

An assessment of leadership development needs of school leaders for the 4.0

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Letuma, N.R.; Awodiji, O.A.; & Naicker, S.R. (2023). An assessment of leadership development needs of school leaders for the 4.0, *Journal of Management and Business Education* 6(3), 395-414.

<https://doi.org/10.35564/jmbe.2023.0021>

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Language: English

Received: 7 Jul 2023 / Accepted: 22 September 2023

Funding. The authors received no financial support for the research, authorship, and/or publication of this article.

Acknowledgments. The authors express their gratitude to all school authorities and participants who were involved in the study. All authors whose studies were reviewed are greatly appreciated.

Ethic Statement. Ethical clearance (Sem 1-2022-069) to conduct the study was received from the ethical committee of the University of Johannesburg to whom the researchers are affiliated. Furthermore, the Department of Basic Education (DBE) granted approval for research to be conducted in two districts. Ethical measures were applied based on ethical principles outlined by Elias y Theron (2012) namely, the protection of the integrity, fairness, and respect for privileges.

ABSTRACT

As a result of the fourth industrial revolution (4.0), school leaders need to consider if their existing abilities and competences satisfy future-fit leaders' requirements. This study evaluated the leadership development (LD) needs of school leaders in the 4.0 era. A survey design was used. Cluster sampling technique was adopted to randomly select a sample of 505 school management teams (SMT). The study found that school leaders require LD that will enable them to become proficient with technology applications, technology hardware, and emerging 4.0 technologies. Leaders must be trained in the use of cutting-edge 4.0 technology, applications, and technology. With regard to gender there was no significant difference in technological knowledge but LD needs in the areas of agility, information management, problem solving, communication and collaboration

will benefit female leaders. This study contributes significantly to the basic school leadership development in Africa by addressing 4.0 training needs. This includes the understanding of school leaders' training needs, as well as the way in which gender influences training needs. It is recommended that the education department develop training programmes and implement mechanisms such as professional learning communities, mentoring and coaching to enhance school leadership competencies for the 4.0.

Keywords. Leadership skills, Leadership development, School leaders, Technology, 4.0

RESUMEN

Como resultado de la cuarta revolución industrial (4.0), los líderes escolares deben considerar si sus habilidades y competencias existentes satisfacen los requisitos de líderes preparados para el futuro. Este estudio evaluó las necesidades de desarrollo de liderazgo (LD) de los líderes escolares en la era 4.0. Se utilizó un diseño de encuesta. Se adoptó la técnica de muestreo por conglomerados para seleccionar al azar una muestra de 505 equipos de gestión escolar (SMT, por sus siglas en inglés). El estudio encontró que los líderes escolares requieren LD que les permita familiarizarse con aplicaciones tecnológicas, hardware tecnológico y tecnologías emergentes 4.0. Los líderes deben recibir formación en el uso de tecnología de vanguardia 4.0, aplicaciones y tecnología. En cuanto al género, no hubo diferencias significativas en el conocimiento tecnológico, pero las necesidades de LD en las áreas de agilidad, gestión de la información, resolución de problemas, comunicación y colaboración beneficiarán a las líderes mujeres. Este estudio contribuye de manera significativa al desarrollo básico del liderazgo escolar en África al abordar las necesidades de formación 4.0. Esto incluye la comprensión de las necesidades de formación de los líderes escolares, así como la forma en que el género influye en las necesidades de formación. Se recomienda que el departamento de educación desarrolle programas de formación e implemente mecanismos como comunidades de aprendizaje profesional, mentoría y coaching para mejorar las competencias de liderazgo escolar para la era 4.0.

Palabras clave. Habilidades de liderazgo, Desarrollo de liderazgo, Líderes escolares, Tecnología, 4.0

INTRODUCTION

The skills of school administrators must be upgraded immediately in order to have them ready for the fourth industrial revolution (4.0). According to Armstrong et al. (2018), South Africans view the 4.0 as an "incoming thunderstorm" because it is happening too quickly to give people enough time to prepare. The technological revolution has altered the social, economic, ecological, and sociological aspects of existence (Kim & Kareem, 2019). Undoubtedly, the 4.0 impacts the educational sector yet the sector is neglected which has far-reaching implications. Careers and institutional development were impacted by the 4.0. Human endeavours have been transformed by the rapid changes of the 4.0. The 4.0 is regarded as a pivotal turning point in this era that offers opportunities for enhancing quality of life on every continent of the world, including Africa (Ramaphosa, 2020). Without a doubt, new technologies like machine learning, AI, and big data are changing the way we live, operate, conduct business, and lead (Ramaphosa, 2020; Kin et al., 2020). The 4.0 acts as a mechanism for addressing Africa's educational challenges (Kayembe & Nel, 2019; Ramaphosa, 2020; Xiaolan, 2020). Therefore, school leaders must realize the importance of putting the school first and use all possible approaches to achieve this.

A shift from handicraft economies to machine economies came as a result of the revolution (Ndung'u y Signé, 2020). The 4.0 aims to influence theories of LD, with a focus on bringing

educators into the world of work. The evolution of human production reveals a constant quest for improvement (Brahima, 2020; Lin & Lukodono, 2021). During the First Industrial Revolution, industrial processes were automated using steam and water power. In the Second Industrial Revolution, electricity replaced steam and water. As electronics and information technology developed during the Third Industrial Revolution, production and service delivery became more automated (Lin & Lukodono, 2021).

Since the middle of the 20th century, the Third Wave has gained strength, giving rise to the 4.0. The lines between the physical, digital, and biological realms are merging thanks to technology convergence (World Economic Forum [WEF], 2017). Robotics, virtual reality, cloud computing, big data, AI, and the IoT are just a few of the technologies that have helped shape Industry 4.0 (Chao Jr., 2017).

School leaders are trapped in the difficult position of coping with the system's pressure points. Leaders rely on instructions about change responses, steps, guidelines, and procedures from higher authorities (Harris & Jones, 2020). School leaders face a number of complex challenges when implementing change in 4.0. To effectively lead change in the 4.0 era, school leaders must be familiar with the change process and possess relevant competencies (Spiro, 2010). According to Acton (2020), school leaders received very scant training on how to be change leaders in 4.0 era. Rather, they gained experience in their roles as change agents by networking with trusted colleagues and on-the-job training.

The 4.0 uses cutting edge technology to build increasingly advanced and integrated systems. Artificial intelligence (AI), information and communication technology, the internet of things (IoTs), automation, 3D printing, and smart boards are the technologies that makeup Industry 4.0 (Erboz, 2017; Schwab, 2016; World Economic Forum, 2016). Changing technologies have made the educational system more susceptible to adapting, altering, optimising, improving, and becoming more effective and efficient (Richardson et al., 2013). Virtual worlds, smart cities, big data, IoTs, and AI have all helped advance growth in the changing era (Eleyyan, 2021; Gleason, 2018). Alade et al. (2021) examined leadership functions in relation to 4.0 adaptability. It was discovered that South African construction firms use just a handful of 4.0 technologies, namely the IoTs, 3-D printers, and cloud computing.

In recent years, the IoTs has made its appearance. The IoTs is a network of linked sensors found in cars and home appliances that exchange information and collaborate (Eleyyan, 2021). The IoTs also refers to the relationship between things (products, services, places, etc.) and people (Schwab, 2016). Multi-gadget communication and data sharing is made possible by the Internet of Things. At its core, the 4.0 is based on IoTs (Karabegović & Husak, 2018). IoT seems to have the ability to influence people's lives and work environments significantly (De Saullés, 2016). In this era where the internet of things is rapidly invading classrooms and enhancing administration in unimaginable ways, school leaders must promote technology integration (Raman & Thannimalai, 2019). And to do this, they must be reskilled to have relevant capacities to operate.

Additionally, the 4.0 era features 3D printing (Eisenberg, 2013). Using digital files, 3D printing creates three-dimensional objects (Kayembe & Nel, 2019). Among the disciplines where 3D printing is used are medicine and automobile production (Franta, 2015). As of today, 3D printing is important to almost every sector (Kayembe & Nel, 2019). Education employs 3D printing technologies to improve instruction, develop skills, and engage teachers and learners (Bull, et al., 2015). 3D printing appears to encourage school leaders' innovation and problem solving, according to Bull et al. (2015).

ICT refers to telecommunications "technologies" that promote access to information (Ratheeswari, 2018). It is essential to incorporate ICTs into learning and teaching in this information age in order to help learners develop and use key skills (Ratheeswari, 2018). School leaders are responsible for ICT use for school effectiveness (Apsorn et al., 2019). In order to experiment with

innovative teaching, learning, and administration practices, school leaders must be aware of current technology.

AI is also a key driver of the 4.0, a rapidly evolving technology that impacts people every day (Butter-Adam, 2018). AI has existed for 60 years (Perez et al., 2018). Perez et al. (2018) explain that AI refers to the development of robots capable of learning, reasoning, planning, and perception. In essence, AI is computer software with human characteristics. In spite of its importance, AI has received very limited consideration in educational leadership (Wang, 2021). Simulators have been used in educational leadership preparation, but the literature on the interaction between AI and educational leadership is sparse (Dexter, 2020). Therefore, the need to assess school leaders' knowledge of AI.

Technological advancements are making many sectors more automated and digitised (Acemoglu & Restrepo, 2018). There will be a new wave of automation in the future, enabling robots to perform highly skilled and perhaps non-routine tasks (Neufeind et al., 2018). Automation means machines taking over the duties people used to perform (Acemoglu & Restrepo, 2018; Neufeind et al., 2018). Automation in the workplace allows for economic growth and new opportunities in unanticipated areas of need because it reduces costs and frees up personnel (Halal et al., 2016). In the education sector, school leaders and administrators need to be aware of the possibility of automation taking over school administration.

Technology like smartboards, which can be controlled via screen touch, can be incredibly helpful when utilised properly in school (Aktas & Aydin, 2016). With the advent of new technology, smartboards are readily updated and are becoming a necessity in classrooms. In schools, digital smartboards are commonly used to assist teaching and learning (Mun et al., 2019). Using technologies like smartboards will certainly help schools supervise instruction effectively since COVID-19 has taught school leaders and teachers to continue their duties despite increased technological advancement (Author et al., 2022).

The significance of school leadership in helping create "change" through innovation and imagination in the digital age (Prestiadi et al., 2020) discuss. It is becoming increasingly clear to school leaders that technology knowledge is lacking in education, as well as a lack of leadership training related to digital competence (Ribble, 2013; Christensen et al., 2018). For school leaders to be prepared as future-fit leaders, it is critical that they build the knowledge and abilities that will support their capacity for change management (Wong & Ng, 2020). In the 4.0 era, good school leadership is widely acknowledged, but it is unclear what leadership skills are necessary to achieve favourable outcomes (Kim & Kareem, 2019). In contrast to COVID-19, most school leadership development programmes are likely to be out of date with the challenges school leaders face today (Harris & Jones, 2020). The purpose of this inquiry was to identify the LD needs of school leaders that enable them to respond to the demands of the 4.0 with an emphasis on technical tools and 4.0 competencies. The term school leaders referred to in this study includes principals, deputy/vice-principals and department heads (DHs) who constitute the School Management Team (SMT) in South African schools.

As a consequence of 4.0, technologies that are anticipated to dramatically change learning and instructional processes will affect the education sector (Xing & Marwala, 2017; Prestiadi et al., 2020). Throughout the period of the COVID-19 epidemic, 4.0 technology surged within the education industry. In response to the pandemic, a shift from traditional to digital classrooms was urgently needed. Thus, education systems across the globe shifted to an online setting (Harris & Jones, 2020; Mahyoob, 2020) and school leaders were expected to take a lead in the shift. The unpreparedness of school leaders came to light as the pandemic disrupted the global education system (Marshall et al., 2020). Various schools were incapable of continuing with teaching and learning because of technical equipment shortages and the need for training (Kuhfeld et al., 2020; van Lancker & Parolin, 2020). Lack of technical resources prevented South African public schools, especially those in disadvantaged areas, from carrying out educational activities during the COVID-

19 lockdown (Chisango & Marongwe, 2021). The COVID-19 pandemic provided school leaders with a double-edged sword in the form of the worst experiences and the best opportunities to assess their readiness for future-fit leadership. School leaders striving to be effective “players in school change” (Kim & Kareem, 2018; Prestiadi et al., 2020) must embrace the advances of the 4.0. Naidoo (2019) contends that school leaders in South Africa bear the responsibility for the professional administration of their institutions, fostering the development of their schools as well as school effectiveness.

Leadership in 4.0 also involves being a “digital leader” who possesses sufficient digital literacy, vision, customer understanding, agility, risk-taking, and collaboration skills. In order to develop 4.0 leadership, leaders need to rethink how they connect people with information technology (Salina et al., 2021). Numerous studies have outlined the 4.0 leadership competencies. According to the World Economic Forum (2019), leadership forms in 4.0 include accountability and responsibility, systems leadership, technological leadership, entrepreneurial leadership, adaptive leadership, and societal shaping. Hanafi, et al. (2018) identified the following characteristics for leadership in the 4.0 era: visionary, courageous, passionate, strategic thinking/planning, focused, collaborative, innovative, eager to change, and communicative. The World Economic Forum (2021) recognised the 4.0 leadership paradigm as encompassing cross-hierarchical, agile, motivating, team-oriented, and digital leaders with accountability. Most of the literature on business and manufacturing is available, but there is scant research on the 4.0 leadership qualities needed by African basic school leaders.

Additionally, 4.0 leadership indices include being humble, confident, agile, socially sensitive, visionary, fearless, idealised influences, inspirational motivation, innovative, passionate, strategic thinking, honest, and able to focus. They also included being emotionally intelligent, entrepreneurial, team-oriented, adaptable, accountable, communicative, willing to change, tech-savvy, and perceptive (Bernard, 2021; Salina et al., 2021). In addition to the formal qualifications of school leaders, soft skills can help leaders succeed at work regardless of their level of knowledge or experience (Oluwalola & Awodiji, 2021). According to Oluwalola y Awodiji (2021), soft skills such as problem-solving, communication, critical thinking, and ethical skills will positively influence job performance. Thus, the more soft skills the school leaders have, the more effective they are.

To become informed, emotionally mature, and responsible leaders, Sundararajan y Sundararajan (2023) argued that people must break self-misconception-driven emotional cycles. Thus, school leaders must be informed on the relevant skills that will make them relevant in 4.0. School leaders' 4.0 competences were evaluated in this study on a range of criteria, including knowledge level, technology proficiency, agility, information management and evaluation (MIE), communication expressiveness, collaboration, and critical thinking and problem-solving.

Studies indicate that school leaders influence school achievement positively in the contemporary technological age (Leithwood et al., 2020). Therefore, school leaders must improve their leadership competencies to overcome the challenges posed by the 4.0 with the intention of meeting 4.0 challenges (Kim & Kareem, 2019; Prestiadi et al., 2020). The challenges that school leaders face during times of change can be complex especially without the appropriate training and support. The lack of assistance and training available to school leaders in the face of new developments in education is disappointing (Vlachopoulos & Makri, 2017; Beauchamp et al., 2021).

In the 4.0, technology is seen as a field dominated by males. In the disciplines of “science, technology, engineering, and mathematics”, females face regular obstacles (Miller, 2017). Hammond et al. (2020) contend that men are perceived as science and technology professionals, whereas women are merely viewed as teachers. Nonetheless, women have excellent intellectual abilities, which enable them to prepare students for careers in the future (Annis y Nesbitt, 2017). As Devnew and Storberg-Walker (2018) argue, identifying the differences between men and women’s LD needs can help build leadership capacity in both groups.

Based on Naidoo y Potokri's study (2021), female school leaders are aware of the need to adapt their leadership skills to rapidly changing digital contexts. Naidoo y Potokri (2021) found that the skills required for females to effectively lead schools in the 4.0 era and become better 4.0-aligned leaders require emotional intelligence, effective communication, and collaboration. In addition to demonstrating compassion, kindness, concern, and nurturing, women leaders demonstrate emotional intelligence, acceptance, and attention to others, as well as motivation. In contrast, male leaders have the ability to be indifferent, self-interested, productive, authoritative, tenacious, and dominant in their leadership approach (Adler & Osland, 2016). In Saudi Arabian schools, Alkrdem (2014) found that gender did not affect LD. Moreover, technology integration, LD, and leadership activities are not influenced by gender (Raman & Thannimalai, 2019). Thus, the current study investigated if school leaders' gender influences their 4.0 leadership needs.

Research objectives

The following research objectives were set to be achieved in this study:

To identify knowledge of the 4.0 school leaders possessed.

To investigate basic technological knowledge areas school leaders need.

To assess how proficient are school leaders are with technology applications in carryout their task.

To identify school leadership skills needed to lead in the 4.0

To examine if there is significant difference between male and female school leaders in 4.0 leadership skills development needs.

Research questions

The following research questions were raised to guide this study:

What knowledge of the 4.0 do school leaders have?

In order to lead in the 4.0, what basic technological knowledge areas do school leaders need?

How proficient are school leaders with technology applications?

What are the school leadership skills needed to lead in the 4.0?

Research hypothesis

H01: A significant gender gap does not exist in 4.0 leadership skills development needs of school leaders.

LITERATURE REVIEW

Leadership development of school leaders

The continual training, learning, growth, and successful development of leaders that happens inside an organisational work environment is regarded as LD (Kempen & Steyn, 2016). LD may also be understood as the process of enhancing school leaders' knowledge and abilities in order to increase their leadership potential (Baran, 2014). Additionally, LD is a way to get or maintain credentials like academic degrees, conference attendance, and on-the-job informal learning opportunities (Awodiji et al., 2020). To this end, school leaders' LD should include providing them with the resources they need to enhance learning and teaching in their schools. This will enable them to improve their skills and workplace standards.

Leadership development for school leaders has become increasingly important to policymakers in recent years (Brauckmann et al., 2020). Given the plethora of studies indicating the crucial impact of school leadership in improving students' learning outcomes, this heightened attention is not unexpected (Branch et al., 2013; Leithwood et al., 2020). Value changes, technology advancements, and other societal changes have raised expectations, but policymakers recognise

that issues and challenges inside the school must be managed within, placing importance on management capabilities (Gurr & Drysdale, 2016; Sebastian et al., 2018).

A national advanced diploma programme for school leaders and managers was initiated in South Africa in 2021, but it has not yet become a mandatory professional qualification for school leaders. It is more likely, however, that school leaders have acquired knowledge while on the job (Schleicher, 2012), which makes it easier for them to fulfil their responsibilities. Aljbour (2021) suggests that LD could provide school leaders with the tools they need to cope with the demands of the 21st century. The LD of educational leaders must be a continuous activity. LD is a strategy that seeks to improve the competence and enhance the knowledge and expertise of leaders (Vlachopoulos & Makri, 2017; Aljbour, 2021).

School leaders' development and the 4.0

School leaders play a key role in this transformation. A prominent enabler of effective management in the 21st century is technology, which has enabled innovation and improved efficiency (Suleman et al., 2023). A school leader without a strong understanding of educational technology trends cannot harness the potential of today's digital tools. Any change that promotes school effectiveness begins with school leaders. The school leader will be ill-prepared if they do not understand current educational technology trends. Leadership development research has shifted in recent decades towards identifying leadership attributes that are crucial to institutional success (Bitterová, et al., 2014; Shet et al., 2017). In order to lead school in the 4.0, the LD of school leaders is essential. It is apparent from the study of Mdluli y Makhupe (2017) that leaders need to be flexible and proactive innovators in order to adapt to big shifts. The role of school leaders carries considerable responsibilities, and assessing their leadership abilities is an important attempt to "improve" them (Mdluli y Makhupe, 2017; Moloï & Mhlanga, 2021). Moloï and Mhlanga (2021) undertook research to identify the primary features necessary to steer the 4.0 in the education system of the nation. The findings indicated that South African education is not equipped for the 4.0, while the "private sector" is fostering areas of expertise (Moloï & Mhlanga, 2021). Additionally, their research revealed that only a small number of participants understood the 4.0 and its implications (Moloï & Mhlanga, 2021). A specific set of skills and training that school leaders will need for the future is not identified in the report. Asio y Bayucca (2021) found that school leaders had varying levels of digital competencies. Aljbour's (2021) research employed a descriptive-analytical approach to study the views of Jordanian educational leaders' developmental needs. The research findings revealed a substantial necessity for meeting the operational, academic, and social training demands of educational leaders, in addition to their IT-related training requirements (Aljbour, 2021). In the digital age, what skills development do school leaders need?

Gender and 4.0 school leadership competencies development

Studies have discussed male leadership styles in the 21st century, while few have discussed female leadership models in South African schools (Schmidt & Mestry, 2012; Adler & Osland, 2016). Female school leaders face significant gender issues in their work (Jayaweera & Weligamage, 2021). Researchers agree that technology, as one component of 4IR, is male-dominated, with females marginalised (Miller, 2017). A study by Naidoo y Potokri (2021) found that female school leaders recognise that they must adapt their leadership skills to the rapidly changing technology environment. In today's tech-driven workplace, female can demonstrate distinct 4.0 leadership traits, such as sensing, listening, accepting, approaching, collaborating, supporting, and encouraging (Chuang & Eversole, 2022). Defnew y Storberg Walker (2018) argue that female and male leaders may benefit from recognising gender differences in LD. According to Alkrdem (2014), Saudi Arabian school leaders' development was not determined by gender. Awodiji y Naicker (2023) found that male and female school leaders did not significantly differ in their 4.0 professional needs. School leaders' gender does not determine their 4.0 leadership skills development needs.

Additionally, LD and technology integration are not moderated by gender (Raman & Thannimalai, 2019). Research by Hammond et al. (2020) found that technology is perceived to be a male-dominated sector, with women underrepresented. In addition to the rise in country income, job-related sex inequality in the workplace, bias and discrimination at home, and gender biases in tertiary education admissions (professors assigned lower proficiency rates to females compared to males among identical applications among science students), among others, contributed to the gender gap.

METHODOLOGY

Research design

An evaluation of school leaders' 4.0 LD needs was conducted using a quantitative method based on the post-positivist paradigm through a survey design. In order to promote objectivity and the correctness of the data, a questionnaire was used to gather data (Brace, 2018) to explore South African LD needs.

Study respondents

Out of 15 districts in the Gauteng Province of South Africa, two were chosen randomly for educational purposes (Pace, 2014). A minimum of five school leaders were needed in each school. The principal, deputy principal, and head of department (HOD) make up the management teams for schools. Together, the two districts have 1000 school management teams (SMTs)/school leaders. Qualtrics' online sample size calculator was used to determine the sample size, which had a 5% margin of error. In order to generalise findings, a minimum sample size of 286 was calculated. To allow for attrition, the researcher used 600 questionnaires. As a representative sample cannot be taken from the entire population, only a representative sample can be taken (Acharya, 2013). Thus, using cluster sampling techniques, 505 school management teams (SMTs) based were selected randomly.

Scale validity

Five-point Likert scale questionnaire tagged the School Leadership Development Needs for the 4.0 (SLDN4.0) was used. The SLDN4.0 has 71 items presented in four subsections. Seven items measure a school leader's knowledge of 4.0 attributes, four items measure their technology needs, seven items measure their competency using 4.0 applications, and 53 items measure their 4.0 leadership skills.

The content and construct validities were estimated (Mohajan y Mohajan, 2017; Sürücü y Maslakçı, 2020). In this study, to estimate for content validity ratio (CVR) eight panelists were consulted in order to judge "essentiality" and "non-essentiality" of items based on 4.0 knowledge level, competency in using some applications, LD needs, and leadership skills (Lawshe, 1975). The panelists consisted of an educational psychologist, one expert in educational technology, three experts in measurement, and evaluation, and four experts in educational leadership and management (Lawshe, 1975; Keller et al., 2020).

Based on the suggestions that arose from the validation process, ambiguous phrases and texts in the questionnaire were revised. Consequently, panelist judgments were applied to compute the content validity ratio (CVR) and the content validity index (CVI). The CVIs for all the variables were calculated as 0.83, 0.55, 0.78, and 0.81, respectively, suggesting high validity (Lawshe, 1975; Polit et al., 2007; Rodrigues, et al. 2017). Furthermore, construct validity was determined using R-studio software. Parallel analysis was used to establish scale factors (Nguyen & Waller, 202). Prior to parallel analysis, ten factors adapted and validated from related empirical studies were proposed. Parallel analysis yielded eight factors, with items one and thirty not loaded.

An internal consistency test was conducted on the instrument. Thus, the validated instrument was administered to 30 respondents who were not included in the final survey but were randomly selected from the target population. Cronbach's alpha was used to estimate the reliability of the survey items based on respondents' scores. Cronbach's alpha measure is called the "internal consistency" use when there are numerous quantifications in the test items (Bonette & Wright, 2015; Jerry et al., 2017; Taber, 2018). Cohen et al. (2017) consider values above 0.80 as more reliable. On aggregate, Cronbach's alpha showed that the construct of the questionnaire was highly reliable at 0.97. In this reliability test, Cronbach's alpha was close to 1, indicating high reliability (Pallant, 2011). Similarly, all subscales of the scale with alpha values above 0.7 were highly consistent. Consequently, the scale had a high level of consistency. Therefore, the scale is a suitable assessment tool for assessing the leadership skills needed in schools.

Data gathering procedure

Emails were sent to 600 school leaders using Google Forms. Three hundred and forty-nine responses were received online. In lieu of a low return rate, 200 hard copies of the questionnaire were taken to school sites to school leaders who did not participated on the online survey while strictly adhering to the COVID-19 guidelines. As a result, 156 paper copies were returned with two unusable forms. In total, 505 school leaders participated in the study.

Ethical consideration

Ethical clearance (Sem 1-2022-069) to conduct the study was received from the University to whom the researchers are affiliated. Furthermore, the Department of Basic Education (DBE) granted approval for research to be conducted in two districts. Ethical measures were applied based on ethical principles outlined by Elias y Theron (2012) namely, the protection of the integrity, fairness, and respect for privileges.

Data analysis procedure

The biodata of the respondents was described using percentages while mean and standard deviation were used to answer the four first research questions. To survey the difference in mean scores of 4.0 leadership skills development needs (dependent variables) and gender (independent variable), the researchers used inferential statistics based on independent t-tests. Data was analysed using IBM SPSS 27 software.

RESULTS

Profiles of respondents

Participants were split into 50.7% female and 49.3% male. In addition, 58.0% were employed at the primary school level and 42.0% at the secondary school level. Most of the participants were HODs 67.7%, followed by principals (18.6%) and vice/deputy principals (13.7%). Among the respondents, 34.5% hold a bachelor's degree, followed by a master's degree (7.3%), a PhD (0.8%), and an honours degree (57.4%). Comparatively, 35.6% of respondents were between the ages of 41 and 50, 19.4% were between the ages of 25 and 30, and 36.2% of respondents were between the ages of 31 and 40. According to years of experience, 26.5% of participants had 6-10 years, 22.4% had 11-15 years, 18.2% had 16-20 years, 11.9% had 0-5 years, 10.3% had 26+ years, and 10.7% had 21–25 years. Sixty-two percent of respondents came from Gauteng West, and 37.4% from Johannesburg West.

Research question one: What knowledge of the 4.0 do school leaders have?

Table 1. School leaders' knowledge of 4.0

S/N	4.0 Attributes	Mean	SD	Remark
i.	4.0	2.5	1.0	SE
ii.	3D printing	2.4	0.7	SE
iii.	IoT	2.8	1.0	LE
iv.	AI	2.5	0.8	SE
v.	ICT	2.8	1.0	LE
ix.	Automation	2.2	0.8	SE
lix	Smart Board	2.8	1.0	LE
	Weighted Mean	2.6		LE

Based on Scale: 3.6–4.0=Very Large Extent (VLE), 2.6–3.5=Large Extent (LE), 1.6–2.5=Some Extent (SE) and 1.0–1.5 = Not at All (NA).

According to the weighted mean score in Table 1, school leaders exhibited high levels of 4.0 knowledge. Among the 4.0 attributes, 3D printing (2.4+0.7), AI (2.5+0.8), and automation (2.2+0.8), were not fully known to school leaders, because their mean scores fell below the weighted mean.

Research question two: In order to lead in the 4.0, what basic technological knowledge areas do school leaders need?

Table 2. Basic technological areas needed by school leaders for 4.0

S/N	Technology Needs	Mean	SD	Remark
1	Learn how to use IT applications	2.7	1.0	LE
2	Training on how to use technology	2.7	0.8	LE
3	Skills in surfing the internet	2.9	0.9	LE
4	Training on the 4.0 new technologies	2.9	1.0	LE
	Weighted Mean	2.8		LE

The scale runs from 1.0–1.5= Not at All (NA); 1.6–2.5=Some Extent (SE); 2.6–3.5=Large Extent (LE); 3.6–4.0=Very Large Extent (VLE).

This shows that school leaders need a large amount of knowledge and opportunities in IT applications, training on the 4.0 new technologies, the use of technology applications, and surfing the internet to a large extent.

Research question three: How proficient are school leaders with technology applications?

Table 3. Technology competency among school leaders

S/N	Tasks	Mean	SD	Remark
1	Installing and/or downloading software	3.8	1.1	E
2	Gathering information from the internet	4.4	0.7	E
3	Connecting a printer to a computer	4.3	0.9	E
4	Adding effects to Pictures	4.1	0.8	E
5	Creating a spreadsheet	3.0	0.9	M
6	Receiving online information via web tools (Twitter feeds, Google+, Zoom, Google meet, RSS feeds, LinkedIn, etc.)	4.2	0.8	E
7	Sending an email	4.7	0.7	VE

Weighted Mean

4.1

E

Key: 4.6–5.0 = Very Easy (VE); 3.6–4.5= Easy (E); 2.6–3.5 = Moderate (M); 1.6–2.5 = Difficult (D); and 1.0–1.5 = Cannot Do (CD),

A weighted mean score of 4.1 was achieved by school leaders on these applications based on Table 3. Sending an email, for example, was quite straightforward for the school leaders. However, it is easy to use printers, edit photos, download and install software/apps, and surf the internet to gather information. School leaders were moderately capable of creating spreadsheets. School leaders would need training on how to use a spreadsheet effectively to accomplish the administrative task.

Research question four: What are the school leadership skills needed to lead in the 4.0?

Table 4. 4.0 Leadership skills needed by school leaders

S/N	4.0 Leadership Skills	Mean	SD
i.	Agility	3.13	1.03
ii.	Communication expressiveness and collaboration	3.12	0.90
iii.	Creativity	3.10	0.96
iv.	Critical thinking and problem solving	3.27	0.91
v.	Information management and evaluation	3.04	0.99
	Weighted Mean	3.13	

Scale: High= 3.70–5.0, Average= 2.40–3.60, Low=1.0–2.30

The 4.0 leadership competencies that school leaders must possess are shown in Table 4. In terms of leadership skills, school leaders displayed average skills based on a weighted mean of 3.13. Leaders at the school exhibited average 4.0 leadership skills. To be effective and efficient in the 4.0 era, more training is needed for school leaders to acquire 4.0 leadership skills. In an increasingly competitive economic environment, leadership positions require far more skills than average.

Research hypothesis

H₀₁: A significant gender gap does not exist in 4.0 leadership skills development needs

Table 5. School leaders' 4.0 leadership skills development needs compared by gender using an independent t-test

Leadership Development Needs	Male		Female		t(503)	p
	M	SD	M	SD		
Agility	3.02	1.05	3.25	1.00	2.582	.010
Communication expressiveness & collaboration	3.03	0.92	3.21	0.87	2.221	.027
Information management and evaluation	2.93	1.00	3.16	0.96	2.553	.011
Creativity	3.02	0.98	3.18	0.93	1.940	.053
Critical thinking & problem solving	3.19	0.93	3.35	0.87	1.973	.049

As shown in Table 5, substantial gender distinctions were found in five 4.0 leadership skills: "Agility" (t = 2.582, p<0.01), "Information management and evaluation" (t=2.553, p<0.01), "Communication expressiveness and collaboration" (t = 2.221, p<0.03), "Critical thinking and problem solving" (t = 1.973, p<0.05) and "Creativity" (t =

1.940, $p=0.05$). In comparison to their male counterparts, female school leaders were significantly more likely to require LD in 4.0 leadership skills. School leaders, however, had similar LD needs in terms of 4.0 knowledge. School leaders' 4.0 leadership skills differed only by gender.

DISCUSSION

An assessment of school leaders' LD needs was conducted in this study. IoT, 3D printing, AI, automation, and smart boards are among the 4.0 technologies (Erboz, 2017; Schwab, 2016; World Economic Forum, 2016). The school leaders have some knowledge about 4.0, but they need to learn more. Consequently, school leaders do not fully understand the 4.0 initiative. In related study, Alade et al. (2021) found that the leaders of the construction firms in South Africa mostly rely on a few 4.0 technologies: the IoTs, 3-D printers, and cloud computing. In Moloi and Mhlanga's (2021) study, school leaders were found to be unaware of the 4.0. Time might have played a role in the differences in the findings. However, the COVID-19 pandemic lockdown may have improved their knowledge of the 4.0. Some attributes of the 4.0 or related training might have been introduced to school leaders between 2021 and 2022. The non-variance in the school leaders' knowledge level of 4.0 could be informed by factors such as COVID-19 pandemic that forced integration of technology into education via remote school. Also, the declaration by the president of South Africa on the present of 4.0 could have created sufficient awareness that bridged the knowledge gap.

Furthermore, school leaders indicated that they needed extensive training in IT applications, internet surfing skills, and 4.0 technologies. The findings support Aljbour's (2021) conclusion that educational leaders' needs for technical and IT-related training are high. Moreover, Moloi y Mhlanga, (2021) submitted that a brief introduction to the 4.0 is also needed for schools. It can be concluded that school leaders will require substantial reskilling programmes that will provide them with 4.0 capacity to lead school in this digital era effectively.

According to Table 3, school leaders generally found technology applications easy to use. In particular, school leaders found it very easy to send an email, attach a printer to their computer, edit a photo, download and/or install software/apps, use web tools to receive online information, and surf the internet in order to gather information. However, they were moderately proficient in creating spreadsheets, which are essential for their daily administrative tasks such as record keeping and result imputation/computations. School leaders found that sending emails, connecting a printer to their computer, editing pictures, installing software, receiving online information, and surfing the web were all very easy. However, they were moderately proficient at creating spreadsheets, which are essential for day-to-day tasks like record keeping and results computation. To analyse and keep records, school leaders need Microsoft Excel training. Using technology effectively is a skill school leaders need to develop (Bull et al., 2017). Technology should be incorporated into school administrators' training, including spreadsheets and graphing calculators (Bull et al., 2017).

In this study, school leaders scored lower than expected on 4.0 leadership skills than an average. School leaders have moderate 4.0 skills. In order to become efficient and effective in the 4.0 age, school leaders need to gain more 4.0 leadership skills. It has been shown that school leaders must improve their leadership competencies to deal with the challenges posed by the 4.0 (Kim y Kareem, 2019; Prestiadi et al., 2020). Consequently, school leaders must give adequate attention to information management and evaluation since they deal with school data and students' results. In today's competitive economic environment and digitalised world of work, leadership positions require far higher than average skills. For leaders to survive the developments of the 4.0, Mdluli and Makhupe (2017) provide that flexibility, adaptability to rapid change, and active innovation are imperatives.

The results of Table 5 indicate no statistically significant differences between males and females when it comes to knowledge of technology, technological needs, or competence in using technology. Further, Hammond et al. (2020) classified males as "professionals" in science and technology, and females as "teachers". Nevertheless, significant gender differences were found in all the 4.0 leadership skills, namely "agility", "creativity", "communication and collaboration", and "critical thinking and problem-solving". Female school leaders displayed considerably higher LD needs than their male counterparts in 4.0 leadership skills. According to Alkrdem (2014), Saudi Arabian school leaders' development was not determined by gender. School leaders' 4.0 LD needs vary significantly, contradicting the findings by Awodiji y Naicker (2023) that 4.0 LD is not determined by gender. The contradiction might have been informed by factors such study areas, respondents understanding of the 4.0 attributes, and government policy in relation to 4.0.

Conclusion

This study has achieved its objective of assessing the LD needs of school leaders for the 4.0. LD needs were compared using the independent-sample t-test with male and female leaders. It was found that school leaders have a substantial amount of 4.0 knowledge which can be further enhanced. School leaders for the 4.0 identified technology application knowledge, hardware knowledge, and knowledge of 4.0 technologies as necessary. Despite the ease of using many technological applications, school leaders had difficulty using spreadsheets. School leaders demonstrated moderate leadership skills. For the 4.0 leadership skills, gender does play a role.

Implications of the study

It is therefore implies that, in organising LD programmes for school leaders, the gender of the school leaders' must be put into consideration due to the variation in their LD needs. The 4.0 requires school leaders to acquire a new set of skills through LD programmes. According to the study, school leaders need training in using applications, technology, and cutting-edge 4.0 technologies.

In order to increase the understanding of the 4.0 attributes, the DBE should organise large-scale workshops for school leaders. School leaders who have expertise in creating spreadsheets should mentor leaders who lack this skill as part of mentoring and coaching programmes. Based on the findings, schools should create PLCs in order for school leaders to collaborate with other school leaders in learning different 4.0 skills and knowledge.

In order to provide school leaders with the proficiency necessary to address the requirements and demands of the 4.0, the DBE must understand their importance and allocate resources more efficiently. Based on the study's findings, the education department should consider the gaps that need to be filled for the current development needs of their school leaders in order to empower them with relevant competencies for the 4.0. In terms of theory, the study addresses school leadership needs for 4.0 in Africa. Besides understanding school leaders' training needs, a gender-based approach should also be considered.

Study limitations

The study had a number of limitations. A total of two districts were included in the sample out of 15 districts in Gauteng Province. As a result, the findings cannot be generalised across the province. The proportion of males and females who answered the questionnaire, as well as the proportion of primary and secondary school leaders, could have affected the results. In addition, some 4.0 leadership skills like emotion intelligence, social intelligence, ethical, and AI skills were not included in this study. Researchers did not investigate the link between school leaders' 4.0 leadership and school effectiveness. By doing so, we can determine if 4.0 leadership competence contributes to school effectiveness.

Suggestions for further studies

It is expected that 4.0 research will continue to contribute to the development of a proactive, productive digital world in schools in the future. These research advancements will increase the likelihood of a just digital future within educational institutions. A qualitative inquiry into the School leadership development needs for the 4IR could be conducted. A qualitative approach will elicit in-depth knowledge to supplement this quantitative study. Examining the relationship between school leaders' 4IR development needs and school effectiveness. As a result, it will be possible to determine whether 4IR leadership competency improves school performance. An investigation of professional development's moderating effect on 4IR leadership skills and the effectiveness of the instructional leadership of school leaders can be conducted. Is there any influence from the level of education and ages of each School leader in relation to the decision to adopt a new technology? Also, moderating role of Artificial Intelligence's on the influence of educational leadership on students' learning and motivation.

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DECLARATION OF CONFLICTING INTERESTS

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

CRedit AUTHOR STATEMENT

All authors have contributed equally to all parts of the work.