, with the ultimate goal of realising superior levels of performance and growth (Samad et al., 2022). The essence of transformational leadership lies in its ability to inspire and motivate followers by demonstrating a unique blend of charismatic leadership, intellectual stimulation, and individualised consideration (Diana, 2022; Syarifuddin, 2023). Transformational leaders prioritise their followers' personal and professional growth while ensuring that current tasks are completed. They aim to establish a shared vision in the workplace, encouraging collaboration. This approach enables transformational leaders to bring about impactful changes in organisational structure, promote innovation, and cultivate a dynamic and forward-thinking culture aligned with the organisation's overarching objectives (Yusup and Maulani, 2023).

Transformational leadership is essential in empowering individuals, fostering personal growth, and promoting collaboration, resulting in positive organisational changes and improved performance (Tang et al., 2024). Leaders who inspire transformation encourage followers to exceed their limitations and work together towards a common goal (Alblooshi et al., 2021). This approach leads to significant improvements in organisational outcomes and cultivates a culture of innovation, commitment, and collective accomplishment. By unlocking the potential of individuals and promoting interaction within teams, this leadership style enables significant and sustainable progress for organisations.

2.1. Overview of Education 4.0

Education 4.0 is an innovative method of education that utilises cutting-edge technologies to equip learners with the necessary skills for the digital era (Prestiadi, 2020; Tandon and Tandon, 2020). The emphasis is on individualised and interactive educational experiences, integrating technology such as artificial intelligence, machine learning, virtual reality, and big data analytics. This student-centred paradigm seeks to deviate from standardised methodologies and address individual needs and interests.

Education 4.0 revolutionises learning by nurturing critical thinking, creativity, and problem-solving skills through interactive and project-based activities, enhancing

student engagement and knowledge retention via gamification and interactive platforms. Tailored to meet industry demands, it equips students with the digital literacy and essential skills needed for professional success, bridging the gap between traditional education and the evolving digital workforce (Khan et al., 2022; Promrub and Sanrattana, 2022; Tanucan et al., 2023). This approach ensures students are proficient in theoretical knowledge and prepared to apply their skills in practical scenarios, making them highly adaptable and sought after in the digital age.

Implementing Education 4.0 faces challenges such as unequal access to digital resources and technology, necessitating a focus on equitable technology distribution, addressing socioeconomic disparities, and supporting marginalised communities (Banerjee, 2020; Chan, 2022; Gonzales et al., 2021; Kraugusteeliana, 2023; Soleas, 2020). Essential steps include investing in technology infrastructure, comprehensive teacher training, and ongoing support for effective integration. Education 4.0, a significant shift towards technology-driven education, offers the potential to transform teaching and learning. By overcoming these obstacles and ensuring fair access, Education 4.0 can establish a holistic educational system that equips students with essential skills for the modern world, making education more inclusive and effective (Ajaps, 2023; Bass, 2023; Kjellgren and Richter, 2021; Madgafurova, 2023).

The concept of Education 4.0 has evolved significantly, reflecting the rapid technological advancements and changing global educational needs. In this revised section, we explore the definition of Education 4.0, drawing upon authoritative sources, including insights from the World Economic Forum. Expanded narrative explores the multifaceted aspects of Education 4.0, highlighting technological advancements and pedagogical innovations reshaping the educational landscape.

Education 4.0 represents a paradigm shift towards more student-centred learning, emphasising the importance of developing critical thinking, creativity, and problem-solving skills. This approach prepares students to navigate the complexities of the 21st century, underscoring the evolving role of educators in facilitating a learning environment that fosters these essential competencies. The integration of digital technologies catalyses methodological shifts in teaching and learning processes, driving changes in curriculum design to better align with the demands of a digitally driven global economy.

Moreover, the discussion on Education 4.0 is enriched by incorporating specific references to the World Economic Forum's framework, which outlines critical components of this educational model. By aligning discussion with globally recognised perspectives on academic innovation and reform, we aim to comprehensively understand Education 4.0 as a holistic approach to reimagining education for the digital age. This section examines how Education 4.0 extends beyond mere technological integration, advocating for a complete reevaluation of how education is delivered, experienced, and valued in society.

In embracing a broader and more comprehensive perspective on Education 4.0, this paper contributes to the ongoing discourse on the evolution of educational paradigms. Including diverse elements, from pedagogical strategies to curriculum development, highlights the comprehensive nature of Education 4.0 and its potential to revolutionise the academic experience. By examining these components in depth, we underscore the critical importance of transformational leadership in navigating and

shaping the future of education in a rapidly changing world.

2.2. Importance of transformational leadership in higher education

Transformational leadership is crucial in steering educational institutions towards success in the digital era within Education 4.0 (Fatmawaty et al., 2023; Mandagi et al., 2023; Prestiadi and Sumarsono, 2020). These leaders motivate their teams to adopt a shared vision of constructive change and advancement (Davidavičienė et al., 2020; Forner et al., 2020; Jaroliya and Gyanchandani, 2021; Mysirlaki and Paraskeva, 2020; Orsini and Rodrigues, 2020; Peng et al., 2021; Soleas, 2020). They possess a distinct and well-defined outlook on the future of education, effectively inspire and enable their team members, and give priority to individual development.

Transformational leadership plays a vital role in Education 4.0 by effectively dealing with the opportunities and difficulties presented by digital breakthroughs (Bonfield et al., 2020; Supermane, 2020). Educational institutions must adjust to the swiftly advancing technology and exploit its potential to augment teaching and learning. Transformational leaders cultivate an atmosphere that promotes innovation, inspires educators to experiment with novel instructional methods, use technology, and utilise data for well-informed decision-making (Carpio-Mendoza et al., 2023; Klaic et al., 2020; Lei et al., 2020; Owusu-Agyeman, 2019).

Moreover, transformational leadership is essential in establishing a learning environment that prioritises the needs and interests of students (Othman and Hamid, 2023). Education 4.0 prioritises individualised instruction and transformative leaders engaging students in learning, promoting active involvement and acknowledging and fostering their distinct talents. The institution creates a supportive and all-encompassing learning atmosphere that highly regards student participation and independence (Susilawati, 2021; Wider et al., 2024).

In the era of Education 4.0, fostering collaboration and building strong relationships within the educational community is crucial. The successful integration of technology and instructional approaches greatly depends on educators working together. This collaboration is essential for implementing technological tools and sharing knowledge, ideas, and exemplary practices. Transformational leaders are pivotal in creating and nurturing a collaborative environment within educational institutions. These leaders encourage educators to come together, exchange innovative methods, cooperate on joint initiatives, and acquire knowledge from one another, facilitating continuous growth and improvement in education (Admiraal et al., 2019; Billingsley et al., 2020; Hartiwi et al., 2020; Karlberg and Bezzina, 2022; Özdemir et al., 2020). Ultimately, this collaborative environment empowers educators to enhance their teaching practices, engage students more effectively, and collectively contribute to advancing education in the digital age.

Transformational leadership equips educational leaders with the ability to effectively overcome challenges and leverage the opportunities offered by Education 4.0, fostering a culture of originality and innovation (Purwanto et al., 2020; Zainal and Mohd Matore, 2021). These leaders enhance educational quality by prioritising student needs and interests, building strong collaborative networks, and equipping students with critical digital-age skills. This holistic approach improves educational

standards and prepares students to thrive in a rapidly evolving technological landscape, ensuring they are well-equipped to meet future demands.

In the era of Education 4.0, the successful integration of technology and instructional approaches greatly depends on educators working together (Dexter and Richardson, 2020; Valverde-Berrocoso et al., 2021). This collaboration is essential for implementing technological tools and sharing knowledge, ideas, and exemplary practices. Transformational leaders are pivotal in creating and nurturing a collaborative environment within educational institutions. These leaders encourage educators to come together, exchange innovative methods, cooperate on joint initiatives, and acquire knowledge from one another, facilitating continuous growth and improvement in education. Ultimately, this collaborative environment empowers educators to enhance their teaching practices, engage students more effectively, and collectively contribute to advancing education in the digital age (Bonfield et al., 2020; Starkey, 2020).

Recognising the critical role of transformational leaders in creating such dynamic educational environments and exploring how these leaders are cultivated is imperative. The development of transformational leadership qualities essential for navigating Education 4.0's challenges encompasses targeted strategies. These include professional development programs that enhance visionary and adaptive leadership capabilities, mentorship, and peer networks that encourage sharing innovative practices and opportunities for leaders to manage creative projects (Hashimy et al., 2023: Kilag et al., 2024). Such initiatives augment educational leaders' adaptability and responsiveness and reinforce the collaborative networks crucial for integrating technology and instructional approaches effectively. By focusing on these developmental strategies, educational institutions can ensure their leadership is well-equipped to foster a culture that embraces and thrives on the principles of Education 4.0 (Ationg et al., 2023; Sopian et al., 2023).

3. Past approaches to leadership in higher education

Traditionally, leadership in higher education frequently adhered to a hierarchical and bureaucratic methodology (Chan et al., 2018). The decision-making process was centralised, with authoritative directions from higher authorities and minimal involvement from academics and students. The main emphasis was on upholding stability and safeguarding traditions. Leaders were perceived as individuals who primarily fulfilled administrative roles rather than actively driving and implementing transformative changes. Nevertheless, with the progression of higher education, there is an increasing acknowledgement of the necessity for transformative leadership (Usman, 2020). Transformational leaders in higher education institutions inspire and motivate individuals, creating an environment that promotes ongoing progress and flexibility.

3.1. Traditional leadership in higher education

Conventional leadership methods have historically been widespread in higher education settings (Adame et al., 2021; Karsono et al., 2022; Musundire, 2021). These styles generally prioritise stability and upholding the existing state of affairs rather

than emphasising innovation and change. Autocratic and bureaucratic leadership are two prevalent traditional leadership types in higher education (Chhanwaland Deshmukh, 2020).

Autocratic leadership is distinguished by a centralised decision-making process in which leaders possess substantial control and authority (Erdem, 2021; Fransen et al., 2020; Hogg, 2021). They exercise autonomy in decision-making, frequently without soliciting advice or feedback from academics and staff. This type of management can impede collaboration, suppress creativity, and establish a hierarchical power structure inside the organisation. Bureaucratic leadership, in contrast, mainly depends on rules, regulations, and established procedures (Zhang et al., 2022). Leaders who adopt this approach prioritise compliance with laws and guidelines, often sacrificing flexibility and adaptability. Implementing bureaucratic leadership can lead to sluggish decision-making procedures, restricted independence for academics and staff, and an inflexible organisational framework that may hinder innovation.

Autocratic and bureaucratic leadership styles may have been productive in previous times when stability and conformity were highly esteemed (Akonkwa et al., 2022; Moskovich, 2020; Soto-Morettini, 2023). Nevertheless, in the current dynamic higher education environment, these approaches can limit expansion and impede the capacity to adapt to emerging requirements.

It is noteworthy that although traditional leadership styles continue to exist, there is an increasing acknowledgement of the necessity for more flexible and transformative leadership techniques in higher education (Graham and Donaldson, 2020; Lamm et al., 2021). These strategies emphasise the importance of working together, fostering creativity, and creating a shared vision to address the problems and opportunities presented by Education 4.0.

3.2. Limitations of past leadership approaches in Education 4.0

Applying previous leadership approaches in education may demonstrate constraints when implemented within the framework of Education 4.0. Conventional leadership styles, such as authoritarian or bureaucratic approaches, may need help effectively dealing with the distinct requirements of the digital era.

A fundamental constraint is the absence of skill and flexibility. Education 4.0 necessitates leaders who can promptly and efficiently adapt to technological progress, shift student requirements, and evolve teaching methods (Costa et al., 2022). Conventional leadership styles frequently prioritise stability and strict adherence to established systems, which can impede creativity and the capacity to adopt new techniques.

The potential for a hierarchical approach to decision-making is a crucial consideration in Education 4.0. Collaborative and inclusive practices, where educators and students actively engage and take ownership, are fundamental for nurturing creativity and fostering a sense of ownership. However, traditional leadership methods relying on hierarchical structures and unilateral decision-making may hinder stakeholder involvement and dedication, limiting the potential for transformative change.

Furthermore, traditional approaches may need to focus more on cultivating a culture that encourages continuous learning and professional development. Education 4.0 prioritises continuous learning throughout one's life, integrating new technology, and adjusting to a swiftly evolving information environment. Leaders should cultivate a growth mentality and provide constant training and skill enhancement for professors and staff.

Adopting transformational leadership strategies prioritising creativity, cooperation, and adaptation in the context of Education 4.0 is imperative to address these constraints. These techniques give stakeholders more influence, encourage a shared vision, and allow educators to handle the challenges and possibilities of the digital age effectively.

4. Current landscape of transformational leadership in higher education

Transformational leadership is increasingly acknowledged as a successful method for promoting good change and innovation in the present higher education environment. Academic establishments increasingly emphasise the significance of forward-thinking leadership, enabling individuals, cultivating a collaborative culture, and adopting technology integration (Sirat and Wan, 2022). Leaders in higher education who possess transformational qualities can inspire and motivate teachers, staff, and students to achieve their maximum capabilities, adjust to technological progress, and improve the entire educational experience. Transformational leadership influences the future of higher education by advocating a shared vision, cultivating a mindset focused on learning and encouraging cooperation.

4.1. Integration of technology and education in higher education

Incorporating technology in higher education has become more widespread, revolutionising student learning and teacher instruction methods. This integration can improve the educational experience by granting access to various materials, fostering interactive and collaborative learning, and equipping students for the digital era.

Technology integration provides a notable advantage in terms of accessibility. Online learning platforms, digital textbooks, and multimedia tools enable students to conveniently and flexibly access educational information anytime and from any location. This adaptability caters to various learning preferences and allows for learning at one's own pace.

Moreover, technology enables interactive and cooperative learning experiences. Virtual classrooms, video conferencing, and online discussion forums facilitate student interaction with classmates and teachers, promoting active engagement and knowledge exchange (Zeeshan et al., 2022). Furthermore, technology reduces customised learning experiences by utilising adaptive learning platforms that customise information according to the specific needs of each learner.

Finally, incorporating technology in higher education provides students with essential digital literacy skills required in today's professional environment. Technology-enhanced learning settings foster the development of digital literacy, critical thinking, and problem-solving skills. Nevertheless, it is crucial to consider

challenges such as guaranteeing fair and equal access, tackling the disparity in digital resources, and upholding the standards of online education. However, incorporating technology in higher education can profoundly transform instruction methods and knowledge acquisition, equipping students with the necessary skills to navigate the digital and linked world they will encounter after completing their studies.

4.2. Transformational leadership and technological adaptation

Transformational leadership is essential for assisting organisations in adapting to technological changes. This leadership style prioritises the encouragement and motivation of individuals to reach their maximum capabilities while cultivating a culture that promotes creativity and the ability to adjust to new circumstances (Zhao et al., 2024b).

Regarding technological adaption, transformational leaders can successfully convey the vision for change, highlighting the advantages and possibilities technology may offer the organisation. They motivate people to adopt emerging technology by fostering a collective sense of mission and enthusiasm.

Transformational leaders also foster a culture of continuous learning inside the organisation (Ahmad and Rochimah, 2021). They promote ongoing professional growth and offer opportunities for individuals to obtain the requisite expertise and knowledge to adjust to technological advancements effectively. Leaders cultivate a learning culture to guarantee that staff possess the necessary skills to handle the ever-changing technological landscape.

Moreover, transformational leaders empower employees to assume responsibility for technological adaptation. They entrust authority and foster independence, enabling individuals to engage in experimentation, innovation, and the discovery of imaginative solutions. This strategy enhances staff involvement and cultivates a feeling of responsibility for the technical modifications, resulting in increased dedication and achievement.

To summarise, transformational leadership is crucial in steering organisations through adapting to new technologies. Transformational leaders may enable the successful integration and utilisation of technology within organisations by employing effective communication, cultivating a learning mentality, and empowering staff.

4.3. Transformational leadership practices in higher education: Examples

Transformational leadership methods are recognised in higher education as an effective way to motivate and empower individuals within educational organisations (Al-Husseini et al., 2021; Saad Alessa, 2021). These techniques foster positive transformation, innovation, and collaboration, ultimately enhancing student achievement.

The University of Malaya established the Empowering Leaders for Excellence in Academics and Education (ELITE) program to foster visionary leadership among its members. The program involved workshops, seminars, and mentorship to teach academics, administrators, and staff leadership skills. As a result of this effort, Malaya University (UM) has developed a culture of leadership excellence, equipping

individuals with essential skills and knowledge to improve teaching, research, and overall institutional performance.

Universiti Teknologi Malaysia (UTM) has made remarkable strides in academia under the dynamic leadership of Professor Zaini Ujang. The UTM Research Management Centre has streamlined research and funding processes, while the Innovation and Commercialization Centre has fostered entrepreneurship. Furthermore, UTM has partnered with Microsoft to enhance digital literacy, showcasing the university's commitment to progress, research, industry relationships, and technology adoption in higher education. These initiatives are a testament to the transformative leadership that drives UTM forward.

INTI University boasts an esteemed Industry Advisory Board (IAB) comprising experts from diverse fields. The IAB's paramount goal is to ensure the university's courses align with the latest industry standards. The collaboration between the IAB and industry specialists ensures that the programmes offered by INTI are current, enhancing students' readiness for the workforce. This approach forges a strong link between education and real-world practicalities, equipping students with the necessary skills to thrive in their chosen careers.

Taylor's University has recognised the importance of technology in education and has implemented a comprehensive plan for complete digital transformation. This plan includes adopting new digital technologies, platforms, and sophisticated pedagogical approaches to enhance the quality of education. Administrators at Taylor's University have encouraged educators to incorporate new technologies and revolutionise their instructional methods. As a result, students at Taylor's University have shown higher levels of engagement, increased access to a broader range of materials, and improved collaboration among teachers.

In higher education, transformational leadership techniques encompass the establishment of a compelling vision, the provision of individualised support, the promotion of innovation, and the nurturing of collaboration. These strategies enable educators to enhance educational institutions' overall success and progress.

5. Future perspectives for transformational leadership in Education 4.0

In the current age of Education 4.0, the role of transformative leadership cannot be overstated. As technology continues to advance at an incredible pace, educational leaders must take charge of the evolving academic landscape by embracing and integrating emerging technologies, fostering a culture of creativity and innovation, and promoting digital literacy among both students and teachers (Bergdahl and Nouri, 2021; Kilag et al., 2023; Kruse et al., 2020; Montgomery, 2020). Additionally, addressing ethical and equity concerns arising from integrating technology is essential. The key to success lies in forging partnerships with industry, implementing interdisciplinary approaches, and prioritising continuous learning. By leveraging transformative leadership, educators can create a dynamic, student-centric, and future-oriented educational environment that equips students for success in an ever-changing world.

5.1. Anticipated changes and challenges in higher education

Higher education is expected to substantially transform and confront many obstacles in the upcoming years. The ongoing technological progress will reshape the educational environment, necessitating institutions to adjust and efficiently utilise digital tools. Online and hybrid learning formats are anticipated to become increasingly widespread, enabling enhanced flexibility and accessibility (Keiper et al., 2021; Liu, 2021). Nevertheless, guaranteeing the calibre and efficacy of these educational methods will pose a crucial obstacle.

In today's world, industries are undergoing rapid transformations, which means a persistent need for continuous learning and acquiring new skills (Burbules et al., 2020; Machkour and Abriane, 2020; Mohamed Hashim et al., 2022). To cater to the varied requirements of learners, higher education institutions must offer adaptable and individualised learning routes. However, institutions will require assistance balancing affordability and retaining academic performance, given the increasing cost of education and the necessity for financial sustainability.

In the coming years, it is crucial to prioritise fairness, diversity, and inclusivity (Zhao et al., 2024a). Educational institutions should focus on creating inclusive environments that promote the well-being of all individuals, especially those who belong to underrepresented groups and foster a strong sense of belonging. It is essential to narrow the achievement gap and ensure that everyone has equitable access to educational opportunities. Visionary leadership, creative education strategies, and a commitment to continuous improvement and adaptation are necessary to effectively address the anticipated changes and challenges.

5.2. Potential benefits of transformational leadership in Education 4.0

Utilising transformational leadership in the context of Education 4.0 has the potential to bring numerous benefits. This leadership style can inspire and motivate educators and students, encouraging them to embrace and adapt to changes and promoting a culture of innovation and flexibility (Al-Husseini et al., 2021; Sciarelli et al., 2020). Transformational leaders can help individuals take ownership of their learning and personal growth, leading to increased academic involvement and better academic outcomes.

The goal is to create a unified vision for integrating technology into education, promoting digital literacy, and preparing students for the digital age. Additionally, transformative leadership encourages collaboration and cooperation among educators, facilitating the exchange of ideas and best practices. This approach also prioritises a student-focused learning environment accommodating individual needs and preferences. Through Education 4.0, transformative leadership can lead to improved teaching and learning outcomes, greater student engagement, and the development of essential skills for thriving in a rapidly evolving landscape.

5.3. Strategies for developing transformational leaders in Education 4.0

As part of the Education 4.0 framework, developing leaders in higher education who can drive transformation is crucial. It requires a comprehensive strategy that can adapt to the constantly evolving dynamics of education and technology (Miranda et

al., 2021; Mohamed Hashim et al., 2022). A vital component of this strategy is to create a culture that encourages innovation and adaptation. Educational leaders must possess the skills and knowledge to effectively incorporate cutting-edge technology into the curriculum, such as artificial intelligence, virtual reality, and data analytics. It will enhance learning and equip students with the necessary skills for a technologically advanced job market.

University administrators can leverage AI analytics to tailor the learning experience to each student's needs and styles. Moreover, leaders seeking to transform higher education should focus on creating collaborative networks with stakeholders inside and outside their institutions. Partnering with industry, tech firms, and other educational bodies through internships or joint research can offer students practical skills and insights into future careers, ensuring academic programs remain relevant and progressive (Berbegal-Mirabent et al., 2020; Pan et al., 2021; Zhuang and Shi, 2022).

As a leader, it is imperative to prioritise continuous professional development and recognise its significance. Participating in workshops and conferences dedicated to innovative educational technologies and teaching methods is crucial to fostering a dynamic, education-focused environment. This dedication to acquiring knowledge sets an excellent example for students and professors.

Possessing effective communication and change management skills is essential for any leader. They should be able to articulate their vision for the future of education clearly and concisely. It will help motivate teachers, staff, and students to embrace new ideas and approaches. For instance, implementing a new digital learning platform in a university requires leaders to effectively communicate its benefits and provide necessary training and support to ensure its successful adoption.

In the era of Education 4.0, creating transformative leaders is paramount to the growth of the educational system. It can only be achieved by combining technical expertise, collaborative networking, continuous learning, and change management. Integrating these efforts can establish a cutting-edge, flexible, and student-centered educational ecosystem that prepares leaders of tomorrow.

In the era of Education 4.0, creating transformative leaders is paramount to the growth of the educational system. It can only be achieved by combining technical expertise, collaborative networking, continuous learning, and change management (Anthonysamy et al., 2020; Hadgraft and Kolmos, 2020). Integrating these efforts can establish a cutting-edge, flexible, and student-centered educational ecosystem that prepares leaders of tomorrow. As the threshold of the Education 4.0 era is approached, the indispensable role of transformational leadership in sculpting the future of education becomes increasingly clear. With their visionary outlook and innovative approaches, transformational leaders are pivotal in navigating the complexities of integrating cutting-edge technologies and pedagogies. Their ability to inspire and motivate, coupled with a commitment to fostering a lifelong learning and adaptation culture, ensures that educational institutions are prepared and thrive in rapid technological advancements (Jafar et al., 2020). This leadership style is crucial for creating educational environments that are responsive, dynamic, and aligned with the principles of Education 4.0, thereby equipping students with the skills and knowledge necessary for success in the 21st century.

5.4. Implications for educational leaders and policymakers

Education 4.0 has substantial ramifications for educational leaders and politicians. Initially, leaders must modify their strategies to navigate institutions through the changes effectively. They should adopt transformational leadership, promoting a culture that encourages ongoing learning and development (Budur, 2020). Leaders may ensure the successful use of technology in teaching and learning by prioritising the cultivation of digital skills among personnel. Policymakers play a vital role in creating a favourable environment for Education 4.0. They are responsible for developing policies that enable fair and equal access to technology while addressing the gap in digital skills through teacher training programs. Policymakers should prioritise data privacy and security, ensuring that legislation protects sensitive information and promoting ethical use of technology in education.

Collaboration and partnerships play a crucial role in transforming education. By bringing together academic institutions, industry stakeholders, and community organisations, innovative solutions can be created, and best practices can be shared (Ferguson and Roofe, 2020; Mercer-Mapstone and Bovill, 2020; Mian et al., 2020). Policymakers are essential in supporting this cooperation by facilitating knowledge exchange and building relationships across sectors. To meet the demands of Education 4.0, educational leaders and governments must proactively and strategically tackle the necessary changes. It requires transformational leadership, supportive policies, and a focus on teamwork to overcome challenges and seize opportunities while ensuring equitable access, high-quality education, and positive outcomes for all learners.

5.5. Recommendations for future practice and research

In the era of Education 4.0, the effective incorporation of technology requires continuous adaptation and improvement. Educators and researchers must prioritise cultivating teachers' and students' digital literacy skills (Basilotta-Gómez-Pablos et al., 2022; Falloon, 2020; Fontichiaro and Johnston, 2020). Educators and children can navigate the digital environment successfully and securely by offering extensive training and fostering digital literacy abilities (Liu et al., 2021). Further inquiry should identify effective strategies for promoting digital literacy in various school settings.

In education, effective collaboration and information sharing are essential. Educators must participate in professional learning communities to exchange best practices, innovative ideas, and first-hand observations (Caena and Vuorikari, 2022; Olin et al., 2020). Forging dynamic partnerships between academia, industry, and government can expedite the process of identifying research goals and implementing evidence-based policies. Additionally, further research is necessary to assess the impact of Education 4.0 on student accomplishments, educational experiences, and equal opportunities for all. Through qualitative and quantitative approaches in longitudinal research, it can understand the long-term effects of Education 4.0 and make informed decisions to improve education policies.

In the era of Education 4.0, it is imperative to give ethical concerns the utmost importance and establish unambiguous ethical standards for using technology (Akgun and Greenhow, 2022; Kong et al., 2023; Grassini, 2023). It involves guaranteeing data confidentiality and eliminating algorithmic partiality. Further research is imperative in

crafting ethical frameworks that align with the requisites of Education 4.0. Involving all stakeholders in the implementation of ethical procedures is crucial. Additionally, fostering digital literacy and collaboration in Education 4.0 is paramount. Researchers should assess the impact of technology on education, explore collaborative frameworks, and tackle ethical quandaries to augment the knowledge base of Education 4.0.

6. Conclusion

Transformational leadership is essential for driving innovation, embracing technological advancements, and creating an environment that supports Education 4.0 in the ever-evolving higher education landscape. This leadership style is known for its ability to inspire, motivate, and facilitate the development of individuals and organisations. Incorporating advanced technologies like artificial intelligence, virtual reality, and data analytics into educational methods is critical. Transformational leaders promote a culture of continuous improvement and empowerment in academic institutions. They prioritise these institutions' agility, adaptability, and alignment with the demands of the digital age. They aim to equip students with the necessary skills to succeed in an interconnected world.

The evolution of Education 4.0 necessitates a departure from traditional hierarchical and bureaucratic leadership styles to embrace transformational leadership. This shift is crucial for fostering adaptability, collaboration, and a forward-thinking mindset. Conventional leadership approaches prioritising stability and strict adherence to established protocols may need to meet the demands and potential of the digital age. In contrast, transformational leadership fosters a dynamic and inclusive learning environment that leverages technology to ensure all students have access to high-quality education.

Higher education is experiencing a wave of transformative leadership, driving remarkable progress in integrating technology, academic excellence, and collaborative environments. These leaders are adept at navigating their institutions through technological advancements, fostering a culture of education, and empowering faculty and students to embrace new tools and methodologies. By championing initiatives that promote accessibility, engagement, and digital literacy, transformational leaders are raising the bar for academic practices and outcomes.

Challenges and opportunities will advance as the education landscape evolves with Education 4.0. To navigate these intricacies successfully, transformative leadership will be crucial. The prosperity of higher education institutions depends on their ability to cultivate and harness transformative leadership, enabling them to embrace innovation, adopt technological advancements, and equip students with the necessary skills to flourish in the digital era. By prioritising continuous learning, adeptness with technology, and collaborative relationships, educational leaders can create a dynamic and student-centered learning environment that prepares learners for success in an ever-evolving world.

In light of the evolving educational paradigms, this narrative underscores the critical need for academic leaders and policymakers to embrace and enact the principles of transformational leadership within the context of Education 4.0. It calls

for a concerted effort towards integrating innovative technologies and pedagogies that prioritise adaptability, student engagement, and a culture of continuous improvement. The exploration offers a foundation for future initiatives to enhance educational practices, urging a forward-looking stance that anticipates the needs of tomorrow's learners. Advocating for a dynamic, student-centered approach to education, envision a future where the full spectrum of possibilities offered by Education 4.0 is realised. It ensures that students are well-prepared for the challenges of the digital age and are equipped to lead and innovate within it.

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